Operation Manual

for Elite GC2020

Gas Chromatograph

V1.0.0

Warning Staements:

Note: This information is a special statement from the manufacturer about the instrument, deserving your attention.

Note: This information is important and should be heeded.

Warning: This information serves as a warning to pay special attention. Non-compliance with these instructions may result in personal injury to you or others, or damage to the instrument.

Danger: This information indicates a high level of danger, be cautious.

High Voltage Danger:

- It is strictly forbidden to disassemble the cover of the instrument while it is in operation. High voltage inside the instrument during operation may cause personal injury, and disassembling the cover may expose some electrical components.
- When replacing fuses or disassembling for maintenance, first unplug the power cord. Turning off the power switch of the instrument only stops its operation but does not completely cut off the high voltage.
- If the power cord is aged or damaged, it must be replaced immediately.

High Temperature Danger:

- When the instrument is operating or after it has been shut down, components such as the sampler, detector, column oven, and the exhaust vent can become very hot. Avoid contact to prevent burns. If parts need replacing, wait until the instrument has cooled down or use protective measures.
- Be cautious of hot gases emitted during the cooling of the instrument to prevent burns.
- Flammable items must not be placed at the back of the instrument to avoid ignition by the hot gases emitted.
- PVC and other gas pipes should be kept away from the instrument's exhaust vent to prevent melting and causing danger due to the hot gases emitted.

Gas Source Danger:

- Comply with the relevant rules for transportation, storage, management, and safe use of gas cylinders and gas sources used by the instrument.
- When using hydrogen as a carrier gas or FID fuel gas, be aware of the risk of explosion due to hydrogen leakage into the column oven. Therefore, ensure the gas source is turned off before connecting the pipelines, install the chromatographic column and correctly connect

the inlet and detector joints. Check for leaks at all pipeline connections and valves before opening the hydrogen gas source to prevent explosion due to hydrogen leakage.

- When analyzing special samples (such as toxic substances), the instrument may emit toxic substances. It is essential to discharge these substances outside to a safe location to prevent indoor contamination and accidents.

The information in this instruction document is subject to change without notice. Equipment upgrades (hardware and software) due to technological advances will not be notified in writing.

Catalogue

Welcome to become a user of Elite GC2020 gas chromatograph!

1 Instrument Introduction

1.1 The Working Principle of Gas Chromatograph

Gas chromatography analysis technology is a technique for separating and analyzing multi-component mixtures. It mainly utilizes the differences in boiling points, polarity, and adsorption coefficients of the components in the sample within the chromatographic column, allowing for separation of the components and qualitative and quantitative analysis.

The gas chromatograph uses a gas as the mobile phase (carrier gas). When the sample is introduced into the sampler and vaporized, it is carried by the carrier gas into either a packed column or a capillary column. Due to differences in the boiling points, polarity, and adsorption coefficients of the components in the sample, the components are separated in the column. The detector attached to the column then detects the components in sequence based on their physicochemical properties, and the data is sent to the chromatography workstation. The chromatography workstation records and analyzes the gas chromatograms of the components to produce an analysis report. The simplified working principle diagram is as follows:

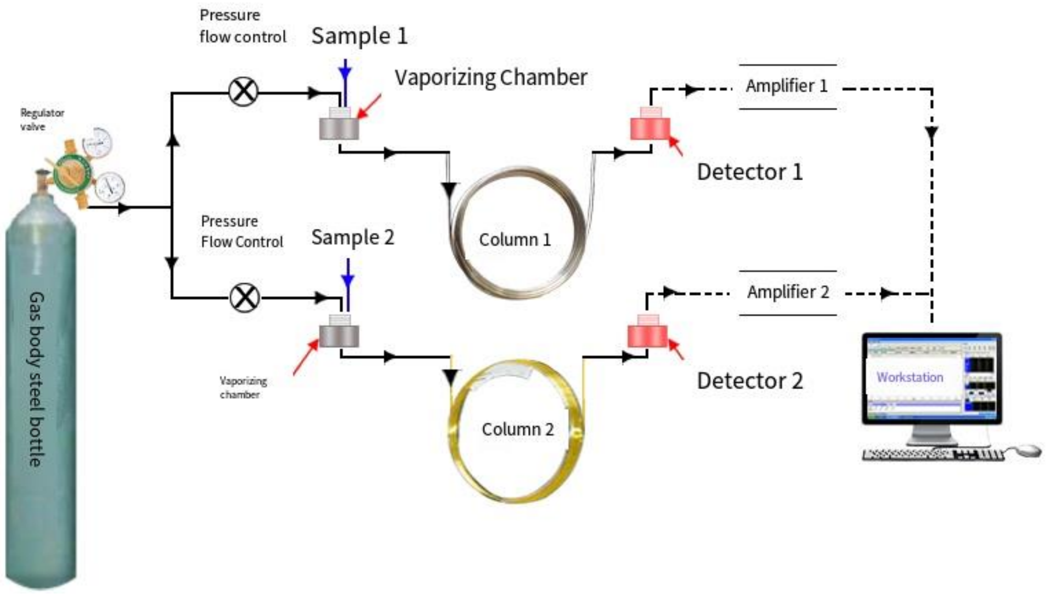


Fig 1-1 Simplified Diagram of the Working Principle of a Gas Chromatograph

This analytical method is widely used in petrochemicals, biochemistry, medicine and health, sanitary quarantine, food inspection, environmental protection, the food industry, medical clinics, and other departments due to its high separation efficiency, fast analysis speed, and low sample requirements. Gas chromatography has solved problems related to intermediate product quality inspection, scientific research, pollution detection, and production control in these fields.

1.2 Features of the Elite GC2020 Gas Chromatograph

The traditional gas chromatograph works with one chromatograph, one workstation, one computer, and one printer. This mode of operation makes it very inconvenient for users such as chemical plants, laboratories, and institutions to use and manage the instrument, leading to redundant investment and waste. Equipping numerous computers also brings inconvenience to users in equipment and data management. Additionally, this traditional mode often requires using a chromatograph from one manufacturer and a workstation from another to function, making it difficult to fully utilize the system's capabilities and improve its performance. Adding functions requested by users, such as remote data transmission and monitoring of multiple instruments, becomes even more challenging.

Addressing the drawbacks of traditional gas chromatographs, our company, leveraging decades of development, has innovatively designed and developed a new type of gas chromatograph with international advanced technology. This instrument incorporates the latest high-integration industrial-grade chips, bus technology, Ethernet technology, micro-flow gas control technology, and data processing software, optimizing temperature control accuracy and gas control precision, fundamentally enhancing the instrument's reliability.

The Elite GC2020 Gas Chromatograph, utilizing network communication technology and featuring a high-precision AD conversion circuit, allows multiple chromatographs to share a single computer for data analysis, printing, and storage. It enables remote control of the instrument and distant transmission of chromatographic data, facilitating real-time quality management by enterprise personnel.

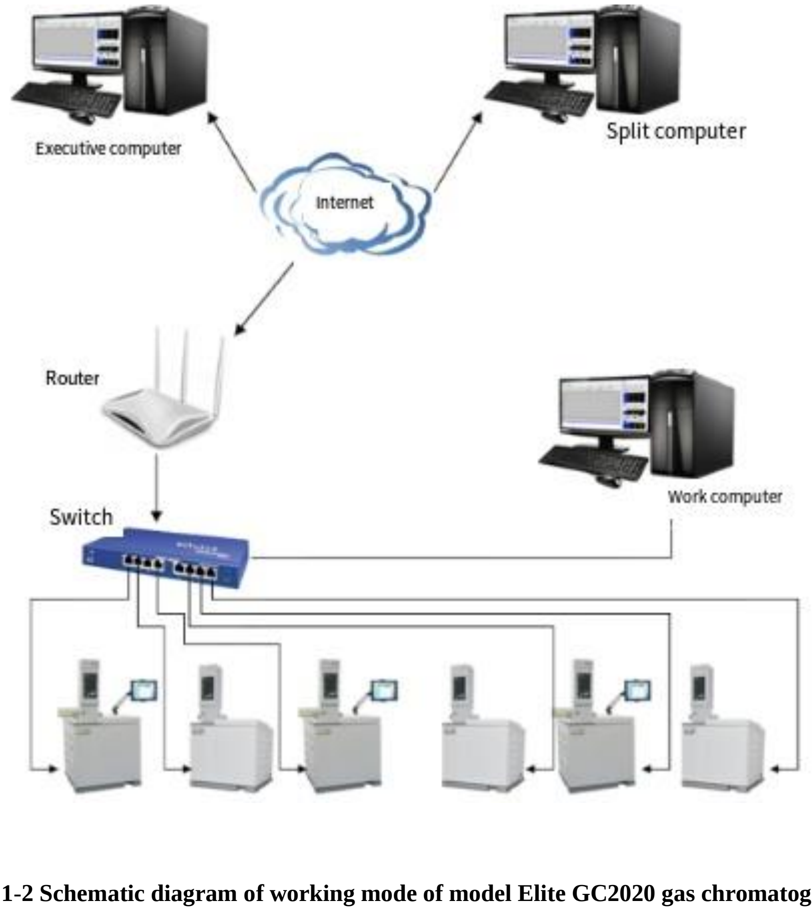


Fig 1-2 Schematic diagram of working mode of model Elite GC2020 gas chromatograph

Key Features of the Elite GC2020 Gas Chromatograph:

- Advanced 100/1000 Mbps Ethernet communication interface with built-in IP protocol stack, enabling remote data transmission through internal LANs and the Internet, simplifying laboratory setup and data management.
- Three independent IP addresses for connection to laboratory computers, quality control departments, and higher management authorities like environmental bureaus for real-time monitoring of instrument operation and data analysis results.

- The dedicated workstation supports multiple chromatographs, enabling data processing and reverse control of instruments, simplifying document management.
- Internet connectivity to the manufacturer allows remote diagnostics and updates (user-configurable).
- Equipped with a 7-inch color LCD touch screen supporting hot-swapping, usable as a handheld controller.
- Multi-processor parallel operation ensures increased stability and reliability; options for various high-performance detectors like FID, TCD, ECD, FPD, and NPD, with a capacity to install up to three detectors simultaneously for complex sample analysis.
- Modular design for easy and convenient maintenance.
- State-of-the-art microcomputer temperature control system with high precision and superior reliability and interference resistance; features eight independent temperature control outputs, capable of at least twenty-stage program temperature ramping, and an automatic rear door system for the column oven, enhancing near-room temperature control and faster heating/cooling rates.
- Advanced Electronic Flow Control Unit (EFC)、 Electronic Pressure Control Unit (EPC) for digital gas path control, significantly improving instrument stability and reproducibility of analysis results.
- Built-in low-noise, high-resolution 24-bit AD circuitry with baseline storage and subtraction functions.
- The standard workstation is compatible with WinXP, Win2000, Win7, Win8, Win10, and other operating systems.
- The chromatograph's microcomputer system, having complete proprietary intellectual property rights, supports the standard MODBUS/TCP protocol, enabling integration with DCS systems.

1.3 Elite GC2020 Gas Chromatograph Model and Technical Specifications

The Elite GC2020 gas chromatograph comprises a sampler, detector, chromatographic column oven, gas flow control system, heating control system, signal detection system, and network data transmission workstation.

1.3.1 Elite GC2020 Gas Chromatograph (Electronic Flow Control Type)

The Elite GC2020 gas chromatograph enhances the traditional mechanical valve chromatograph by integrating precise gas electronic flow control technology, significantly advancing its automation and overall performance. The successful development and application of gas electronic flow control technology, combined with the instrument's network remote control capabilities, enable unmanned, decentralized monitoring, and centralized control.

Fig 1-3 Exterior of the Elite GC2020 Gas Chromatograph

Main Technical Specifications:

- Display Operation: 7-inch color LCD touchscreen, can be used as a handheld controller
- Temperature Control Zones: 8 channels
- Temperature Control Range: Room temperature plus 4 °C to 450° C, increment: 1 °C, accuracy: ±0.1 °C
- Programmed Temperature Steps: 16 steps (expandable)
- Rate of Temperature Increase: 0.1 to 60 °C/min
- Gas Path Control: Full electronic pressure and flow control
- Range: 0 to 100 Psi (pressure); 0 to 1000 mL/min (flow rate)
- Resolution: 0.01 Psi (pressure); 0.01 mL/min (flow rate)
- External Events: 8 channels; 2 channels for auxiliary control output
- Types of Samplers: Packed column injection, capillary injection, six-port valve gas injection, automatic sampler
- Number of Detectors: Up to 3 (maximum); choice of FID, TCD, ECD, FPD, and NPD
- Injection Start: Manual or automatic options available
- Communication Interface: Ethernet: IEEE802.3

1.3.2 Detector Technical Specifications

1. Hydrogen Flame Ionization Detector (FID)

Detection limit: $\leq 3\times10^{-12}$ g/s(Hexadecane/Isooctane)

Baseline noise: ≤0.05 PA

Baseline drift: ≤0.2P A/30 min

Linearity range: $\geq 10^{6}$

2. Thermal Conductivity Detector (TCD)

Sensitivity: S≥10000mV•ml/mg(Benzene/Toluene) (with options for 1, 2, 3, 4 times amplification)

Baseline noise: ≤20 μV

Baseline drift: ≤30 μV/30 min

Linearity range: ≥10^4

3. Electron Capture Detector (ECD)

Detection limit: ≤1×10^{-13} g/ml (propyl BHC-isoctane solution)

Baseline noise: ≤0.03 mV

Baseline drift: ≤0.2 mV/30 min

Linearity range: ≥10^3

Radioactive source: 63Ni

4. Flame Photometric Detector (FPD)

Detection limit: (S)≤5×10^{-11} g/s,

(P)≤1×10^{-12} g/s; (Methyl parathion - anhydrous ethanol solution)

Baseline noise: ≤3×10^{-13} A

Baseline drift: ≤2×10^{-12} A/30 min

Linearity range: Sulfur ≥10^2, Phosphorus ≥10^3

5. Nitrogen and Phosphorus Detector (NPD)

Detection limit: (N)≤5×10^{-13} g/s,

(P)≤5×10^{-13} g/s; (Methyl parathion - anhydrous ethanol solution)

Baseline noise: ≤5×10^{-13} A

Baseline drift: ≤2×10^{-12} A/30 min

Linearity range: Sulfur ≥10^2, Phosphorus ≥10^2

1.4 Elite GC2020 Series Main Configuration Explanation

1.4.1 EPC and EFC Control System

The EPC and EFC control system is a gas micro-flow control system, designed and manufactured using high-precision proportional valves, pressure sensors, and flow sensors. Compared to traditional mechanical valve control methods, it significantly improves the precision of gas pressure and flow control, enhancing the instrument's automation level and overall performance by overcoming the temperature compensation limitations of traditional mechanical valves.

1.4.2 Chromatographic Column Oven

The Elite GC2020 gas chromatograph's column oven has a large capacity, facilitating the installation of packed or capillary columns. It features a high-power heating filament and a rear door structure, which greatly increases the heating and cooling rate. The column oven temperature control employs dual software protection, ensuring the safety of the chromatographic column. The thermal stirring uses a low-noise motor and high-quality stainless steel fan blades, ensuring smooth operation.

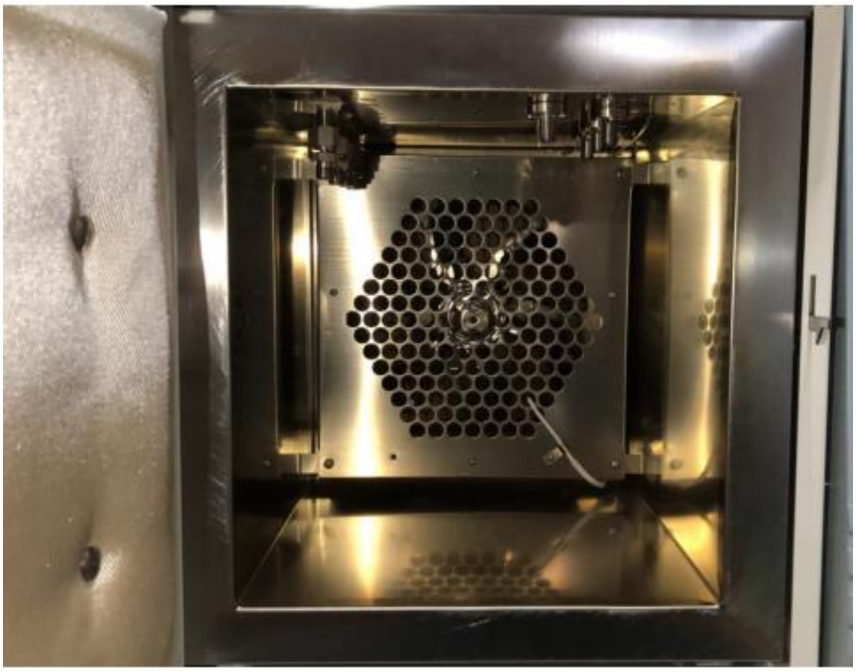
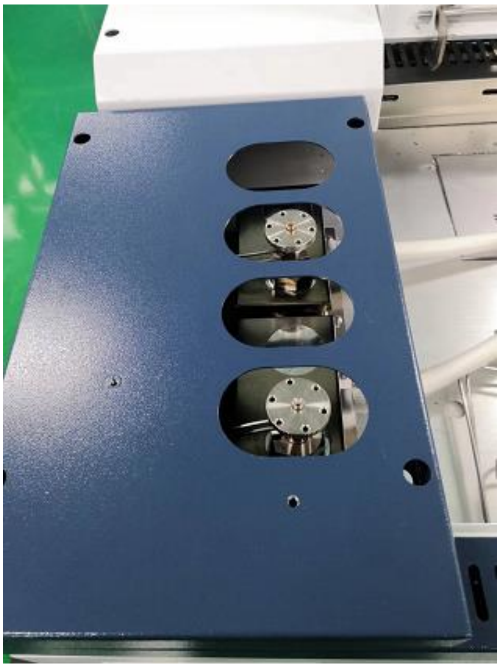


Fig 1-4 Elite GC2020 column oven

1.4.3 Packed Column and Capillary Vaporizers

The Elite GC2020's packed column vaporizer is located at the top left front side of the column oven, as shown in Figure 1-5. The capillary vaporization chamber, as shown in Figure 1.8, is controlled by a microcomputer system that sets and controls its temperature. The top part of the vaporization chamber is a heat dissipation cap, with a T-type fluororubber sampler pad embedded below it. The sampler's carrier gas inlet is connected to the output port of the gas path control system.



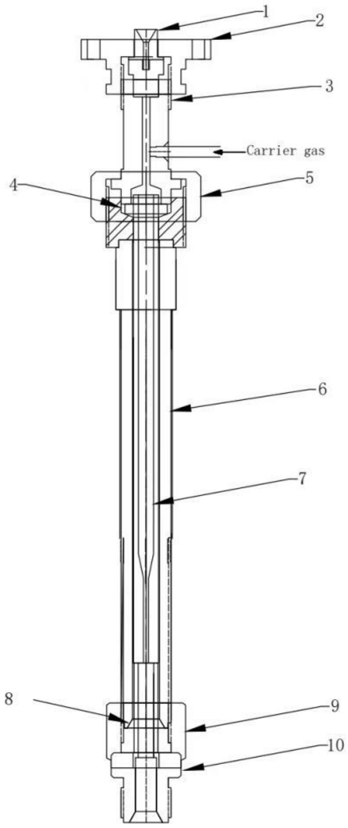


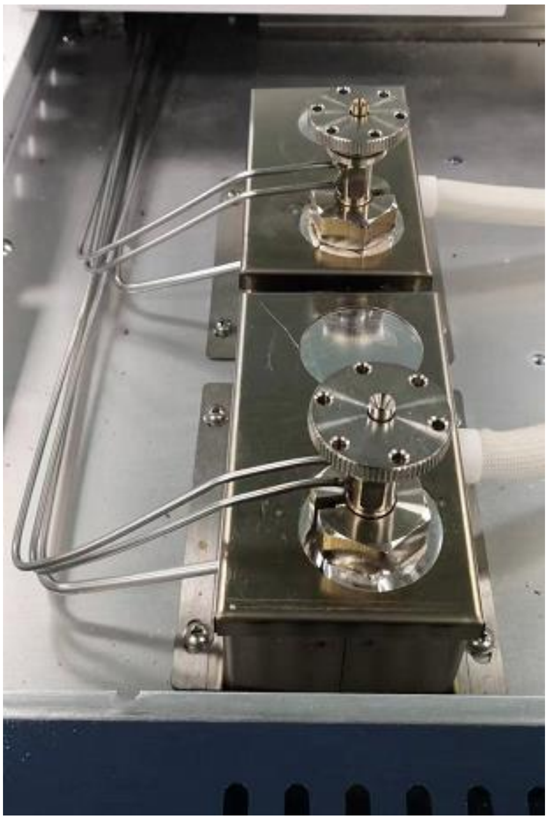
Fig 1-5 Schematic Diagram of the Elite GC2020 Gas Chromatograph Sampler

1. injection port； 2. cooling structure； 3. split-flow；4.graphite seal gasket； 5.compression nut ； 6.compartmen； 7.glass inner lining tube； 8.graphite seal gasket； 9.tightening nut； 10. column adapter；

Note: 1.The Elite GC2020 model can be equipped with multiple samplers, allowing up to four packed chromatographic columns to be installed simultaneously.

2. The sampler can directly install packed columns with an outer diameter of Φ4 mm, and with an additional liner, can also accommodate Φ3 mm packed columns.

3. The Elite GC2020 can install a specialized capillary diaphragm purging splitter sampler for capillary split/splitless sampling. Up to three can be installed simultaneously, compatible with 0.1~0.53 mm capillary columns.



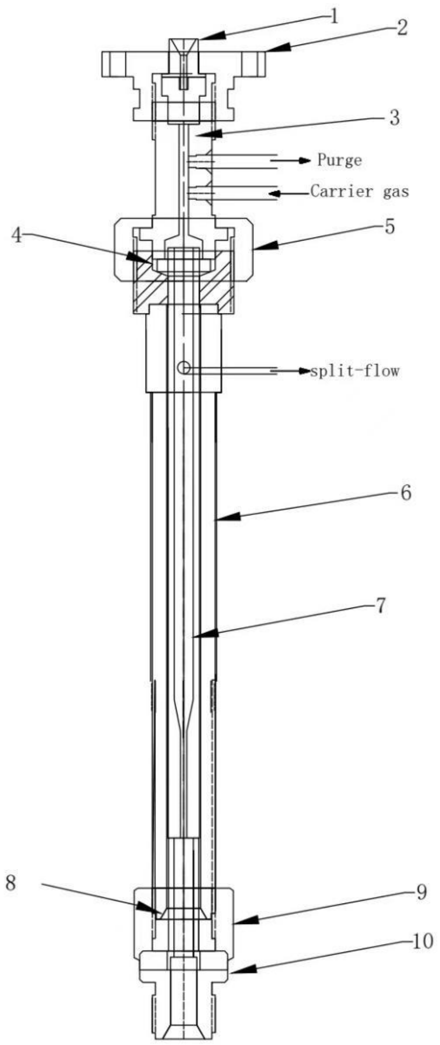


Fig 1-6 Schematic Diagram of the Diaphragm Purging Split Sampler

1.injection port； 2. cooling structur； 3. split-flow； 4. graphite seal pad；5.compression nut； 6.compartment ； 7. glass inner lining tube； 8. graphite seal pad； 9. tightening nut； 10. column adapter；

1.4.4 Thermal Conductivity Detector (TCD)

The Elite GC2020 gas chromatograph can be equipped with a thermal conductivity detector (TCD), as shown in Figure 1-7.

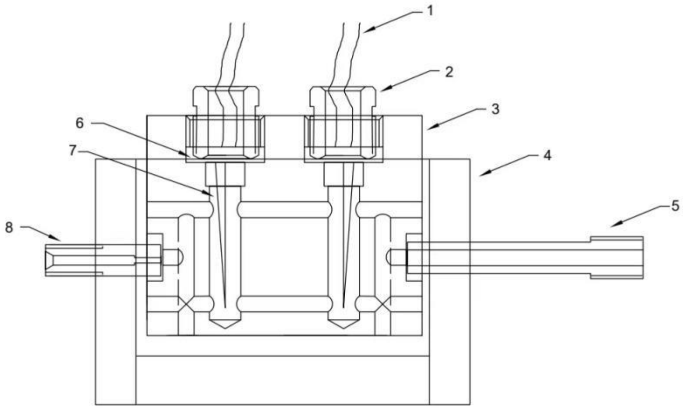


Fig 1-7 Schematic Diagram of the TCD Detector

1. tungsten wire lead； 2.compression nut； 3. cavity； 4.heat block； 5. outlet connection；
6.copper washer； 7.tungsten wire； 8.inlet connection ；

Its structure and working principle are as follows: Four symmetrical chambers are machined in a heat conductor, each containing a thermosensitive component. Two of these chambers serve as measuring cells, and the other two as reference chambers. The thermosensitive components in the measuring and reference cells form the four arms of a Wheatstone bridge, which is connected to the thermal conductivity detector's signal processing board for controlling the bridge's operation and processing chromatographic data. Additionally, the thermal conductivity detector is equipped with electric heating elements and temperature sensors, interfaced with the temperature control system to regulate its heating temperature.

The TCD's reference cell is only subjected to the carrier gas flow. The components eluting from the chromatographic column enter the measuring cell along with the carrier gas. When only the carrier gas flows through both the reference and measuring cells, and its thermal conductivity coefficient remains constant, the bridge is balanced, and the chromatograph outputs a baseline signal. During sampling, after the sample is separated, it is carried into the measuring cell by the carrier gas. The differing thermal conductivity coefficients between the carrier gas and the components cause the bridge to become unbalanced, resulting in the chromatograph outputting a peak signal.

Note: The use of the TCD detector must adhere to the principle of "gas on first, then heating, then current." Do not set the bridge current without carrier gas flow, as it may damage the rhenium~tungsten wire! When shutting down, turn off the bridge current first, then cool down, and only turn off the carrier gas after the TCD temperature drops to 50 °C above room temperature!

Note: When operating the TCD, avoid using excessively high currents. High current operation accelerates the oxidation of the tungsten wire, reducing the detector's lifespan.

The relationship between the type of carrier gas, temperature, and bridge current is illustrated in the following diagram:

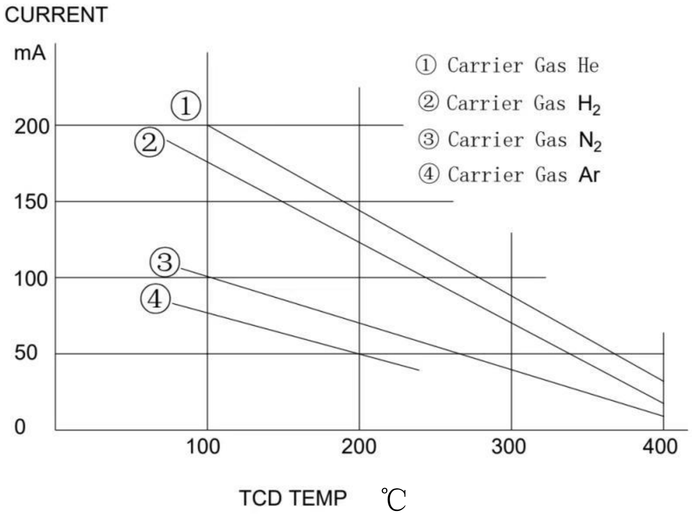


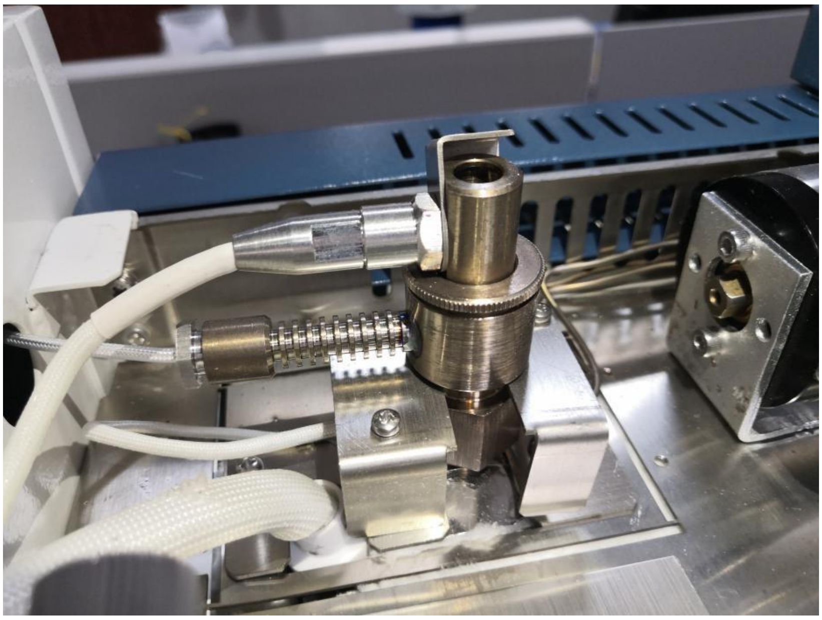
Fig 1-8 The relationship between the type of carrier gas, the temperature and the number of bridge flow

Note: To prevent damage to the TCD detector, the bridge current setting value is not saved when the machine is turned off. That is, when the machine is powered on, the TCD bridge current setting value is automatically set to 0 mA.

Warning: The presence of oxygen in the carrier gas will shorten the life of the TCD tungsten wire. The carrier gas must be thoroughly deoxygenated!

1.4.5 Flame Ionization Detector (FID)

The FID detector, a mass-sensitive detector, is characterized by high sensitivity, a wide linear range, and relative insensitivity to changes in operational conditions, making it stable and especially suitable for routine analysis of constant or trace amounts. Its fast response makes it ideal for rapid trace analysis when combined with capillary column technology, making it the most widely used detector in gas chromatography. The Elite GC2020 gas chromatograph can be equipped with two independent hydrogen flame ionization detectors, as shown in the figure:



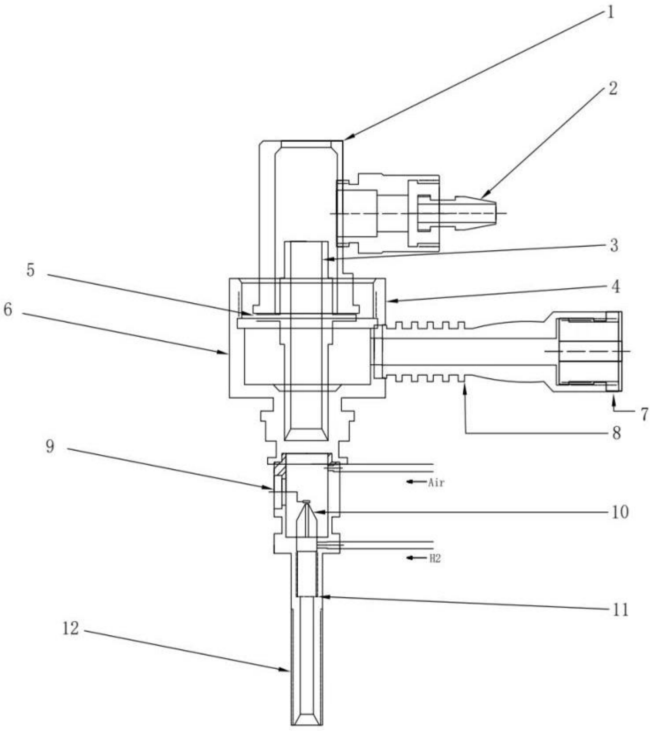


Fig 1-9 Schematic Diagram of the FID Detector

1. dust cap； 2.hot-wire-ignition； 3.collecting cylinder； 4.ion chamber pressure cap； 5.insulated PTFE pad； 6. ion chamber； 7. signal line clamping nut； 8.signal line connector ； 9. polarization pole)； 10.ceramic nozzle； 11. nozzle base ； 12.fid base；

The FID detector is placed at the front end of the main unit's top. Its base is installed inside a heat conductor, which also contains electric heating elements and temperature sensors, interfaced with the temperature control system. The polarizing electrode is connected to the FID microcurrent amplifier's polarizing voltage output. The collector electrode's output signal is connected to the FID microcurrent amplifier via a low-noise cable. Hydrogen and air enter through stainless steel tubes from the gas path control system above the main unit.

The principle of the flame ionization detector is as follows: The sample burns in a hydrogen flame, generating an ion stream. Under the action of a polarized electric field, positive and negative ions move directionally, reaching the collector electrode and generating a weak current signal, which is then amplified and processed by the microcurrent amplifier before being sent to the chromatography data processing system.

Note:

Do not open the FID combustion gas hydrogen when no chromatographic column is connected to prevent hydrogen from entering the column oven. When shutting down the instrument, first close the hydrogen and air, extinguish the FID flame, and then close the carrier gas after cooling.

The FID is a high-sensitivity detector, and the gas sources used must be high-purity, purified carrier gas, hydrogen, and air.

To prevent contamination of the detector, it is best not to connect the aged chromatographic column to the detector. Seal the detector end with a sealing nut. When aging with hydrogen, the hydrogen gas from the chromatographic column outlet should be discharged to a safe place.

Before powering on, check whether the circuit connections are complete and correct, and whether the gas type meets the requirements.

Warning: When the instrument is working, the collector electrode has a high voltage of about 200 V. Please be cautious to prevent electric shock!

1.4.6 Electron Capture Detector (ECD)

The Electron Capture Detector (ECD) is an ionization detector that is selective and highly sensitive. It only responds to electronegative substances (such as those containing halogens, sulfur, phosphorus, nitrogen). The stronger the electronegativity of a substance, or the higher its electron absorption coefficient, the higher the sensitivity of the detector. For electrically neutral (non-electronegative) substances, like alkanes, there is no signal.

In the ECD detection cell, the radioactive source (63Ni) emits radiation (beta rays) that ionize the inert gas (N_2). A pulsed voltage is applied to the collection electrode to capture electrons and generate current. When strongly electronegative molecules enter, they absorb electrons, forming negative ions. Since negatively charged molecules move slower than free electrons and take longer to reach the positive electrode, and the probability of recombination with positive ions also increases, the electron density in the detector decreases, and the number of electrons captured per pulse reduces. The number of pulses is adjusted based on the degree of electron reduction to maintain a constant current of electrons per unit time, making the number of pulses proportional to the density of strongly electronegative molecules.The ECD device principle diagram is as follows:

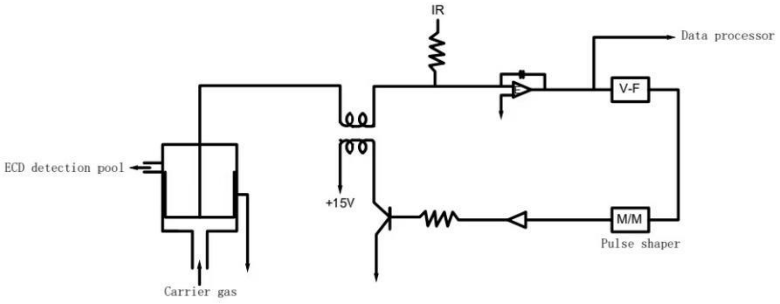


Fig 1-10 Simplified Diagram of the ECD Device

Through amplifier E, the set current IR is compared with the average pulse current formed in the ECD detection cell. When the two voltages are equal, they are sent to the next stage voltage-frequency converter (VFC). The pulses emitted by the VFC, adjusted to the appropriate pulse amplitude and height, are sent to the ECD detection cell, forming a control circuit.

Warning: It is strictly forbidden to disassemble the ECD detector without taking professional protective measures! (The radioactive source (63Ni) can cause harm to your health)

The radioactive source (63Ni) is a strictly controlled material and must not be discarded as ordinary waste.

Our company holds an exemption for end-users of source-inclusive chromatographs, meaning customers who purchase our source-inclusive instruments are not required to obtain a "Radiation Safety License" from local environmental authorities. However, customers need to establish a usage log for source-inclusive instruments, manage them strictly, and cooperate with our company for tracking investigations of these instruments. For the disposal of source-inclusive chromatographs, it is mandatory to notify our company for record-keeping and recycling. Unauthorized handling of the radioactive source (63Ni) by the user units of source-inclusive instruments is prohibited!

1.4.7 Flame Photometric Detector (FPD)

The Flame Photometric Detector (FPD) is a high-selectivity, high-sensitivity detector for phosphorus and sulfur compounds used in gas chromatography. When samples containing phosphorus or sulfur compounds are burned in a hydrogen-rich flame, phosphorus compounds primarily emit light at a wavelength of 526 nm as HPO fragments, while sulfur compounds emit characteristic light at 394nm as S_2 molecules. The photomultiplier tube converts the light signal into an electrical signal, which is recorded after being amplified by a microcurrent amplifier. This type of detector has a sensitivity of several tens to hundreds of coulombs per gram, with a minimum detectable amount of 10~11 grams. Also, the response ratio of organic phosphorus and sulfur to hydrocarbons can reach 10^4, which helps eliminate interference from large solvent peaks and hydrocarbons, making it highly effective for trace analysis of phosphorus and sulfur. It is a primary tool for detecting organophosphorus pesticides and sulfur pollutants.

As shown in Figure 1-11, the FPD system mainly consists of two parts: flame emission and photoelectric signal system.

The flame emission part of the detector consists of a burner and an emission chamber, with various gas pathways and nozzles comprising the burner, also known as the burning head. The universal nozzle is made up of an inner hole and an outer annular hole. The effluent from the gas chromatography column mixed with air enters through the central hole, while excess hydrogen flows out through the surrounding annular hole. This creates a larger diffusion flame rich in hydrogen, where hydrocarbons and sulfur or phosphorus compounds are decomposed in the flame, producing complex chemical reactions and emitting characteristic light. Sulfur and phosphorus emit light in the upper part of the diffusion-rich hydrogen flame, while hydrocarbons mainly emit light at the oxygen-rich base of the flame. Therefore, placing an opaque light shield at the base of the flame to block the light from hydrocarbons can enhance the selectivity of the FPD. To reduce the volume of the emission chamber, a glass or quartz tube can be installed above the nozzle to lower the detector's response time constant.

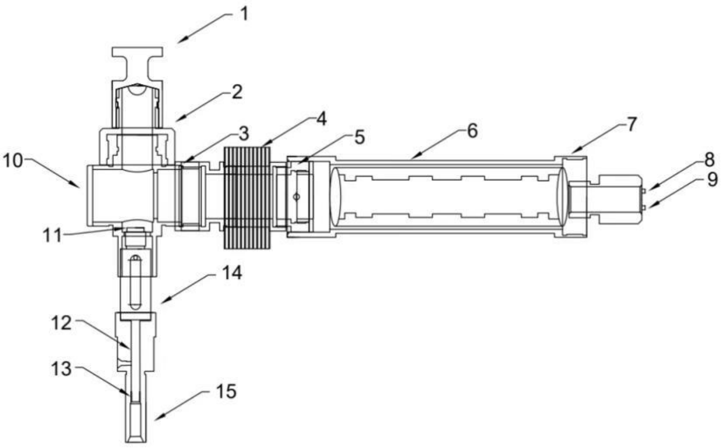


Fig 1-11 Schematic Diagram of the FPD System

1. release joint nut； 2. release joint； 3.light room； 4.heat dissipation cylinder ； 5.filter and pressure pad ； 6. photomultiplier tube ； 7. high voltage base； 8. signal connector； 9.high pressure connector； 10. light window nut； 11. lens hood；12.glass inner lining tube； 13.jackscrew； 14.top base； 15.lower base；

The photoelectric signal part, on the right, is separated from the emission chamber by a quartz window and heat sink to avoid the influence of large amounts of water vapor, combustion products, and high temperatures generated during luminescence on the photoelectric system. The FPD does not convert all light into electrical signals but uses filters to select the characteristic light of sulfur and phosphorus.

Warning: It is strictly forbidden to turn on the high-voltage power supply if there is any light leakage in the detector!

1.4.8 Nitrogen and Phosphorus Detector (NPD)

The Nitrogen-Phosphorus Detector (NPD), also known as a Thermal Ionization Detector (TID), is a high-selectivity and broad-linear-range detector for analyzing compounds containing nitrogen and phosphorus. Developed in 1961 by Cremer et al., the original NPD utilized a heated alkali source above the FID nozzle. However, the use of volatile alkali metals as the source led to short lifespans and unstable sensitivity, limiting its practical value. In 1974, Kolb used non-volatile cesium carbonate and silicon dioxide sintered into cesium silicate beads, addressing the issue of short bead lifespan. As the beads are heated electrically in a cold hydrogen flame, the stability and sensitivity of the detector significantly improved, reducing the background baseline current from 10^{-9} A to 10^{-13} A. Consequently, NPD became one of the most commonly equipped detectors in gas chromatography, widely used in environmental protection, medicine, clinical, biochemistry, food, and other fields for trace analysis of nitrogen and phosphorus compounds.

The structure and operation of the NPD vary depending on the product model. A typical structure is shown in Figure 1-12.

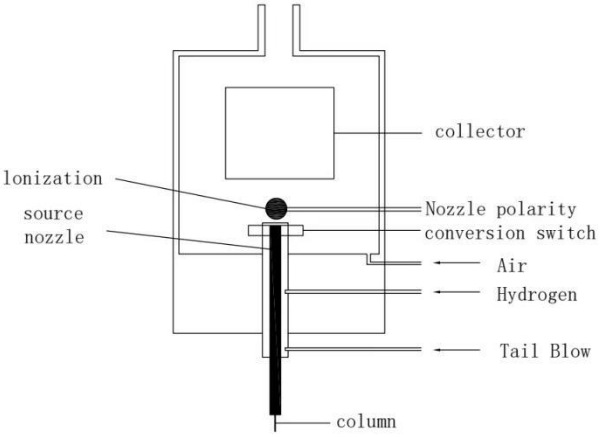


Fig 1-12 Structure Diagram of NPD

The operation mode of the NPD in the Elite GC2020 detector is nitrogen-phosphorus type, as shown in Figure 1-13, with the nozzle not grounded.

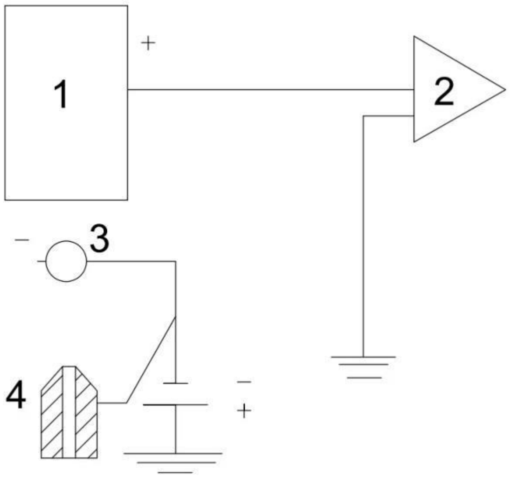


Fig 1-13 Schematic Diagram of Non-Grounded Nozzle

1. Collector electrode ;2. Amplifier; 3. Ion source; 4. Nozzle

The air and hydrogen gas flow rates are relatively small [VV_{Air}: 100~150 mL/min, V_{H}^{2}: 4～6 mL/min]. The ionization source is electrically heated to red heat, forming a cold flame around it. Organic compounds containing N and P undergo cracking and excitation reactions here, resulting in selective detection of N and P, with selectivity towards hydrocarbons reaching 10^{2}～10^{4}.

1.4.9 Display Screen and Keyboard

The display screens of the Elite GC2020 series are all 8-inch color LCD touch screens, allowing users to clearly view the instrument's working status.

The touch screen interface is designed to be simple, comprehensive, easy to operate, and user~friendly.

1.4.10 External Event Control and Communication Output

The external event control of the Elite GC2020 gas chromatograph is located inside the instrument. To the right of the control board, a column of terminals serves as external event control outputs. From bottom to top, two terminals form one group, representing: Event 1, Event 2, Event 3, Event 4, Event 5, Event 6, Event 7, Event 8, Event 9, and Event 10.

The instrument's communication uses a 100/1000 Mbps adaptive Ethernet interface. It connects to the computer with the workstation installed via a network cable.

Note: To maintain high resolution and stability, a 24 bit AD circuit is integrated inside the instrument. The conventional analog signal is no longer output, and it can only connect to our company's workstation.

1.4.11 Power Switch

The power switch is solely for the machine's power.

Warning: When turning on the machine, if there is a possibility of touching electrical parts, disconnect the power plug from the power source! When the power switch is off, some parts inside the chromatograph still have high voltage!

1.5 Instrument Application Environment

1.5.1 Installation Environment

The Elite GC2020 gas chromatograph should be operated within a temperature range of 5 to 35 ℃ and a relative humidity range of 0 to 85%. However, it is ideally used in an environment where people feel comfortable (under appropriate constant temperature and humidity conditions). In such conditions, the instrument can perform optimally, and its lifespan is extended.

Exposing the instrument to corrosive substances (whether gases, liquids, or solids) can jeopardize the materials and components of the Elite GC2020 gas chromatograph, and should therefore be avoided.

The test bench for installing the Elite GC2020 gas chromatograph must be stable. Vibrations from the bench can impact the instrument's stability. To ensure proper ventilation of hot air from the column oven, at least 30cm of space should be left at the back of the instrument (and flammable items should not be placed there!). Additionally, a 30~40 cm space is required for installation and maintenance of the chromatograph.

The Elite GC2020 gas chromatograph requires a 10/100 M or gigabit Ethernet connection. Ethernet can be set up using hubs or switches.

1.5.2 Power Environment

The power supply for the Elite GC2020 gas chromatograph should be 220 V±10% (50 Hz±0.5 Hz), and the power provided should be no less than 2500 W. For safety, the panel and casing of the Elite GC2020 gas chromatograph are grounded with a three-core power line in accordance with the requirements of the International Electrotechnical Commission.

Note: To reduce electrical noise from the instrument, each unit must be properly grounded.

Warning: It is strictly prohibited to replace the ground wire with water pipes, gas pipes, neutral wires, etc.!

1.5.3 Gas Environment

To achieve the best performance from the Elite GC2020 gas chromatograph, the gases used must meet certain purity levels. The following purity values are recommended:

Table 1-1 Gas environment

Detector	Gas Function	Gas Name	Purity
FID	Carrier gas	N_2 or He	Not less than 99.999%
TCD	Carrier gas	He, H_2, or N	Not less than 99.999%
ECD	Carrier gas	N_2(most appropriate)	Not less than 99.999% (Deoxygenated)
NPD	Carrier gas	N_2 or He	Not less than 99.999%
FPD	Carrier gas	N_2 or He	Not less than 99.999%
Tail Gas		N_2	Not less than 99.99%
Fuel Gas		H_2	Not less than 99.99%
Support Gas		Air	Clean, dry

We recommend installing a purifier on the gas line. After prolonged use, the molecular sieve and silica gel within the gas purifier should be reactivated.

2 Instrument Installation

2.1 Unboxing the instrument

Upon receiving the instrument, please promptly check the quality of the external packaging. If any damage is found, immediately contact the manufacturer or the seller. After unboxing, check the accompanying parts against the delivery list. If there are discrepancies or visible damage to the instrument, contact the manufacturer or seller immediately to avoid unnecessary financial losses or delays in your work.

2.2 Installing the Instrument

After verifying everything is in order, carefully place the instrument in a suitable position on the workbench. The workbench must be stable. Do not stack flammable materials behind the instrument and ensure there is space for maintenance.

2.2.1 Installation of Gas Supply

Before using the Elite GC2020 gas chromatograph, refer to section 1.5.3 and equip the gas supply according to the type of detector you plan to use.

Install the gas supply in a safe location. If using cylinder gas sources, the cylinders should be securely fastened to prevent accidental tipping. Regardless of the type of gas source used (such as gas generators, cylinder sources, air compressors, etc.), carefully verify that the quality of the produced gas meets the requirements of the Elite GC2020 gas chromatograph. Failure to do so may affect the analysis results or cause contamination or damage to the chromatograph.

2.2.2 Installation of Pressure Reducers

If using cylinder gas sources, follow these steps to install the pressure reducers:

Remove the low-pressure outlet heads of two oxygen pressure reducers and one hydrogen pressure reducer. Attach the pressure reducer connectors and screw on the low-pressure output regulators (do not tighten fully).

Install the pressure reducers onto the cylinders. After tightening the nuts, open the high-pressure valves of the cylinders. The high-pressure gauge of the pressure reducer should indicate pressure.

After closing the cylinder high-pressure valves, the high-pressure gauge reading should not drop. If it does, there is a leak that must be identified and rectified before use.

2.2.3 Installation of External Gas Lines

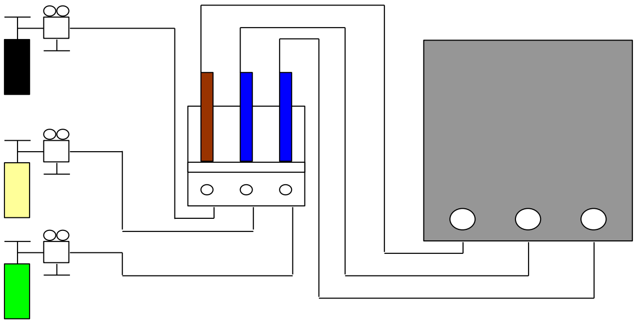


Fig 2-1 External Gas Line Connection Diagram

The Elite GC2020 gas chromatograph uses polyethylene, PTFE, stainless steel, or copper tubing with an external diameter of Φ3×0.5 mm for external gas line connections, as shown in the diagram above (Figure 2-1).

Note:

1. The vent ports of the gas line splitter and detector should be piped outdoors to prevent indoor air pollution when analyzing toxic and harmful substances.
2. Regularly check for leaks during operation. A leak can, at best, affect normal instrument operation and, at worst, cause accidents (such as explosions due to hydrogen leaks).
3. Input pressure of carrier gas to the chromatograph: 0.5 MPa;
4. Input pressure of air to the chromatograph: 0.5 MPa;
5. Input pressure of hydrogen to the chromatograph: 0.4 MPa.

2.2.4 System Leak Testing

After installing the gas lines, it is necessary to perform a leak test to prevent accidents. Follow these steps for leak testing:

Turn off the main power supply of the instrument.

With the pressure regulator knob of the cylinder in the relaxed position, open the high-pressure valve of the cylinder. Then slowly adjust the low-pressure regulator knob so that the low-pressure gauge reads: 0.5 MPa for the carrier gas cylinder, 0.4 MPa for the hydrogen cylinder, and 0.5 MPa for the air cylinder (for generators, use the pressure indicated when the generator stops operating).

Close the high-pressure valve of the cylinder, and close the carrier gas, hydrogen, air, tail blow, splitting, and purging valves on the chromatograph. Relax the cylinder's low-pressure regulator knob and observe if the pressure gauge reading drops. If the pressure does not drop within 10 minutes, the system is leak-free; otherwise, there is a leak in the gas line that needs to be carefully checked and rectified.

3 Operation of the Chromatograph

3.1 Display operation:

The Elite GC2020 gas chromatograph is equipped with six temperature control algorithms, allowing for independent temperature settings and controls for eight temperature control zones. The chromatograph oven also features a 20-step programmed temperature rise capability. The oven's rear door opens and closes automatically based on the oven's temperature control algorithm.

The Elite GC2020's display screen is an 8-inch Chinese character LCD touch screen, allowing for a clear view of the instrument's operational status. The virtual keyboard is designed to be straightforward and intuitive, with complete functions and simple operation.

Start The button is for starting data collection and analysis; if a programmed temperature rise is set, it initiates the temperature rise program.

Note: If pressing the button Start for data collection or temperature rise has no effect during display Waiting ●, this indicates it is inactive.

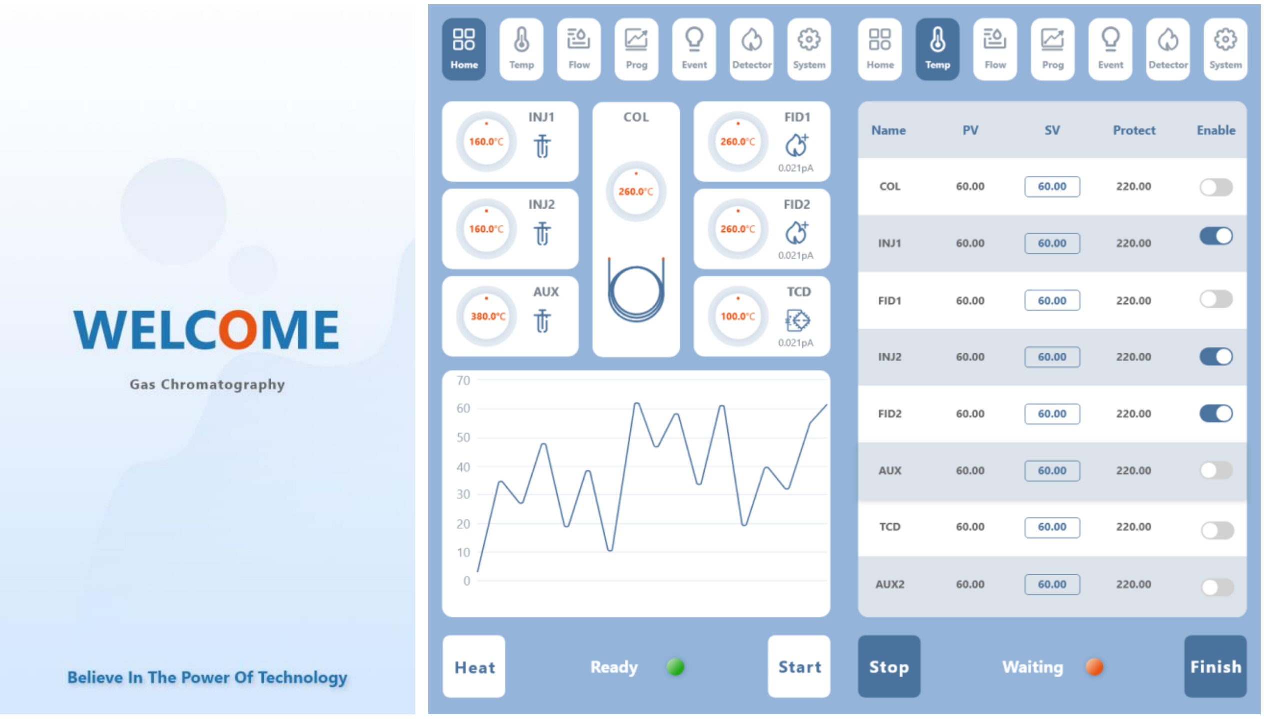
Finish The button ends signal analysis or stops the temperature rise program in progress.

Ready ● The icon indicates that the measured temperature of each controlled unit permitted to control temperature has reached the set value. The column oven temperature should be within ±0.5 ℃ of the set value, and other temperatures within ±5 ℃ of the set value, indicating readiness for sample analysis.

After powering on the instrument, press the button Heat in the lower-left corner to enter the temperature control state. If the EPC circuit is present, it will automatically open the gas control.

3.2 Viewing and Setting Temperature Control

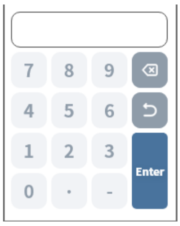
Power on the instrument, tap the screen to enter the main interface, and press the button to enter the temperature display state. Here, you can view the operational status of each temperature control route, as shown in the figure below: Temp



Name	PV	SV	Protect	Enable
COL	60.00	60.00	220.00	○
INJ1	60.00	60.00	220.00	●
FID1	60.00	60.00	220.00	○
INJ2	60.00	60.00	220.00	●
FID2	60.00	60.00	220.00	●
AUX	60.00	60.00	220.00	○
TCD	60.00	60.00	220.00	○
AUX2	60.00	60.00	220.00	○

Fig 3-1 Viewing and setting the temperature control function

"Actual" displays the actual temperature of the eight temperature control routes. You can set the corresponding area temperature in the setting area and activate it ●. If the enable button ○ is grayed out, that route's temperature will not be heated.

"Set" allows you to input the desired temperature for your sample. To enter, tap the corresponding box , input the temperature value using the pop-up buttonboard, and press Enter to complete the input.

"Protect" displays the protective temperature of the eight temperature control routes. This temperature is automatically calculated by the instrument based on the user's settings and does not require modification.

3.3 Turning the Temperature Control System On or Off

With the instrument powered on, pressing the button Heat initiates heating. If EPC is present, H_2 displays the flow rate.

When the column oven temperature reaches ±0.5 ℃ of the set value and other enabled routes reach ±5 ℃ of the set value, the icon appears Ready ●, indicating readiness for sample analysis after baseline stabilization.

Note: In the display state, pressing the button Start after sampling will initiate the analysis phase in the workstation Ready ●. Simultaneously, if programmed temperature rise parameters and external event parameters are valid, the instrument will enter the programmed temperature rise and external event control states. After sampling is completed, analysis can be manually ended by pressing Finish, or it can be controlled via the workstation.

In the temperature control state of the instrument, pressing the button Stop turns off temperature control. You will hear the sound of the internal relay releasing, and the rear door will open automatically for cooling.

3.4 Viewing and Setting Programmed Temperature Rise

With the instrument powered on, press the button to enter the programmed temperature display state.

Prog

Name	PV	SV	Protect	Enable
COL	60.00	60.00	220.00	○
INJ1	60.00	60.00	220.00	●
FID1	60.00	60.00	220.00	○
INJ2	60.00	60.00	220.00	●
FID2	60.00	60.00	220.00	●
AUX	60.00	60.00	220.00	○
TCD	60.00	60.00	220.00	○
AUX2	60.00	60.00	220.00	○

First Keep Time： 5.00 min

No.	Speed °C/min	Final °C	Keep min
1	5.00	200.00	10.00
2	0.00	0.00	0.00
3	0.00	0.00	0.00
4	0.00	0.00	0.00
5	0.00	0.00	0.00
6	0.00	0.00	0.00
7	0.00	0.00	0.00
8	0.00	0.00	0.00

Fig 3-2 View and setting of program temperature rise

Programmed temperature rise refers to the process of the column oven temperature rising according to set values during sample analysis. For example: the column oven is set at 60 ℃, held for 5 minutes, then raised at a rate of 5 ℃ to 200 ℃ and held for 10 minutes. Settings can be made as shown in the figure above. Column oven temperature is set in the temperature interface and cannot be set in this interface. Subsequent temperature rise stages follow the same pattern.

Note: The ending temperature of the temperature rise program must be higher than the set temperature of the column oven, and each subsequent stage temperature must be higher than the previous one.

Note: If the temperature rise rate of a stage is set to 0, the programmed temperature rise for that stage and subsequent stages becomes invalid. A rate of 0 in the first stage invalidates the entire programmed temperature rise.

Programmed Temperature Rise Operation:

With the instrument powered on, press the button Heat to enter the temperature control system. When the instrument is in the state Ready ●, pressing the button Start starts the programmed temperature rise control (Note: to start the program, connect to the workstation).

During the chromatograph's temperature rise program, when the instrument enters the initial temperature hold state, "Initial Temp" is displayed in the display area.

When the instrument enters the temperature rise state, "Rising" is displayed.

When the instrument enters the temperature hold state, "Hold" is displayed.

When the instrument enters the cooling state, "Cooling" is displayed.

Upon completing a full cycle of the programmed temperature rise, the timing stopwatch in the status display area stops and resets. The instrument automatically opens the rear door of the column oven to rapidly cool down to the initial temperature, thus shortening the cooling time of the instrument. When the temperature inside the column oven drops to the initial temperature (±1℃), is displayed Ready ●, awaiting the start of the next programmed temperature rise. This process repeats.

During the execution of programmed temperature rise, pressing the button Finish under the temperature control system will interrupt the temperature rise program, returning the instrument to a constant temperature state.

Remarks for Chromatographs with TCD Detectors:

Note: Operation of the TCD detector must follow the "first purge, then heat, then current" rule. That is, do not set the bridge current when the TCD detector is not purged with carrier gas, otherwise, the tungsten filament will be damaged! When turning off the instrument, be sure to first turn off the bridge current, then cool down, and only after the TCD temperature is near room temperature, turn off the carrier gas.

Note: Please avoid using too high a current for TCD operation. High current operation will accelerate the oxidation of the tungsten filament, damaging the TCD detector's lifespan.

Note: To prevent damage to the TCD detector, the bridge current setting is not saved when the machine is turned off. When the machine is turned on, the TCD bridge current setting automatically deProblems to 0 milliamps.

Warning: The presence of oxygen in the carrier gas will shorten the lifespan of the TCD tungsten filament. Ensure complete deoxygenation of the carrier gas!

3.5 Viewing Detectors

When the instrument is powered on, press the button Detector to enter the detector interface:

FID1

Ignition Duration : 3 s

Ignition Threshold : 2 pA

Signal : 0.023 pA

FID2

Ignition Duration : 3 s

Ignition Threshold : 2 pA

Signal : 0.023 pA

TCD1

Current : 180 mA

Polarity :

Signal : 0.023 mV

Fig 3-3 Checking the detector

For example, with dual FID+TCD, the interface allows for setting ignition duration, ignition threshold, and performing ignition operations on the detector. The signal values of the corresponding detectors can be viewed.

If there are multiple detectors, you can press the button LAST NEXT to find and set the respective detectors.

3.6 Viewing Flow Rates

With the instrument powered on, press the button Flow to enter the flow rate interface:

INJ1
Carrier 0.00 sccm
Split 0.00 sccm
Purg 0.00 sccm
Ratio 0.00 : 1

DET1
H2 0.00 sccm
Air 0.00 sccm
Aux 0.00 sccm

INJ2
Carrier 0.00 sccm
Split 0.00 sccm
Purg 0.00 sccm
Ratio 0.00 : 1

DET2
H2 0.00 sccm
Air 0.00 sccm
Aux 0.00 sccm

INJ3
Carrier 0.00 sccm
Split 0.00 sccm
Purg 0.00 sccm
Ratio 0.00 : 1

DET3
H2 0.00 sccm
Air 0.00 sccm
Aux 0.00 sccm

Fig 3-4 Viewing traffic

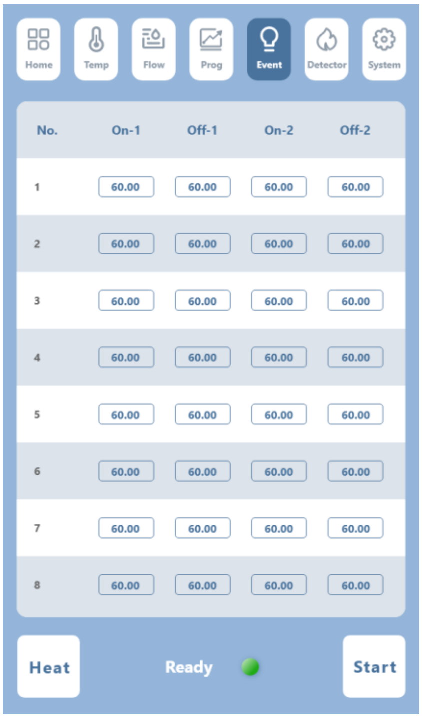
This interface displays the flow rates for respective samplers (INJ) and detectors (DET), and allows manual setting of flow rates: Clicking on the respective window brings up a digital buttonpad, and after setting, press confirm to complete the setting.

Note: This interface is designed for EPC modules. Flow rates can be entered on the display screen and workstation. If the instrument uses mechanical valves, this interface does not allow input.

3.7 Viewing Events

When the instrument is powered on, press the button to enter the event interface Event.

This interface comprises 8 event paths, and external events can be designed in this interface

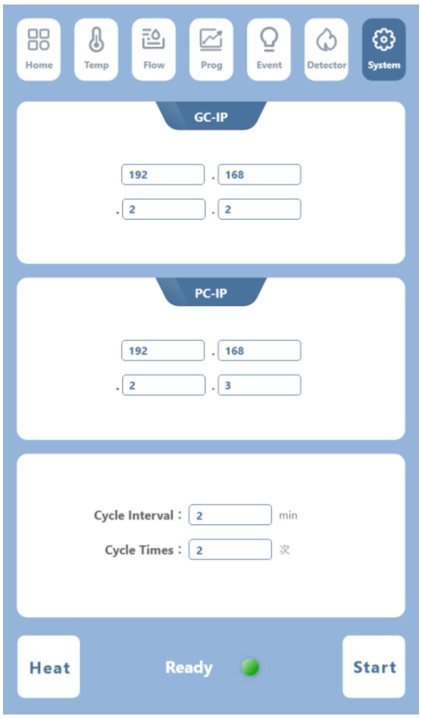


No.	On-1	Off-1	On-2	Off-2
1	60.00	60.00	60.00	60.00
2	60.00	60.00	60.00	60.00
3	60.00	60.00	60.00	60.00
4	60.00	60.00	60.00	60.00
5	60.00	60.00	60.00	60.00
6	60.00	60.00	60.00	60.00
7	60.00	60.00	60.00	60.00
8	60.00	60.00	60.00	60.00

Fig 3-5 Viewing events

3.8 Viewing and Setting Network Parameters:

With the instrument powered on, press the button System to enter the network parameter display state.



GC-IP

192 . 168 . 2 . 2

PC-IP

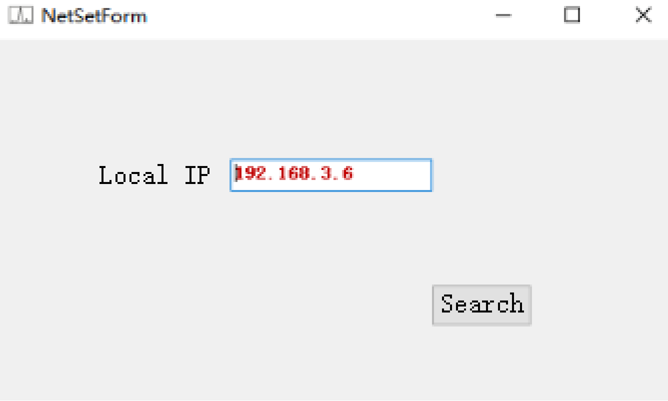
192 . 168 . 2 . 3

Cycle Interval：2 min

Cycle Times：2 次

Fig 3-6 Viewing and setting network parameters

Note: These parameters do not need to be set. After powering on the instrument, connect the chromatograph to the computer workstation with an Ethernet cable, open the workstation, click on the network configuration



Local IP 192.168.3.6

in the bottom left corner, and a window will pop up. Click search, and a green dot will appear in the bottom left corner of the workstation. Double-click this dot, and if a checkmark appears on the green dot, it indicates that the instrument is connected to the workstation.

The "Local IP" in the interface refers to the IP address of this chromatograph. Typically set to **an unused IP address within the same network segment as the company's LAN**.

"Subnet Mask" should be set to the same subnet mask used by the company's LAN, typically 255.255.255.0.

"Gateway" should be set to the same gateway used by the company's LAN, typically 192.168.x.1.

"Work Computer" refers to the IP address of the computer running the workstation software, i.e., set to the IP address of the computer where the workstation software operates. This parameter must be set correctly; otherwise, the chromatograph cannot connect to the workstation software.

The IP address of the computer running the workstation software can be found in the properties of "Internet Protocol (TCP/IP)" under "Local Connection" in "Network Neighborhood." It can also be viewed in the command state of the operating system using the "IPCONFIG" command (see section 4.2.2 for details).

"Supervisor Computer" refers to the IP address of the business supervisor's computer (such as the chief engineer, quality control manager, etc.) who installs the workstation software on their computer to monitor the operation status and analysis data of the chromatograph. To use this feature, this parameter must be set correctly; otherwise, the chromatograph cannot connect to the supervisor's workstation. If the supervisor does not monitor the chromatograph's operation and analysis data, there is no need to install the workstation software; simply set this IP address to an unused address within the LAN.

"Leadership Computer" refers to the public network IP address (generally via the internet) of the supervisory system established by the administrative supervisory unit (such as the Bureau of Technical Supervision, Health Bureau, Environmental Protection Bureau, etc.) to monitor the chromatograph's operation and analysis data. If the supervisory authority does not have such requirements, simply set this IP address to an unused address within the LAN. The "Leadership" indicator shows <——>, indicating a successful connection between the chromatograph and the workstation; if this indicator is not displayed, the chromatograph is not successfully connected to the workstation.

Note: In a LAN, the IP address of the chromatograph and the workstation computer must be within the same network segment. **That is, the first three sets of data in the IP address must match.**

Note: The IP address of the chromatograph and the workstation computer must not conflict with other network devices.

Note: The chromatograph's IP address operates in a static IP address mode. It does not support the "Automatic IP Address Acquisition" function.

Note: Since the working mode of this chromatograph is to automatically connect to the workstation after powering on, for stable system operation, **the workstation computer's IP address must be fixed**. The IP address of the workstation computer should operate in a static IP address mode, not in the "Automatic IP Address Acquisition" mode.

Warning: The local computer, supervisor computer, and leadership computer set in the chromatograph **must not be the same**! This will cause abnormal baseline data in the workstation. **If the business supervisor and the higher-level supervisor are not using these, set these two IP addresses to non-existent addresses in the LAN.**

4 Maintenance and Care of the Instrument

4.1 Cleaning the Sampler

The sampler, especially the vaporizer tube, is prone to contamination, making cleaning essential.

1. To clean the sampler, use a solvent-soaked cotton ball for thorough cleaning, followed by blowing with a strong air flow to remove cotton fibers and dry the solvent.
2. For cleaning the liner, soak it in acetone for 1~2 hours, then use ultrasonic waves for over 30 minutes. If stubborn contaminants persist, use a φ1.6 stainless steel wire and cotton swab dipped in acetone for removal, followed by ultrasonic treatment.
3. New sampler pads should be treated before replacement. Then install the vaporizer tube pad and sealing nut properly.

The sampler must undergo strict leak testing after cleaning before it can be used again.

4.2 Cleaning the Hydrogen Flame Ionization Detector (FID)

1、Remove the FID cover, collector tube, and insulating gasket, and clean them with acetone or alcohol, followed by drying.

2、For severe contamination, place the components in an ultrasonic cleaning solution, rinse thoroughly with water after sonication, then clean with alcohol and dry.

3、If the detector is contaminated with chromatographic stationary phase, use a solvent that can dissolve the stationary phase for cleaning.

4、If the nozzle is contaminated, follow the same cleaning procedure.

4.3 Installation of Chromatographic Columns

4.3.1 Installation of Packed Columns

The installation of packed columns at both the sampler and detector is similar. Leave a sufficient empty column space at the sampler end (at least 50 mm) to prevent the syringe needle from touching the glass wool or packing material at the column end. Similarly, leave enough space at the detector end (at least 40 mm) to prevent the nozzle's bottom end from touching these materials, as shown in Figure 4-1:

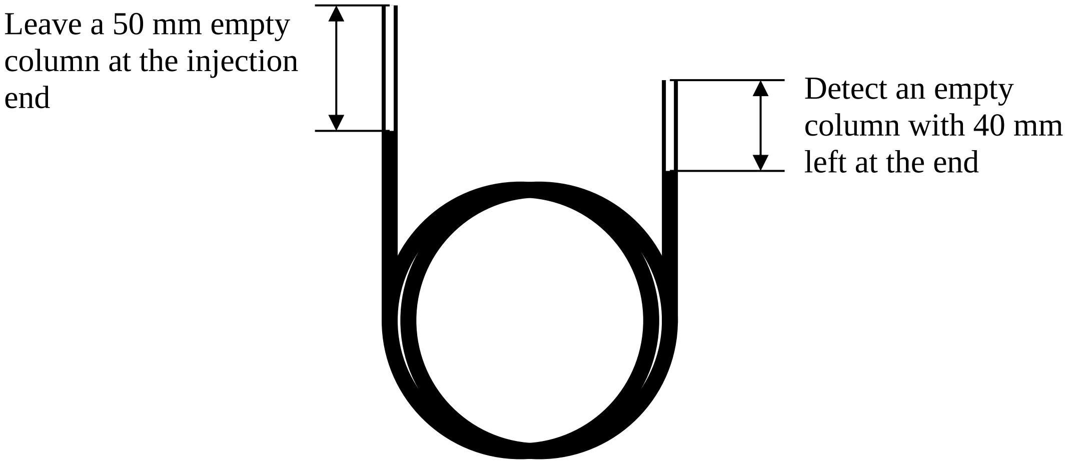


Fig 4-1 Schematic diagram of the blank tube parts at both ends of the filling column

Due to the rigidity of glass, glass-packed columns must be installed at both ends of the sampler and detector. Follow the same installation procedure for each end. For detector end installation, refer to the relevant section for the specific detector used.

For the Elite GC2020 Gas Chromatograph, use Φ3 mm or Φ4 mm packed columns connected to the sampler.

Installation steps:

1. Slide the M10×1 Φ3 mm column nuts onto both ends of the column.
2. Place Φ3 mm graphite rings on both ends of the column, followed by the appropriate inner diameter liner. Push upward into the bottom of the detector and tighten the nuts.
3. Adjust the height of the column at the sampler end as required and tighten the nuts.
4. Check for leaks using a neutral soap solution; there should be no air leakage.
5. Dry off the soap solution.
6. Installation steps for Φ4mm columns are the same.

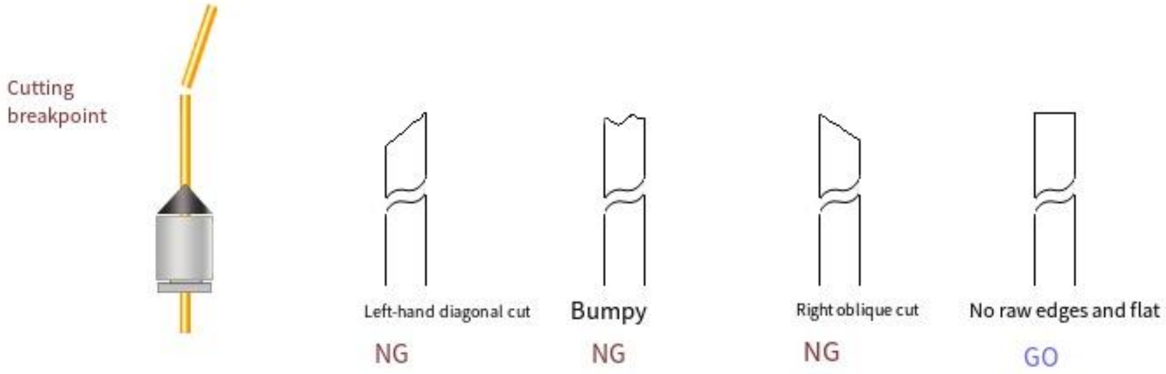
Note: The sampler end of the packed column should maintain about 50 mm of empty space to avoid difficulties during sampling. Mark the column during packing to avoid mixing up the sampler and detector ends. Similarly, leave enough space at the detector end (at least 4 mm).

4.3.2 Installation of Capillary Columns

Fused silica capillary columns are quite uniform and do not require additional arrangement. However, the ends of the column should be freshly cut, smooth, and neat, with no burrs, and free from particulate matter from the column, stationary phase, and sealing gaskets.

To prepare, cut the column end with a suitable specialized cutting tool  at the desired location. Normally, install the column nuts and gaskets before cutting.

Note: Wear protective eyewear to avoid potential eye injury from particles generated while cutting glass or fused silica capillary columns. Handle capillary columns carefully to avoid skin injuries. Due to the rigidity of the columns, it is very important to take these precautions in advance.



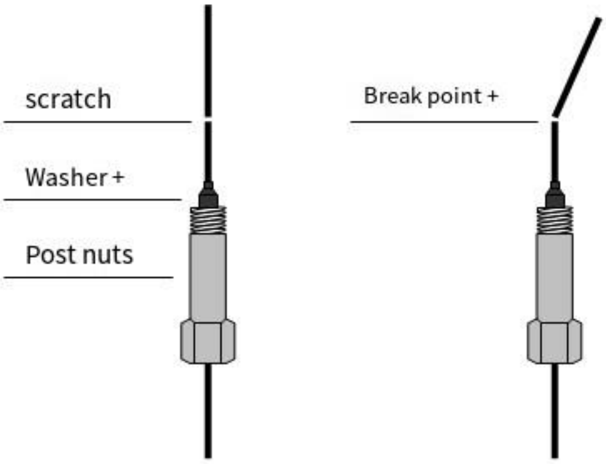


Fig 4-2 Fused Quartz Capillary Columns

Capillary columns are wound on a metal frame, which is suspended on the capillary column bracket inside the column oven. The ends of the column extend from the bottom of the frame, smoothly bending towards the interfaces of the sampler and detector, ensuring that no part of the column touches the inner walls of the oven. The graphite gasket may contaminate the column when passing through, so cut the column ends as described in "Preparing Fused Quartz Capillary Columns."

The diagram below shows the required lengths for connecting the column to the vaporizer chamber and FID, leaving 40 mm for the vaporizer chamber and 86 mm for the FID.

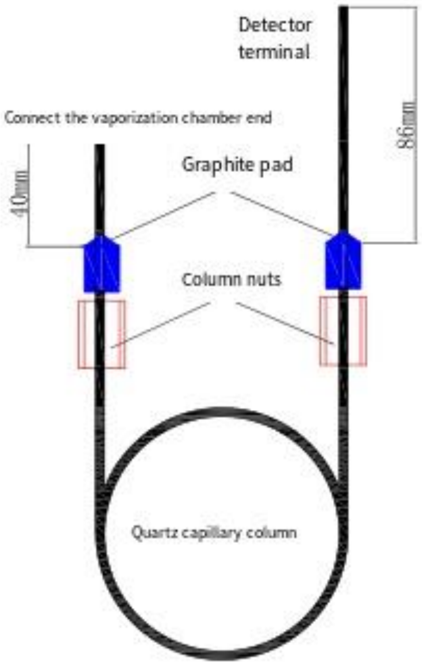


Fig 4-3 Installation of quartz capillary column

4.4 Maintenance of the Gas Purifier

The flow control system includes a filter housing 5A molecular sieves. These sieves require regular replacement or activation. The activation temperature is 350 °C for 4 hours.

5 Troubleshooting and Solutions

5.1 Startup Issues

5.1.1 No Response at Startup

Problem Diagnosis	Check methods and repairs
Power Supply Issue	Check the mainssupply.
Blown Fuse	Check and replace the fuse.
Display Not Lighting Up	Check the display screen.

5.1.2 Failure in Startup Initialization

Problem Diagnosis	Check Method and Repair
Power Board Failure	Check the +12V, +5V, +15V, -15V of the power board.
RS485 Component Failure on Signal Board	Remove signal boards one by one to identify the issue.
RS485 Component Failure on Display Board	Remove display boards sequentially to resolve the issue.

5.1.3 Failure to Connect

Prombem Diagnosis	Check Method and Repair
Network Cable Issue	Check the network cable, ping the GC on the PC.
Incorrect IP Address Setting	Check and correctly set the IP address.
Computer OS Firewall Blocking	Disable the firewall.
Antivirus Software Blocking	Disable the antivirus software.
Network Indicator Light of Computer or Chromatograph Off	Check network cable, switch, chromatograph, or computer.
Connection Intermittent	Check the network and for any IP address conflict.

5.1.4 Connected but No Baseline Movement

Problem Diagnosis	Check Method and Repair
Detector Signal Board Issue 1:	Check on the GC if the detector is recognized.
Detector Signal Board Issue 2:	Verify the detector signal on the GC is normal.
Detector Signal Board Issue 3:	Check for duplicate settings of similar detector boards.

5.2 Chromatogram Peak Issues

5.2.1 No Baseline

Problem Diagnosis	Check Method and Repair
Detector Board Not Installed	Check if the detector board is installed.
Detector Board Fault	Replace the detection board.
Baseline and Background Color Identical	Change the color setting.
Incorrect Sampling Rate	Adjust the sampling rate (20 times/sec).
Chromatograph Not Connected to Computer	Check network and network parameters.

5.2.2 No Chromatogram Peaks

Problem Diagnosis	Check Method and Repair
Sampler Temperature Too Low	Increase sampler temperature.
Sampler Blocked	Replace the sampler.
Amplifier Power Disconnected	Check the amplifier.
No Carrier Gas Flowing	Check if the carrier gas line is blocked or if the gas cylinder is empty.
Silicone Rubber Leaking	Replace silicone rubber.
No Flame	Ignite
No FID Polarization Voltage	Resolve issues with polarization voltage connection.

5.2.3 Normal Retention Time but Reduced Sensitivity

Problem Diagnosis	Check Method and Repair
Sampler Leaking	Replace the sampler.
Incorrect Sensitivity Setting	Select appropriate sensitivity.
Carrier Gas Leak	Detect and address the leak.
Incorrect Hydrogen and Air Flow Rates for FID	Adjust their flow rates.
No High Voltage in Detector (FID)	Install high voltage.

5.2.4 Trailing Peaks

Problem Diagnosis	Check Method and Repair
Sampler Tube Contaminated	Clean the sampler tube.
Column Oven Temperature Too Low	Increase column oven temperature.
Sampler Temperature Too Low	Increase sampler temperature.
Incorrect Column Selection	Choose the appropriate chromatography column.

5.2.5 Split Peaks

Problem Diagnosis	Check Method and Repair
Sample Quantity Too Large	Reduce sample quantity.
Sample Congealing in the System	First increase column temperature, then select appropriate sampler, column, and detector temperatures.

5.2.6 Poor Chromatogram Peak Separation

Problem Diagnosis	Check Method and Repair
Column Too Short	Choose a longer column.
Stationary Phase Loss	Replace or recondition the chromatography column.
Column Temperature Too High	Reduce column temperature.
Incorrect Stationary Phase Selection	Choose the appropriate chromatography column.
Carrier Gas Flow Rate Too High or Too Low	Adjust the carrier gas flow rate.

5.2.7 Flat-topped Peaks

Problem Diagnosis	Check Method and Repair
Amplifier Input Saturated	Reduce sample quantity, lower amplifier sensitivity.
Recorder Zero Point Shift	Check recorder zero point and make necessary adjustments.

5.2.8 Baseline Abrupt Change

Problem Diagnosis	Check Method and Repair
External Electromagnetic Interference	Eliminate external electromagnetic interference affecting the instrument's normal operation.
Power Plug Contact Issue	Securely install the power socket.
Incorrect Hydrogen and Air Flow Rates	Readjust the hydrogen and air flow rates.

5.2.9 Irregular Baseline Fluctuation During Isothermal Operation

Problem Diagnosis	Check Method and Repair
Poor Instrument Installation Location	Install the instrument in a location without strong vibrations, preferably on a vibration-free concrete platform.
Poor Grounding of the Instrument	Check and ensure proper grounding.
Unsuitable Stationary Phase	Choose the appropriate stationary phase.
Improper Carrier Gas Flow Setting	Adjust the carrier gas flow properly.
Carrier Gas Leakage	Detect and address the leak.
Detector Contamination	Cleaning the detector.
Detect and address the leak.	Properly adjust the hydrogen and air flow rates.

5.2.10 Prolonged Retention Time and Low Sensitivity

Problem Diagnosis	Check Method and Repair
Carrier Gas Flow Rate Too Slow	Increase the carrier gas flow rate.
Change in Carrier Gas Flow After Sampling	Replace the sampler silicone rubber.
Sampler Silicone Rubber Leak	Replace the sampler silicone rubber.

5.2.11 Signal Drops Below Baseline and Flameout at Peak Emission

Problem Diagnosis	Check Method and Repair
Excessive Sample Quantity	Reduce the sample quantity.
High Carrier Gas Flow Rate	Choose the appropriate carrier gas flow rate.
Low Hydrogen or Air Flow Rate	Readjust the hydrogen and air flow rates.
Flame Nozzle Contamination	Clean the flame nozzle.
Loss of Stationary Phase in the Column	Recondition the chromatography column.

5.2.12 Baseline Does Not Return to Zero

Problem Diagnosis	Check Method and Repair
Detector Contamination	Cleaning the detector.
Amplifier Fault	Checking the amplifier.

5.2.13 Irregular Peaks at Intervals

Problem Diagnosis	Check Method and Repair
Insulator Electrical Leakage	Detect and address the leakage.
Amplifier Fault	Remove impurities from the flow path.
Flame Fluctuation	Adjust the appropriate hydrogen and air flow rates.
High-Frequency Signal Line Fault	Check the high-frequency signal line.
Detector Dust	Clean using a bulb syringe.

5.2.14 Regular Spikes at Equal Intervals

Problem Diagnosis	Check Method and Repair
Water Condensation in the Hydrogen Line	Remove water from the line and replace or reactivate the drying agent.
Blockage in the Flow Path	Remove impurities from the flow path.
Air leakage	Detect and address the leak.
Flame Fluctuation	Adjust the appropriate hydrogen and air flow rates.

5.2.15 Round Peaks

Problem Diagnosis	Check Method and Repair
Exceeding the Detector's Linear Range	Reduce the sample quantity.
Inappropriate Amplifier Selection	Select a suitable amplifier.

5.2.16 High Baseline Noise

Problem Diagnosis	Check Method and Repair
Chromatography Column Contamination	Replace the chromatography column.
Carrier Gas Contamination	Replace or regenerate the carrier gas filter.
High Carrier Gas Flow Rate	Readjust the carrier gas flow rate.
Poor Grounding	Check and ensure good grounding.
High Resistance Contamination	Clean the contaminated high resistance.
Sampler Contamination	Clean the sampler's sampling tube.
High or Low Air or Hydrogen Flow Rate (FID)	Readjust the air or hydrogen flow rate.
Air or Hydrogen Contamination	Replace the hydrogen or air filter.
Water Condensation in FID	Increase the FID temperature to remove water.
High-Frequency Signal Line Fault	Check the high-frequency signal line.

5.2.17 Additional Peaks

Problem Diagnosis	Check Method and Repair

Residue Peaks from Previous Sample	Wait until the previous sample is completely eluted before sampling again.
Water Condensation in Chromatography Column Affecting Peak Emission	Install or regenerate the purifier with suitable operational conditions.
Sample Decomposition	Lower the sampler temperature.
Sample Contamination	Ensure sample cleanliness.

5.2.18 Sawtooth Baseline

Problem Diagnosis	Check Method and Repair
Fatigue of the Steady Flow Valve Diaphragm	Replace the diaphragm or repair the valve.
Pressure Variation in Carrier Gas Cylinder Reducing Valve	Adjust the pressure at another point on the carrier gas valve.
Improper Gas Flow Rate	Reset the gas flow rate.

5.2.19 Inverted Peaks

Problem Diagnosis	Check Method and Repair
Excessive Hydrogen Flow Rate (FID)	Adjusting the hydrogen flow rate.
Incorrect Setting of Positive and Negative Switches	Change the positive and negative switches to the correct positions.
Misconnected Tungsten Wire Leads in Reference and Measurement Chambers (TCD)	Check the wiring of tungsten wires in the reference and measurement chambers.

5.2.20 Baseline Unidirectional Change Without Sampling (FID)

Problem Diagnosis	Check Method and Repair
Low Detector Temperature	Increase the detector temperature.
Column Temperature Control Stopped Heating or Out of Control	Repair the temperature control system and platinum resistance heating wire.
Gas Leak	Detect and address the leak.

5.2.21 Unidirectional Baseline Drift

Problem Diagnosis	Check Method and Repair
Significant Change in Detector Temperature	Stabilizing the detector temperature
Drift in Amplifier Zero Point	Repair the amplifier components.
Significant Increase or Decrease in Column Temperature	Stabilize the chromatography column temperature.
Gas Leak	Detect and address the leak.

5.2.22 Irregular Baseline Changes During Temperature Increase

Problem Diagnosis	Check Method and Repair
Excessive Column Loss	Choose the appropriate chromatography column, use a column temperature far below the maximum operating temperature of the stationary phase, and age the column.
Inappropriate Operational Conditions	Select suitable operational conditions.
Chromatography Column Contamination	Replace the chromatography column.

5.2.23 Periodic Baseline Fluctuations

Problem Diagnosis	Check Method and Repair
Poor Temperature Control of Detector	Check for good contact
Low Pressure in Carrier Gas Cylinder	Replace the carrier gas cylinder
Improper Column Oven Temperature Adjustment	Check the contact of the platinum resistance.
Improper Adjustment of Carrier Gas Flow Rate	Readjust the carrier gas flow rate.
Improper Adjustment of Air and Hydrogen (FID)	Readjust the air and hydrogen flow rates.

5.2.24 Baseline Changes After Programmed Temperature Increase

Problem Diagnosis	Check Method and Repair

Increased Column Loss with Temperature Rise	Choose the appropriate chromatography column or age the chromatography column.
Incorrect Column Flow Speed Adjustment	Correct the column flow speed.
Chromatography Column Contamination	Replace the chromatography column.

6 Maintenance of Thermal Conductivity Detector (TCD)

6.1 Points to Note for TCD

During the use of the TCD, the following should be noted and adhered to:

- Do not set the bridge current when no carrier gas is flowing to avoid burning out the tungsten wire.
- For the initial aging of the column, do not connect the post-column carrier gas to the thermal conductivity cell, and leave it open in the column box; do not use hydrogen for aging, generally use nitrogen. Absolutely do not set the bridge current during aging.
- The thermal conductivity cell detector is a precision component, do not disassemble the tungsten wire inside the cell body to avoid unnecessary damage.

6.2 Analysis and Troubleshooting of Common Faults in TCD

6.2.1 No Peak Emission During Sampling

Problem Diagnosis	Check Method and Repair
Current Not Set	First set the current.
Broken Tungsten Wire	Replace the tungsten wire
Internal Connectors and Wiring of TCD Thermal Conductivity Power Unit Not Properly Connected	Reconnect the related plugs and sockets.
Injector Leak or Blockaged	Replace the injector.
Silicone Rubber Leak	Replace the silicone rubber

6.2.2 Excessive Signal Output Without Sampling

Problem Diagnosis	Check Method and Repair
Tungsten Wire Inside the Cell Touching the Cell Wall	Contact the manufacturer for repair.
Mismatched Tungsten Wire Resistance	Contact the manufacturer for repair.
Internal Connectors and Wiring of TCD Thermal Conductivity Power Unit Not Properly Connected	Reconnect the related plugs and sockets.

6.2.3 High Baseline Noise

Problem Diagnosis	Check Method and Repair
Impure Carrier Gas (Carrier Gas Purity is Very Important)	Purify the carrier gas, including deoxygenation and drying.
Contamination of the Thermal Conductivity Cell	Clean the cell body and the sampler.
Unaged Chromatography Column	Re-age the chromatography column. Silicone Rubber Leak: Replace the silicone rubber.
Silicone Rubber Leak	Replace the silicone rubber
Leak in the Gas Path System and Connection to the Chromatography Column	Detect and address the leak.
TCD Working Current Set Too High	Lower the working current setting to the appropriate value.
Unstable Thermal Conductivity Power Supply	Contact the manufacturer for repair.

Appendix A: Electrical Conditions Details

A qualified electrical technician should be able to supply the system with an appropriate power source. This is required whether modifying existing electrical equipment or installing new equipment.

- ✓ Estimate the total power requirements for the area.
- ✓ Install convenient output lines.
- ✓ Develop a plan for electrical safety.
- ✓ Ensure all wiring complies with local standards.
- ✓ Determining Power Requirements

Calculate the power needs for your area.

Note: The total power should include original equipment plus any additional equipment planned for future expansion.

Voltage Limits

At any instrument installation site, when the system is powered, the phase-to-neutral voltage should remain within +10% to -10% of the rated voltage, measured at the system's power input side.

Frequency Limits

The permissible line frequency limits depend on the narrowest limits within the system (measured at the instrument's power line input). The Elite GC2020 network gas chromatograph operates within a wide range of 50 Hz to 60 Hz.

Harmonic Distortion

The total harmonic distortion on the instrument's feed line should not exceed 5% (measured at the instrument’s power input after powering up).

Power Anomalies

In some areas, the power lines used by instrument systems may experience excessive voltage drops, shock voltages, transient voltages, outages, or other anomalies, making the system operation unreliable. Therefore, it is necessary to check the quality of the power supply. If any aspects do not meet the system's requirements, they should be corrected.

Power Noise

The Elite GC2020 network analyzer is designed to withstand reasonable input line noise. However, many noises from other utilities are beyond the control of the GC-97/99 network analyzer. These noises mainly come from other electrical devices nearby, such as motors, solenoids, SCR rectifiers, and X-ray machines.

Additionally, there may be "neutral-to-ground noise" caused by poor neutral contact and "ground-to-ground" noise due to poor floor grounding. The maximum permissible line noise is 3 V (rms) from 30 Hz to 50 Hz.

An oscilloscope can measure minor "ground-to-neutral" voltages, as analog meters can give distorted readings if the voltage is distorted. Generally, if the voltage is lower than the measurement results, there is an issue.

Noise Elimination

To eliminate noise from existing or future electrical installations, we insist on installing a qualified feed line between the main distribution panel and the instrument distribution panel. Check that neutral connections and grounding are good (see the "Grounding" section below).

If there are still transient phenomena after installing a qualified feed line, then a device to reduce input electrical noise should be installed.

Power Interference

Input power noise that interferes with the power output or interferes with the signal lines in the system can cause the instrument system to malfunction. These input interferences can be categorized as shocks, drops, and transients, as described below: "Shocks" and "Drops" are sudden changes in positive or negative input voltages, lasting around 5 milliseconds. Generally, "Shocks" and "Drops" should not exceed ±15% of the normal rated line voltage and should return to a stable state within 17 milliseconds (60 Hz) or 20 milliseconds (50 Hz).

"Power Voltage Transients" are sudden changes in positive or negative input voltages, lasting between 1 millisecond and 5 milliseconds. If the duration of such transients exceeds 20% of the rated voltage (depending on their energy), it can disrupt the instrument's functionality.

A power input disturbance monitor is useful for monitoring the quality of input power and characterizing disturbances. Since power line disturbances can occur hourly, daily, or weekly, the monitor should be connected for at least a week. Do not consider the results absolute, as the disturbance values can vary with seasonal changes.

The test method uses a spike signal with a 0.5 microsecond rise time and a 10 microsecond pulse duration, twice the amplitude of the power voltage.

Power Processing Equipment

If transient phenomena still occur after installing dedicated feed lines and grounding, then devices that reduce input power line interference should be installed. There are basically four types of devices that can accomplish this task:

1. Isolation transformers
2. Power voltage regulators
3. Motor-generator sets
4. Uninterruptible power supplies

Line conditioning equipment's capacity must meet current and future needs. The minimum rating recommended by our factory is 5 KVA, sufficient for current requirements and future expansion.

Appendix B: Grounding

Proper grounding of the instrument is crucial for safe and reliable operation. Generally, most countries and regions require grounding of electrical equipment to ensure personal safety.

Safety Grounding

Various standards typically require the installation of a safety conductor for electrical equipment. The standards usually state that each phase conductor (neutral) should be accompanied by a safety conductor of the same size.

Generally, safety standards require that the safety conductor be connected to the conductive surfaces of electrical equipment that operators might touch or that might become energized due to electrical accidents. Under normal operating conditions, this line should not carry return AC current. If the instrument's frame is not grounded, or if the phase wire accidentally touches the frame, the voltage on the frame could reach a hazardous level.

Connecting the safety ground wire to the instrument's chassis can prevent the risk of electric shock, as this forms a very low impedance circuit that will trip the circuit breaker or blow the fuse. Each instrument product has a safety grounding device, which completes the circuit when connected to a grounded socket or when the instrument's grounding ring is connected to the ground wire as specified by the user.

As described below, the instrument's safety ground wire is usually connected to the building's conduit through an insulated grounding device, thereby grounding the circuit's distribution. Under all circumstances, local and national safety standards must be adhered to.

The safety ground wire must be correctly connected to the terminal of the main distribution ground bus. Generally, it should be understood that the impedance of the ground wire returning from any load to the main ground bus must be less than 1 ohm.

Noise-Free Grounding

To ensure good operation of the Elite GC2020 network instrument, we insist on using a noise-free grounding device. This type of grounding is also called "insulated grounding" because it is separate from other electrical grounding devices in the building. When connecting the Elite GC2020 network instrument to other instruments, using "insulated grounding" helps maintain system reliability.

In most cases, ordinary grounding does not meet requirements because such grounding cannot be free of noise caused by poor grounding. Noise may also come from RF transmitters, and the ground wire may carry a steady current.

Typical noisy grounding situations include:

1. Conduits
2. Roof and building beams
3. Sprinkler pipes (grounding to these pipes is generally not allowed by most fire codes).
4. Raised floor support structures.
5. Gas pipes

Grounding to these pipes can easily be affected by building noise caused by poor grounding, and due to antenna effects, they may also pick up electrical interference.

Acceptable grounding objects (consult with the local electrical inspection department to choose a locally acceptable grounding method):

1. Use a properly sized wire connected to the building's main pipeline or the ground entry point of the main conduit.
2. Drive a grounding rod deep into moist soil and connect it to the ground entry point.
3. Connect to other reliable grounding points.

The insulated ground wire must be firmly connected to the device. Do not use clamps to attach the ground wire to pipes or grounding posts. Also, avoid using methods that could loosen the connection. The connection must be soldered with copper or tin to minimize the drop in insulation resistance at the ground joint. Improper installation may result in resistance at the joint, plus resistance along the ground wire, leading to unwanted potential on the insulated grounding device. Prevent accidental contact with other ground wires during installation, as this can adversely affect insulation. The insulated wire must be connected to the insulated bus in the distribution panel, then connected from the panel via connectors to the ground wire and separately to each unit of the instrument system. The insulated bus can consist of a grounding plate in the distribution panel.

The size of the wire used should minimize the grounding impedance from the farthest point to the main distribution grounding point. Consult with the local electrical inspection department regarding the wire size.

When a network processing device is installed in a multi-story building, the device's casing should be connected to the building's structural rebar to reduce grounding noise. One end of the ground wire should be connected to the casing of the network processing device, and the other end should be welded to the nearest rebar of the building. Grounding to the building's rebar is preferable to a separate grounding post in the basement.

Neutral-to-Ground Connection Quality Measurement

Several devices on the market are specifically designed to measure the quality of grounding systems. These devices include a grounding tester that guides current in the ground wire for testing and can indicate the quality of grounding (via a display light or an ohm scale). Another device is a ground resistance tester to measure the resistance of the grounding system.

If the grounding impedance is too high, check several items. If no network processing device or designated grounding device is installed, check the neutral-to-ground (N-G) connection at the building's main distribution panel. If a network processing device is installed, check the N-G contact on the device again. If the current N-G contact is inappropriately located, it should be relocated to a suitable position, as improper location can cause unwanted current on the grounding conductor.

The connection of the grounding wire should be checked to ensure it is in good condition. If the size of the grounding wire is smaller than that of the circuit wires, or if the grounding wire is not insulated, it is recommended to replace it with an insulated wire of the same size as the circuit wires.

Balancing Electrical Load

Balancing the electrical load in three-phase and split-phase systems is crucial because:

- It reduces the adverse effects of external voltage drops and changes on equipment powered by individual transformers.
- It enhances the performance of insulated transformers.
- It extends the life of transformers.

An unbalanced load creates a voltage difference between the neutral and ground wires. Measuring this voltage can indicate whether the load is balanced. To balance the load, use a clamp ammeter to first measure the current in each phase, then remove the power lines from the instrument system's distribution panel, rearrange the load, and measure again. Repeat this process until the current in the neutral line is minimized.

Measuring the voltage difference between the neutral and ground can also verify load balance. After powering the instrument, use an oscilloscope to measure the voltage difference between the neutral and ground at the instrument's power input terminals. The shorter the connection of the ground clip probe, the better. Remove the power line from the system's distribution panel, rearrange the load, and repeat the measurement until the voltage difference between the neutral and ground is minimized.

Balancing the load on other feed lines may further reduce the neutral-to-ground voltage, as can increasing the size of the feed lines. If the neutral-to-ground voltage on the system's distribution panel is too high, hang a dedicated feed line from the main distribution panel.