GALVANIC
APPLIED SCIENCES

AccuChrome™

GAS CHROMATOGRAPH

OPERATION MANUAL

P/N: MA2963
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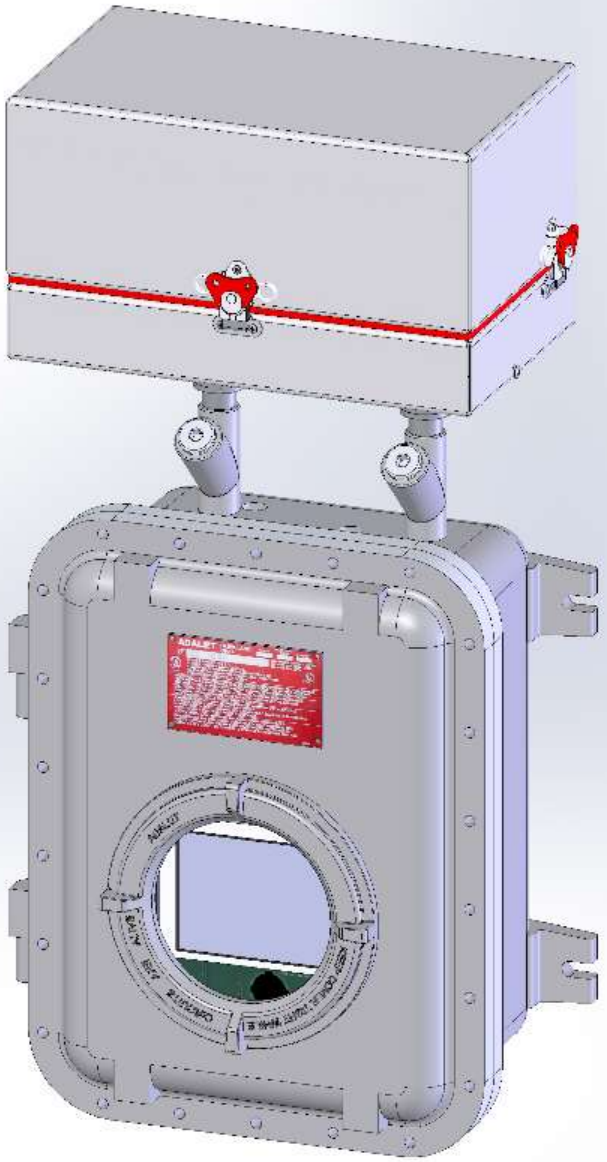

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NOTICES

This system is covered by a limited warranty. A copy of the warranty is included with this manual. The operator is required to perform routine maintenance as described herein on a periodic basis to keep the warranty in effect. For routine maintenance procedures, refer to Maintenance Section.

All information in this manual is subject to change without notice and does not represent a commitment on the part of Galvanic Applied Sciences, Inc.

No part of this manual may be reproduced or transmitted in any form or by any means without the written permission of Galvanic Applied Sciences, Inc.

Note: Changes or modifications not expressly approved by Galvanic Applied Sciences, Inc. could void the user's authority to operate the equipment.

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Safety Symbols used in Manual

The Danger symbol indicates a hazardous situation that, if not avoided will result in death or serious injury.

The Warning symbol indicates a hazardous situation that, if not avoided could result in death or serious injury.

The Caution symbol with the safety alert symbol indicates a hazardous situation that, if not avoided could result in minor or moderate injury.

The Notice symbol is used to highlight information that will optimize the use and reliability of the system.

Important Safety Guidelines for Galvanic Applied Sciences Inc., ACCUCHROME Gas Chromatograph

⚠WARNING This equipment must be used as specified by the manufacturer or overall safety will be impaired.

⚠WARNING Access to this equipment should be limited to authorized, trained personnel ONLY.

⚠WARNING Due to the thermal mass of the hardware, cooling of the items takes substantial time.

⚠WARNING Observe all warning labels on the analyzer enclosures.

The analog outputs and alarm relay contacts may be powered by a source separate from the one (s) used to power the analyzer system. Disconnecting the AC Mains Source (s) may not remove power from the analog output signals or the alarm relay contacts.

Any safety recommendations or comments contained herein are suggested guidelines only. Galvanic Applied Sciences Inc. bears no responsibility and assumes no liability for the use and/or implementation of these suggested procedures.

This system, when operating in its normal mode, and/or when it is being serviced, maintained, installed and commissioned contains items which may be hazardous to humans if handled or operated incorrectly or negligently. These hazards include, but are not limited to:

- High Voltage Electrical Energy
- Toxic and Explosive Gases
- High Temperature Surfaces

⚠CAUTION Access to this equipment should be limited to only to authorized, trained personnel.

Manufacturer's Warranty Statement

Galvanic Applied Sciences Inc. ("Seller") warrants that its products will be free from defects in materials and workmanship under normal use and service in general process conditions for 12 months from the date of Product start-up or 18 months from the date of shipping from Seller's production facility, whichever comes first (the "Warranty Period"). Products purchased by Seller from a third party for resale to Buyer ("Resale Products") shall carry only the warranty extended by the original manufacturer. Buyer agrees that Seller has no liability for Resale Products beyond making a reasonable commercial effort to arrange for procurement and shipping of the Resale Products. Buyer must give Seller notice of any warranty claim prior to the end of the Warranty Period. Seller shall not be responsible for any defects (including latent defects) which are reported to Seller after the end of the Warranty Period.

THIS WARRANTY AND ITS REMEDIES ARE IN LIEU OF ALL OTHER WARRANTIES OR CONDITIONS EXPRESSED OR IMPLIED, ORAL OR WRITTEN, EITHER IN FACT OR BY OPERATION OF LAW, STATUTORY OR OTHERWISE, INCLUDING BUT NOT LIMITED TO, WARRANTIES OR CONDITIONS OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, WHICH SELLER SPECIFICALLY DISCLAIMS.

Seller's obligation under this warranty shall not arise until Buyer notifies Seller of the defect. Seller's sole responsibility and Buyer's sole and exclusive remedy under this warranty is, at Seller's option, to replace or repair any defective component part of the product upon receipt of the Product at Seller's production facility, transportation charges prepaid or accept the return of the defective Product and refund the purchase price paid by Buyer for that Product. If requested by Buyer, Seller will use its best efforts to perform warranty services at Buyer's facility, as soon as reasonably practicable after notification by the Buyer of a possible defect provided that Buyer agrees to pay for travel time, mileage from the Seller's facility or travel costs to the airport / train station closest to Buyer's facility plus all other travel fees, hotel expenses and subsistence.

Except in the case of an authorized distributor or seller, authorized in writing by Seller to extend this warranty to the distributor's customers, the warranty herein applies only to the original purchaser from Seller ("Buyer") and may not be assigned, sold, or otherwise transferred to a third party. No warranty is made with respect to used, reconstructed, refurbished, or previously owned Products, which will be so marked on the sales order and will be sold "As Is".

Limitations
These warranties do not cover:

- Consumable items such as lamps.
- Analyzer components which may be damaged by exposure to contamination or fouling from the process fluid due to a process upset, improper sample extraction techniques or improper sample preparation, fluid pressures in excess of the analyzer's maximum rated pressure or fluid temperatures in excess of the analyzer's maximum rated temperature. These include but are not limited to sample filters, pressure regulators, transfer tubing, sample cells, optical components, pumps, measuring electrodes, switching solenoids, pressure sensors or any other sample wetted components.
- Loss, damage, or defects resulting from transportation to Buyer's facility, improper or inadequate maintenance by Buyer, software or interfaces supplied by Buyer, operation outside the environmental specifications for the instrument, use by unauthorized or untrained personnel or improper site maintenance or preparation.

- Products that have been altered or repaired by individuals other than Seller personnel or its duly authorized representatives, unless the alteration or repair has been performed by an authorized factory trained service technician in accordance with written procedures supplied by Seller.
- Products that have been subject to misuse, neglect, accident, or improper installation.
- The sole and exclusive warranty applicable to software and firmware products provided by Seller for use with a processor internal or external to the Product will be as follows: Seller warrants that such software and firmware will conform to Seller's program manuals or other publicly available documentation made available by Seller current at the time of shipment to Buyer when properly installed on that processor, provided however that Seller does not warrant the operation of the processor or software or firmware will be uninterrupted or error-free.

The warranty herein applies only to Products within the agreed country of original end destination. Products transferred outside the country of original end destination, either by the Seller at the direction of the Buyer or by Buyer's actions subsequent to delivery, may be subject to additional charges prior to warranty repair or replacement of such Products based on the actual location of such Products and Seller's warranty and/or service surcharges for such location(s).

Repaired Products
Repaired products are warranted for 90 days with the above exceptions.

Limitation of Remedy and Liability
IN NO EVENT SHALL SELLER BE LIABLE TO BUYER FOR ANY INDIRECT, CONSEQUENTIAL, INCIDENTAL, SPECIAL OR PUNITIVE DAMAGES, OR FOR ANY LOSS OF USE OR PRODUCTION, OR ANY LOSS OF DATA, PROFITS OR REVENUES, OR ANY CLAIMS RAISED BY CUSTOMERS OF BUYER OR ANY ENVIRONMENTAL DAMAGE OR ANY FINES IMPOSED ON BUYER BY ANY GOVERNMENTAL OR REGULATORY AUTHORITIES, WHETHER SUCH DAMAGES ARE DIRECT OR INDIRECT, AND REGARDLESS OF THE FORM OF ACTION (WHETHER FOR BREACH OF CONTRACT OR WARRANTY OR IN TORT OR STRICT LIABILITY) AND WHETHER ADVISED OF THE POSSIBILITY OF SUCH DAMAGES OR NOT.

Section 1 Overview of the AccuChrome Gas Chromatograph

1.1 Analyzer General Description

1.1.1 Introduction

The ACCUCHROME gas chromatograph is designed to identify and quantify the components of natural gas and natural gas products. It can also be used to measure other gaseous samples when fitted with appropriate columns. It calculates the energy content and provides mole percent concentrations of each component as per GPA 2172-09 or ISO 6976. The chromatograph is fully automated and designed to perform on-line, real time analysis. The Windows™ based configuration program allows the user to view chromatograms as well as configure the analyzer.

The component concentrations and the calculated physical properties are available via serial Modbus and/or Modbus TCP/IP.

The ACCUCHROME is available in both Class 1 Division 1 and Class 1 Division 2 models. Each of these models is also available with the option of AC power.

1.2 General Mode of Operation of the Gas Chromatograph

A detailed discussion of the theory of the separation and detection of the gases of interest via gas chromatography is presented in Section 11. In addition, the definition of terms relevant to gas chromatography and the description of various equations used in determination of the concentration of gases are presented in Section 13. If the reader in unfamiliar with gas chromatography, it may be useful to review these appendices.

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Section 2 **Analyzer Design**

2.1 Overview

The standard ACCUCHROME (Figure 2-1) consists of two compartments. The upper compartment is referred to as the 'chromatograph oven', and houses the components involved in the chromatograph analysis process. The 10 port valve (and 6-port valve, in High Speed Heating Value Analysis analyzers), the chromatograph column(s), and the thermal conductivity detector (TCD) are described further in Sections 2.2 and 2.3. A heater maintains a constant temperature within the oven, which is critical for proper separation of the sample gasses and the stability of the detector.

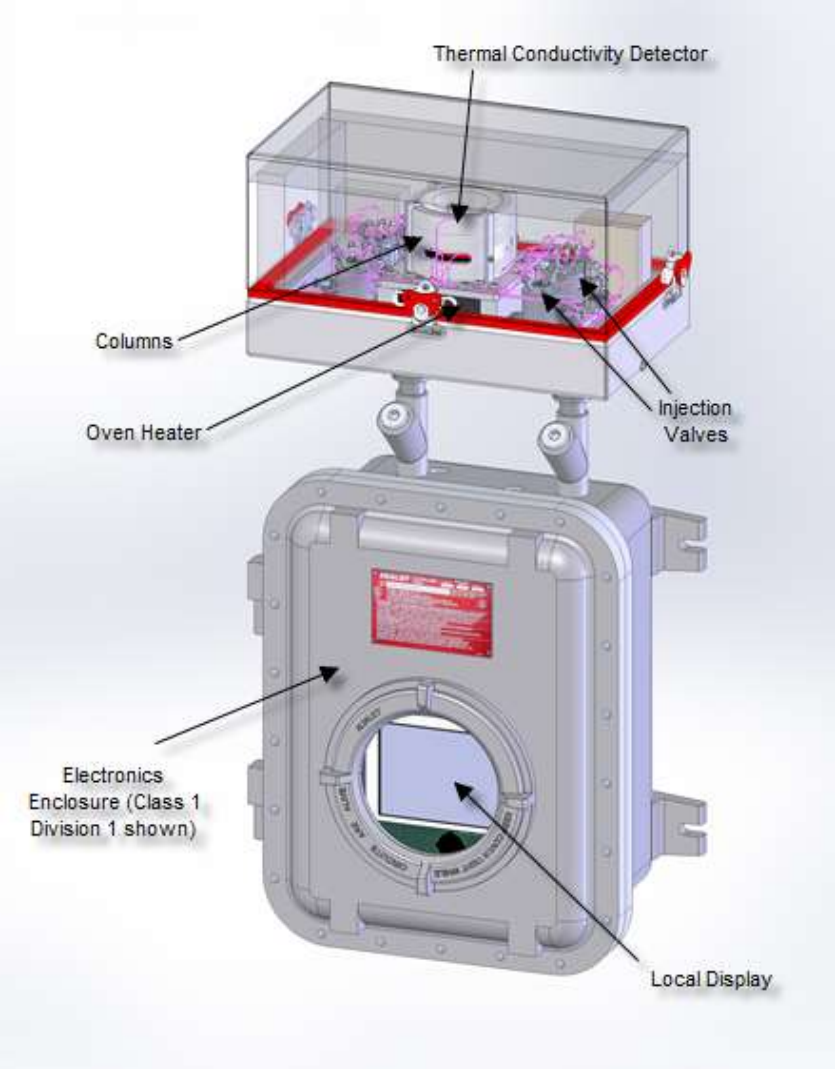


Figure 2-1: Main Components of the Accuchrome Gas Chromatograph-Class 1 Division 1

The lower compartment houses the ACCUCHROME electronics.

2.2 Chromatograph Oven

2.2.1 Injection/Switching Valves

The ACCUCHROME uses Valco Model DV22 injection/switching valves for directing the flow of carrier gas and sample gas within the chromatograph oven. See Section 15 of this manual for more information about the operation and maintenance of the valves.

2.2.2 Chromatograph Columns

The ACCUCHROME uses micro-packed columns for the separation of the natural gas into its constituent components. The stationary phase is either porous polymer or liquid coated diatomaceous earth and is packed into a 1/16" O.D. tube. The length of the column will depend on the specific separation requirements.

The micro-packed columns are manufactured by Galvanic Applied Sciences. The chromatograph valve and column are shown in Figure 2-2.

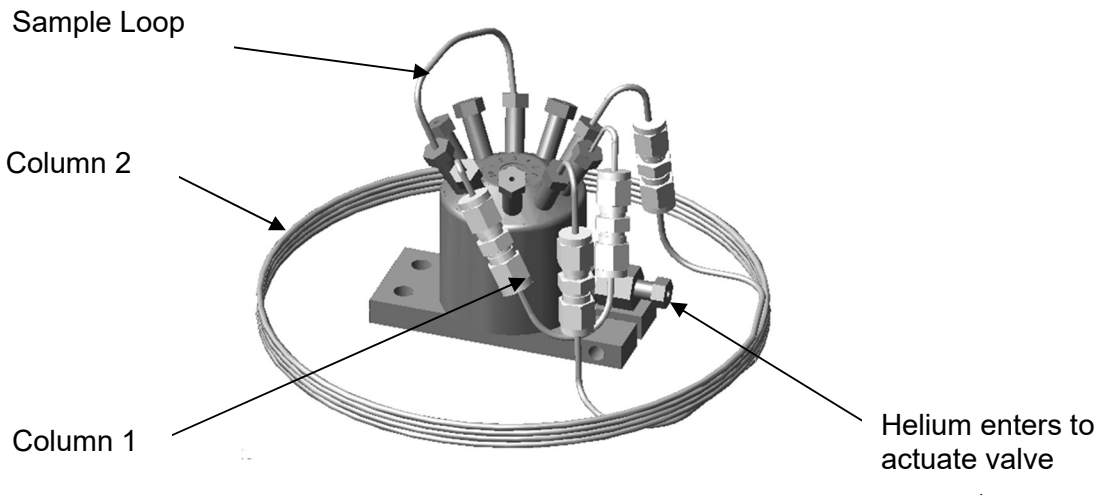


Figure 2-2: Chromatograph Valve and Columns

2.2.3 Thermal Conductivity Detector

A thermal conductivity detector (TCD) is used to detect the amount of each individual component as it elutes from the chromatograph columns (Figure 2-3). The TCD is housed inside the chromatograph oven and is kept at a very stable temperature to minimize drift.

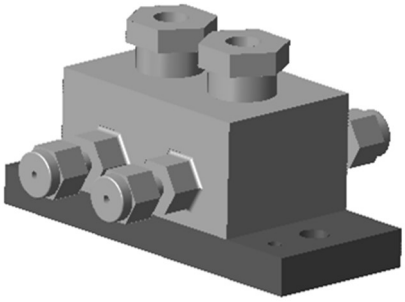


Figure 2-3: Thermal Conductivity Detector

The TCD consists of 2 thermistor beads housed in separate compartments, the Reference Cell and the Measure Cell.

When there are no components eluting from the column(s), both of the thermistors are exposed to carrier gas and will be at the same temperature and thus have the same resistance. In this case the Wheatstone Bridge is balanced and the voltage from the circuit will remain at zero. The outlet of the column is plumbed to the Measurement cell so that when a compound elutes from the column it passes through the Measurement cell while the Reference cell contains only carrier gas.

Heat from the Measure thermistor will be transferred away from the Thermistor by the gas that passes through the Measure Cell. The amount of heat that is transferred will depend on the amount of gas that is flowing past and that gas's ability to conduct heat (its thermal conductivity). The temperature of the Measure Thermistor, and thus its resistance, will change. In this case the Wheatstone Bridge will become unbalanced and a voltage deflection will be observed.

2.3 Electronics Enclosure

The electronics enclosure houses the controller board, the I/O board and the display. Class 1 Division 1 models also have 2 intrinsic safety (IS) barrier boards. Figure 2-1 shows the Class 1 Division 2 model.

2.3.1 The Controller Board

Figure 2-4 shows the controller board. This board contains the microprocessor and associated components.

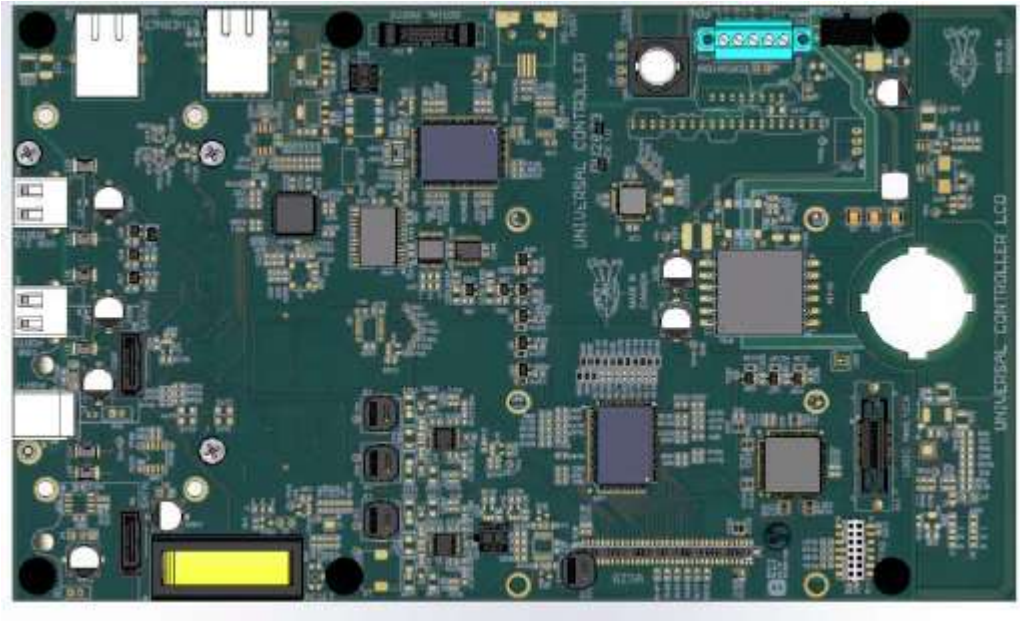


Figure 2-4: The Controller Board

2.3.2 The I/O Board

Figure 2-5 shows the I/O board. The I/O board contains all of the inputs and outputs required for the GC analysis as well as customer connections. See Section 12 for detailed descriptions of the connections.

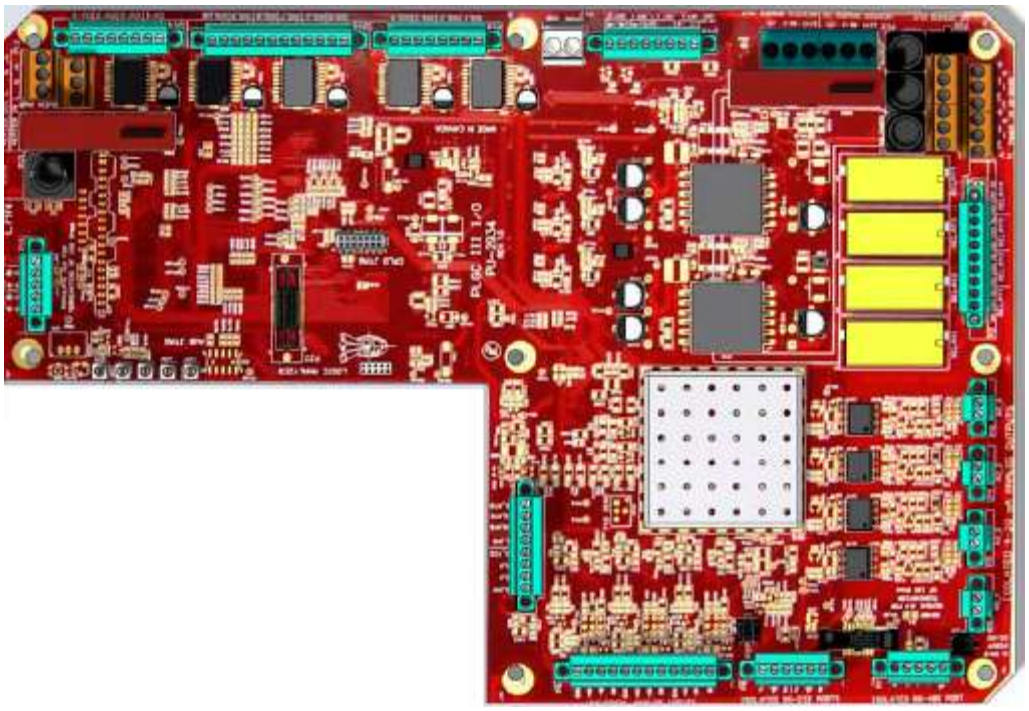


Figure 2-5: The I/O Board

2.3.3 The Display

The display (Figure 2-6) is mounted on the analyzer electronics enclosure door (for both Div 1 and Div 2 models). The display uses a local intrinsically safe keypad for navigation and can be used to view status data about the chromatograph.

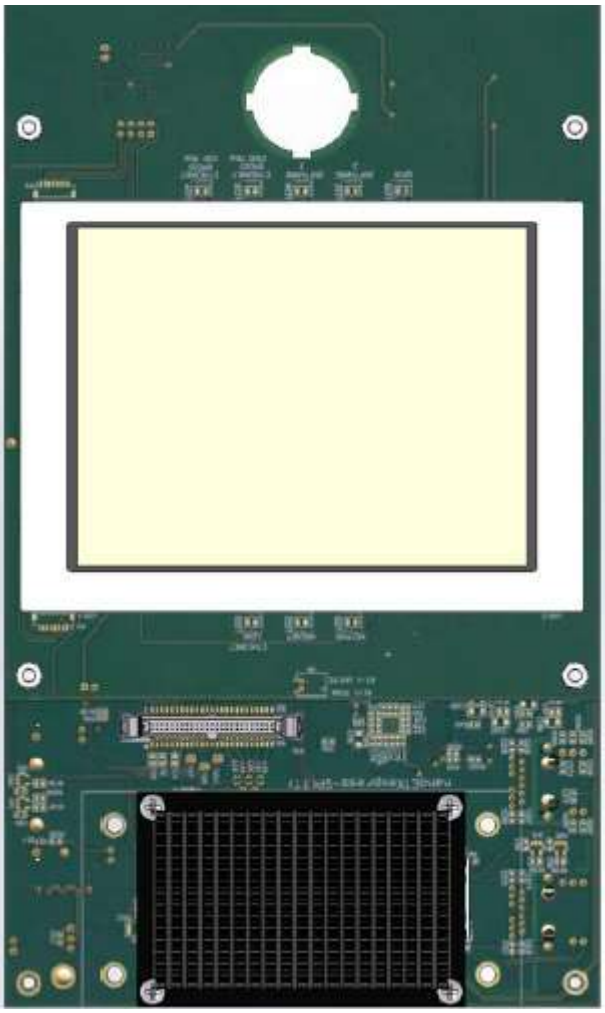


Figure 2-6: The Display

The display is an industrial VGA display with 640 x 480 resolution. It uses TFT technology with 260,000 colors and is sunlight readable.

2.3.4 The Intrinsic Safety (IS) Barrier

The IS barrier (Figure 2-7) is used in the Class Division 1 units only. All electrical signals that connect from inside the explosion proof enclosure to inside the GC oven must pass through the IS barrier. The purpose of the IS barrier is to limit the amount of electrical energy that can exit the explosion proof enclosure to avoid creating an ignition source.

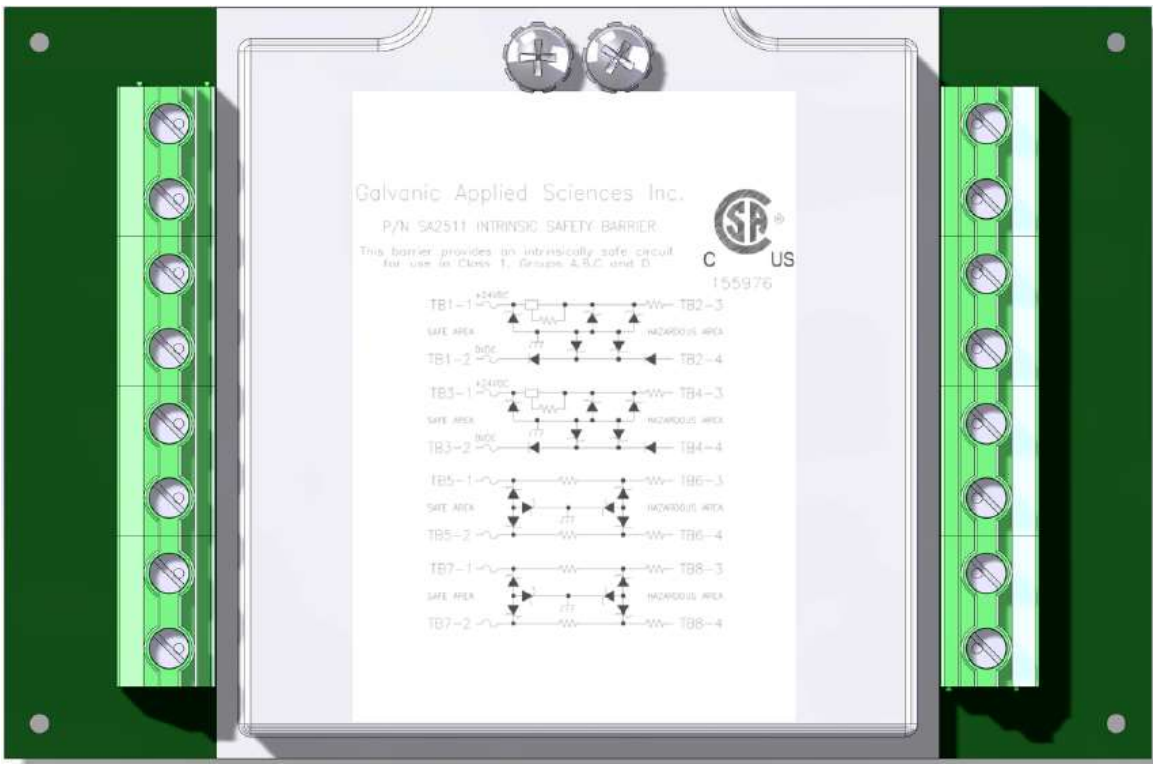


Figure 2-7: The Intrinsically Safe Barrier

2.4 Typical GC Oven Arrangements

2.4.1 12-Minute Cycle Time Systems

The oven compartment for a typical 12-minute cycle time ACCUCHROME system is composed of a Valco model DV22 10 port valve and two columns (some applications may only require one).

- The valve, which performs sample injection and back flushing, is actuated by the carrier gas. It is specifically designed for heavy-duty applications and is rated at 1,000,000 injections before requiring service. The injection volume is controlled by a fixed-volume sample loop.
- Chromatography columns are employed to separate the natural gas. In two column natural gas analysis systems, Column 1 separates all components except C6+, trapping C6+ for a quick back flush out. Column 2 separates the remaining components. The total analysis time is about 12 minutes, and the analysis is run isothermally at 70° C.
- The temperature of the chromatograph oven is controlled to minimize retention time shifts due to ambient temperature changes. The gas flow paths for single column and two column configurations are shown in Figure 2-8 and Figure 2-9.

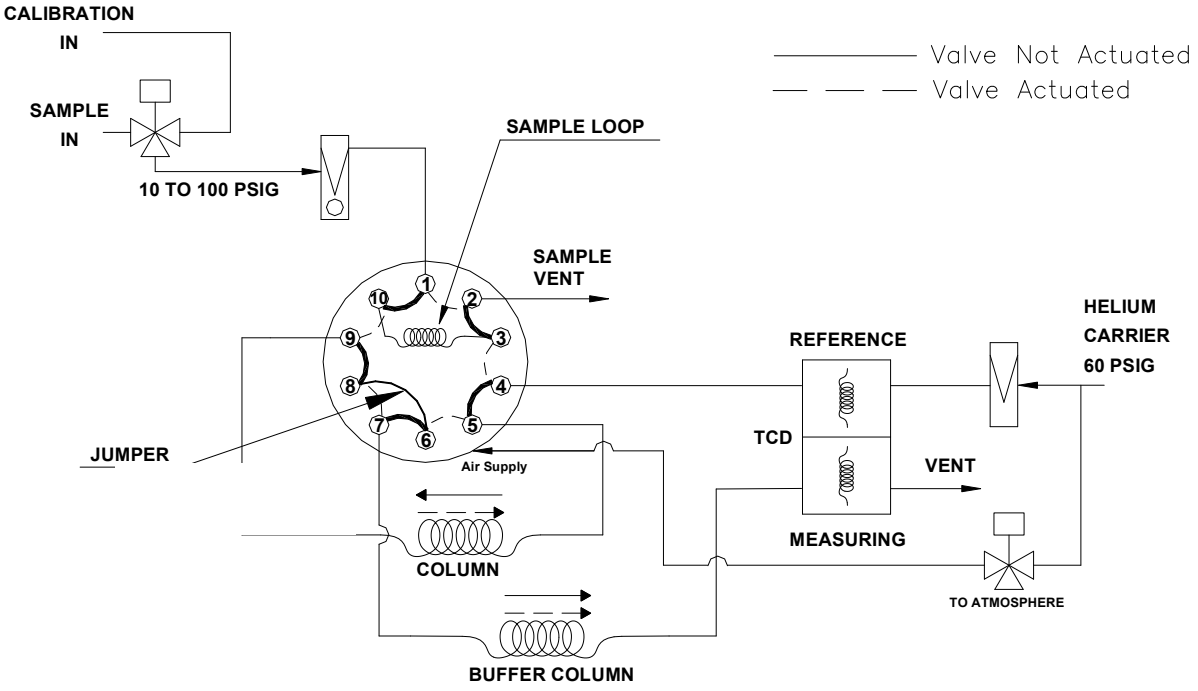


Figure 2-8: Single Column Flow Diagram

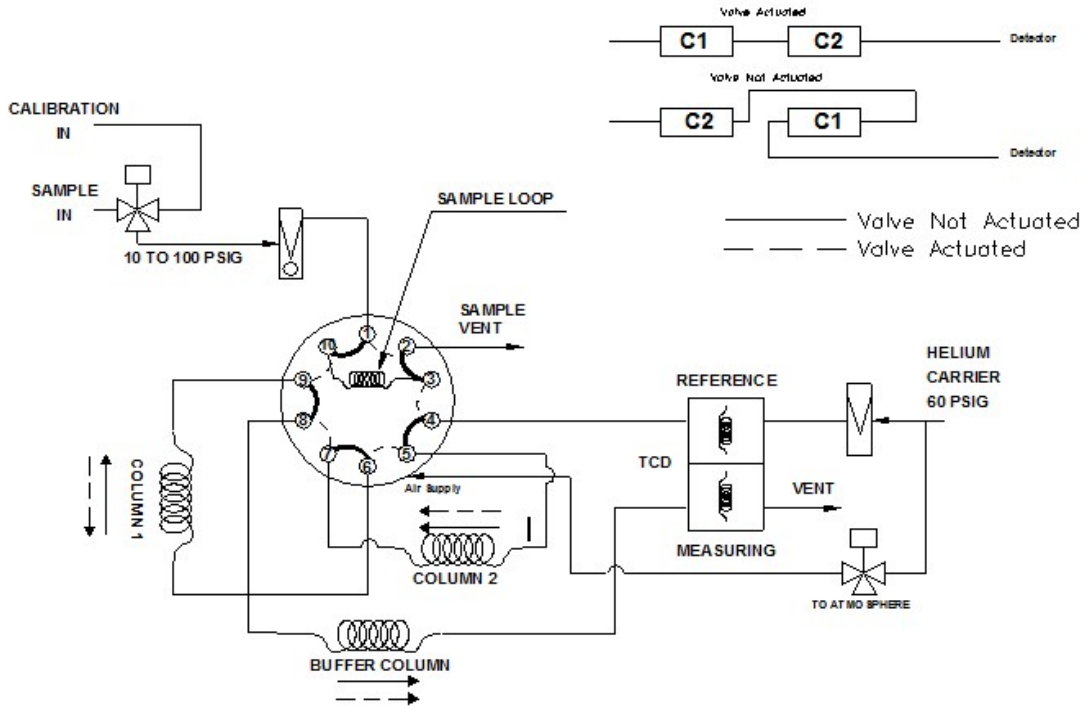


Figure 2-9: Two Column Flow Diagram

2.4.2 4-Minute Analysis Cycle

The oven compartment for a typical 4-minute cycle time ACCUCHROME system is composed of one Valco model DV22 10 port valve, one Valco model DV22 10 port valve and four columns.

Four chromatography columns are used to facilitate the rapid analysis of the sample gas. All components but C6+ pass through column 1, and C6+ is trapped by column 1 for a quick back flush out. Column 2 allows for the rapid passage of nitrogen, methane, carbon dioxide and ethane into column 3, while separating the heavier hydrocarbon components propane, i-butane and n-butane, and i-pentane and n-pentane. Once ethane has entered column 3, the six-port valve is actuated, trapping nitrogen, methane, carbon dioxide and ethane in column 3.

The heavier components pass through a jumper (marked in the diagram as R1), a short piece of tubing containing no packing material, on their way to the detector. Once n-pentane has eluted, the six-port valve is actuated a second time, and nitrogen, methane, carbon dioxide and ethane then elute from column 3. Total analysis time is about 4 minutes, and as before the analysis is run isothermally at 70°C. The gas flow path for the HSHV analysis is shown in Figure 2-10.

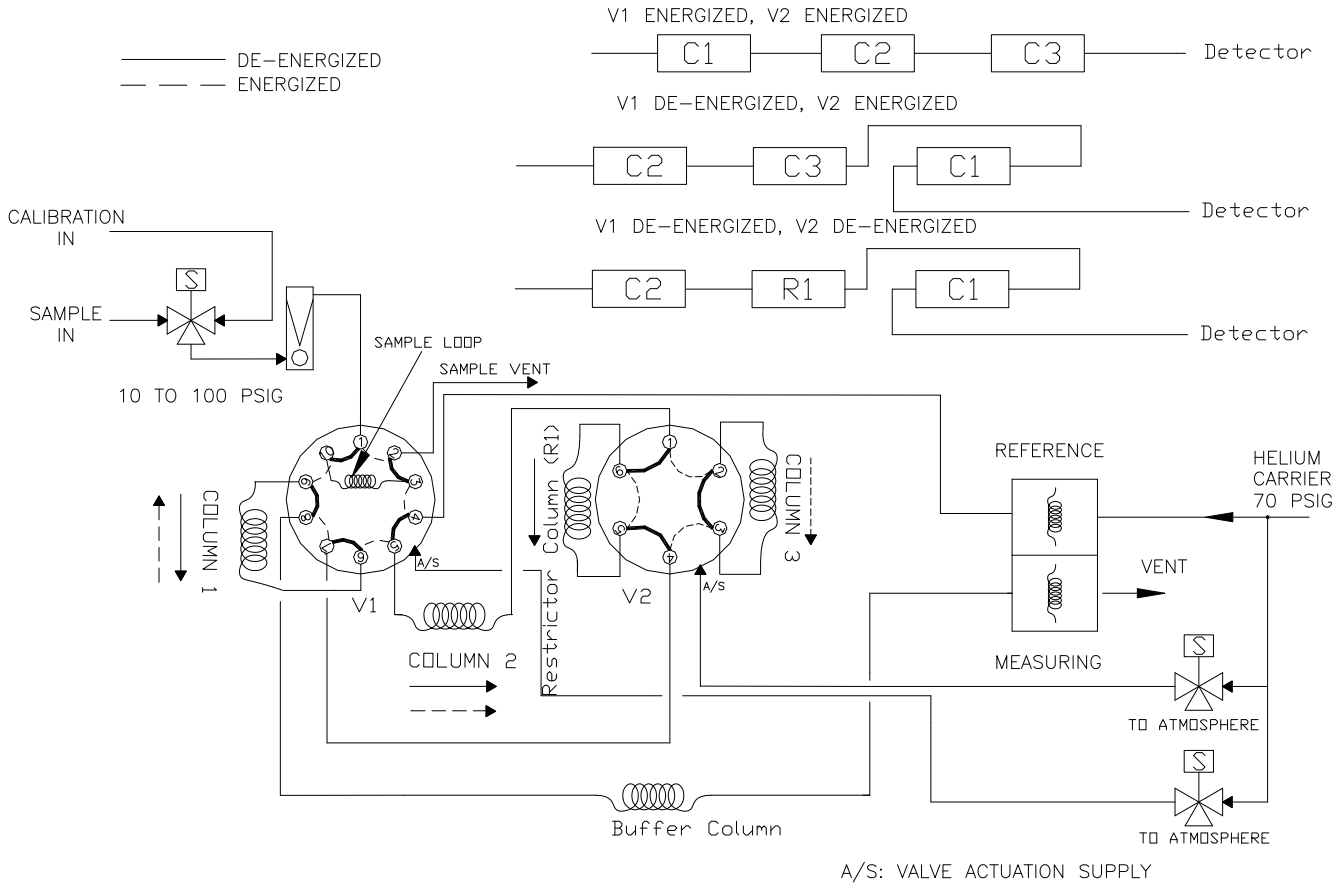


Figure 2-10: 4-Minute Analysis Flow Diagram

Section 3 Installation

3.1 Receiving the System

When the ACCUCHROME Natural Gas Chromatograph arrives, inspect the packaging for external signs of damage. If there is any obvious physical damage, immediately contact the shipping agent and Galvanic Applied Sciences to report the damage and request that the carrier's agent be present when the unit is unpacked. It is recommended that you retain the shipping container so that it may be used for future shipment of the unit, if necessary.

3.2 Environmental Requirements

3.2.1 Temperature/Humidity

The ACCUCHROME Natural Gas Chromatograph is designed to be operated at ambient temperatures from -18°C to +60 °C. The humidity should be between 0 and 95%, non-condensing. For maximum accuracy and reliability it is recommended that the analyzer be housed in an environmentally controlled shelter or enclosure.

For outdoor installations, the analyzer should be protected from direct sunlight and rain. Enclosures are available from Galvanic Applied Sciences.

3.2.2 Space Requirements /Weight

The size and weight of the ACCUCHROME Natural Gas Chromatograph is presented in Table
3-1. The installation site should provide adequate room for opening the cabinet doors for maintenance and repair procedures. Complete dimensional information is provided in Figures 3-1 and 3-2.

When the system is installed, leave 6” between the unit and other devices.

Table 3-1: Space/Weight of the ACCUCHROME Chromatograph

	Size	**Weight**
Class 1, Div 1	AC: 1216 mm (47.875”) H x 686 mm (27”) W x 260 mm (10.25”) DC: 838 mm (33”) H x 686 mm (27”) W x 260 mm (10.25”)	AC: 61kg (135 lbs) DC: 54.4kg (120 lbs)
Class 1, Div 2	838 mm (33”) H x 686 mm (27”) W x 235 mm (9.25”)	38.5kg (85 lbs)

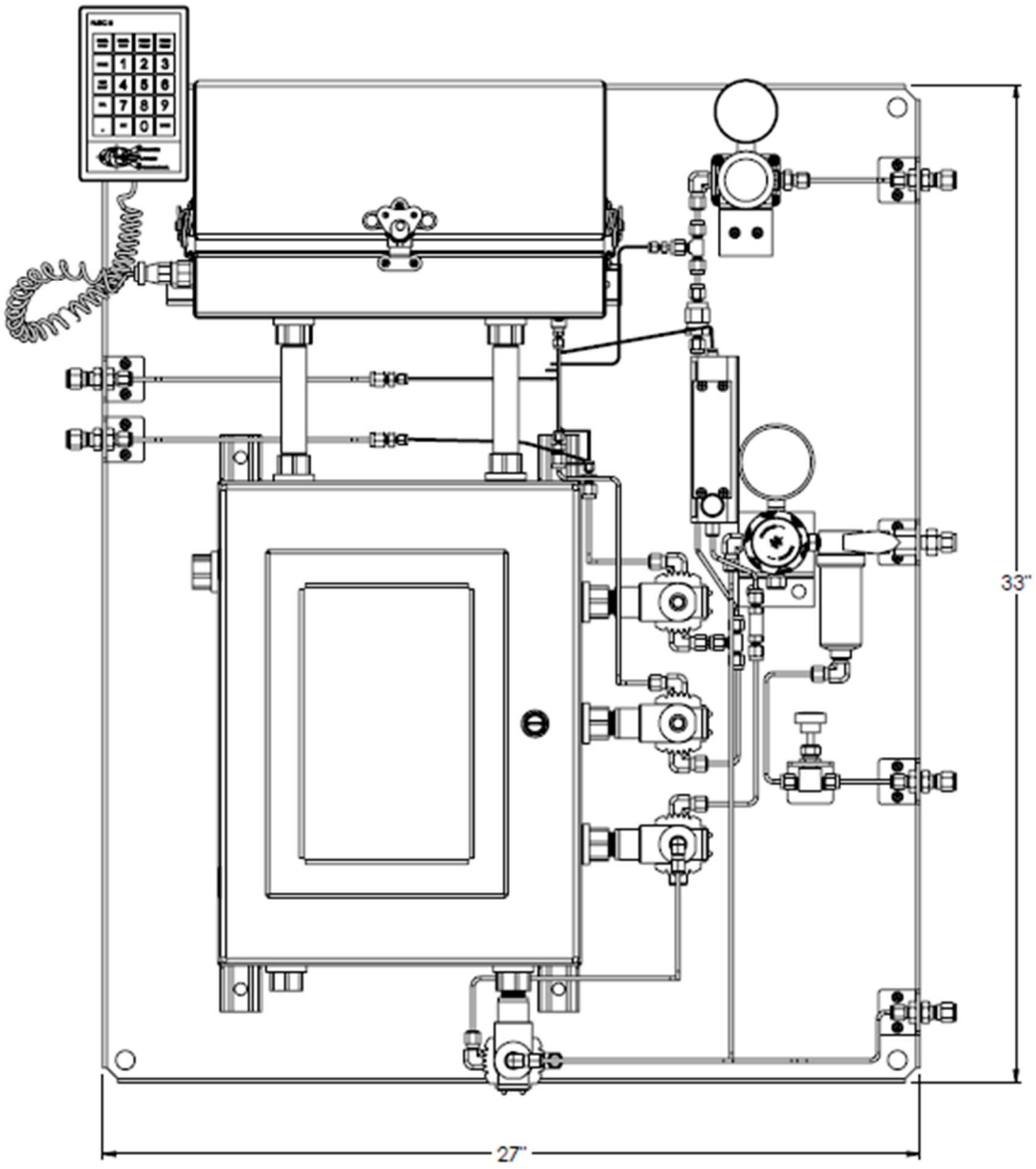


Figure 3-1: Physical Dimensions - Class 1, Div 2 ACCUCHROME Chromatograph

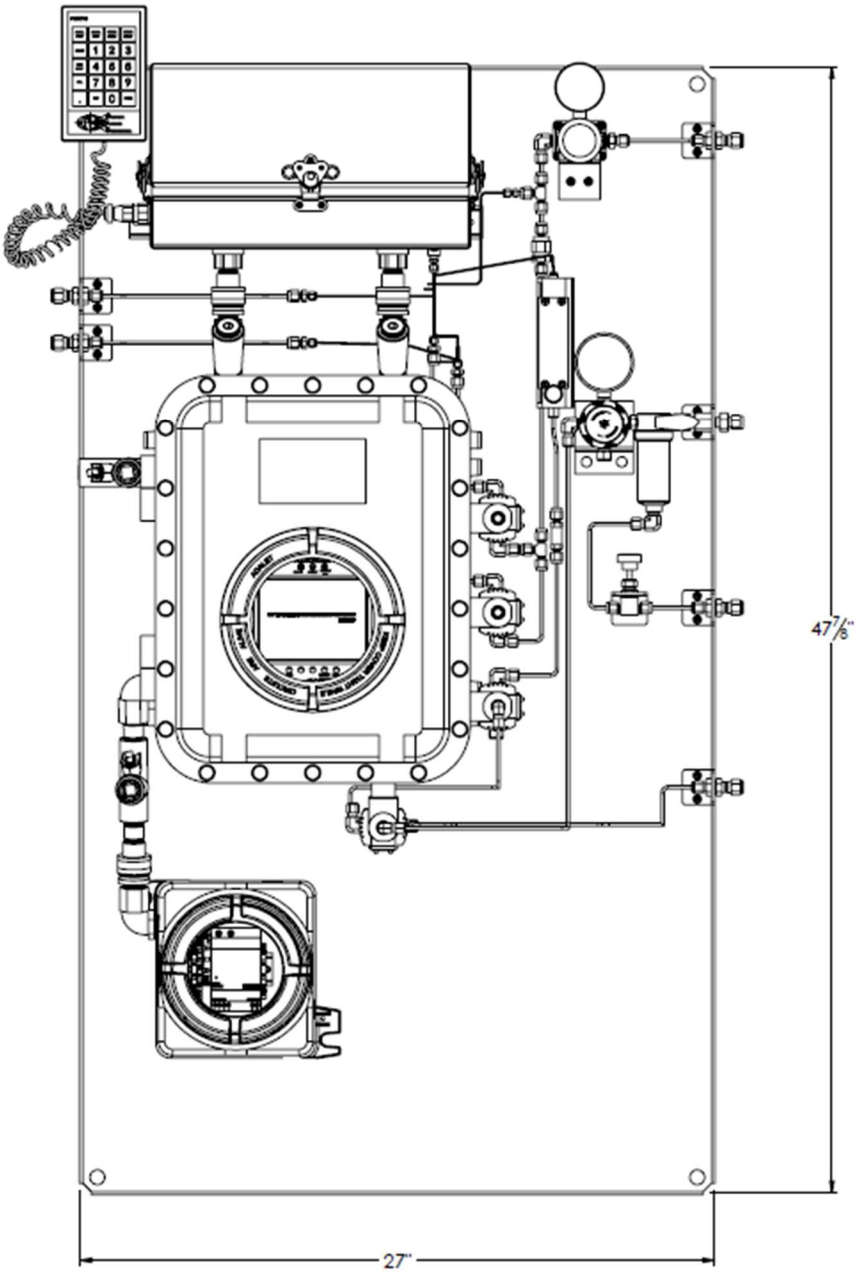


Figure 3-2: Physical Dimensions - Class 1, Div 1 Explosion Proof ACCUCHROME Chromatograph

⚠WARNING

Explosion Hazard – Substitution of components may impair suitability for Class 1, Division 1 or Class 1, Division 2.

Risque d'explosion – La substitution de composants peut render ce material inacceptable pour les emplacements de Classe I, Division 2.

3.3 Sampling Considerations

3.3.1 Sampling Point Location

The ACCUCHROME Natural Gas Chromatograph should be located at a point as close as possible to the stream being analyzed to avoid lag times and sample degradation in the delivery line. The samples sent to the analyzer must be representative of the stream.

3.3.2 Sample Volume and Flow Rate

The sample should be supplied to the analyzer at a maximum pressure of 100 psig. A flow meter at the analyzer will control the flow into the analyzer's sample valve at 50cc/min. A bypass sweep is recommended to reduce lag time in the sample lines.

3.3.3 Sample Conditioning

An optional sampling system is available with the ACCUCHROME Natural Gas Chromatograph to regulate and filter the sample. The sample system is required if the sample is not available at a pressure less than 100 psig, contains particulates, or is subject to liquid dropout. Consideration must be taken of normal conditions as well as abnormal conditions when designing the sample system as contamination may be an issue. Please contact Galvanic Applied Sciences for assistance.

3.4 Electrical Requirements

The ACCUCHROME is available with 24 VDC power input or 90-240 VAC power input.

The power consumption is approximately 150 watts at start-up and approximately 50 watts when running at constant temperature.

3.5 Unpacking

The ACCUCHROME Natural Gas Chromatograph is packed for shipment in a wooden crate.

To unpack the system:

a) Remove the lid by undoing the screws.

b) Once the lid is off, remove the excess packing material and boxes from the shipping crate.

c) Visually inspect the small packages to ensure that no major damage has occurred. If damage has occurred, contact the shipping company and Galvanic Applied Sciences. Place the small packages aside in a safe, secure storage area as they are not needed at this stage of the system installation.

d) Inspect the internal equipment to ensure that no damage has occurred and that no components have become loose during transport.

   If any damage is visible contact Galvanic Applied Sciences Inc. immediately and do not proceed with the system installation. Do not attempt to facilitate repairs yourself as this will negate and/or invalidate any possible insurance claim or equipment warranty.

e) If no damage is apparent, the analyzer system is ready for transport to the installation (sample point) site.

3.5 Installation Steps

The ACCUCHROME analyzer was tested and configured at the factory. The program parameters are documented in the Configuration Report (enclosed with this manual).

To install the ACCUCHROME Natural Gas Chromatograph:

a) Firmly bolt the analyzer to the plant support structure. The structure should be able to support the system.

   The Class 1 Div 1 system has four (4) 3/4" diameter holes to accommodate the mounting to the plant support structure. The plant support structure should be suitable for mounting the analyzer frame.

   The Class 1, Div 2 system has four (4) 3/4" diameter holes to accommodate the mounting to the plant support structure. The plant support structure should be suitable for mounting the analyzer frame.

Follow all plant/company safety procedures while installing the ACCUCHROME.

b) Connect the source of carrier gas. The carrier gas should be supplied to the analyzer at 80 - 100 psig using ¼" stainless steel tubing. For uninterrupted carrier gas it is recommended that a cross over manifold system be used.

c) Connect the calibration gas. The calibration gas should be connected to the analyzer using 1/4” stainless steel tubing at 15 psig.

d) Connect the sample gas. The sample gas is extracted from the process pipe by means of a sample probe. Galvanic Applied Sciences recommends the use of a probe/regulator type assembly for the gas extraction. The pressure should be dropped at the sample point from pipeline pressure to 30 - 50 psig and further reduced at the analyzer to 15 psig. 1/4” stainless steel lines are recommended. The hydrocarbon dewpoint of the sample should be taken into consideration to ensure that the temperature of the sample gas does not drop below the hydrocarbon dewpoint of the sample. This may require the use of heated sample transfer lines.

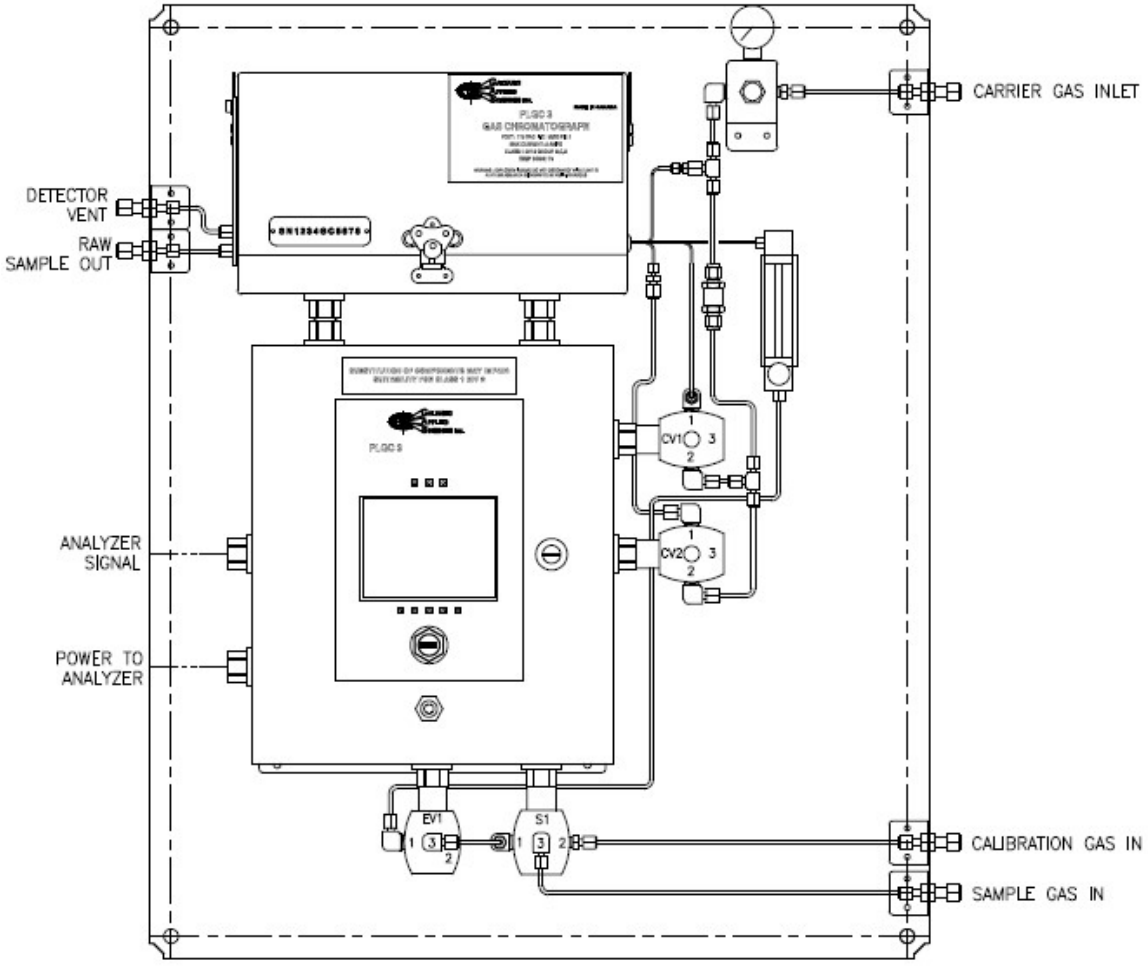


Figure 3-3: Gas Tube-in Ports and Vent, Class 1, Div. 1 System

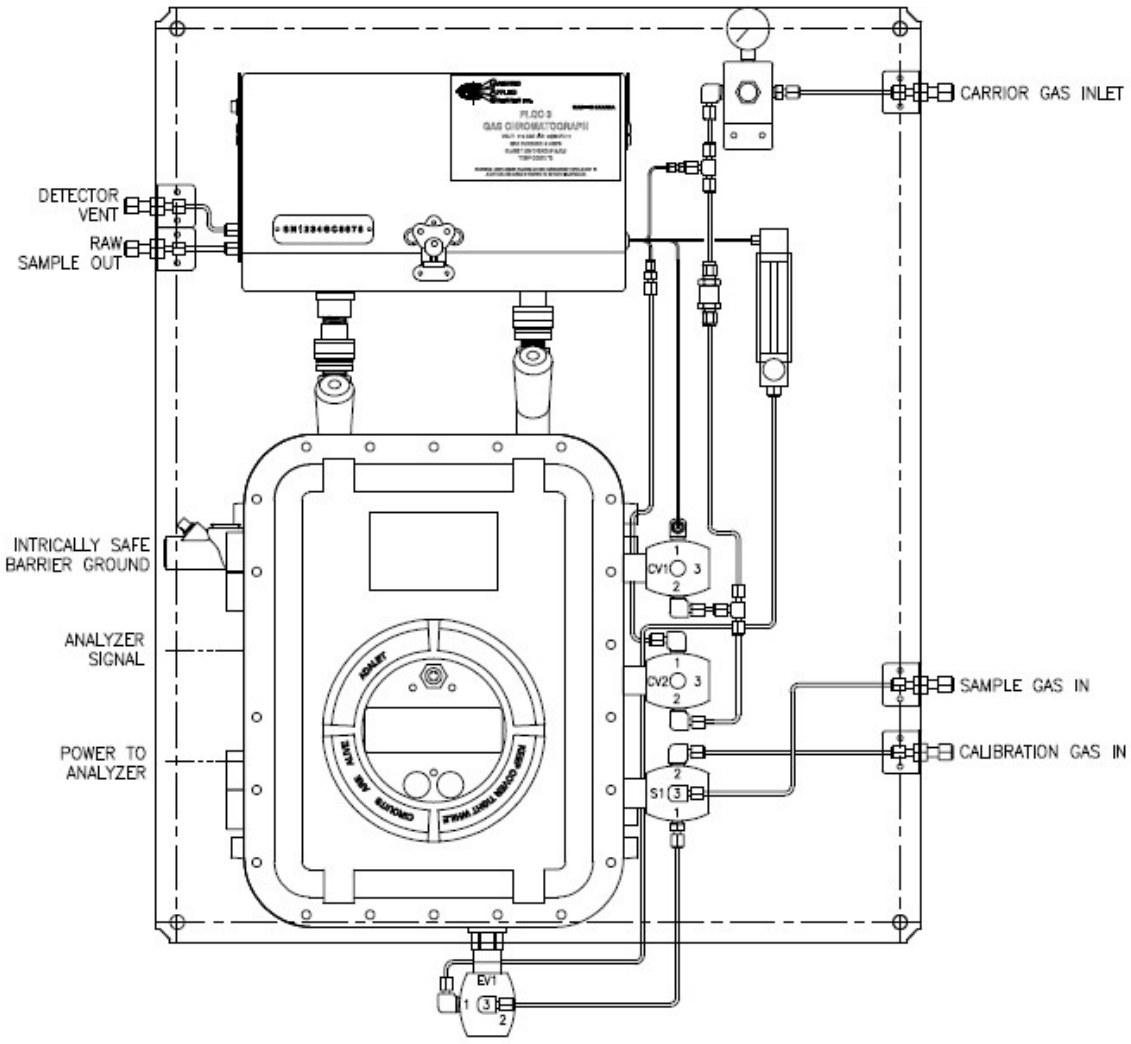


Figure 3-4: Gas Tube-in Ports and Vent, Class 1, Div. 2 System

e) There are 2 vents from the oven on the ACCUCHROME. One vent , the “Sample Vent” is used for the gas that flows through the chromatograph injection valve’s sample loop. This line can be vented to atmosphere or to a low pressure flare header. The second vent, the “Detector Vent”, is used for the effluent from the chromatograph column(s). This must be vented to atmosphere.

f) Connect Signal Cables(s) to the analyzer. The analysis results are available on Modbus Serial, Modbus TCP/IP, or by 4-20 mA signals.

See Section 12 for detailed wiring instructions.

NOTICE **Installation of the conduit, wiring and disconnect devices must comply with all applicable national, local and user electrical codes.**

g) Connect the power to the analyzer.

NOTICE

A switch or circuit breaker should be included in the building installation. The switch/circuit breaker shall be in close proximity to the equipment and within easy reach of the operator. The switch/circuit shall be marked as the disconnecting device for the equipment.

h) Power up the system.

3.6 Interfacing the Chromatograph to the Computer

Connection to the analyzer can be made by ethernet, serial port (RS232 or RS485). To connect the Chromatograph to the Computer:

a) Connect the cable between the chromatograph and the computer.

b) Access the *System* tab on the display on the chromatograph using the *Next Panel* key on the keypad.

c) Access the *Network* sub-panel (Figure 3-5) using the *Next Panel* key on the keypad.

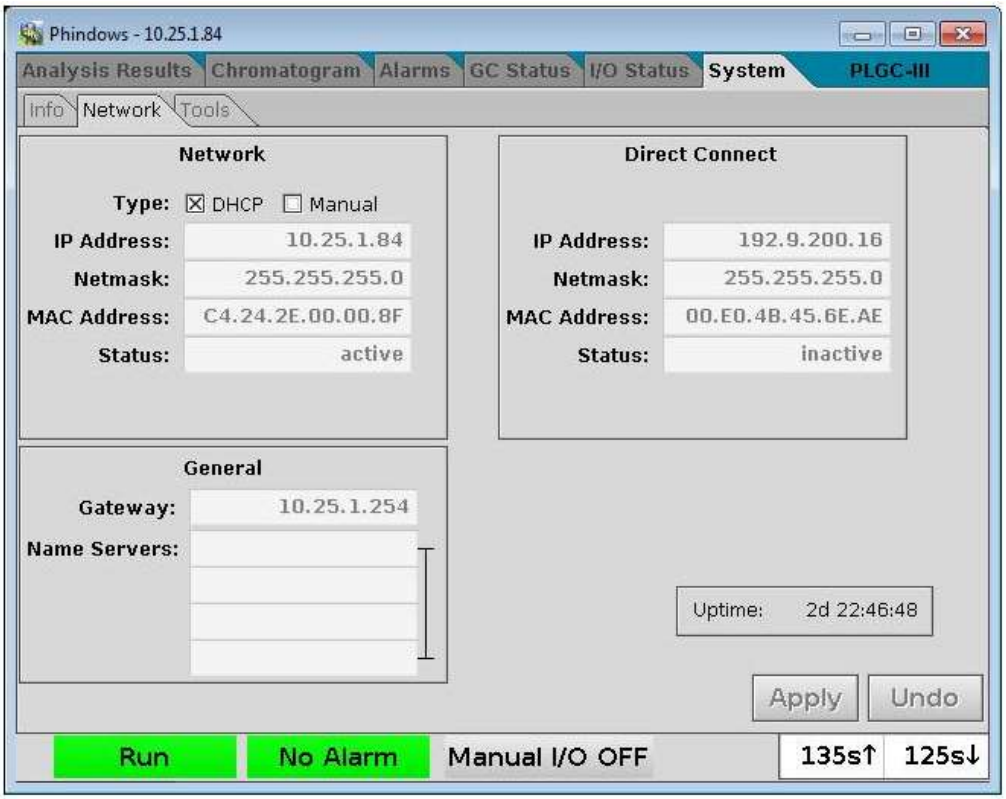


Figure 3-5: Network Sub-panel

NOTICE **A detailed description of the use of the keypad and display is presented in Section 4.2.**

d) Select either DHCP or Manual and press *Enter*.
   - If DHCP is selected, the local area network will automatically assign an IP address to the unit.
   - If Manual is selected, the user must enter the IP address, netmask and gateway.

e) Press *Apply*.

3.7 Customer Connections

Typical connection to the analyzer is by ethernet, serial port (RS232 or RS485) or analog signal (4-20mA). Up to four relay signals can be connected for status and fault monitoring.

Section 4 The User Interaction Scheme

4.1 Overview

The display on the chromatograph provides a broad overview of the system status and the concentration of the various compounds in the sample. The display and keypad used for local control are described in Section 4.2.

The application software (GUI) on the computer is designed to generate a configuration (which describes the overall operation of the system), collect and process chromatographic data, generate reports and archive data. Section 4.3 describes how to log onto the system. The application software is divided into two parts:

- *View* - used for routine operation of the chromatograph (Section 4.4).
- *Edit* - used to establish the configuration. The configuration is transmitted to the system (Chapter 5). A variety of configurations can be generated and downloaded as required to meet the needs of the facility.

Chapter 6 presents a discussion of routine operation of the system and Chapter 7 presents a description about how the system is calibrated.

4.2 Navigating the Chromatograph Display

The display (the default display is shown in Figure 4-1) on the chromatograph module presents an overview of the system status and the concentration of the various components in the sample. The display is controlled by the keypad provided with the system and a number of screens can be displayed as described below.

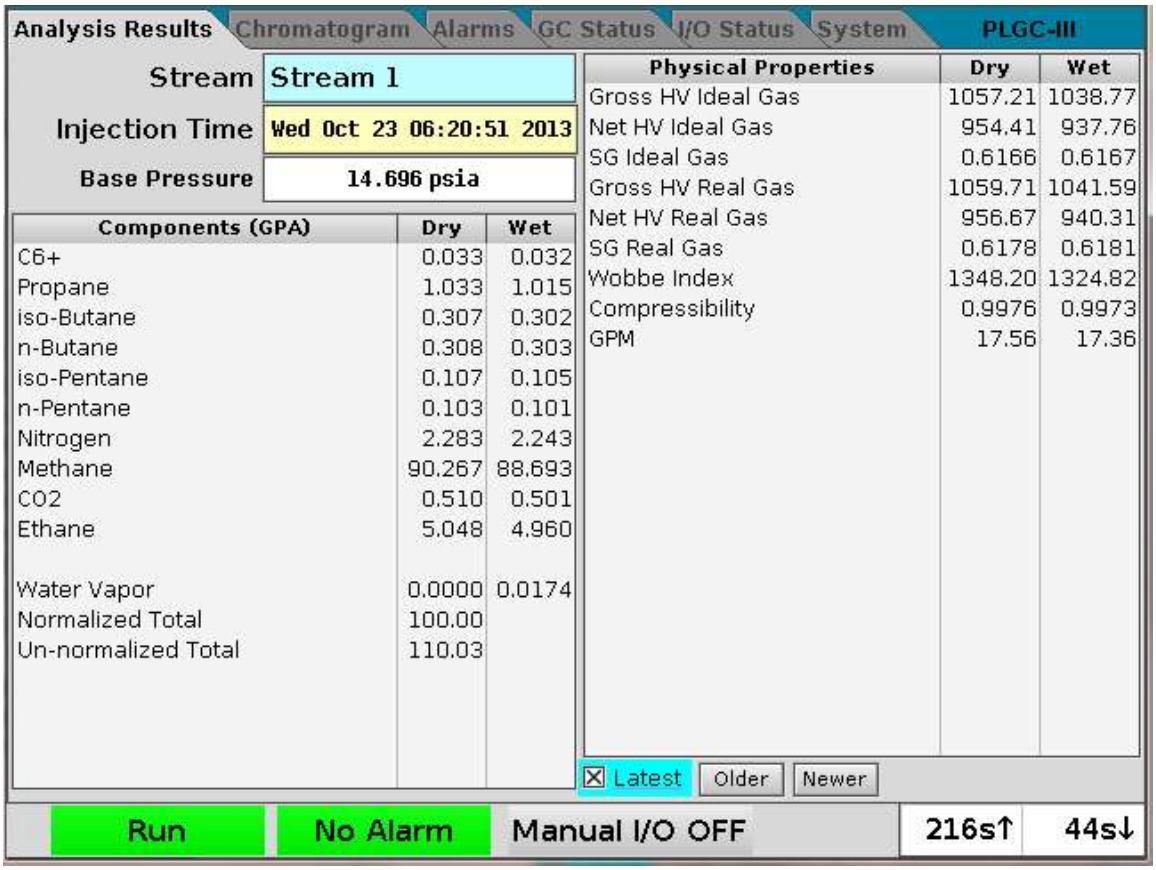


Figure 4-1: The Display on the Chromatograph

The bottom line of the display indicates system status. The right two values indicate the elapsed time and the remaining time of the present run.

The first field on the bottom line of the display will present *Run*, *Halt Pending* or *Halt*, depending on the present status of the chromatograph.

The second field on the bottom line of the display indicates alarm status. If an alarm is present, the field will turn red and read *Alarm*.

4.2.1 The Keypad Controller

The Keypad Controller (Figure 4-2) is used to navigate between the various screens of the display, enter data and initiate/terminate runs.

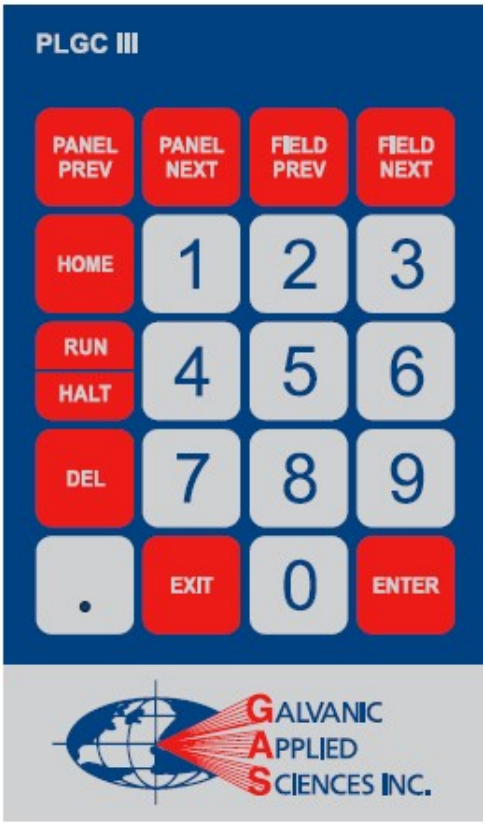


Figure 4-2: The Keypad Controller

Panel Prev/Panel Next - used to navigate between panels on the display

Field Prev/Field Next - used to navigate between fields on a panel.

Home - displays the Analysis Results panel (Figure 4-1)

Run/Halt - Initiates/Stops the present separation

Del - Removes the present setting

Exit - Exits an editable field without changing the value.

Enter - Used to indicate that the present value is to be used.

4.2.2 The Analysis Results Tab

The *Analysis Results* tab (Figure 4-1) presents the analytical results and calculated properties from the most recent run.

Data from the previous run can be obtained by selecting the *Older* button (the check mark by Latest will be removed). The *Newer* button is used to present the newest data if the *Older* button has been used or the checkmark by the *Latest* box can be checked.

4.2.3 Chromatogram Tab

The *Chromatogram* tab (Figure 4-3) presents the chromatogram that is presently being collected.

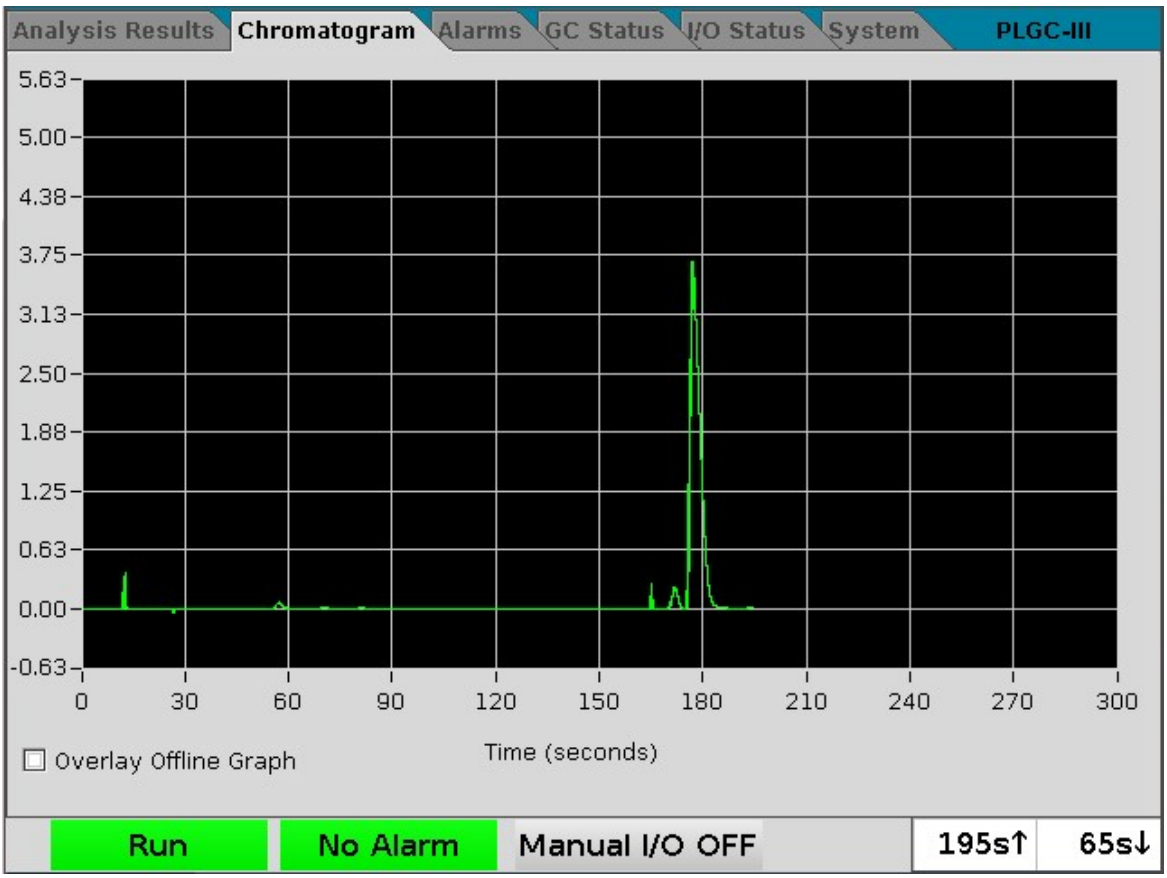


Figure 4-3: Chromatogram Tab

4.2.4 Alarms Tab

The Alarms tab (Figure 4-4) presents a list of alarms that have been observed.

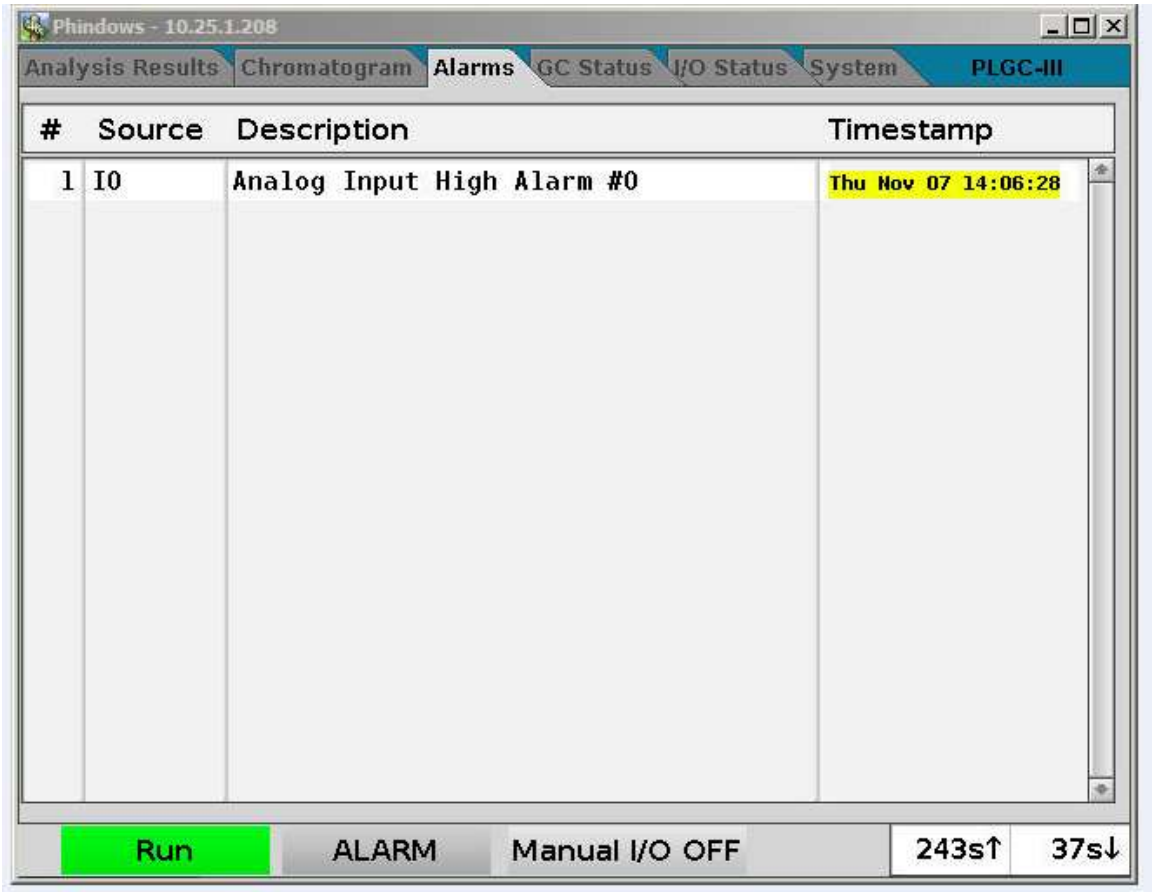


Figure 4-4: The Alarms Tab

4.2.5 GC Status Tab

The *GC Status* tab (Figure 4-5) indicates the instantaneous status of the system and is read-only information.

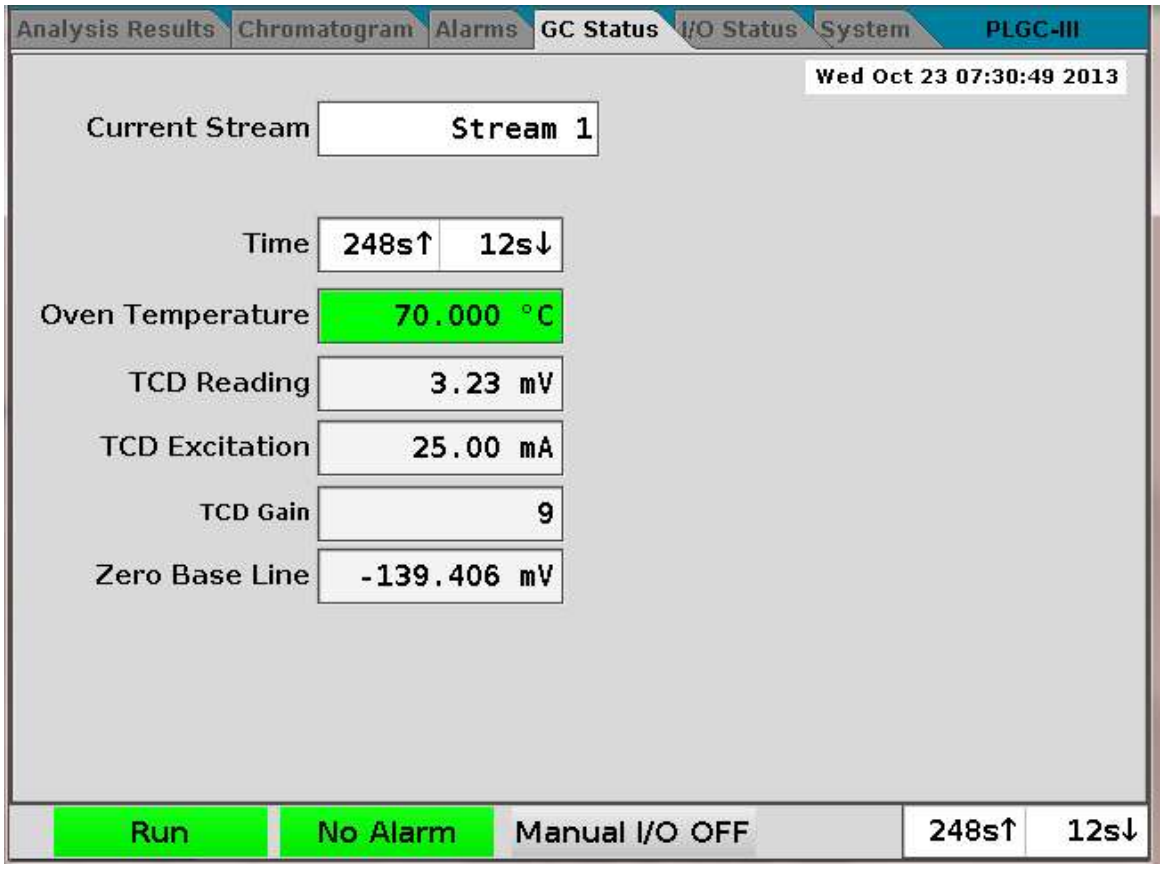


Figure 4-5: GC Status Tab

4.2.6 I/O Status Tab

The *I/O Status* tab (Figure 4-6) is used to indicate the present status of the Digital Inputs, Relays, Valves and Solenoids. A green background indicates that the device is currently turned on while a grey background indicates that it is turned off. This information cannot be edited by the controller.

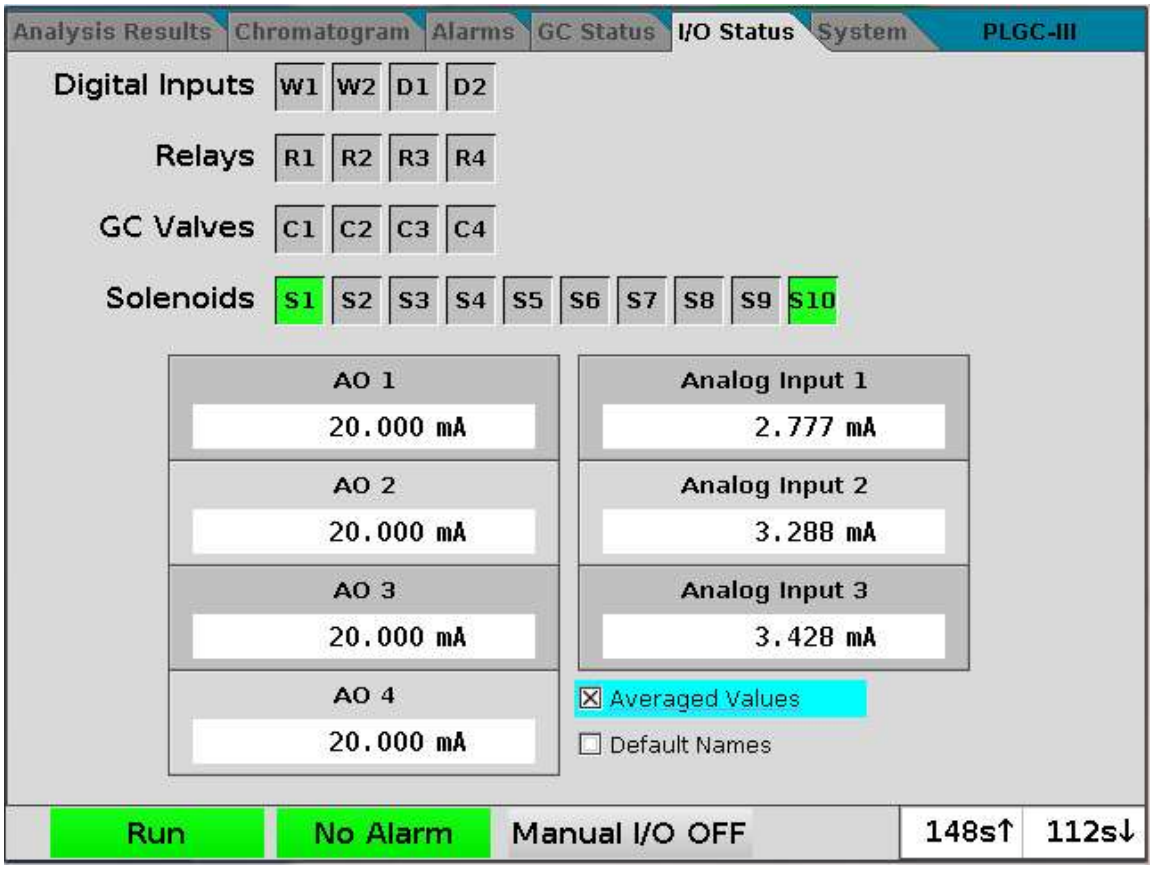


Figure 4-6: I/O Status Tab

If the *Averaged Values* check box is selected, the values are average over a period defined internal to the analyzer

If the *Default Names* check box is selected, the names for the analog inputs and outputs will be the names assigned during manufacturing, rather than names provided by the GUI.

4.2.7 System Tab

The System tab (Figure 4-7) has 3 sub tabs.

4.2.7.1 Info Sub-tab

The *Info* sub-tab (Figure 4-7) presents information that may be useful when you are requesting assistance from Galvanic Sciences. This information cannot be edited.

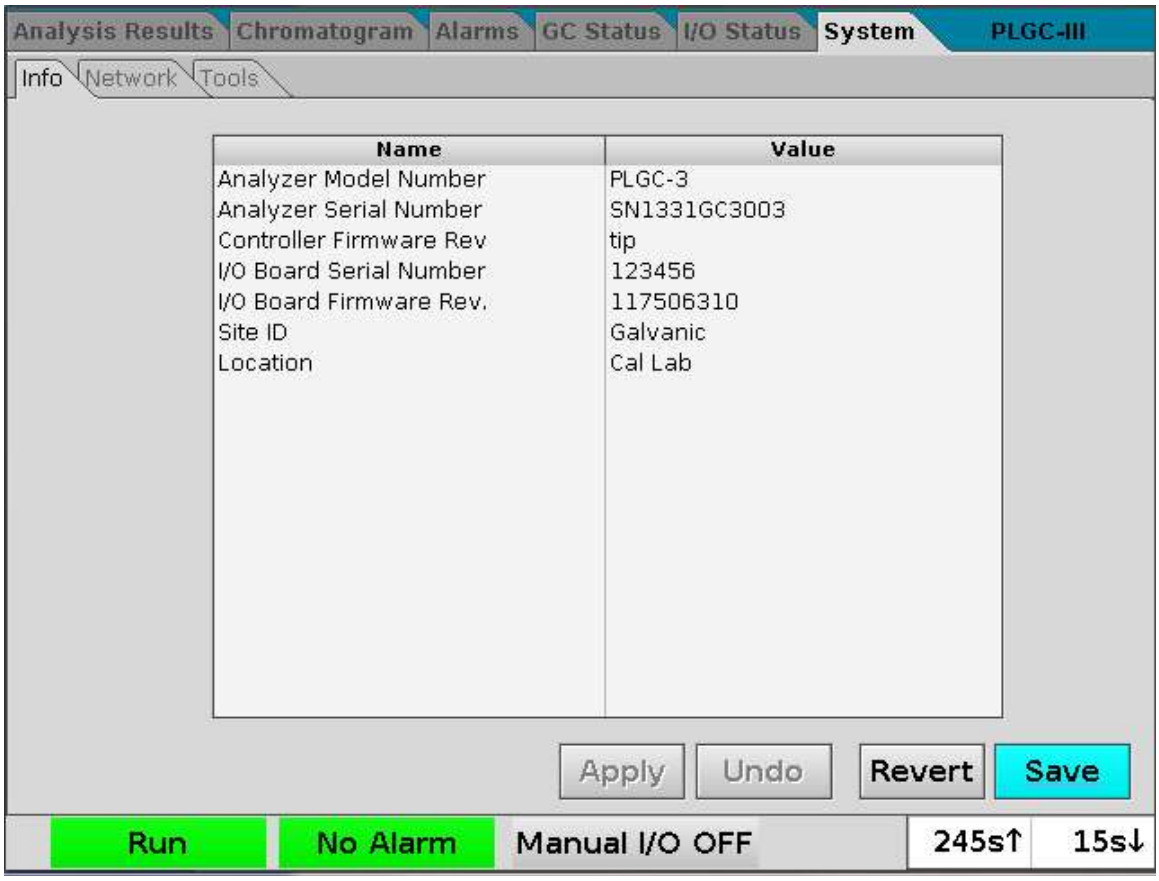


Figure 4-7: Info Screen

The *Revert* button sets the values to the previous settings and the *Save* button is used to enable the changes.

4.2.7.2 Network Sub-tab

The *Network* sub tab (Figure 4-8) is used to establish communication between the chromatograph and the computer. A detailed discussion of this topic is presented in Section 3.6.

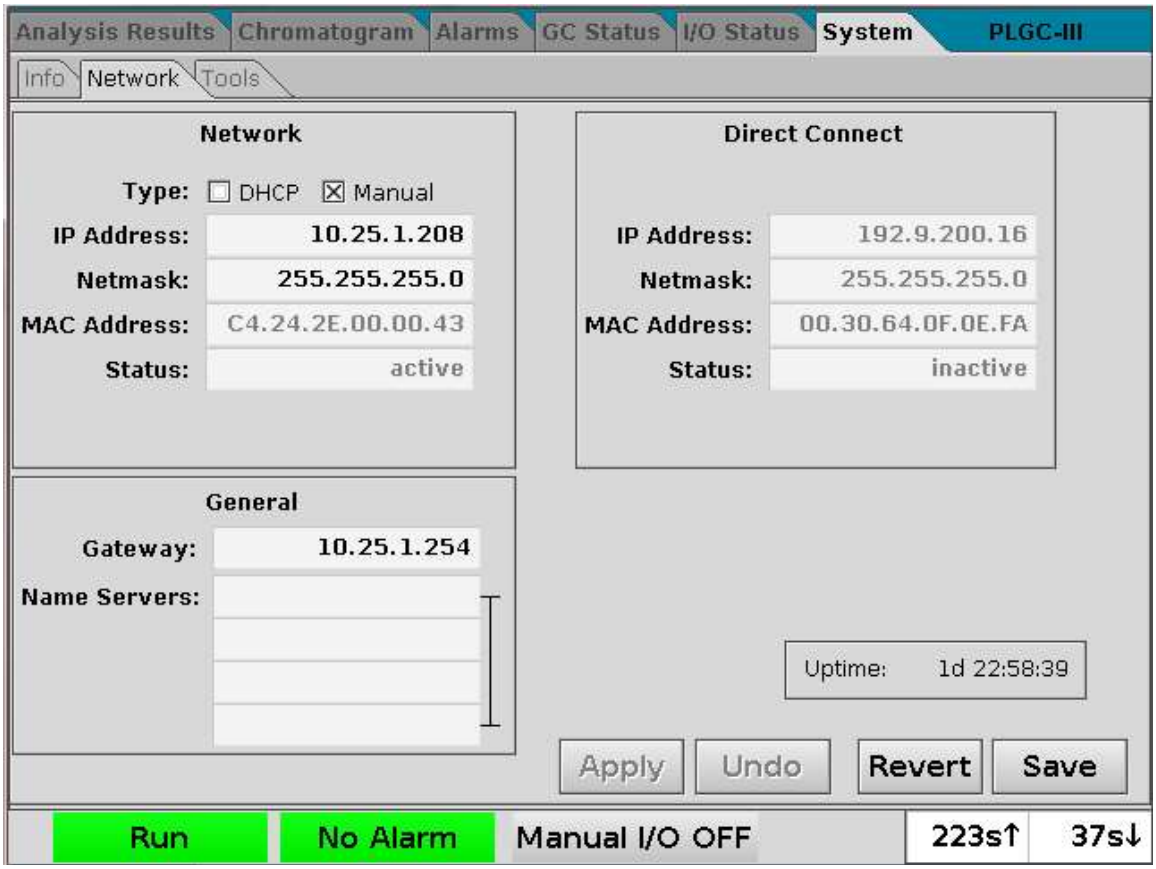


Figure 4-8: The Network Tab

4.2.7.3 The Tools Sub-tab

The *Tools* sub-tab (Figure 4-9) can be used to adjust the backlighting of the display and fan speed for the microprocessor cooler (optional). The *More* and *Less* buttons are used to adjust the settings (the slider is merely an indication of the level and is controlled by these buttons)

The *Analysis Y Range and Analysis X Range* fields are used to set the scale for the display of the Chromatogram (Section 4.2.3).

In addition, this tab presents information about various software modules that may be useful when you are requesting assistance from Galvanic Sciences. This information cannot be edited.

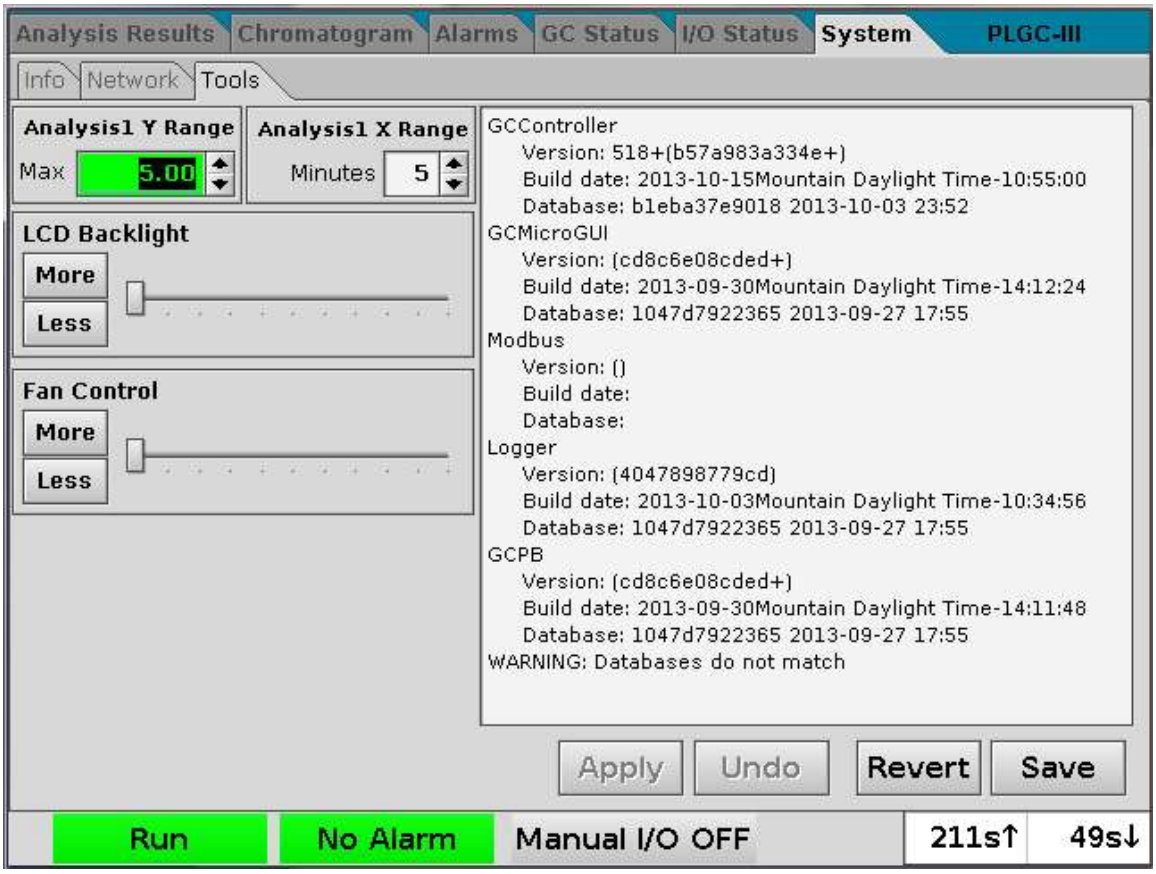


Figure 4-9: The Tools Tab

4.3 Powering Up the Application Software

NOTICE **This discussion assumes that the computer and chromatograph have been interfaced as described in Section 3.**

Start the connection protocol selecting the *ACCUCHROME* icon on the desktop (Figure 4-10).

Figure 4-10: ACCUCHROME Icon

The *Log In Navigation* window (Figure 4-11) will be presented (superimposed on the main window).

Figure 4-11: Log in Navigation Dialog Box

Create New Connection - presents the *New Connection Setup* dialog box (Figure 4-12), which is used the first time the analyzer is connected to the computer. Section 3.6 describes how to assign an IP address to the analyzer.

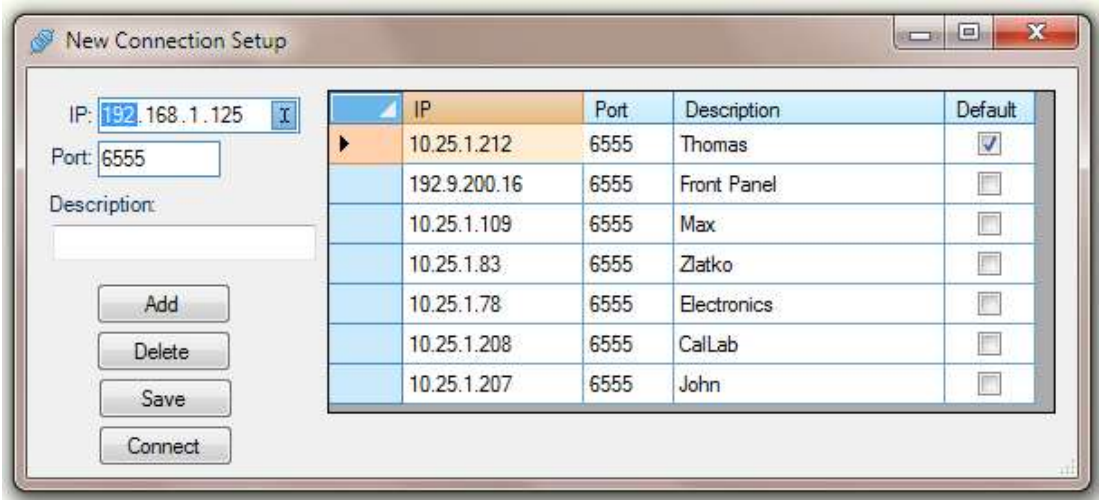


Figure 4-12: New Connection Setup Dialog Box

a) Enter the IP address for the system, ensure that the port is set to 6555 and enter the name for of the system in the *Description* field.

b) Press the *Add* button, then press the *Save* button. The information will appear in the table.

c) Move the ► to the appropriate IP and place a check mark in the default field for that IP.

d) Press *Connect.*

Open Existing Connection - presents the *Existing Connection* dialog box (Figure 4-13), which is used to connect the computer to the chromatograph using a pre-existing IP address.

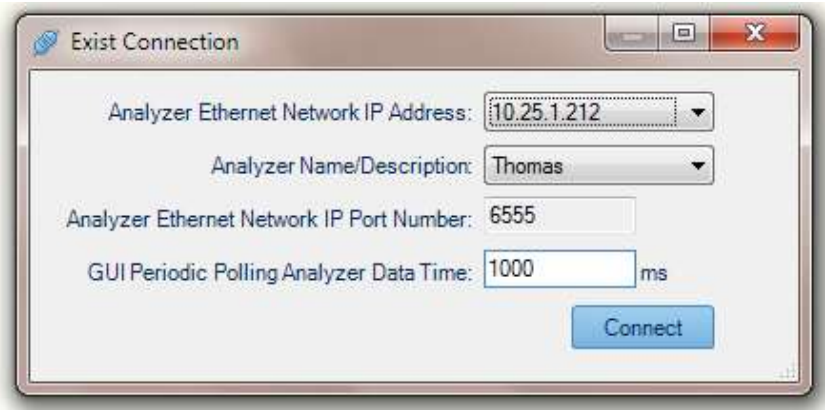


Figure 4-13: Exist Connection Dialog Box

The IP address and description can be selected via the drop down menus. The polling analyzer data time can be set between 200 and 1000 ms. Press **Connect** when the appropriate IP address and name are indicated.

Connect to Front Panel - Allows for communication between the computer and the chromatograph via the front Ethernet connection. This option is normally used when the analyzer is not connected to a network.

Connect to Default Connection - Automatically connects the computer to the system using the IP indicated by the selected default check mark (Figure 4-12).

When the connection between the computer and the chromatograph is made, the *Select Mode* dialog box (Figure 4-14) will be presented.

Figure 4-14: Select Mode Dialog Box

- *View* mode allows the user to collect data using the chromatograph but does not permit changes to the analytical parameters.
- *Edit* allows the user to make changes to the analytical parameters of the analyzer. If Edit mode is chosen, a dialog box will appear, prompting the user to enter a password. Edit mode is described in Section 5.
- *Factory* mode is reserved for service engineers.

4.4 The Main Screen - View Mode

The main screen in *View* mode is presented in Figure 4-15 and consists of a number of different regions.

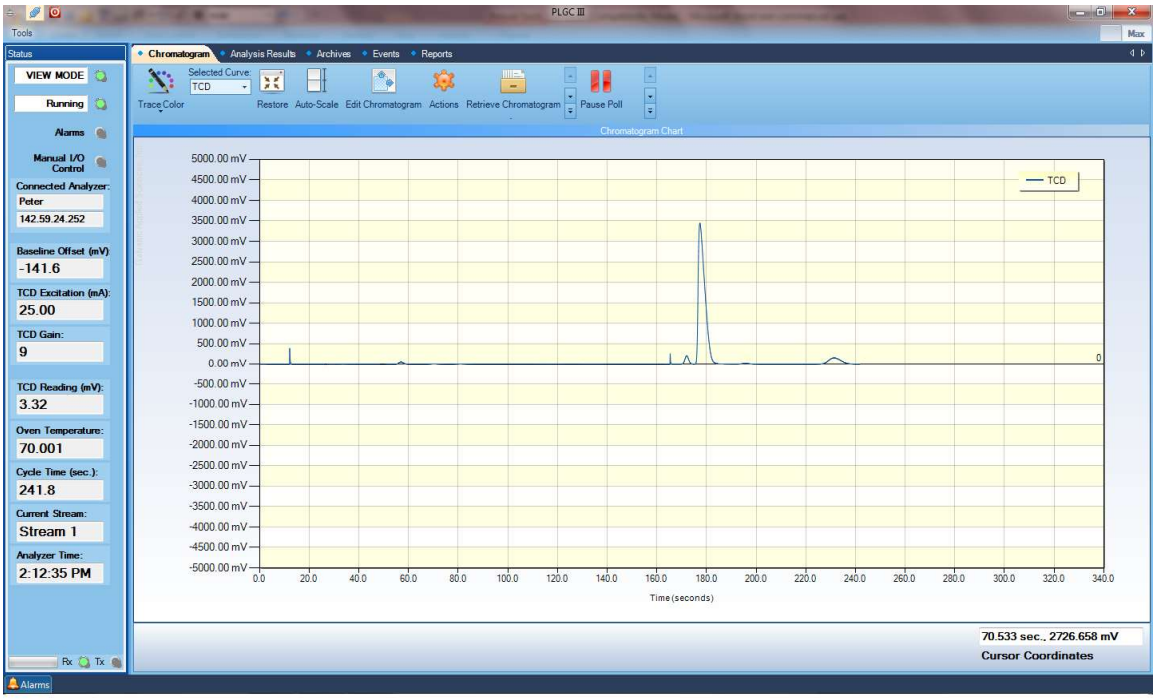


Figure 4-15: Main Screen ACCUCHROME

a) Quick Access Toolbar (Section 4.4.1)

b) Toolbar (Section 4.4.2)

c) System Operating Parameters (Section 4.4.3)

d) Alarms (Section 4.4.4)

e) Min/Max Buttons (Section 4.4.5)

4.4.1 Quick Access Toolbar

The *Quick Access Toolbar* (Figure 4-16) includes a number of items that are used for general purposes.

Figure 4-16: Toolbar

 - Accesses a menu that includes *Restore*, *Move*, *Size*, *Maximize, Minimise* and *Close.* These are standard Windows commands.

 - Toggles between *Connect to Analyzer* and *Disconnect from Analyzer*. This is used to initiate the log-on process.

 - RUN/HALT - When the system is running, pressing the icon will terminate the operation of the system at the end of the present run. During the time between when the Halt Button is pressed and the end of the cycle, the analyzer will be in the Halt Pending Mode. When the system is not running, it will initiate a run.

4.4.2 Toolbar

The *Tools* button immediately below *the Quick Access Toolbar* presents the Toolbar (Figure 4-17).

Figure 4-17: The Ribbon

Log In/Log Out - Presents the Log in Navigation dialog box (Figure 4-11). When the system is logged in, the function of this button toggles to Log Off.

Permanent Configuration Write - stores the present configuration on the chromatograph.

Save Configuration - stores the present configuration on the computer

Change Password - presents a dialog box to enter the existing password and the new password. The new password must be entered two times to verify the correct entry. This dialog box can be used to change the GUI password.

About - presents a dialog box with the version number and software release date. Please provide this information when inquiring about service issues.

4.4.3 System Operating Parameters

The left column of the window presents the status of the system and a variety of operating parameters. These fields are updated once per second and cannot be edited by the operator.

The top line indicates the GUI connection status: OFFLINE, READ ONLY or UPDATE.

The second line indicates the status of the chromatograph: RUNNING, HALT or HALT PENDING.

A green stripe at the bottom of this region indicates that data is being transferred, if the chromatograph is transmitting data to the computer, the Rx indicator will be green. If the, computer is transmitting data to the chromatograph the Tx indicator will be green. A red light by Alarms indicates that an alarm was noted (see bottom of window to view it).

4.4.4 Alarm Tab

The *Alarm* tab at the bottom of the window is provided to access the *Alarms* table and *Events* table, which may provide important operating information.

4.4.5 Min and Max Buttons

The *Min* and *Max* buttons are used to select the overall display of the screen. In *Min* mode,. the Toolbar is presented and the tabbed pages are reduced in size.

4.5 Tabbed Pages

There are five tabbed pages in *Read Only* Mode:

- *Chromatogram* - present chromatographic data and allow for data manipulation (Section 4.5.1).
- *Analysis Results* - presents a listing of analytical data from the chromatograph (Section 4.5.2).
- *Archives* - presents a listing of stored analytical data (Section 4.5.3).
- *Events* - presents a list of the various activities that occurred during the separation (Section 4.5.4).
- *Reports* – provides access to various reports of information on the chromatograph (Section 4.5.5).

4.5.1 The Chromatogram Tab

The *Chromatogram* tab (Figure 4-18) is a running presentation of the chromatographic data collected by the gas chromatograph.

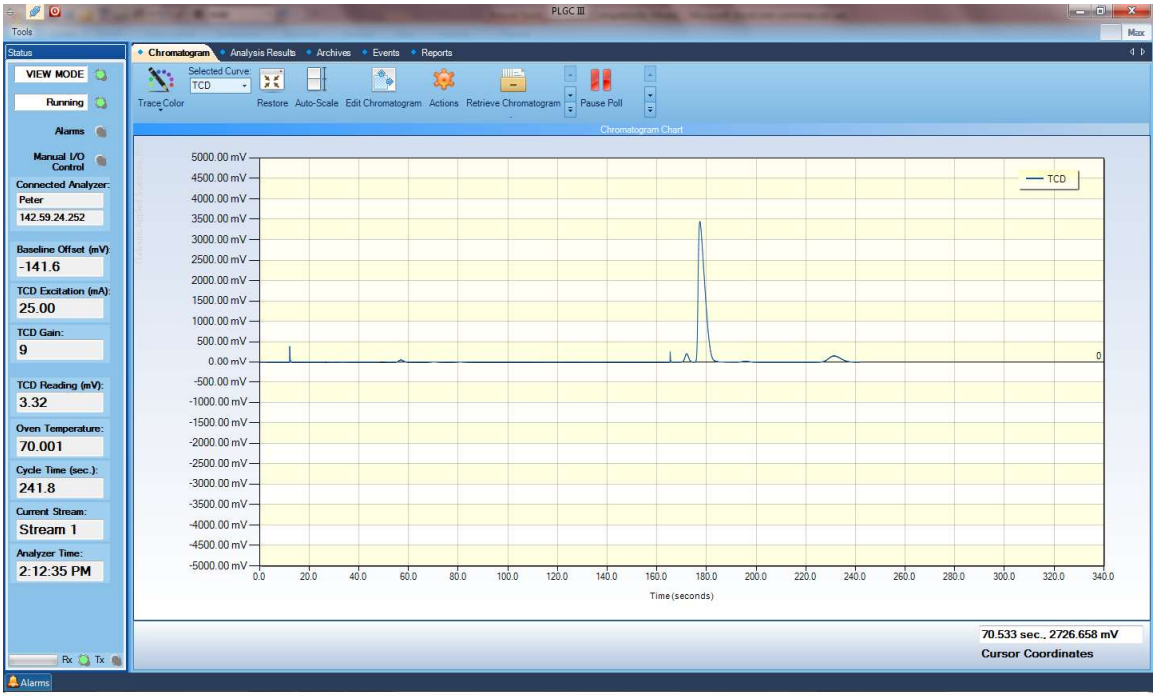


Figure 4-18: Chromatogram Tab

4.5.1.1 Ribbon Bar

Figure 4-19: Chromatogram Tab Ribbon Bar

The *Ribbon Bar* on the chromatogram tab provides access to a number of commands to present the chromatogram as desired.

- *Trace Color* – presents a palette of colors (Figure 4-20). To select the desired color for the TCD trace, move the cursor to it and press the mouse button. This function is a standard Windows feature.

Figure 4-20: Trace Color

- *Selected Curve* – this field indicates the active chromatogram when two or more chromatograms are presented on the display. The active chromatogram can be selected by pressing the ▼ arrow and clicking on the name.
- *Restore* – This restores a zoomed-in part of the chromatogram back to show the whole chromatogram.
- *Auto-scale* - Scales the y-axis so that the largest peak is 75% of full scale.
- *Edit Chromatogram* – presents a dialog box to set the x-axis and y-axis minimum and maximum as well as the X axis interval (Figure 4-21).

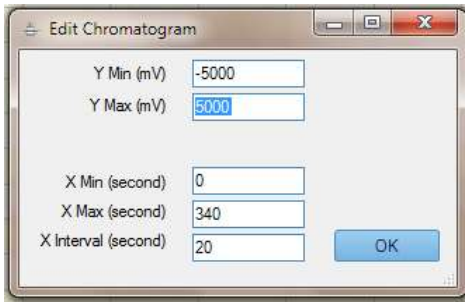


Figure 4-21: Edit Chromatogram Dialog Box

- *Actions* – displays chromatographic actions on the chromatogram (Figure 4-22). Two action lists can be generated.

Figure 4-22: Presenting Actions on the Chromatogram

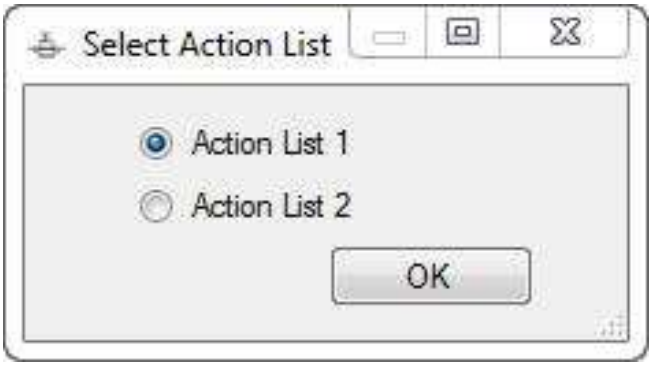


Figure 4-23: Actions list Selection

The action can be edited by dragging them or by right clicking in the action description box. When in Update Mode, pressing the Action button again will generate dialog to decide if user wants to write the change to the analyzer. This is a way of editing the action list from the chromatogram.

- *Additional Functions* -The icon and arrows directly to the right of the *Action* icon are used to access a variety of functions. The selection of the desired function can be performed by pressing the up or down arrows to the left of the icon. As an alternative, all of the icons can be viewed simultaneously by pressing the bottom arrow.

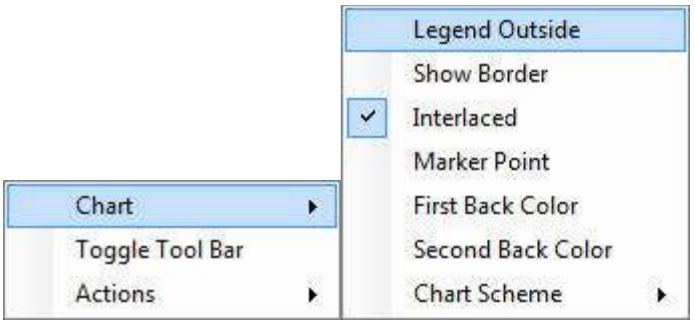


Figure 4-24: Chart options when clicking in the action description box

Figure 4-25: Action when clicking in the action description box

- ***Components*** – displays the chromatogram and below that, each component integration window parameters

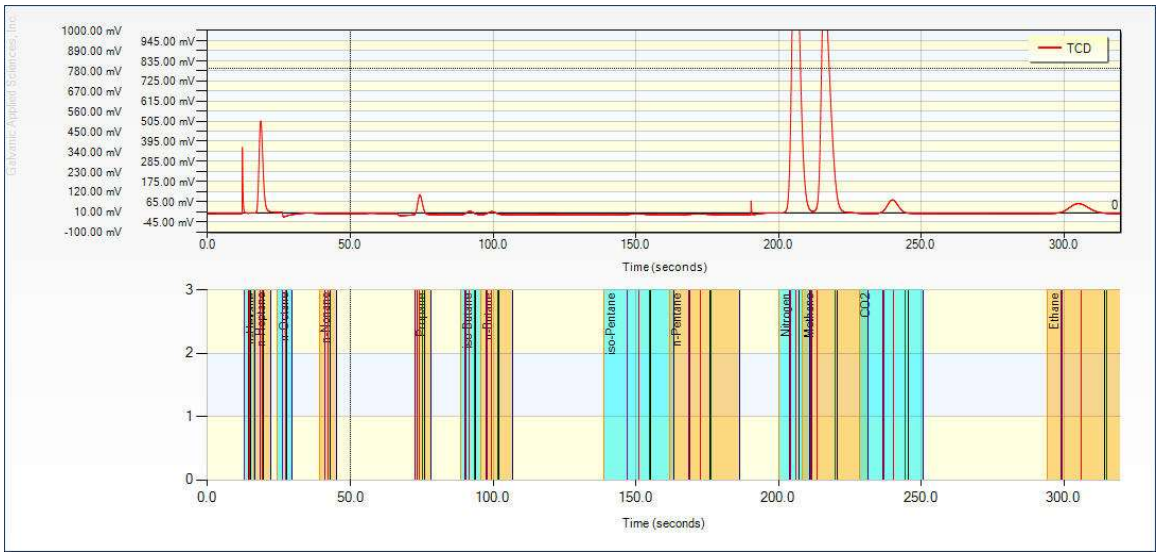


Figure 4-26: Components integration windows along with chromatogram

To look at an individual component and its integration window parameters, use the mouse with the left button down to draw a box around the component of interest. The chromatogram will be zoomed to show only the selected component.

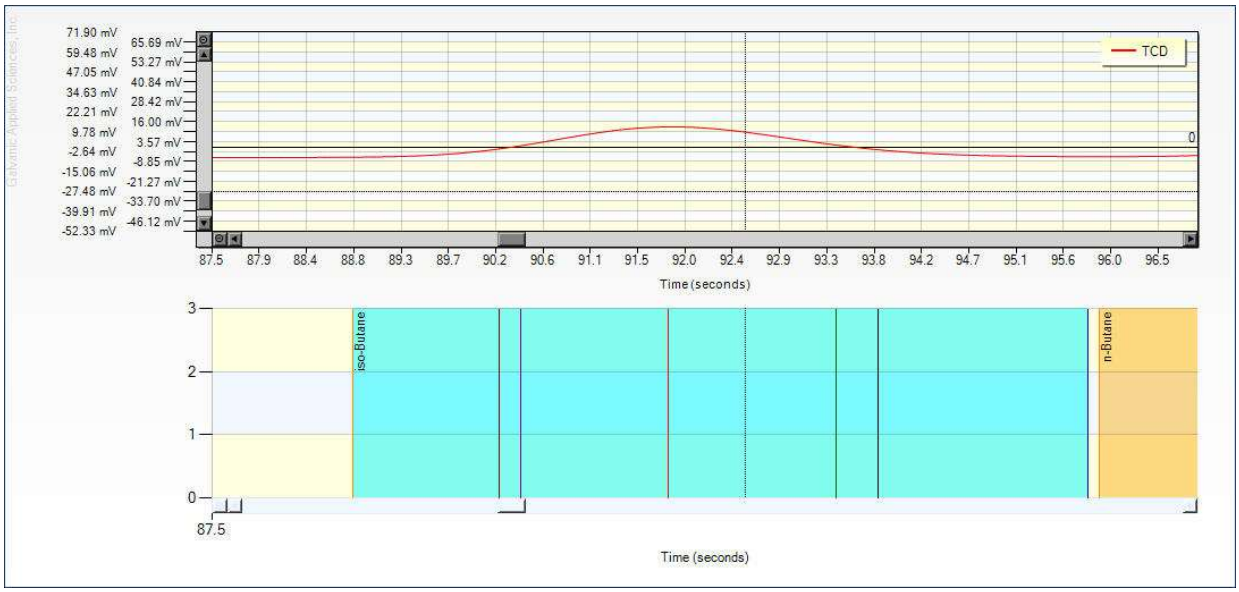


Figure 4-27: Individual component zoomed in

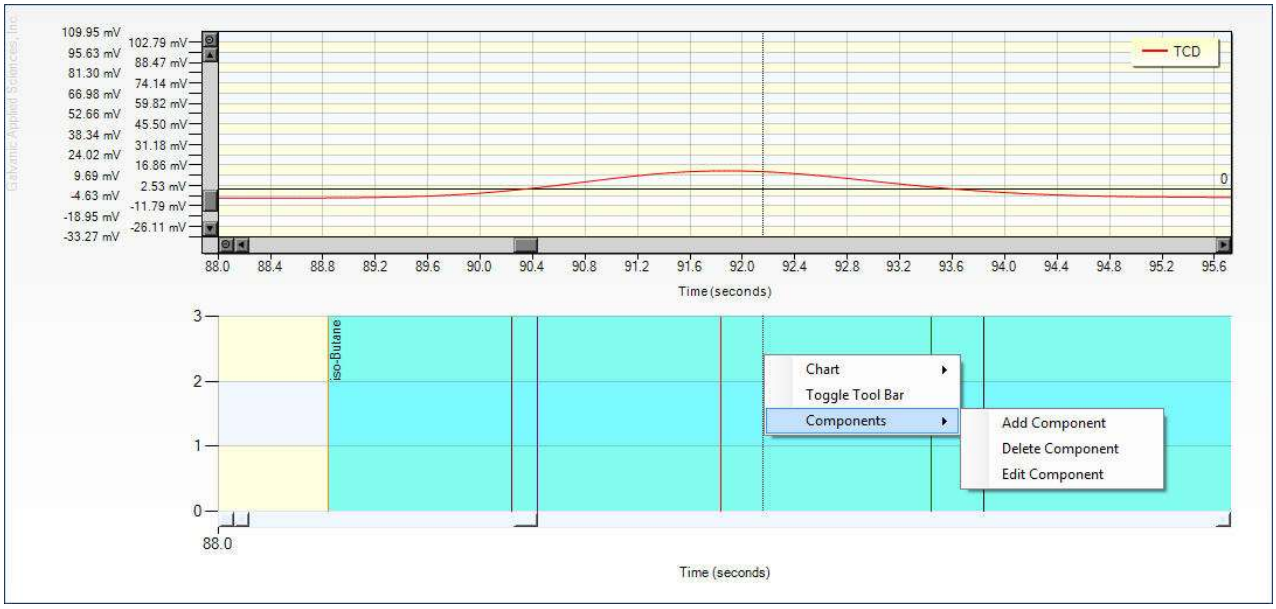


Figure 4-28: Component editing on Chromatogram Tab

The component integration parameters can be edited right on the chromatogram by right clicking the mouse on the retention timeline (line through the highest part of the component peak). Under Components, choose: Edit component.

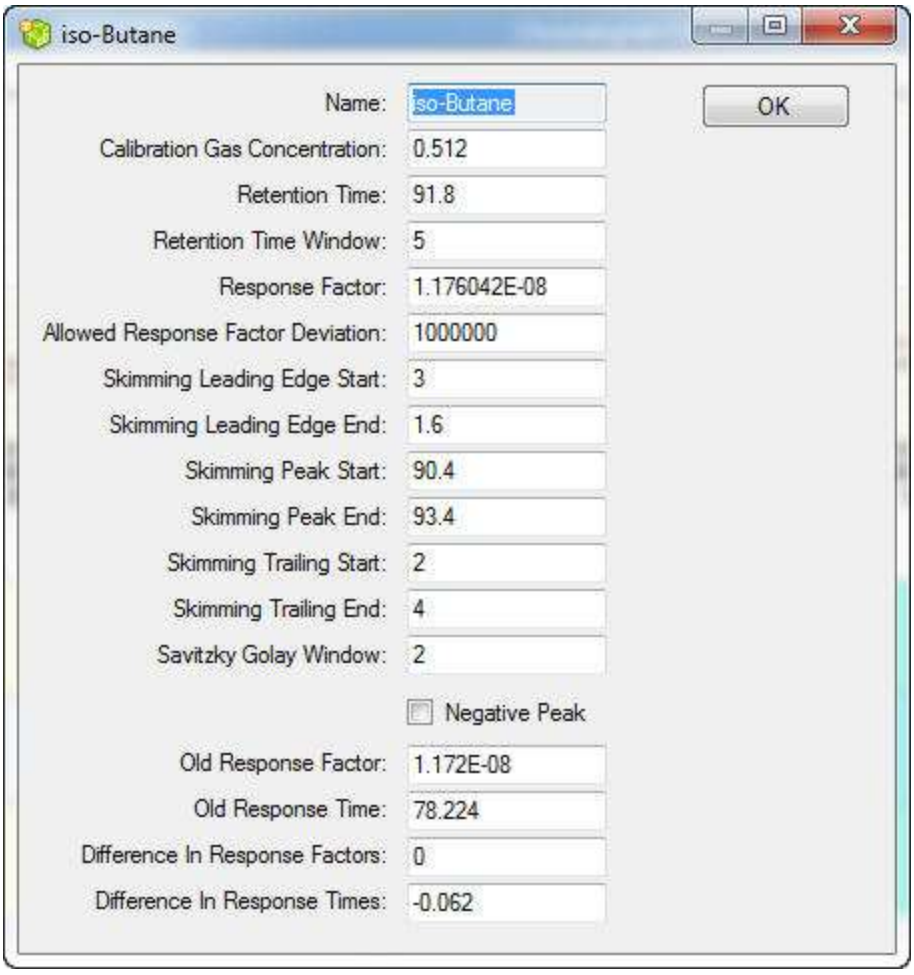


Figure 4-29: Component edit window accessed on the chromatogram Tab

Figure 4-23: Pause Poll Functions

a) *Retrieve Chromatogram* – presents a standard Windows *Open* dialog box *to* download saved files from the chromatograph (*.bin).

b) *Upload Chromatogram* - presents a standard Windows *Open* dialog box *to send* files to the chromatograph.

c) *Analyze Chromatogram* - determines the concentration of the various gases and calculates the relevant parameters using the present configuration.

NOTICE

Retrieving and uploading of chromatograms is normally done as part of the troubleshooting of the system. The user can change the parameters of the component table and determine what the results are with the revised component table values. These calculations are not archived or available for reports.

d) *Show Analysis Markers* - displays markers on the chromatogram that indicate the start and stop points for the integration of each peak, as well as the retention time for each peak.

e) *View Chromatogram* – present a standard Windows dialog box to select a chromatogram file stored on the computer for retrieval and display on the tab.

f) *Factory Chromatogram* - presents a standard Windows *Open* dialog box to download a factory calibration chromatogram.

- Chart Functions – The icon at the extreme right of the ribbon bar is used to access a variety of functions directly related to the chromatogram being collected. The selection of the desired function can be performed by pressing the up or down arrows to the left of the icon.

a) *Pause Poll* - This stops the chromatogram from recording.

b) *Delete Trace* - Removes the present active chromatogram(s).

c) *Clean Chart* - Removes all chromatograms

d) *Toggle a Trace* - Used to select the active trace if more than one trace is displayed

4.5.1.2 Right Clicking on the Plot

The *Chart* command and the *Archive Markers* command are presented if the right mouse button is pressed when the mouse is in the Chromatogram grid.

- *Chart* Command (Figure 4-24).

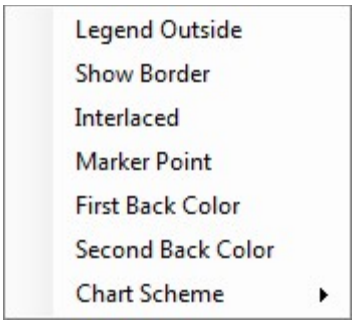


Figure 4-24: Chart Commands

a) *Legend Outside* – Moves the field that defies the trace outside of the chromatogram

b) *Show Border* – places a border around the chromatogram

c) *Interlaced* – if selected, all of the boxes are colored not only half the boxes.

d) *Marker Point* – places markers on the plot which indicate individual data points

e) *First Back Color* – presents a color palette (Figure 4-19) to change the color of the background (Figure 4-25).

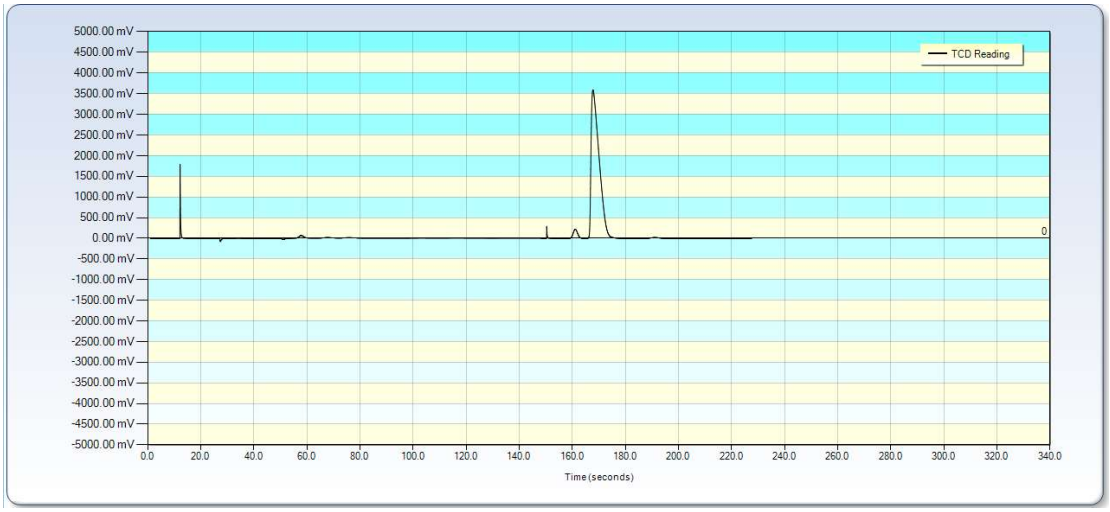


Figure 4-25: Color after First Back Color (also shows border)

f) *Second Back Color* – presents a color palette to change the color of the background so that the positive and negative regions have different coloring.

g) *Chart Scheme* – provides a secondary menu to select the color around the chromatogram. There are three options, light blue, light gray or light brown.

h) *Archive Markers Command* - The *Archive Markers* command presents the *Archived Markers Display Selection* display box (Figure 4-26).

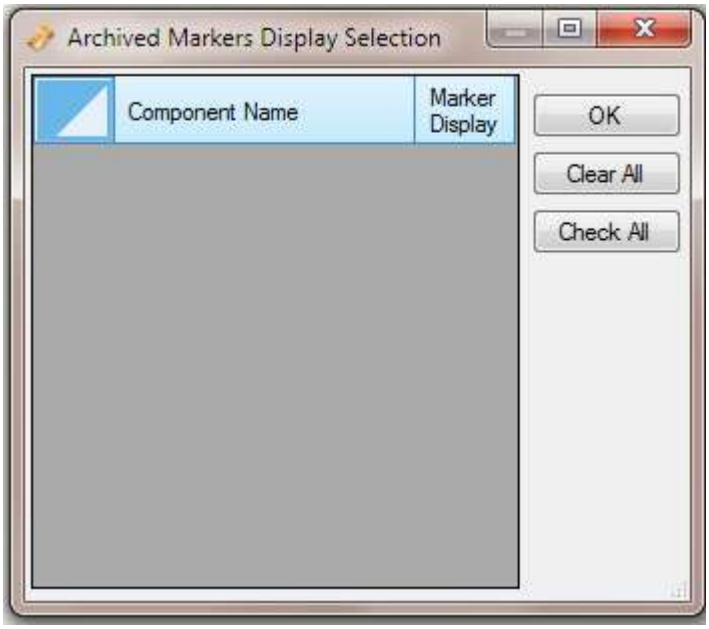


Figure 4-26: Archived Markers Display Selection Dialog Box

4.5.2 Analysis Results Tab

The *Analysis Results* tab (Figure 4-27) presents a detailed listing of the most recent 10 runs of a given type.

Refresh
Display Physical Properties
Display Liquid Mole Percent

Analysis Results

Cal 1
Stream 1

Component Name	Dry Analysis	Saturated Analysis	Dry Analysis	Saturated Analysis	Dry Analysis	Saturated Analysis	Dry Analysis	Saturated Analysis
Analysis Time	8/13/2013 1:47 PM	8/13/2013 1:47 PM	8/13/2013 1:42 PM	8/13/2013 1:42 PM	8/13/2013 1:38 PM	8/13/2013 1:38 PM	8/13/2013 1:33 PM	8/13/2013 1:33 PM
C6+	0.0271	0.0266	0.0276	0.0272	0.0273	0.0268	0.0270	0.0265
Propane	1.0359	1.0178	1.0373	1.0193	1.0342	1.0162	1.0332	1.0153
iso-Butane	0.3014	0.2962	0.3013	0.2960	0.3002	0.2949	0.3002	0.2950
n-Butane	0.3010	0.2957	0.3011	0.2959	0.2996	0.2944	0.2995	0.2943
iso-Pentane	0.0982	0.0964	0.0985	0.0968	0.0978	0.0961	0.0974	0.0957
n-Pentane	0.1040	0.1022	0.1034	0.1016	0.1031	0.1013	0.1078	0.1059
Nitrogen	2.5177	2.4739	2.5128	2.4691	2.5071	2.4635	2.5168	2.4730
Methane	90.1098	88.5415	90.1064	88.5382	90.1179	88.5495	90.1142	88.5458
CO2	0.4789	0.4705	0.4785	0.4701	0.4780	0.4697	0.4773	0.4690
Ethane	5.0261	4.9386	5.0332	4.9456	5.0349	4.9473	5.0267	4.9392
Water Vapor	0.0000	0.0174	0.0000	0.0174	0.0000	0.0174	0.0000	0.0174
Normalized Total	100.0000		100.0000		100.0000		100.0000	
Un-Normalized Total	93.7709		93.6733		93.7935		93.9555	

Figure 4-27: Analysis Results Tab

The left column presents a list of streams for which data is available.

The Refresh icon is used to update the data.

The ►and ◄arrows in the upper right corner are used to scroll the data.

If the *Display Physical Properties* check box is selected, additional information as shown in Figure 4-28 will be presented.

Analysis Results

Cal 1

Stream 1

Component Name	Dry Analysis	Saturated Analysis	Dry Analysis	Saturated Analysis	Dry Analysis	Saturated Analysis	Dry Analysis	Saturated Analysis
Analysis Time	8/13/2013 1:47 PM	8/13/2013 1:47 PM	8/13/2013 1:42 PM	8/13/2013 1:42 PM	8/13/2013 1:38 PM	8/13/2013 1:38 PM	8/13/2013 1:33 PM	8/13/2013 1:33 PM
C6+	0.0271	0.0266	0.0276	0.0272	0.0273	0.0268	0.0270	0.0265
Propane	1.0359	1.0178	1.0373	1.0193	1.0342	1.0162	1.0332	1.0153
iso-Butane	0.3014	0.2962	0.3013	0.2960	0.3002	0.2949	0.3002	0.2950
n-Butane	0.3010	0.2957	0.3011	0.2959	0.2996	0.2944	0.2995	0.2943
iso-Pentane	0.0982	0.0964	0.0985	0.0968	0.0978	0.0961	0.0974	0.0957
n-Pentane	0.1040	0.1022	0.1034	0.1016	0.1031	0.1013	0.1078	0.1059
Nitrogen	2.5177	2.4739	2.5128	2.4691	2.5071	2.4635	2.5168	2.4730
Methane	90.1098	88.5415	90.1064	88.5382	90.1179	88.5495	90.1142	88.5458
CO2	0.4789	0.4705	0.4785	0.4701	0.4780	0.4697	0.4773	0.4690
Ethane	5.0261	4.9386	5.0332	4.9456	5.0349	4.9473	5.0267	4.9392
Water Vapor	0.0000	0.0174	0.0000	0.0174	0.0000	0.0174	0.0000	0.0174
Normalized Total	100.0000		100.0000		100.0000		100.0000	
Un-Normalized Total	93.7709		93.6733		93.7935		93.9555	
Gross Heating Value(Ideal Gas)	1056.71	1038.32	1056.85	1038.46	1056.77	1038.38	1056.72	1038.33
Net Heating Value(Ideal Gas)	953.93	937.33	954.06	937.46	953.99	937.38	953.94	937.34
Specific Gravity(Ideal Gas)	0.6181	0.6182	0.6182	0.6183	0.6181	0.6182	0.6181	0.6182
Gross Heating Value(Real Gas)	1059.20	1041.13	1059.34	1041.27	1059.26	1041.19	1059.21	1041.14
Net Heating Value(Real Gas)	956.18	939.87	956.31	940.00	956.23	939.92	956.19	939.88
Specific Gravity(Real Gas)	0.6193	0.6197	0.6194	0.6197	0.6193	0.6196	0.6193	0.6196
Wobbe Index	1345.89	1322.61	1346.04	1322.75	1346.07	1322.78	1345.94	1322.65
Compressibility	0.9976	0.9973	0.9976	0.9973	0.9976	0.9973	0.9976	0.9973
GPM(corrected for compressibility)	17.540	17.340	17.541	17.341	17.541	17.341	17.540	17.340

Figure 4-28: Display of Physical Properties

4.5.3 Archive Tab

The *Archive* tab (Figure 4-29) presents a summary of recently performed analysis. It includes the time stamp, type of calculation (saturated or dry), the concentration of each gas, the normalized total and un-normalized total of the concentration of the various gases.

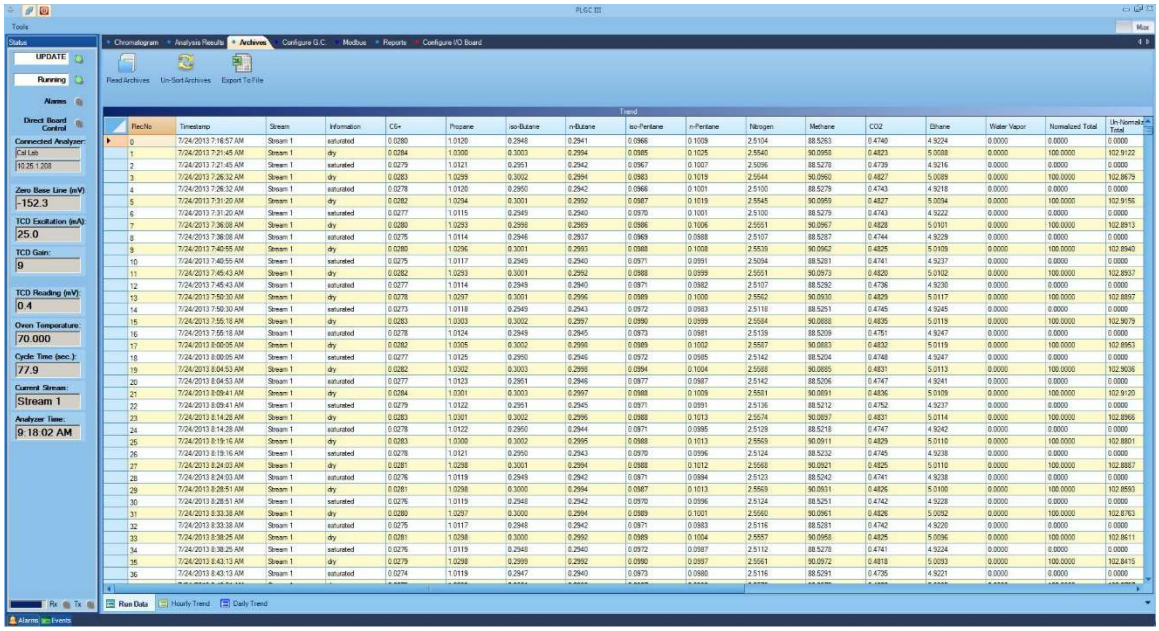


Figure 4-29: Archive Tab

The icons on the top of the tab include *Read Archives*, which is used for updating the archives, and *Export to File* which is used to send the data to Excel.

The *Hourly Trend* tab on the bottom of the screen is used to present a table that is similar to Figure 4-28. It presents the same data as the archive tab at the start of each hour (e.g. 8:00 AM, 7:00 AM, 6:00 AM etc) as well as parameters such as the hourly minimum, maximum and mean.

The *Daily Trend* tab on the bottom of the screen is used to present a table that is similar to Figure 4-28. It presents the same data as the archive tab at a specific time for each day (e.g. July 22, 8:00 AM, July 21, 8:00 AM, July 20, 8:00 AM etc). as well as parameters such as the hourly minimum, maximum and mean. The daily data is collected at the time indicated on the Contract *Start Hour* field on the *Stream Sequencer* part of the *Configure GC* tab in *Update* mode.

4.5.4 Events Tab

The Events tab (Figure 4-30) presents a list of all of the events that have occurred during the analyses

Figure 4-30: Events Tab

4.5.5 Reports Tab

The *Reports* tab (Figure 4-31) is used to generate various reports of analysis and calibration data.

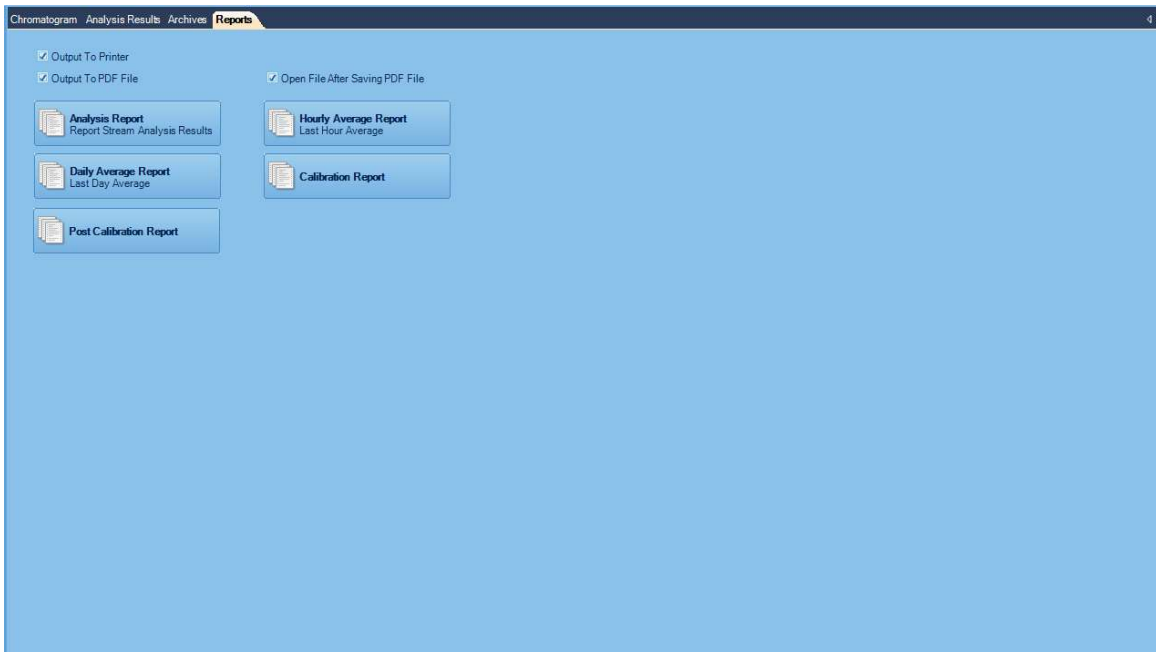
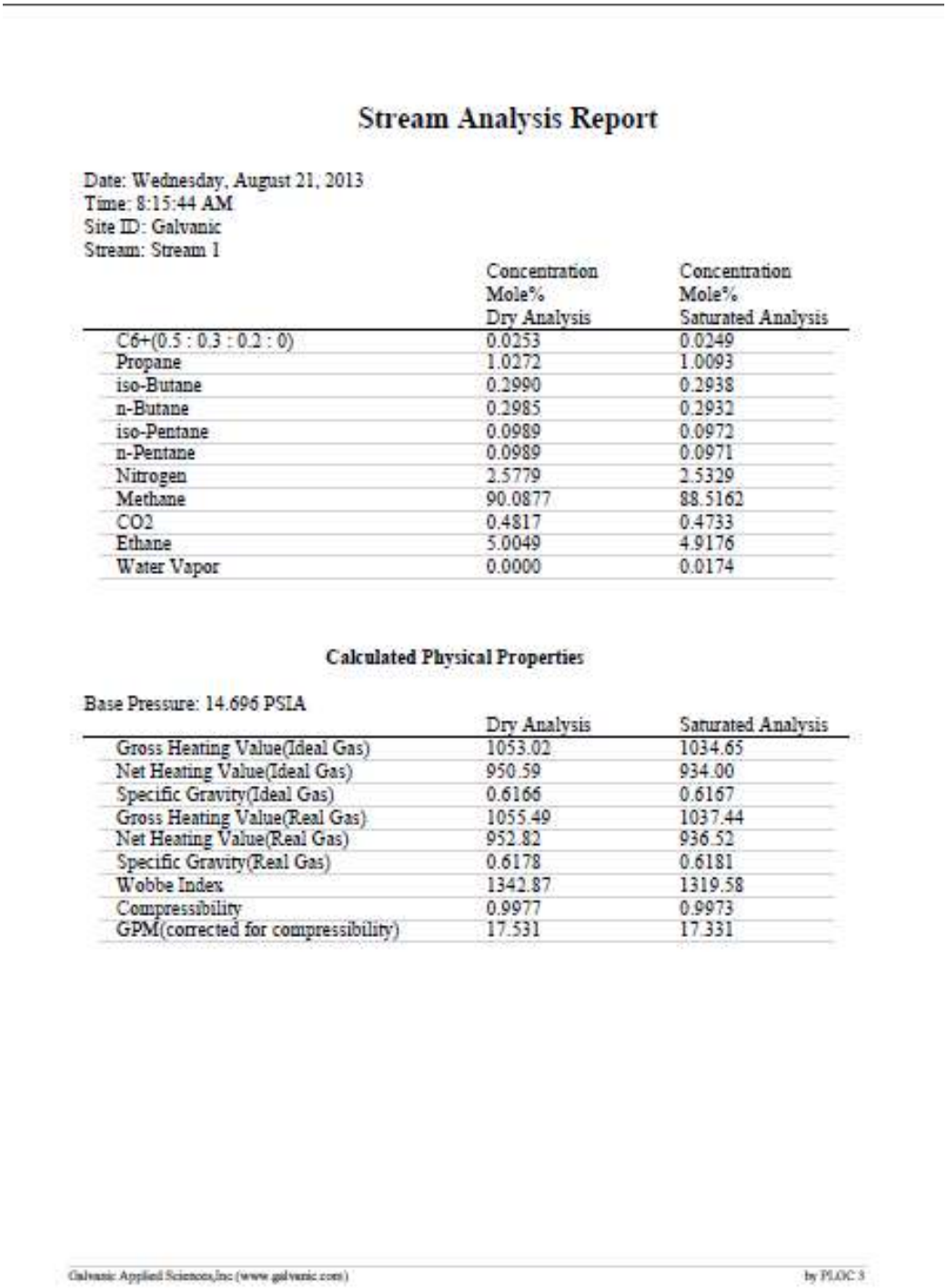


Figure 4-31: Reports Tab

Indicate the desired report format (s) and press the button corresponding to the desired data.

A sample report is shown in Figure 4-32.



Stream Analysis Report

Date: Wednesday, August 21, 2013
Time: 8:15:44 AM
Site ID: Galvanic
Stream: Stream 1

	Concentration Mole% Dry Analysis	Concentration Mole% Saturated Analysis
C6+(0.5 : 0.3 : 0.2 : 0)	0.0253	0.0249
Propane	1.0272	1.0093
iso-Butane	0.2990	0.2938
n-Butane	0.2985	0.2932
iso-Pentane	0.0989	0.0972
n-Pentane	0.0989	0.0971
Nitrogen	2.5779	2.5329
Methane	90.0877	88.5162
CO2	0.4817	0.4733
Ethane	5.0049	4.9176
Water Vapor	0.0000	0.0174

Calculated Physical Properties

Base Pressure: 14.696 PSIA

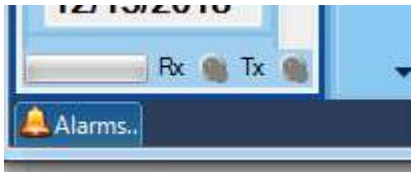
	Dry Analysis	Saturated Analysis
Gross Heating Value(Ideal Gas)	1053.02	1034.65
Net Heating Value(Ideal Gas)	950.59	934.00
Specific Gravity(Ideal Gas)	0.6166	0.6167
Gross Heating Value(Real Gas)	1055.49	1037.44
Net Heating Value(Real Gas)	952.82	936.52
Specific Gravity(Real Gas)	0.6178	0.6181
Wobbe Index	1342.87	1319.58
Compressibility	0.9977	0.9973
GPM(corrected for compressibility)	17.531	17.331

Galvanic Applied Sciences,Inc (www.galvanic.com) by PLOC 3

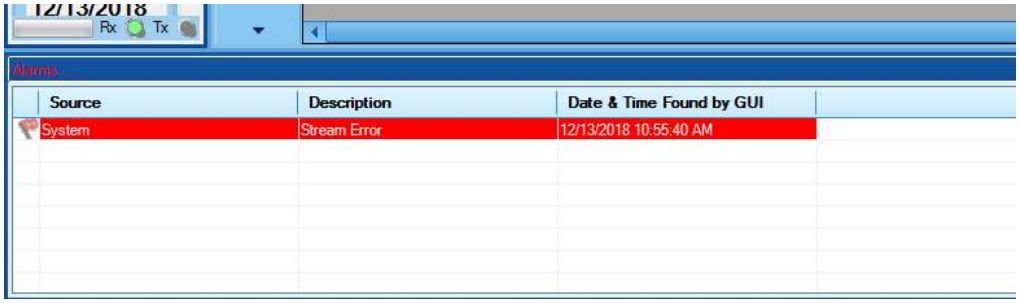
Figure 4-32: Sample Report

4.6 Alarms

The alarms tab shows any active alarms.



Clicking on the alarms tab will open the Alarms tab window.



Section 5 Configuring the GC

5.1 The Configuration

The *Configuration* is the collection of parameters that define the operation of the chromatograph. The *Configure G.C.* tab (Figure 5-1) is accessed by selecting the *Edit* option on the *Select Mode* dialog box (Section 5.2.1), entering the password (the default password is 2222) and pressing the *Configure G.C.* tab.

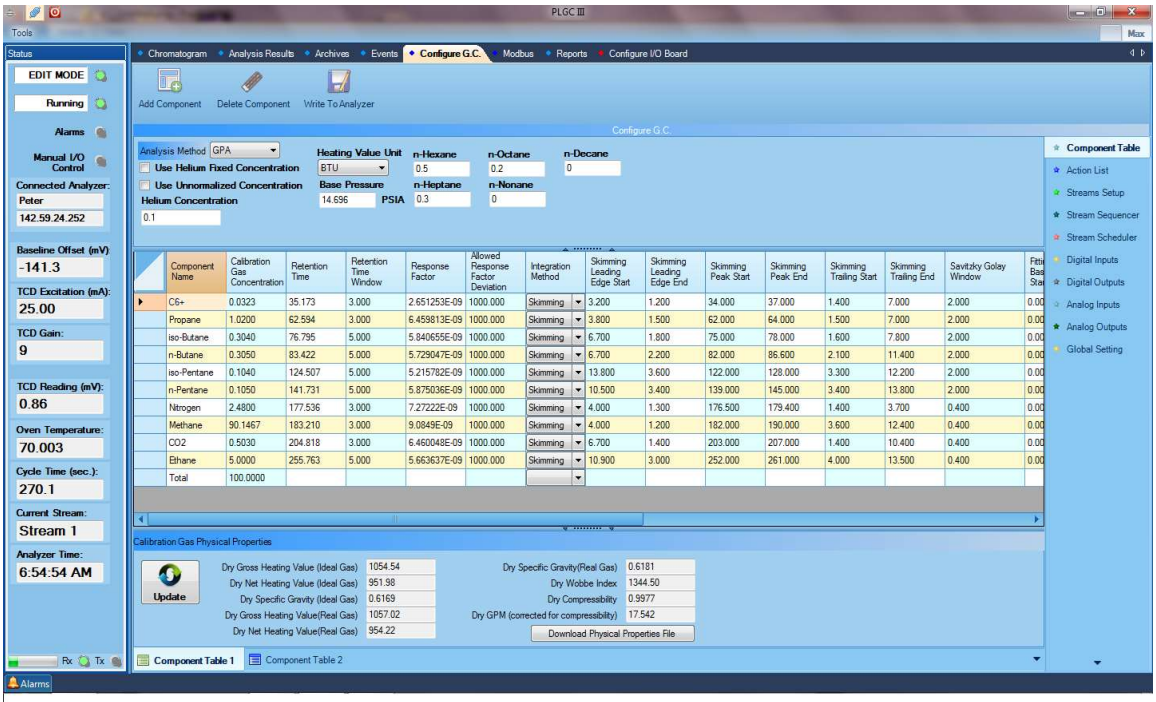


Figure 5-1: ACCUCHROME – Configuration Mode

NOTICE

When *Edit* mode is selected, the display will present the *Modbus* tab (described in Chapter 8) and the *Configure I/O Board* tab (which is reserved for service engineers and is password protected).

The Component Table lists all of the compounds in the sample and includes chromatographic parameters that are used to identify the compounds of interest and perform quantitative analysis (Section 5.4). In addition, the component table includes parameters that describe the calibration gas so that a variety of various physical properties of the sample can be calculated. A configuration can contain two component lists.

The right side of the Configure G.C. tab provides access to several tabs which are used to set actions that should take place during an analysis, scheduling of analyses and enabling input and /output ports. . To access each, simply click on the appropriate name.

- *Action List* - lists the various actions that should be performed during an analysis such as opening or closing a valve or indicating the end of an analysis (Section 5.5). A configuration can contain two action lists.
- *Streams Setup* - used to indicate the component list and action list that should be used for each stream. It also includes alarm settings and information about the sampling process (Section 5.6).
- *Streams Sequencer* - used to select the order of runs in a sequence (Section 5.7).
- *Streams Scheduler* - used to indicate when the various streams should be analyzed. (Section 5.8) By default, the analyzer will run the Streams defined in the Streams Sequencer, but the scheduler can be used to interrupt the sequence. An example of this would be a scheduled auto calibration.
- *Digital Inputs* – used to provide information about the four digital inputs (Section 5.9).
- *Digital Outputs* - used to provide information about the four digital outputs (Section 5.10).
- *Analog Inputs* – used to provide information about the four analog inputs (Section 5.11).
- *Analog Outputs* - used to provide information about the four analog outputs (Section 5.12)
- *Global Setting* – used to indicate system identification (Section 5.13).

When a configuration has been established for a given analytical procedure, it is probable that most of the procedures will be edited on a relatively infrequent basis. Typically, the configuration is edited when the system is validated, when the nature of the sample changes, when a new column is installed, when an additional compound must be monitored or if the schedule should be changed.

On a periodic basis, the system should be calibrated using a gas of known composition. This procedure is described in Section 6 and may require that some parameters on the *Component Table* be edited.

Configurations can be saved and retrieved as desired.

5.2 General Guidelines for Editing a Configuration

When generating/editing a configuration, the following guidelines should be followed:

a) It is necessary to be in *Edit* mode to generate or edit a configuration.

b) After a configuration is generated/edited using the computer, it must be downloaded to the chromatograph to be used. Each configuration tab has its own *Write to analyzer* button. These writes are temporary, meaning that if analyzer power was lost, the changes made to the configuration would also be lost. To make the changes permanent a *Permanent Configuration Write* must be executed from the master tool bar.

c) A configuration can be stored on the computer and retrieved as needed. Configuration files are saved as *.cfg files in the directory of your choice. If a configuration is retrieved, it must be transferred to the chromatograph to be used.

d) If a new or edited configuration is written to the analyzer while an analysis is being performed, then the edits will not take effect until the start of the next run.

e) When navigating from tab to tab in the GUI software, the configuration data for that tab is automatically read from the analyzer. If changes are made, but not written to the analyzer, they will be lost when navigating to another tab.

5.3 The Component Table

The *Component Table* consists of three regions:

- A ribbon which contains controls for the table of chromatographic information and is used to enter a number of values used in calculations. The nature of the ribbon is dependent on the selection of the Method. If the ISO method is used, see Section 5.3.1.1 if the GPA or Liquid method is used, see Section 5.3.1.2. .
- A table for chromatographic parameters (Section 5.4)
- A table that displays the calculated physical properties for the calibration gas. (Section 5.5)

5.3.1 The Ribbon

The *Ribbon* (Figure 5-2) is used to add/remove a line from tables, send a configuration to the chromatograph and enter values required for calculations. Some typical values for all components are found in the table in Section 14. The format of the ribbon is dependent on the *Method* that is employed. If the GPA method is used, see Section 5.3.1.1, if the ISO method is used, see Section 5.3.1.2.

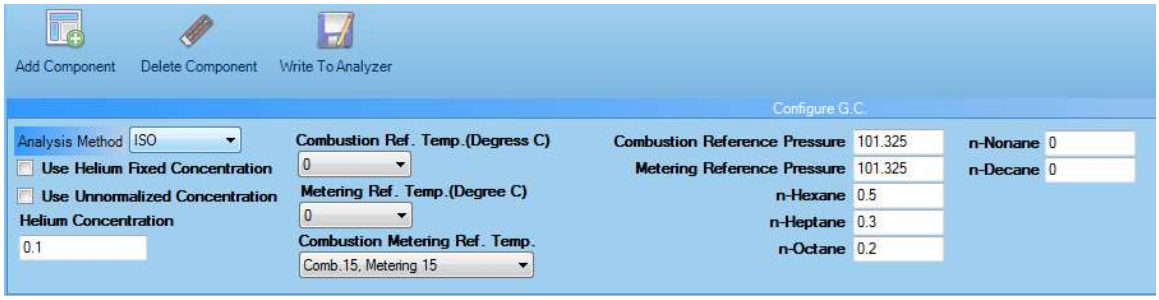


Figure 5-2: The Ribbon (ISO Method)

5.3.1.1 The Ribbon – ISO Method

 *Add Component* – used to add a line to various tables as described below. The line is added directly below the line indicated by the ►.

 *Delete Component* – is used to remove the line in the table indicated by the ►.

 *Write to Analyzer* – sends the present configuration to the analyzer.

The *Use Helium Fixed Factor* check box should be checked if it is desired to correct the analytical results for the He concentration in the gas. The Helium concentration is to be entered in the field below the *Use Unnormalized Concentration* field.

The *Use Unnormalized Concentration* should be checked if it desired that the reported concentration correspond to the actual percentage of each gas is reported (i.e. not normalized to 100%)

Method - This field is used to select if the GPA, ISO or Liquid standard method is to be employed. The fields to the right of the *Method* field on the ribbon are shown in Figure 5-1. If GPA standards are used, see Section 5.3.2.

Combustion Reference Temperature – This field is used to indicate the reference temperature for combustion used to calculate the heating values (at bottom of page). The options are 0, 15, 20 and 25°C.

Metering Reference Temperature – This field is used to indicate the reference temperature for metering used to calculate the heating values (at bottom of page). The options are 0, 15 and 20°C.

Combustion Reference Pressure – This field is used to indicate the reference pressure for combustion used to calculate the heating values (at bottom of page).

Metering Reference Pressure – This field is used to indicate the reference pressure for metering used to calculate the heating values (at bottom of page). The options are 0, 15 and 20°C.

Combustion Metering Reference Temperature – This field is used to indicate the *Combustion and Metering Reference Temperatures*. A drop down menu presents the various options.

Enter the appropriate mole fraction concentration for n-Hexane, n-Heptane, n-Octane, n-Nonane and n-Decane in the calibration sample. The sum of the values should equal 1.000.

5.3.1.2 The Ribbon – GPA or Liquid Method

The *Ribbon – GPA* or *Liquid* Method is presented in Figure 5-3. The ribbon for the liquid mode is identical to that for the GPA method, but the calculations differ.

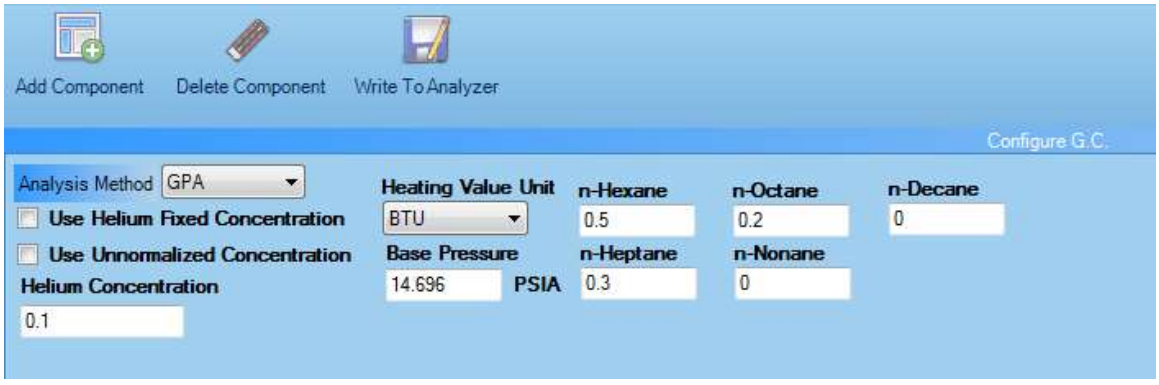


Figure 5-3: The Ribbon – GPA or Liquid Method

 *Add Component* – used to add a line to various tables as described below. The line is added directly below the line indicated by the ►.

 *Delete Component* – is used to remove the line in the table indicated by the ►.

 *Write to Analyzer* – sends the present configuration to the analyzer

The *Use Helium Fixed Factor* check box should be checked if it is desired to correct the analytical results for the He concentration in the gas. The Helium concentration is to be entered in the field below the *Use Unnormalized Concentration* field.

The *Use Unnormalized Concentration* should be checked if it desired that the reported concentration correspond to the actual percentage of each gas is reported (i.e. not normalized to 100%).

Method - This field is used to indicate if the GPA or ISO standard method is employed. The fields to the right on the ribbon are as shown in Figure 5-2. If ISO standards are used, see Section 5.3.1.

Base Pressure - enter the desired pressure for the calculation.

NOTICE **This is not the atmospheric pressure at the site.**

Enter the appropriate fraction concentration for n-Hexane, n-Heptane, n-Octane and n-Nonane in the calibration sample. The sum of the values should equal 1.000

5.4 Chromatographic Parameters

5.4.1 General Parameters

The *Component Table* (Figure 5-4) lists each of the compounds to be analyzed for and includes chromatographic data to identify and quantitate them.

Component Name	Calibration Gas Concentration	Retention Time	Retention Time Window	Response Factor	Allowed Response Factor Deviation	Integration Method	Skimming Leading Edge Start	Skimming Leading Edge End	Skimming Peak Start	Skimming Peak End	Skimming Trailing Start	Skimming Trailing End
C6+	0.0300	34.131	3.000	4.867101E-09	1000.000	Skimming	3.400	1.500	32.700	35.200	1.100	8.200
Propane	1.0000	57.686	3.000	1.1619991E-08	1000.000	Skimming	3.300	1.230	56.700	59.100	1.170	7.070
iso-Butane	0.3000	67.618	5.000	1.1709404E-08	1000.000	Skimming	6.002	1.902	66.100	70.100	2.098	5.998
n-Butane	0.3000	75.666	5.000	1.2013337E-08	1000.000	Skimming	6.081	2.181	74.000	78.600	2.419	12.819
iso-Pentane	0.1000	103.022	5.000	1.3986287E-08	1000.000	Skimming	11.680	2.480	101.200	106.700	3.020	9.920
n-Pentane	0.1000	116.128	5.000	1.1807584E-08	1000.000	Skimming	10.463	3.563	113.600	120.700	3.537	16.837
Nitrogen	2.5000	160.824	2.000	8.901585E-09	1000.000	Skimming	4.302	1.902	159.900	162.800	1.500	5.698
Methane	90.1700	167.464	2.000	1.1209339E-08	1000.000	Skimming	7.045	1.500	167.000	172.000	2.955	11.955
CO2	0.5000	190.762	3.000	8.040777E-09	1000.000	Skimming	13.850	2.300	187.600	192.000	2.700	9.150
Ethane	5.0000	235.670	5.000	7.271844E-09	1000.000	Skimming	14.901	6.101	229.800	239.000	3.900	19.099
Total	100.0000											

Figure 5-4: Component Table

The *Component Table* contains the following:

- Component Name - the name of the compound to be quantified.

NOTICE **Do not edit the names of the components.**

- Calibration Gas Concentration - the concentration of each component found in the calibration gas. These values are typically provided by the supplier of the calibration gas via a certificate included with the gas cylinder.
- Retention Time - the time (in seconds) at which the maximum signal from the detection of the given component is observed by the detector. Peaks in a chromatogram are identified on the basis of their retention times as each component has its own unique retention time. It is suggested that this data be taken as the average of the retention time from at least three chromatographic runs.
- Retention Time Window - the amount of time (in seconds) that a peak is allowed to deviate from the indicated retention time for a given component and still be identified as that component. If, for example, methane has a retention time of 25.95 seconds and a deviation of 5 seconds is allowed, a peak with a retention time anywhere between 21.95 seconds and 31.95 seconds will be identified as methane. Generally speaking, peaks that elute early in the analysis will have small retention time deviations (± 5 seconds or less), while later peaks will have larger deviations (± 10 seconds or more).
- Response Factor – a multiplication factor that converts a raw peak area into a concentration value. When the system is in calibration mode the analyzer will measure several runs of the calibration standard to calculate the average response factor. The response factor is used to calculate the concentration of the components in a run as shown in equation 5-1.

$$\mathbf{Conc_n = RF_n \times Area_n} \qquad \textbf{5-1}$$

Where: $\mathbf{Conc_n}$ = concentration of component **n**
$\mathbf{RF_n}$ = response factor of component **n**
$\mathbf{Area_n}$ = area of peak produced by component **n**

- Allowable Response Factor Deviation - if the response factors are automatically calculated, this represents the range in which the value is acceptable.
- Integration Method - indicate if the Skimming or Fitting integration method should be used. There are two different integration methods provided Skimming (Section 5.4.2) and Fitting (Section 5.4.3). The Fitting option is not active at this time.

5.4.2 Skimming Parameters

If *Skimming* is selected for the Integration method, the Component Table will appear as shown in Figure 5-4.

A peak is defined as the maximum signal within a retention time window. The area of a peak is determined by integrating the signal from the signal minimum prior to the peak to the signal minimum following the peak. ACCUCHROME allows the user to define the window before and after the peak.

The expected retention time of the peak is defined by the *Skimming Peak Start and Skimming Peak End* parameters. These parameters represent the time in seconds from the start of the analysis cycle where the peak for that component is expected to elute.

The *Skimming Peak Leading Edge Start* and *Skimming Peak Leading Edge Stop f*ields are used to define the start time for the integration of the peak. These two numbers represent a window of time where the start of the peak is expected, relative to the retention time of the peak.

The *Skimming Peak Tailing Edge Start* and *Skimming Peak Trailing Edge Stop f*ields are used to define the end time for the integration of the peak. These two numbers represent a window of time where the end of the peak is expected, relative to the retention time of the peak.

The following example shows how the system determines if a peak is a valid peak:

The peak for iso-Butane is expected at 70.405sec. ± 5.000 sec. as defined by the component table.

The *Skimming Peak Start and Skimming Peak End* parameters are 69.2 seconds and 71.8 seconds. This means that the apex of the peak is expected to occur between these two times.

The *Skimming Peak Leading Edge Start* and *Skimming Peak Leading Edge Stop* parameters are 3.6 and 1.3 seconds. This means that the start of the peak integration will occur between 70.405 seconds minus 3.6 seconds (66.804) and 70.405 seconds minus 1.3 seconds (69.105). The start of the peak is defined as the minimum value of the detector signal between these two points. The *Skimming Peak Leading Edge Start* and *Skimming Peak Leading Edge Stop* times are defined relative to the retention time so that the peak integration start time will move with the peak if the retention time of the peak shifts.

The *Skimming Peak Trailing Edge Start* and *Skimming Peak Trailing Edge Stop* parameters are 1.3 and 5.5 seconds. This means that the end of the peak integration will occur between 70.405 seconds plus 1.3 seconds (71.705) and 70.405 seconds plus 5.5 seconds (75.905). The end of the peak is defined as the minimum value of the detector signal between these two points. The *Skimming Peak Trailing Edge Start* and *Skimming Peak Trailing Edge Stop* times are defined relative to the retention time so that the peak integration end time will move with the peak if the retention time of the peak shifts.

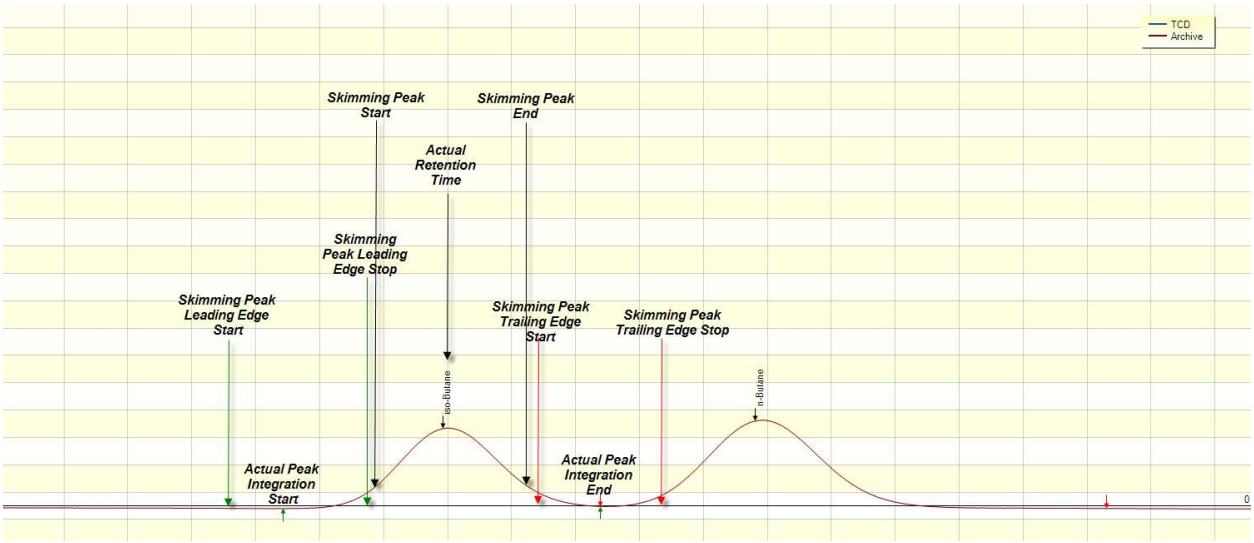


Figure 5-5: Definition of a Peak

Savitsky Golay Window – This is a smoothing factor for the chromatogram and should not be altered.

NOTICE **The following columns are to the right of the parameters for the fitting approach.**

Negative Peak -if the peak for this gas is a negative peak, check the box.
Old Response Factor - This is the response factor generated from the previous calibration.

Old Response Time - This is the retention time generated from the previous calibration.

Difference in Response Time - This is the difference in seconds between the previous calibration and the current calibration.

Difference in Response Factor - This is the per cent change in the response factor from the previous calibration to the current calibration.

5.4.3 Fitting Parameters

This feature is not yet implemented.

5.4.4 Physical Properties of the Calibration Gas

The *Physical Properties of the Calibration Gas* fields (Figure 5-6) shows the calculated physical properties of the calibration gas. These values can be used for comparison when analyzing the calibration gas as an unknown in the Reference mode.

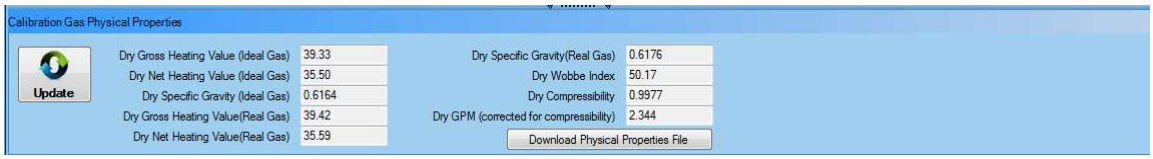
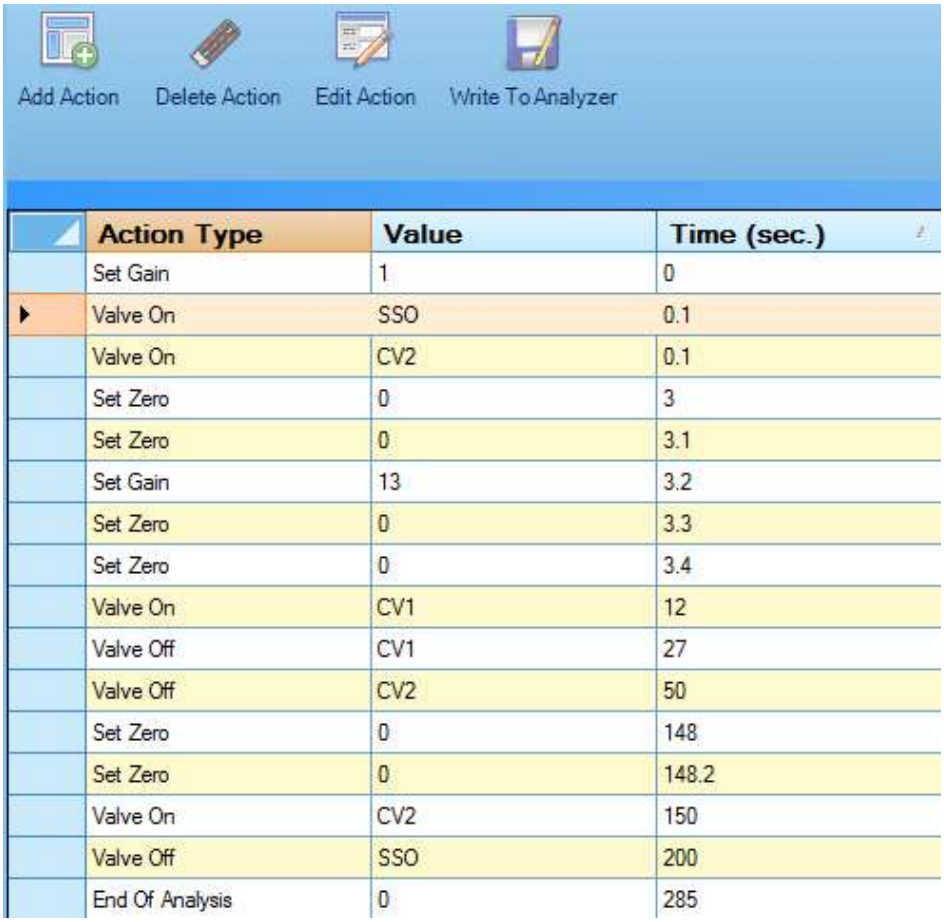


Figure 5-6: Physical Properties of the Calibration Gas

5.5 Action List

The *Action* list (Figure 5-7) is used to program a variety of activities during the separation such as opening/closing a valve, setting the gain, setting a zero and indicating the end of an analysis.



Action Type	Value	Time (sec.)
Set Gain	1	0
Valve On	SSO	0.1
Valve On	CV2	0.1
Set Zero	0	3
Set Zero	0	3.1
Set Gain	13	3.2
Set Zero	0	3.3
Set Zero	0	3.4
Valve On	CV1	12
Valve Off	CV1	27
Valve Off	CV2	50
Set Zero	0	148
Set Zero	0	148.2
Valve On	CV2	150
Valve Off	SSO	200
End Of Analysis	0	285

Figure 5-7: Action List with Tools

 *Add Action* - presents the *Add Action* dialog box (Figure 5-8).

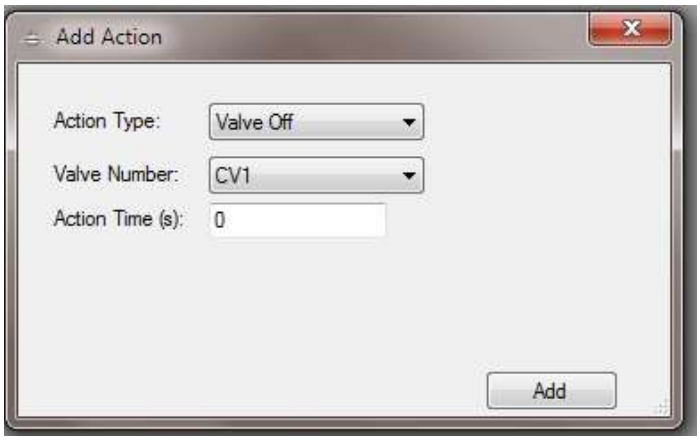


Figure 5-8: Add Action Dialog Box

The *Action Type* is selected via the top drop down menu:

- If a Valve Action (Valve Off, Valve On) is selected, the Valve Number and Action Time for the action can be selected. The Valve number field is used to select the appropriate valve. The SSO entry on the valve number list is used to purge the valve prior to placing the sample in the injector.
- If the Set Gain action is selected, the Add Action dialog box shown in Figure 5-9 is presented.

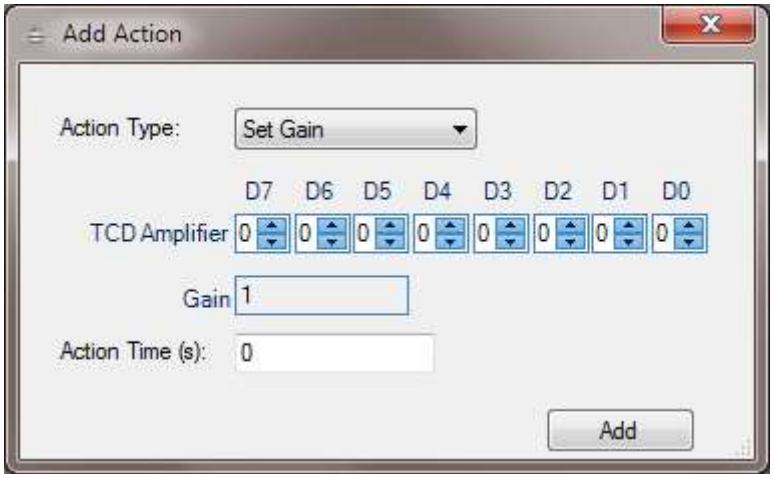


Figure 5-9: Set Gain Action Dialog Box

The gain can be set from 0.2 to 3,200,000 by setting the *Dx* switches (e.g. if D7 is set to 1 and all other are set to 0, the gain is 0.2).

a) If the Set Zero action is selected, the dialog box that is presented allows for setting the time for setting the signal to zero.

 *Delete Action* – is used to remove the line in the Action Table indicated by the ►.

 *Edit Action* – opens the action indicated by the ►and permits editing. This is identical to the *Add Action* icon (the user can edit the time).

 *Write to Analyzer* – transmits the configuration to the analyzer

5.6 Streams Setup

The *Streams Setup* screen (Figure 5-10) is used to set a variety of parameters that define the individual streams that are connected to the system.

 *Add Run* - provides a new tab

 *Delete Run* - removes the highlighted tab

 *Write to Analyzer* - transmits the configuration to the analyzer

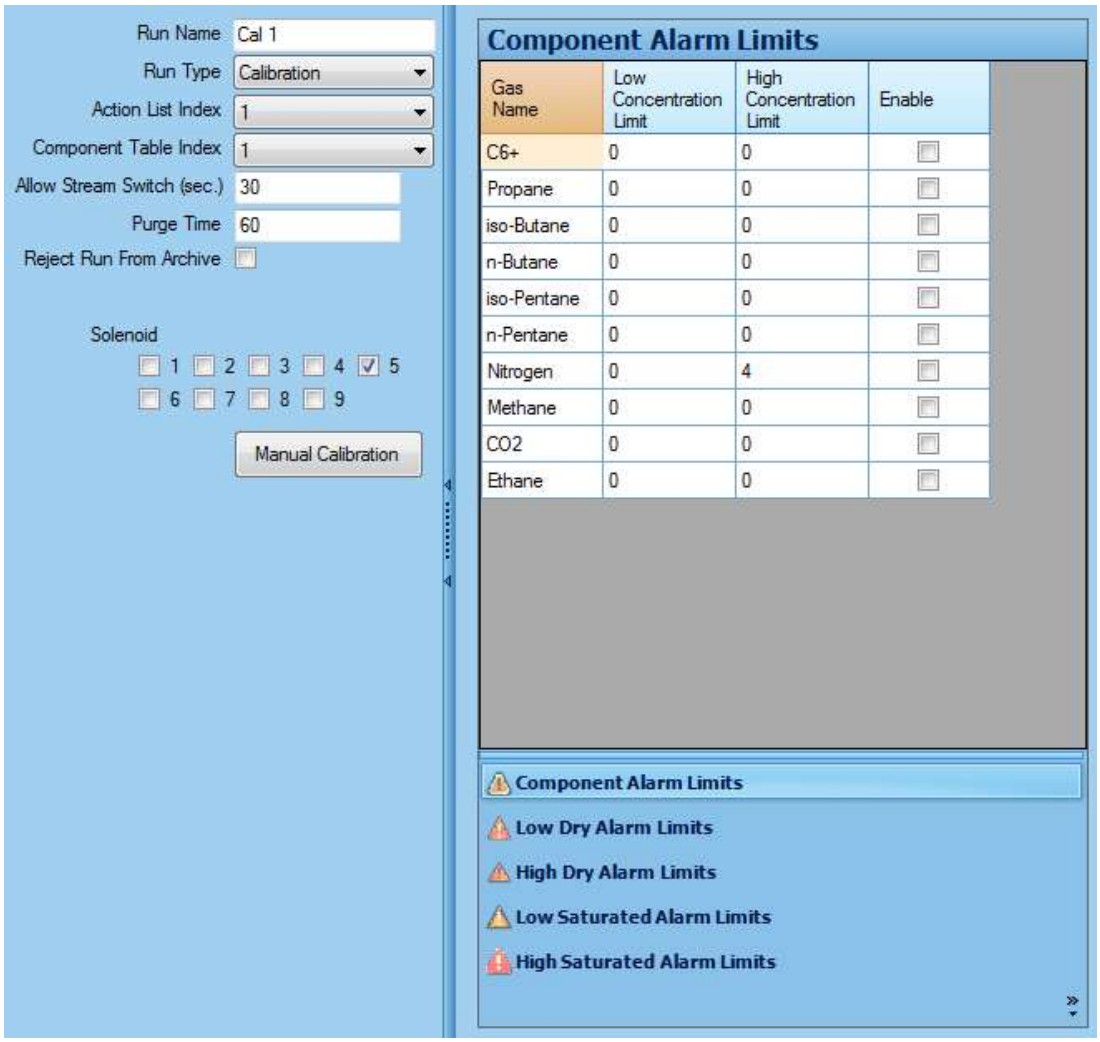


Figure 5-10: Streams Setup

Run Name - User defined

Run Type - The stream type can be an Analysis, a Calibration or a Reference stream, selected via the drop down menu. Selection of a Reference type selection presents the same tab as a *Stream* type. The *Calibration* tab includes a button for *Manual Calibration*, which will initiate a calibration sequence.

Action List Index - used to indicate which *Action List* should be used (1 or 2).

Component Table Index - used to indicate which *Component Table* should be used.

Allow Stream Switch - used to indicate that the analyzer should switch streams during an analysis. This allows the analyzer to purge the sample system with the upcoming stream for a period of time prior to the analysis, so this is typically placed quite early in an analysis. The stream that is switched to is defined either manually in the Analysis Control window, or automatically in the Scheduling section of Sample Handling.

Purge Time - used to indicate the amount of time the analyzer should purge the sample loop prior to initializing a run definition

Reject Run from Archive - If checked, the data from this stream will not be included in the hourly or daily averages if any component high or low alarm is present for this stream.

The *Component Alarms* table is used to indicate the high and low value which should set off an alarm. Enter the desired values and check the *Enable* box if the limits should be used

Additional tables for the Low and High Alarm Limits as well as Low and High Saturated Alarm Limits can presented by clicking on the icons on the entries below the *Component Alarm Limits* fields. A typical table is presented as Figure 5-11 (the format of all of these tables is identical).

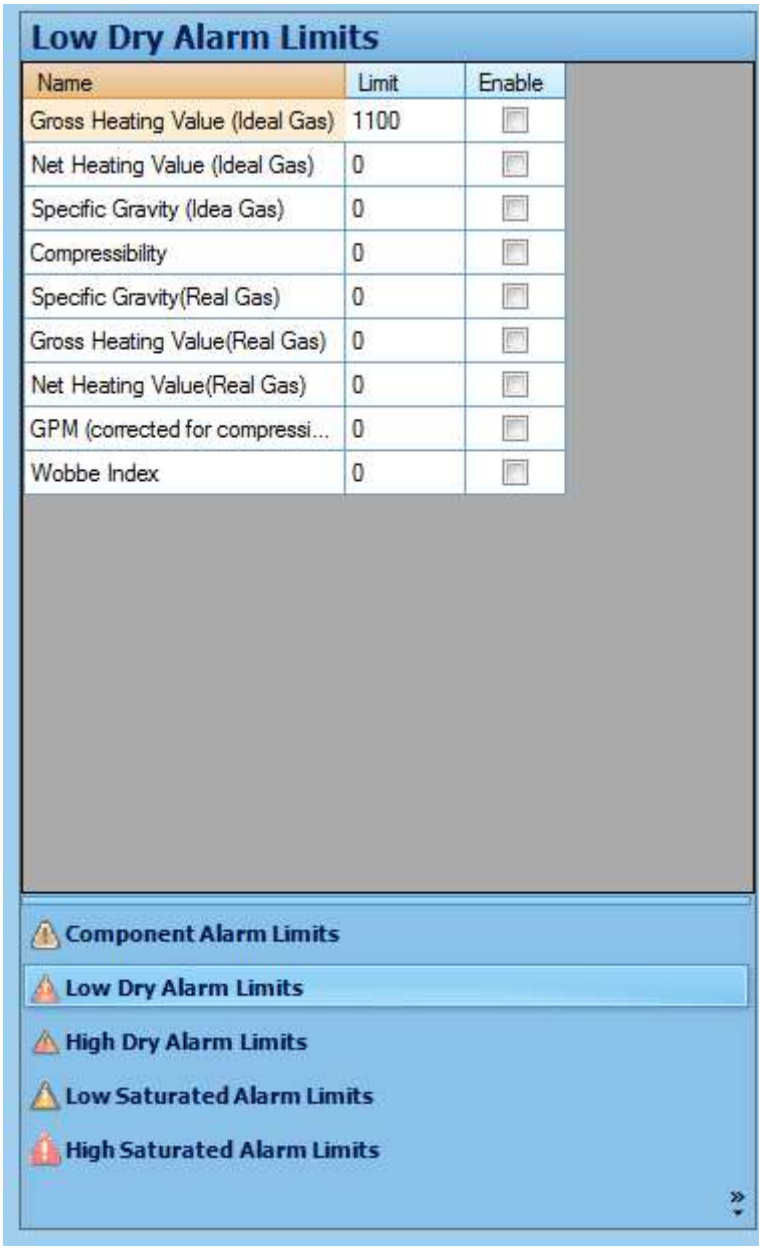


Figure 5-11: Low Dry Alarm Limits Table

 - leads to a menu where you can add or delete icons for the above items and place the icon(s) and definition(s) directly below the table.

5.7 Stream Sequencer

The *Stream Sequencer* screen (Figure 5-12) is used to indicate the order of runs within a sequence.

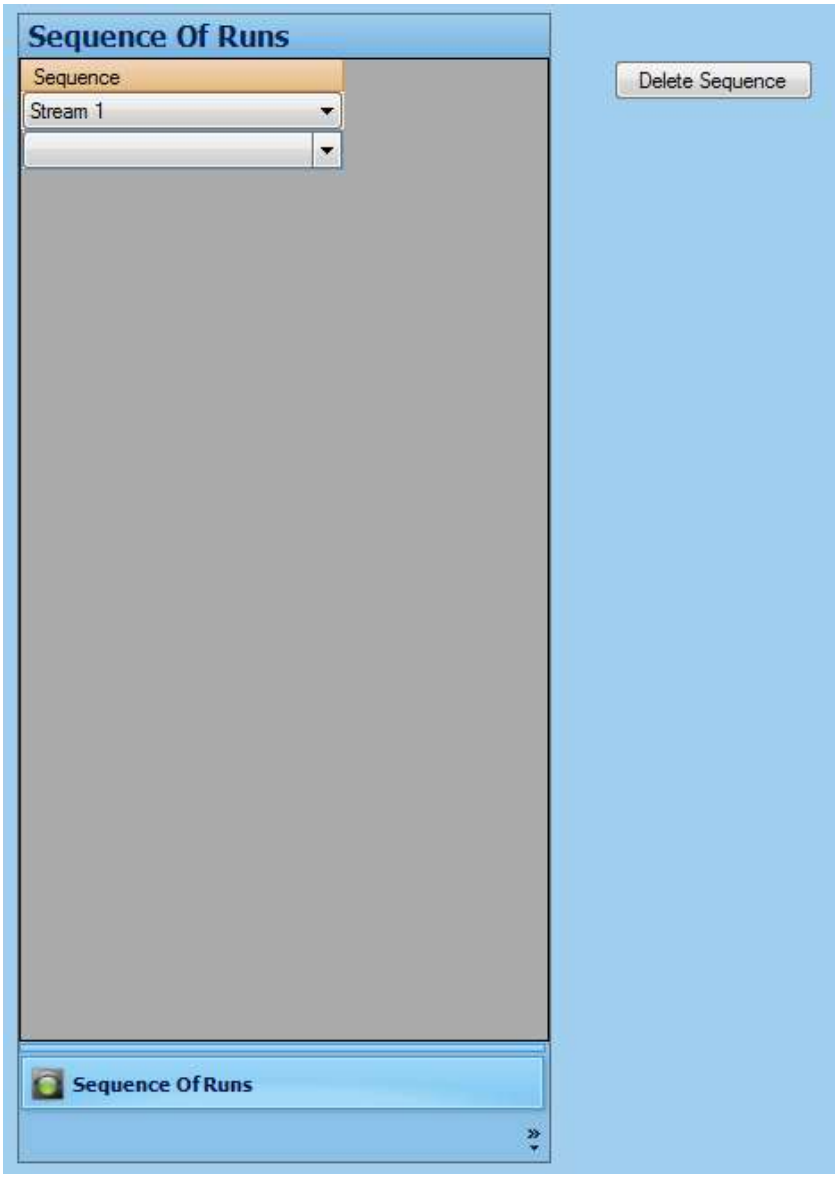


Figure 5-12: Stream Sequencer Screen

To enter a run in a sequence, click on the drop down menu and select the desired run type. The available runs are those that have been generated on the *Streams Setup* screen.

 - leads to a menu where you can add or delete buttons for the above item and place the icon(s) and definition(s) directly below the table.

5.8 Stream Scheduler

The *Stream Scheduler* (Figure 5-13) is used to indicate when the various streams should be analyzed and indicate if a stream is to be analyzed on a repetitive basis. Each stream can be scheduled independently.

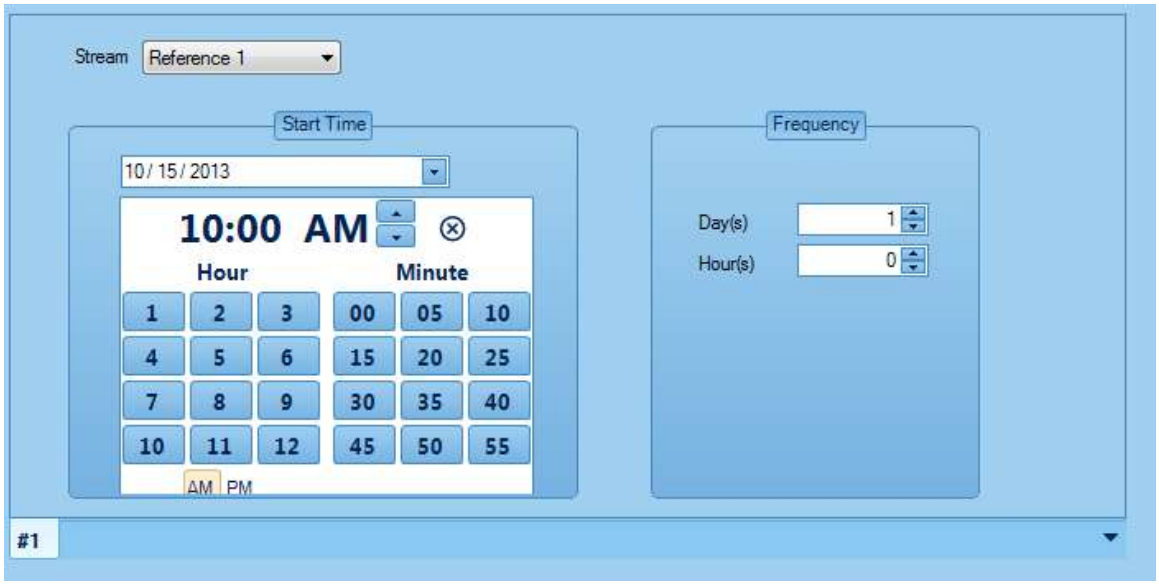


Figure 5-13: Stream Scheduler

To set the start time for a stream:

a) Press the ▼ adjacent to the date to present a calendar of the month indicated in the date line and click on the desired day.

b) Click on the desired hour and minute in the time field. If you want to start a run at a time not indicated in the time field, set an approximate time via the numerical buttons and adjust the time via the ▼ or ▲ button.

If desired, repetitive runs for a given stream can be scheduled by editing the *Days* and *Hours* fields of the *Frequency* region.

5.9 Digital Inputs

The *Digital Inputs* screen (Figure 5-14) is used to define the role of the four digital inputs. The input can be set to *Enable Run* or *Enable Alarm*. If *Enable Run* is selected, then the stream that is defined in the *Run* field will be executed when the input is activated. If *Alarm* is selected, then the digital input is attached to a switching device (such as a pressure switch) and will generate an a alarm if the digital input is activated. Once the parameters are set, the *Write to Analyze*r button should be pressed to send the information to the chromatograph.

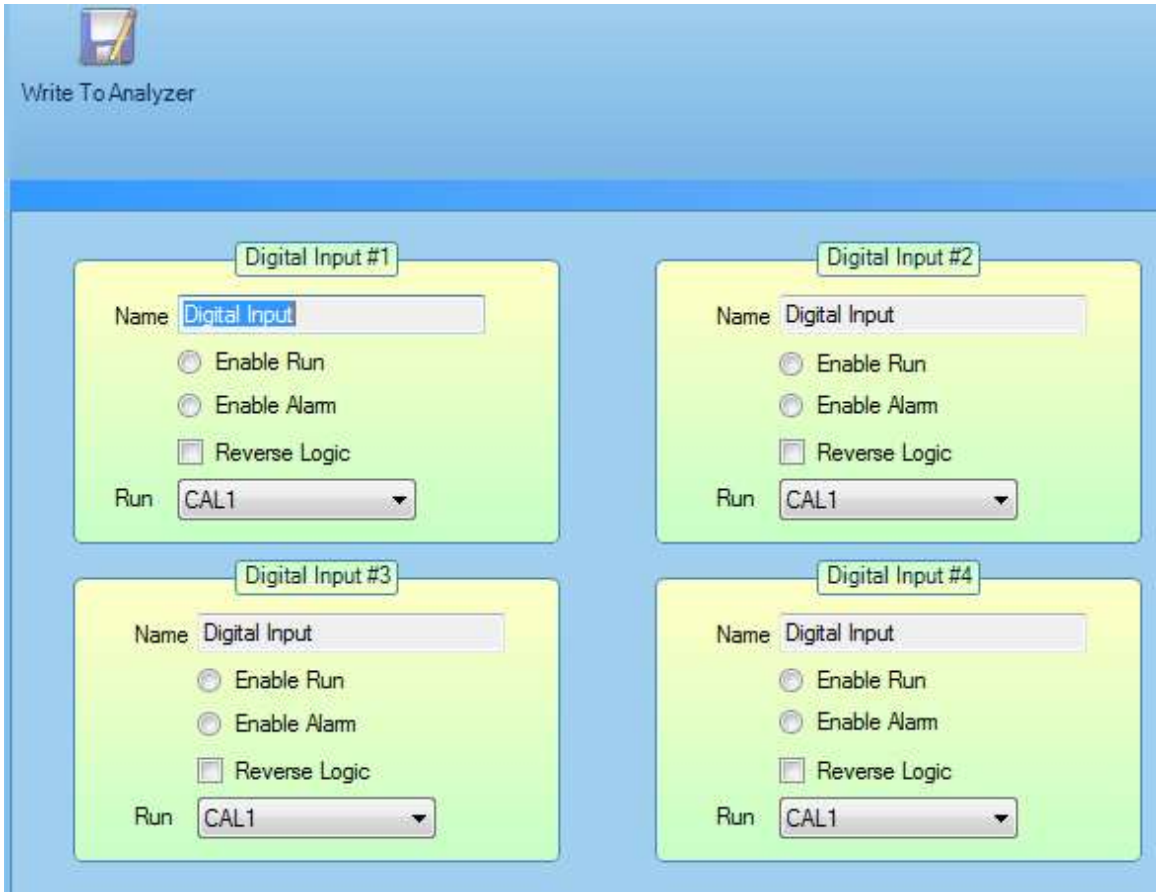


Figure 5-14: Digital Inputs

5.10 Digital Outputs

The *Digital Outputs* screen (Figure 5-15) is used to assign the various available alarms to specific digital outputs. Once the parameters are set, the *Write to Analyzer* button should be pressed to send the information to the chromatograph.

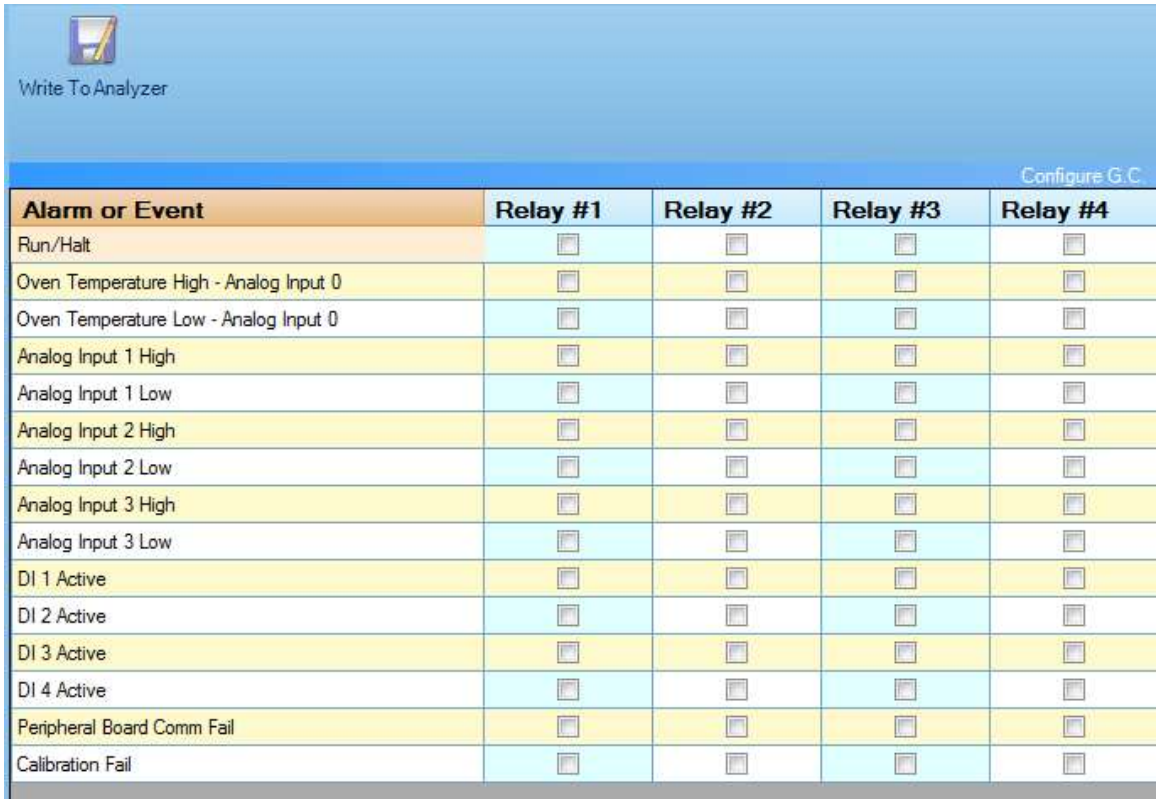


Figure 5-15: Digital Outputs Screen

5.11 Analog Inputs

The *Analog Inputs* screen (Figure 5-16) is used to define the role of the four analog inputs. The alarm limits should be set and the appropriate check boxes selected. Once the parameters are set, the *Write to Analyzer* button should be pressed to send the information to the chromatograph.

Figure 5-16: Analog Input Screen

5.12 Analog Outputs

The *Analog Outputs* screen (Figure 5-17) is used to set parameters for the transmission of data to an external device. The parameter to be transmitted is selected via the *Parameter* drop down menu, the range should be selected and press the *Write to Analyzer* button .

Figure 5-17: Analog Outputs Screen

5.13 Global Setting

The Global Setting tab (Figure 5-18) is used to provide system identification.

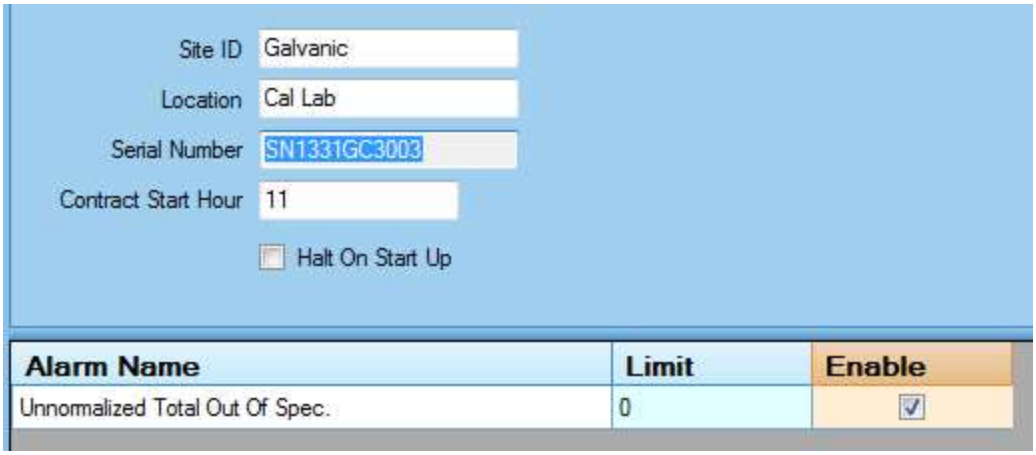


Figure 5-18: Global Setting

The *Contract Start Hour* is the time of day at which the daily average is calculated.

If the *Halt on Start Up* check box is selected, the system will be in Halt mode when it boots up. If the box is not checked, the analyzer will run when it boots up.

The *Unnormalized Total Out of Spec.* entry on the Alarm field is used to set the limit for which an alarm should be raised. As an example, if the entered value is 2%, and the enable check box is checked, an alarm will be issued if the un-normalized total is less than 98% or greater than 102%.

Section 6 Using the Instrument

6.1 Introduction

The ACCUCHROME is designed to monitor the composition of a gas stream on a programmed basis. The system can analyze gas samples, a reference gas (gas of known composition to verify acceptable system operation), and calibration gas (which is used to calculate/recalculate response factors) as desired.

This section is provided to assist the user in the typical operation of the chromatograph and should be used in conjunction with Chapters 4 and 5, which describe the general format of the operating system.

NOTICE

It is assumed in this chapter that the system has been installed, appropriate gas lines have been fitted and all connections to external devices (e.g. alarms) have been made.

There are two modes of operation of the application software:

a) *Vie*w Mode - used to collect/view/Reporting data and viewing archived data (Section 6.2).

b) *Edit* Mode - used to set a broad range of parameters that define the data processing of the data, define the system configuration (e.g. set alarms) and establish a schedule of analyses (Section 6.3).

6.2 View Mode

Analytical data is collected via the *View* mode . In this mode, Reference streams, Calibration streams and Sample streams are analyzed on a periodic basis as selected in Edit mode (data can also be viewed while in the *Edit* mode). The analysis of a calibration stream is to adjust the response factors used to determine the concentration of the various components of the sample. Alarms will be activated upon various events and solenoids will be activated during a separation as defined in Edit mode.

6.2.1 Viewing the Current Chromatogram

The chromatogram is presented on the monitor as it is being collected via the *Chromatogram* tab (Figure 6-1). The chromatogram presentation can be changed via the *Auto-Scale* icon which sets the largest peak to 75% of full scale or the *Edit Chromatogram* icon which presents a dialog box to define the X and Y minima and maxima as well as the X interval.

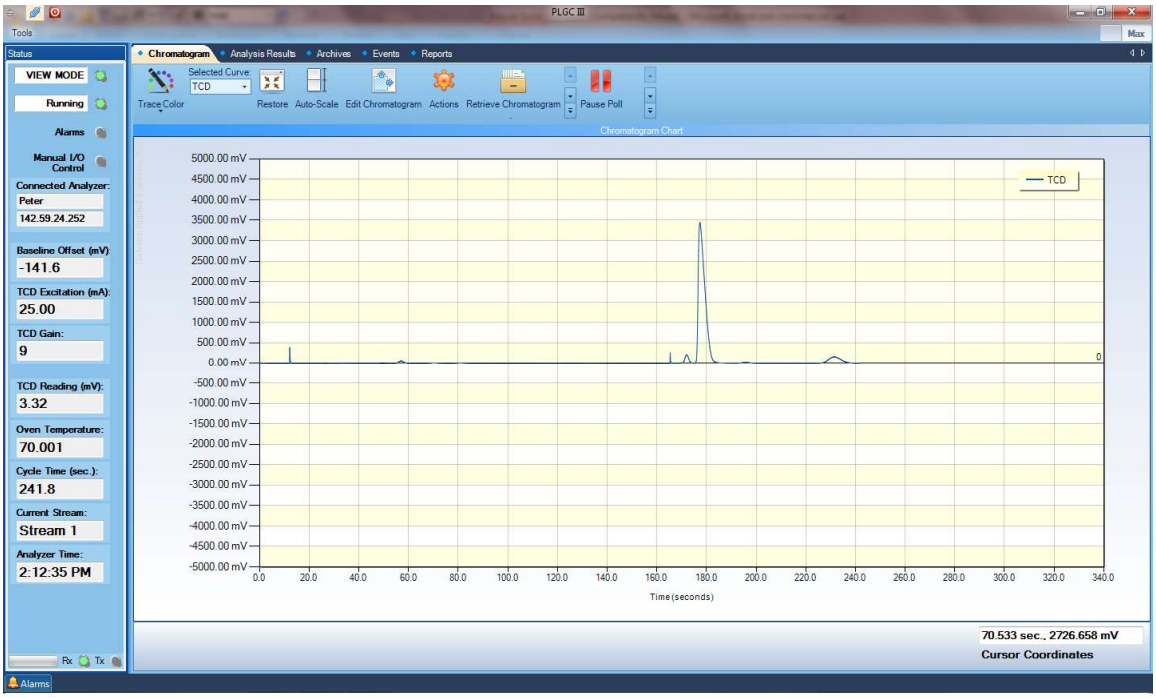


Figure 6-1: A Typical Chromatogram

The chart format can be altered in a variety of ways (e.g. changing the color). To access a drop down menu that includes the options, right click in the chromatogram and press the *Chart* button that is presented.

6.2.2 Viewing Data

A table containing the most recent data can be viewed via the *Analysis Results* tab (Figure 6-2). The stream for which data is displayed is selected by the left column on the screen. The *Refresh* icon on top of the table is used to present the most recent data.

Cal 1
Ref 1
Stream 1

Component Name	Dry Analysis	Saturated Analysis	Dry Analysis	Saturated Analysis	Dry Analysis	Saturated Analysis	Dry Analysis
Analysis Time	5/21/2013 10:39 AM	5/21/2013 10:39 AM	5/21/2013 10:34 AM	5/21/2013 10:34 AM	5/21/2013 10:30 AM	5/21/2013 10:30 AM	5/21/2013 10:25 AM
C6+	0.0300	0.0295	0.0299	0.0294	0.0301	0.0295	0.0300
Propane	0.9974	0.9800	0.9979	0.9805	0.9979	0.9805	0.9977
iso-Butane	0.2997	0.2945	0.3001	0.2949	0.3004	0.2951	0.3005
n-Butane	0.2994	0.2942	0.2994	0.2942	0.2995	0.2943	0.3002
iso-Pentane	0.0985	0.0968	0.0990	0.0973	0.1013	0.0995	0.1006
n-Pentane	0.0990	0.0973	0.0990	0.0972	0.0990	0.0973	0.0985
Nitrogen	2.5012	2.4577	2.5009	2.4573	2.5014	2.4579	2.5001
Methane	90.1749	88.6055	90.1720	88.6027	90.1701	88.6008	90.1719
CO2	0.5001	0.4914	0.4999	0.4912	0.4999	0.4912	0.5004
Ethane	4.9997	4.9127	5.0020	4.9150	5.0005	4.9135	5.0002
Water Vapor	0.0000	0.0174	0.0000	0.0174	0.0000	0.0174	0.0000
Normalized Total	100.0000		100.0000		100.0000		100.0000
Un-Normalized Total	99.8688		99.9514		99.8401		99.8840
Gross Heating Value(Ideal Gas)	1055.79	1037.41	1055.84	1037.46	1055.90	1037.53	1055.89
Net Heating Value(Ideal Gas)	953.07	936.49	953.12	936.53	953.18	936.59	953.17
Specific Gravity(Ideal Gas)	0.6177	0.6178	0.6177	0.6178	0.6178	0.6179	0.6178
Gross Heating Value(Real Gas)	1058.27	1040.22	1058.32	1040.27	1058.39	1040.33	1058.37
Net Heating Value(Real Gas)	955.32	939.02	955.36	939.06	955.42	939.13	955.41
Specific Gravity(Real Gas)	0.6189	0.6192	0.6189	0.6193	0.6190	0.6193	0.6190
Wobbe Index	1345.18	1321.90	1345.22	1321.93	1345.25	1321.96	1345.25
Compressibility	0.9977	0.9973	0.9977	0.9973	0.9977	0.9973	0.9977
GPM(corrected for compressibility)	17.534	17.334	17.534	17.334	17.534	17.335	17.534

Figure 6-2: Analysis Results

Archival data can be viewed via the Archives tab (Figure 6-3).

RecNo	Timestamp	Stream	Information	C6+	Propane	iso-Butane	n-Butane	neo-Pentane	iso-Pentane	n-Pentane	Nitrogen	Methane	CO2	Ethane	Water Vapor	Normalized
0	5/26/2013 1:15:47 AM	Stream 2	dry	0.0459	0.0000	0.2343	0.0000	0.0000	0.0557	0.0015	93.0206	0.0000	0.6213	6.0207	0.0000	100.0000
1	5/26/2013 1:15:47 AM	Stream 2	saturated	0.0451	0.0000	0.2302	0.0000	0.0000	0.0547	0.0015	91.4017	0.0000	0.6105	5.9159	1.7404	0.0000
2	5/26/2013 1:21:02 AM	Stream 3	dry	0.0310	0.3633	0.1920	0.0000	0.0000	0.0666	0.0032	92.7504	0.6026	0.5918	5.3989	0.0000	100.0000
3	5/26/2013 1:21:02 AM	Stream 3	saturated	0.0305	0.3570	0.1887	0.0000	0.0000	0.0654	0.0032	91.1362	0.5921	0.5815	5.3049	1.7404	0.0000
4	5/26/2013 1:26:16 AM	Stream 1	dry	0.0396	0.0000	0.2174	0.0000	0.0000	0.0578	0.0045	92.6827	0.6281	0.6007	5.7691	0.0000	100.0000
5	5/26/2013 1:26:16 AM	Stream 1	saturated	0.0389	0.0000	0.2137	0.0000	0.0000	0.0568	0.0045	91.0697	0.6172	0.5903	5.6687	1.7404	0.0000
6	5/26/2013 1:31:31 AM	Stream 2	dry	0.0488	0.0000	0.2324	0.0000	0.0000	0.0618	0.0034	92.4321	0.6569	0.6105	5.9542	0.0000	100.0000
7	5/26/2013 1:31:31 AM	Stream 2	saturated	0.0479	0.0000	0.2284	0.0000	0.0000	0.0608	0.0033	90.8234	0.6455	0.5999	5.8505	1.7404	0.0000
8	5/26/2013 1:36:45 AM	Stream 3	dry	0.0310	0.3557	0.1931	0.0000	0.0000	0.0492	0.0020	92.7044	0.6064	0.6003	5.4580	0.0000	100.0000
9	5/26/2013 1:36:45 AM	Stream 3	saturated	0.0304	0.3495	0.1897	0.0000	0.0000	0.0483	0.0019	91.0910	0.5958	0.5899	5.3630	1.7404	0.0000
10	5/26/2013 1:41:59 AM	Stream 1	dry	0.0424	0.3561	0.2100	0.0000	0.0000	0.0540	0.0041	92.3844	0.6227	0.5942	5.7319	0.0000	100.0000
11	5/26/2013 1:41:59 AM	Stream 1	saturated	0.0417	0.3499	0.2064	0.0000	0.0000	0.0531	0.0041	90.7766	0.6118	0.5839	5.6322	1.7404	0.0000
12	5/26/2013 1:47:14 AM	Stream 2	dry	0.0409	0.0000	0.2233	0.0000	0.0000	0.0547	0.0057	92.6390	0.6324	0.6052	5.7986	0.0000	100.0000
13	5/26/2013 1:47:14 AM	Stream 2	saturated	0.0402	0.0000	0.2194	0.0000	0.0000	0.0538	0.0056	91.0267	0.6214	0.5947	5.6977	1.7404	0.0000
14	5/26/2013 1:52:30 AM	Stream 3	dry	0.0428	0.0000	0.2182	0.0000	0.0000	0.0668	0.0138	92.5349	0.6401	0.5951	5.7883	0.0000	100.0000
15	5/26/2013 1:52:30 AM	Stream 3	saturated	0.0420	0.0000	0.2144	0.0000	0.0000	0.0657	0.0135	91.0227	0.6290	0.5847	5.6876	1.7404	0.0000
16	5/26/2013 1:57:44 AM	Stream 1	dry	0.0370	0.3464	0.2070	0.0000	0.0003	0.0579	0.0047	92.4919	0.6191	0.6072	5.6286	0.0000	100.0000
17	5/26/2013 1:57:44 AM	Stream 1	saturated	0.0363	0.3403	0.2034	0.0000	0.0003	0.0569	0.0046	90.8821	0.6083	0.5965	5.5307	1.7404	0.0000
18	5/26/2013 2:02:59 AM	Stream 2	dry	0.0428	0.0000	0.2209	0.0000	0.0000	0.0685	0.0169	92.6302	0.6396	0.6067	5.7754	0.0000	100.0000
19	5/26/2013 2:02:59 AM	Stream 2	saturated	0.0420	0.0000	0.2170	0.0000	0.0000	0.0673	0.0166	91.0181	0.6275	0.5961	5.6749	1.7404	0.0000
20	5/26/2013 2:08:14 AM	Stream 3	dry	0.0480	0.0000	0.2295	0.0000	0.0000	0.0590	0.0016	92.5105	0.6514	0.6083	5.8937	0.0000	100.0000
21	5/26/2013 2:08:14 AM	Stream 3	saturated	0.0472	0.0000	0.2255	0.0000	0.0000	0.0579	0.0015	90.9004	0.6401	0.5958	5.7911	1.7404	0.0000
22	5/26/2013 2:13:29 AM	Stream 1	dry	0.0311	0.3534	0.1999	0.0000	0.0003	0.0462	0.0050	92.5924	0.6577	0.5919	5.5221	0.0000	100.0000
23	5/26/2013 2:13:29 AM	Stream 1	saturated	0.0306	0.3472	0.1964	0.0000	0.0003	0.0454	0.0049	90.9809	0.6463	0.5816	5.4260	1.7404	0.0000
24	5/26/2013 2:18:44 AM	Stream 2	dry	0.0464	0.0000	0.2208	0.0000	0.0000	0.0581	0.0048	92.6275	0.6253	0.6079	5.8092	0.0000	100.0000
25	5/26/2013 2:18:44 AM	Stream 2	saturated	0.0456	0.0000	0.2170	0.0000	0.0000	0.0571	0.0047	91.0155	0.6144	0.5973	5.7081	1.7404	0.0000
26	5/26/2013 2:23:58 AM	Stream 3	dry	0.0476	0.0000	0.2277	0.0000	0.0000	0.0700	0.0041	92.4916	0.6408	0.6058	5.9125	0.0000	100.0000
27	5/26/2013 2:23:58 AM	Stream 3	saturated	0.0468	0.0000	0.2237	0.0000	0.0000	0.0687	0.0040	90.8819	0.6296	0.5952	5.8096	1.7404	0.0000
28	5/26/2013 2:29:12 AM	Stream 1	dry	0.0340	0.3446	0.1972	0.0000	0.0001	0.0585	0.0187	92.7124	0.5999	0.6012	5.4333	0.0000	100.0000
29	5/26/2013 2:29:12 AM	Stream 1	saturated	0.0334	0.3386	0.1938	0.0000	0.0001	0.0575	0.0184	91.0989	0.5895	0.5908	5.3387	1.7404	0.0000
30	5/26/2013 2:34:26 AM	Stream 2	dry	0.0395	0.0000	0.2123	0.0000	0.0000	0.0563	0.0021	92.6923	0.6283	0.6060	5.7633	0.0000	100.0000
31	5/26/2013 2:34:26 AM	Stream 2	saturated	0.0388	0.0000	0.2086	0.0000	0.0000	0.0553	0.0020	91.0790	0.6173	0.5954	5.6630	1.7404	0.0000
32	5/26/2013 2:39:40 AM	Stream 3	dry	0.0452	0.0000	0.2329	0.0000	0.0000	0.0618	0.0011	92.4589	0.6522	0.6022	5.9457	0.0000	100.0000
33	5/26/2013 2:39:40 AM	Stream 3	saturated	0.0444	0.0000	0.2288	0.0000	0.0000	0.0607	0.0011	90.8498	0.6409	0.5917	5.8423	1.7404	0.0000
34	5/26/2013 2:44:54 AM	Stream 1	dry	0.0329	0.3688	0.1909	0.0000	0.0000	0.0534	0.0127	92.7512	0.5930	0.6128	5.3832	0.0000	100.0000
35	5/26/2013 2:44:54 AM	Stream 1	saturated	0.0323	0.3634	0.1876	0.0000	0.0000	0.0525	0.0125	91.1369	0.5827	0.6022	5.2895	1.7404	0.0000
36	5/26/2013 2:50:08 AM	Stream 2	dry	0.0392	0.3634	0.2070	0.0000	0.0000	0.0571	0.0036	92.4592	0.6079	0.6117	5.6510	0.0000	100.0000
37	5/26/2013 2:50:08 AM	Stream 2	saturated	0.0385	0.3570	0.2034	0.0000	0.0000	0.0561	0.0035	90.8500	0.5973	0.6010	5.5526	1.7404	0.0000
38	5/26/2013 2:55:24 AM	Stream 3	dry	0.0477	0.0000	0.2378	0.0000	0.0000	0.0589	0.0021	92.4229	0.6828	0.6019	5.9657	0.0000	100.0000
39	5/26/2013 2:55:24 AM	Stream 3	saturated	0.0469	0.0000	0.2337	0.0000	0.0000	0.0579	0.0021	90.8144	0.6513	0.5915	5.8619	1.7404	0.0000

Figure 6-3: Archive Tab

If desired, archival data can be sorted by clicking on the *Stream* column header. To unsort the data, click on the *Reload Downloaded Archives* button. The data can be exported to an Excel spreadsheet by clicking on the *Export to File* button.

6.2.3 Generating Reports

A range of reports can be generated via the Reports tab (Figure 6-4). Select the desired report format (Print, PDF, Open File) and press the button that describes the report that you want.

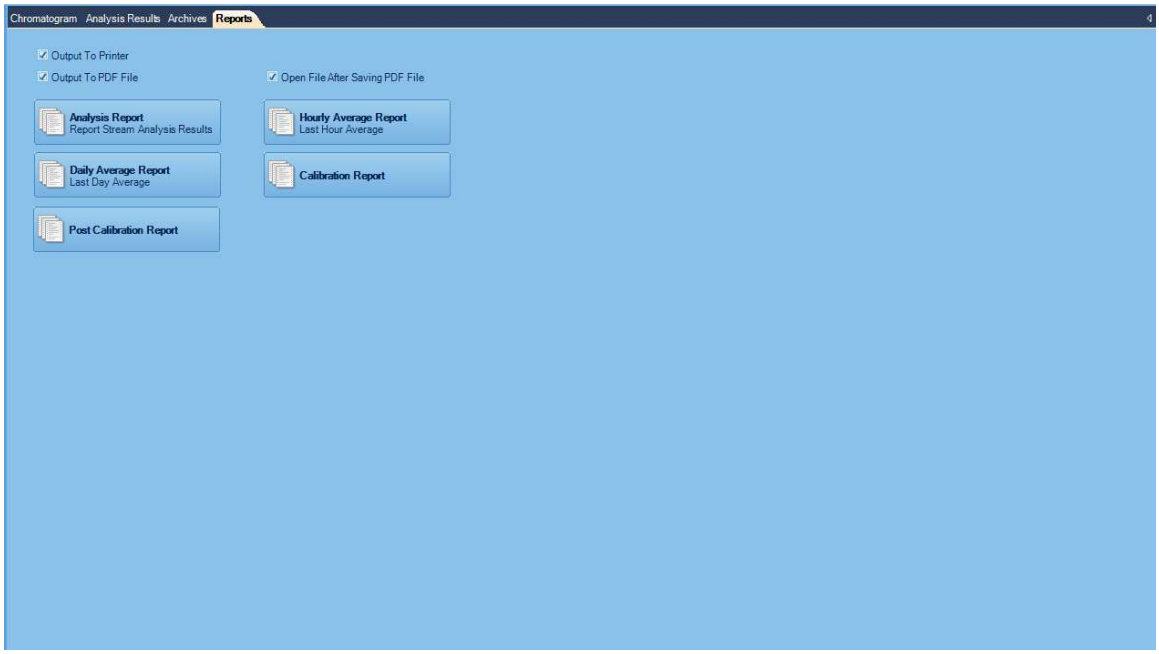


Figure 6-4: The Report Tab

6.3 Setting up the Desired Analysis

In addition to the activities described in the *View* mode, the *Edit* Mode allows the user to edit a broad range of operating parameters, calibrate the system, establish a data collection schedule and setup Modbus parameters.

Typically, the system operating parameters are established during manufacturing and/or during installation. It is not necessary to edit most of them unless a major change in the overall system configuration is made. In this section, we will describe only those activities that are likely to be performed. As an example of this point, the nature of each stream (sample, calibration, reference) is indicated in the *Streams Setup* tab. In normal operation, once the system is configured, the nature of the gases delivered to the chromatograph is not changed.

6.3.1 Editing the Component Table

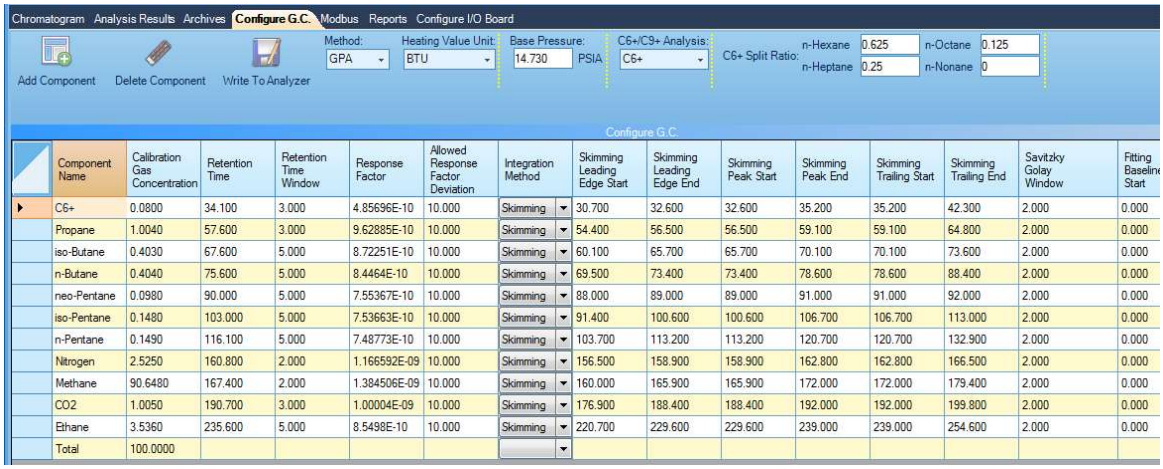
The component table contains a list of the compounds to be analyzed, properties of the calibration gas, the concentration of the various components of the calibration gas and parameters used for integration.

Once the GC is setup it is unlikely that the user would have to add components to the list. However, it may be necessary to change any of the time based parameter due to column ageing and valve wear.

To edit the Component Table:

a) Collect a number of chromatograms from a gas of known composition and determine the retention time for the peak maximum for the compound(s) of interest. It is recommended that the average retention time from at least three runs be used to determine the retention time.

b) Enter the names of each gas (if necessary), the retention time and the concentration of the various components of the gas in the component table (Figure 6-5).



Component Name	Calibration Gas Concentration	Retention Time	Retention Time Window	Response Factor	Allowed Response Factor Deviation	Integration Method	Skimming Leading Edge Start	Skimming Leading Edge End	Skimming Peak Start	Skimming Peak End	Skimming Trailing Start	Skimming Trailing End	Savitzky Golay Window	Fitting Baseline Start
C6+	0.0800	34.100	3.000	4.85696E-10	10.000	Skimming	30.700	32.600	32.600	35.200	35.200	42.300	2.000	0.000
Propane	1.0040	57.600	3.000	9.62885E-10	10.000	Skimming	54.400	56.500	56.500	59.100	59.100	64.800	2.000	0.000
iso-Butane	0.4030	67.600	5.000	8.72251E-10	10.000	Skimming	60.100	65.700	65.700	70.100	70.100	73.600	2.000	0.000
n-Butane	0.4040	75.600	5.000	8.4464E-10	10.000	Skimming	69.500	73.400	73.400	78.600	78.600	88.400	2.000	0.000
neo-Pentane	0.0980	90.000	5.000	7.55367E-10	10.000	Skimming	88.000	89.000	89.000	91.000	91.000	92.000	2.000	0.000
iso-Pentane	0.1480	103.000	5.000	7.53663E-10	10.000	Skimming	91.400	100.600	100.600	106.700	106.700	113.000	2.000	0.000
n-Pentane	0.1490	116.100	5.000	7.48773E-10	10.000	Skimming	103.700	113.200	113.200	120.700	120.700	132.900	2.000	0.000
Nitrogen	2.5250	160.800	2.000	1.166592E-09	10.000	Skimming	156.500	158.900	158.900	162.800	162.800	166.500	2.000	0.000
Methane	90.6480	167.400	2.000	1.384506E-09	10.000	Skimming	160.000	165.900	165.900	172.000	172.000	179.400	2.000	0.000
CO2	1.0050	190.700	3.000	1.00004E-09	10.000	Skimming	176.900	188.400	188.400	192.000	192.000	199.800	2.000	0.000
Ethane	3.5360	235.600	5.000	8.5498E-10	10.000	Skimming	220.700	229.600	229.600	239.000	239.000	254.600	2.000	0.000
Total	100.0000													

Figure 6-5: Component Table

c) Inspect the various peaks in the chromatogram and determine the *Skimming Leading Edge Start, Skimming Leading Edge End*, *Skimming Trailing Edge Start* and *Skimming Trailing Edge Stop* for each peak. This is used to determine the integration window for each peak

The windows should be selected so that the integration includes the entire peak, but does not include extraneous signals. A typical set of integration windows is shown in Figure 6-6.

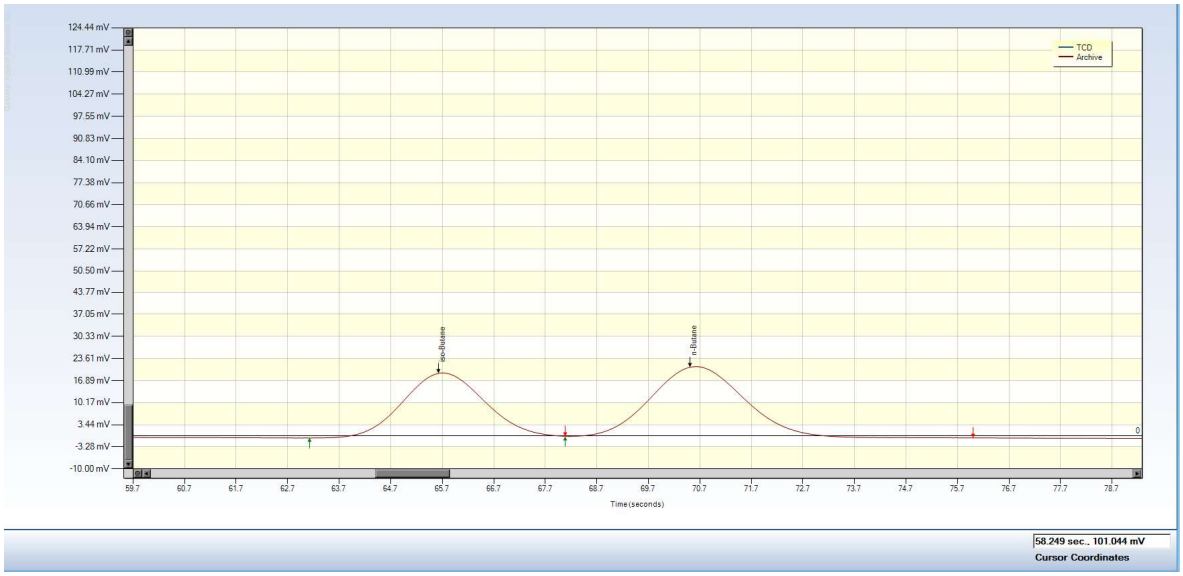


Figure 6-6: Integration Window

d) Select *Skimming* as the Integration Method and enter the integration window data in the appropriate fields.

e) Select the desired items (e.g. method, Heating value Units, Base Pressure and concentration of higher alkanes).

f) Edit the Calibration Gas Physical Properties at the bottom of the window.

NOTICE **Do not adjust the *Savitzky Golay* fields.**

g) Press the *Write to Analyzer* button.

6.3.2 Editing an Action

Actions are used to open/close valves, set the end of analysis or to set a valve purge. A detailed discussion of editing the *Action Table* is presented in Section 5.5.

6.3.3 Editing Alarms

Alarms can be set to report levels of a compound above or below expected limits as described in Section 5.6

Section 7 ACCUCHROME Validation

7.1 Overview

The ACCUCHROME should be validated on a monthly basis or as per the measurement requirements of the user.

The validation process involves analyzing a known gas mixture and comparing the analyzer results to the certified value of the known mixture. This known mixture is referred to as the calibration gas. The validation process is also used to assess the status of the chromatograph and may be useful in indicating the presence of e potential problems such as worn chromatograph valves or contaminated columns.

The calibration gas should be a mixture of all of the gasses the chromatograph is to measure in proportions similar to those in the actual sample. The composition of a typical calibration blend is shown in Table 7-1 for a C6+ measurement of natural gas. The calibration gas should be obtained with a certificate of composition.

Table 7-1: Composition of a Typical Natural Gas Calibration Blend

Component	Mole %
Methane	Balance (89.67 %)
Ethane	5 %
Propane	1 %
n-Butane	0.3 %
iso-Butane	0.3 %
n-Pentane	0.1 %
iso-Pentane	0.1 %
n-Hexane	0.03 %
Nitrogen	1 %
Carbon Dioxide	2.5 %

7.2 Role of the Calibration Gas and the Reference Gas

The calibration gas and the reference gas are the same gas, but are handled differently in the application software. In the *Stream Sequencer* screen, the analyst must indicate the nature of the gas to be analyzed.

- **Calibration Gas** - If the *Calibration Stream* is selected, the certified composition of the calibration gas (which is entered in the *Component Table*) is used in conjunction with the peak area to calculate the response factor for each compound.
- **Reference Gas** - If the *Reference Stream* is selected, the composition of the gas is determined using the existing response factors and reported. When the Reference Stream is run, the chromatograph will analyze the calibration gas and simply report the values for each component without making any adjustment to the response factors. The reported composition of the gas should be compared to that reported by the supplier of the calibration gas to ensure that the system is operating on an acceptable basis.
- **Sample Gas -** If the *Sample Stream* is selected, the composition of the gas will be determined using the existing response factors.

7.3 Performing a Calibration

Before a calibration is performed, it is suggested that the reference stream is analyzed. This allows the user to determine if the chromatograph is operating in an acceptable manner, or a fault is present. As an example, if the is significant plugging of a valve or a column, it is probable that one or more compounds will not elute at the proper time, and the reported concentrations of various components of the sample will be significantly different that that expected for the gas.

NOTICE

If a reference stream is not analyzed before a calibration stream, it is possible that the user will generate an invalid calibration via the calibration process. Running the Reference run allows the user to identify this problem and correct it while running the Calibration will mask the problem by simply adjusting the response factor.

In some cases it may be desirable to perform a daily auto calibration to ensure that the chromatograph is functioning correctly on a day to day basis. A daily calibration can be set up to perform the calibration automatically (see Section 5.8). In this case the chromatograph will automatically make adjustments to the response factors within limits set by the user in the *Allowable Response Factor Deviation* entry of the *Configure G.C*. table .

The chromatograph can also be set up to run the reference gas on a daily basis. In this case the results of the analysis of the calibration gas are reported and the user should compare the results to the reported concentrations provided by the supplier of the gas and determine if the GC is operating correctly based on those results.

To Validate the System:

a) Place the analyzer into Reference mode via the *Stream Sequencer* selection of the *Configure G.C.* tab (Figure 7-1).

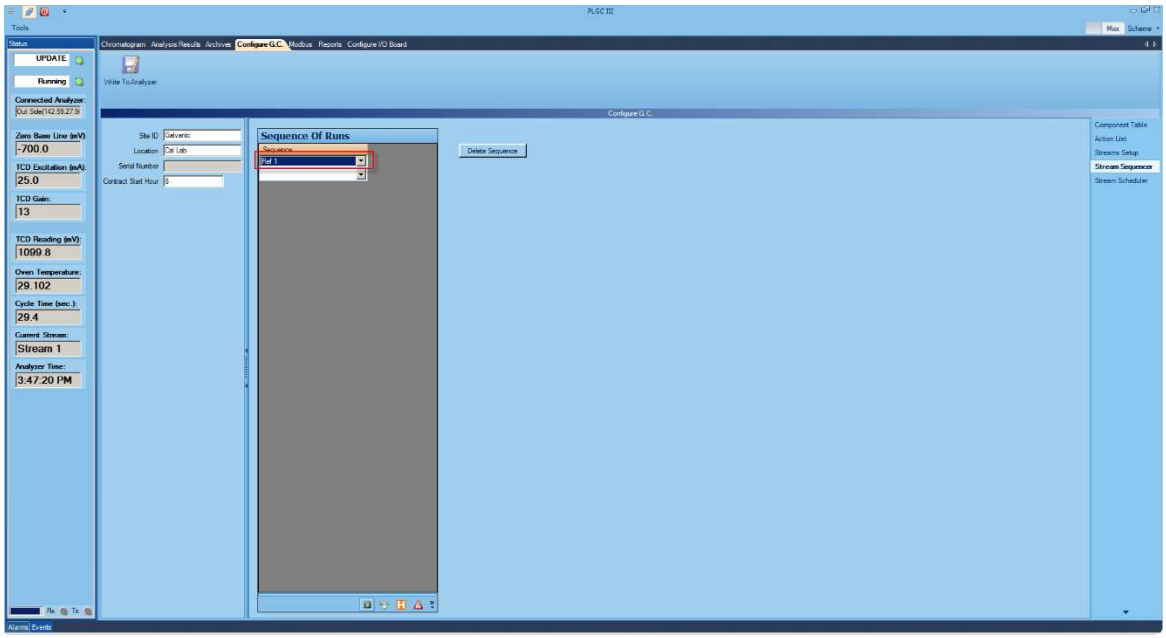


Figure 7-1: Stream Sequencer Selection of the Configure G.C. Tab

b) Set the top entry in *the Sequence of Runs* field to Ref 1 (or Ref 2 as required). If there are additional entries in the table, delete them by moving the highlight to it (the active entry will be highlighted in blue) and press the *Delete Sequence* button.

c) Transmit the changes to the analyzer by pressing the *Write to Analyzer* icon at the top of the window. When the information has been transmitted, made the analyzer will complete the run it is performing and then switch the appropriate solenoid to flow calibration gas to the analyzer.

d) The analyzer will then inject the calibration gas and begin to analyze it. Once the run is complete the results for the analysis can be viewed via the *Analysis Results* tab.

NOTICE **The analyzer will continue to analyze the calibration gas until the user changes the Stream Sequencer back to the process stream(s).**

7.4 Determining if the Chromatograph is Functioning in an Acceptable Manner

There are a number of values that can be checked to see if the system is functioning properly:

a) Compare the results of the analysis of the calibration gas to the certified value of the calibration gas. Typically the value for each component should agree to within the tolerances shown in Table 7-2.

Table 7-2: Typical Allowed Deviation

Component Concentration	Allowed Deviation (ASTM 1945)
0 – 0.01 %	+/- 0.01 %
0.01 – 1 %	+/- 0.04 %
1 – 5 %	+/- 0.07 %
5 – 10 %	+/- 0.08 %
10 – 100%	+/- 0.10%

b) Review the un-normalized total reported by the system for the Reference Gas. Typically the un-normalized total for the calibration gas should be within 98% to 102%. If the un-normalized total is not within tolerance, it is possible that the peaks are not being integrated properly due to a shift in the retention time of one (or more) components.

c) Review the calculated heating value of the calibration gas as analyzed by the chromatograph with respect to the theoretical heating value of the calibration gas. The calculated heating value should typically be within +/- 0.25 BTU.

7.5 Remedial Activities if the Observed Results do not Meet the Certified Values

If the results are not within specification, the following steps should be taken:

a) Verify that the carrier gas pressure is set correctly. The correct setting for the carrier gas is and is also indicated on the carrier gas regulator's pressure gauge. If the pressure is not set correctly then it should be adjusted.

b) Verify that the oven temperature is at the correct set point. The correct set point of the oven is of this manual.

c) Verify the timing of the integration of each peak on the chromatogram. Each peak should be analyzed to ensure that the integration parameters are set correctly and that there has not been any retention time drift that may affect the way the peak is integrated.

d) Compare the actual retention time of the peak to theoretical retention time. The actual retention time can be determined by setting the mouse pointer at the top of the peak on the chromatogram.

e) Check the integration marks for each peak on the chromatogram which indicate where the integration for each peak starts and ends. The marks should include the entire peak. If the marks show that only part of the peak is being integrated, then the integration parameters in the Component Table should be observed and corrected.

f) Make certain that the *Skimming Parameters* for each peak are rational. Skimming parameters are used to indicate the window in which the minimum before the peak and after the peak are to be found and are listed in the Configure G.C. table (Figure 7-2). The windows for a typical peak is shown in Figure 7-3.

Component Name	Calibration Gas Concentration	Retention Time	Retention Time Window	Response Factor	Allowed Response Factor Deviation	Integration Method	Skimming Leading Edge Start	Skimming Leading Edge End	Skimming Peak Start	Skimming Peak End	Skimming Trailing Start	Skimming Trailing End
C6+	0.0300	34.131	3.000	4.867101E-09	1000.000	Skimming	3.400	1.500	32.700	35.200	1.100	8.200
Propane	1.0000	57.686	3.000	1.1619991E-08	1000.000	Skimming	3.300	1.230	56.700	59.100	1.170	7.070
iso-Butane	0.3000	67.618	5.000	1.1709404E-08	1000.000	Skimming	6.002	1.902	66.100	70.100	2.098	5.998
n-Butane	0.3000	75.666	5.000	1.2013337E-08	1000.000	Skimming	6.081	2.181	74.000	78.600	2.419	12.819
iso-Pentane	0.1000	103.022	5.000	1.3986287E-08	1000.000	Skimming	11.680	2.480	101.200	106.700	3.020	9.920
n-Pentane	0.1000	116.128	5.000	1.1807584E-08	1000.000	Skimming	10.463	3.563	113.600	120.700	3.537	16.837
Nitrogen	2.5000	160.824	2.000	8.901585E-09	1000.000	Skimming	4.302	1.902	159.900	162.800	1.500	5.698
Methane	90.1700	167.464	2.000	1.1209339E-08	1000.000	Skimming	7.045	1.500	167.000	172.000	2.955	11.955
CO2	0.5000	190.762	3.000	8.040777E-09	1000.000	Skimming	13.850	2.300	187.600	192.000	2.700	9.150
Ethane	5.0000	235.670	5.000	7.271844E-09	1000.000	Skimming	14.901	6.101	229.800	239.000	3.900	19.099
Total	100.0000											

Figure 7-2: Configure G.C. Table

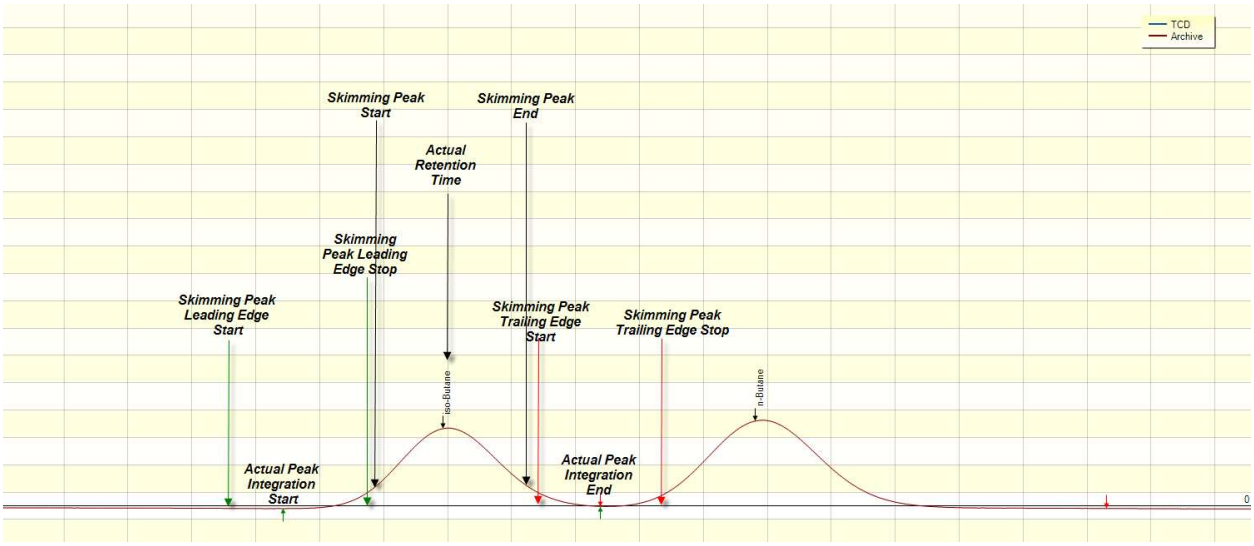


Figure 7-3: Skimming Parameters indicate the Windows in which the peak minima can be found

g) Verify the valve timing. There are 2 areas where drift in the retention times of the peaks may cause problems with the valve actions.

- **C6+ Back Flush** - Chromatograph Valve 1(CV1) is turned ON to inject the contents of the sample loop into Column 1. Nitrogen, Methane, Carbon Dioxide, Ethane, Propane, iso-Butane, n-Butane, iso-Pentane and n-Pentane pass through Column 1 and into Column 2. The flow of carrier gas through Column 1 is then reversed so that hexane and heavier components are eluted through the detector as a composite peak. Ideally, CV1 should be turned OFF when n-Pentane has eluted from Column 1 but the Hexane has not. This point can be determined by setting the CV1 OFF time to a smaller than normal value so that all or some of the n-Pentane gets back flushed from Column 1. The time for CV1 OFF can then be increased in 1 second intervals. For each run observe the area for the C6+ peak and the area for the n-Pentane peak. The CV1 OFF time should be increased until the n-Pentane peak no longer increases and the C6+ peak does not decrease.
- **Ethane/Propane Split** - At this point in the run, Nitrogen, Methane, Carbon Dioxide, and Ethane pass through Column 2 and into Column 3. Chromatograph Valve 2 (CV2) is turned OFF so that Column 3 becomes isolated with Nitrogen, Methane, Carbon Dioxide, and Ethane trapped inside. Column 2 continues to elute until Propane, iso-Butane, n-Butane, iso-Pentane and n-Pentane are eluted through the detector. Ideally, CV2 should be turned off when Ethane has eluted into Column 3 while Propane is still in Column 2. If CV2 is turned off too soon, some or all of the ethane will stay in Column 2. This will cause an error in the amount of area integrated for ethane. If CV2 is turned OFF too late, then some or all of the propane will elute into Column 3, causing an error in the Propane area. The correct time for CV2 to be turned off can be determined by decreasing the CV 2 OFF time so that the peak area for Ethane drops off. This time can then be increased in 1 second intervals. For each run note the peak area for Ethane and Propane. The CV2 OFF time should be increased until the Ethane peak area no longer increases and the Propane peak are does not decrease.

Section 8 **Modbus**

8.1 Overview

The *Modbus* tab allows the user to set up the analyzer to output data in 3 varieties of the MODBUS communication protocol - Enron, Modicon 16, and Modicon Floating Point. As there are a large number of possible configurations for Modbus, and every user may desire a slightly different configuration, this manual will only cover the basics of Modbus configuration. If the user requires assistance in setting up a Modbus configuration, the Service department at Galvanic Applied Sciences Inc. will assist in configuring the unit as desired.

When the *Modbus* selected, the main *Modbus* page (Figure 8-1) is opened. There are three pages to the tab, which are accessed by pressing on the desired format by clicking on the name on the right side of the screen

- Modbus Lists (Section 8.2) - presents the available points and items
- Communication Ports (Section 8.3) - lists the various ports and allows the user to configure the ports used for Modbus communication.

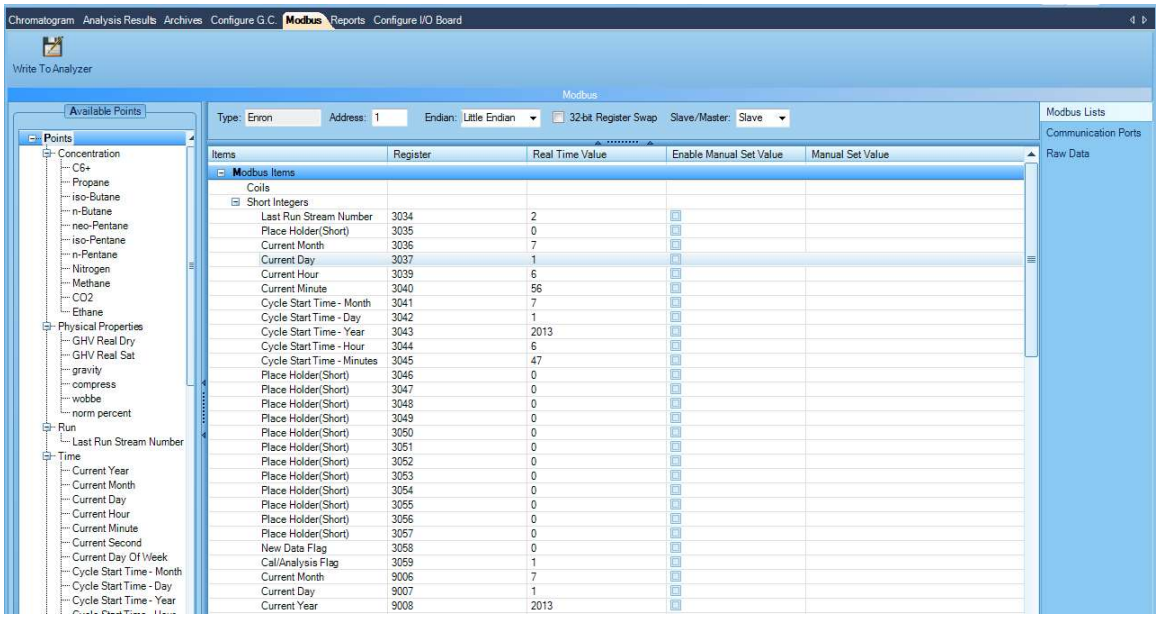


Figure 8-1: Main Modbus Page

The *Write to Analyzer* icon is used to transmit the various setting on the Modbus tab to the analyzer.

8.2 The Modbus List Page

The *Modbus List* page (Figure 8-1) lists general information about the Modbus data protocol. The format will depend, in part on the selections made on the lop line of the page.

Type - There are three Modbus types: Enron (Section 8.2.1), Modicon 16 (Section 8.2.2) and Modicon with Floating Point (Section 8.2.3).

Address - Indicates the Modbus address of the analyzer.

Endian - allows for selection of Big Endian or Little Endian. This parameter defines if the most significant bit or the least significant bit for a word is transmitted first.

32-Bit Register Swap - For 32 bit registers that are transmitted as 2 16 bit words, this parameter determines if the integer or the fraction part of the number is transmitted first in the first word.

Slave/Master - If Slave is selected, the Modbus list will act as a slave and will transmit data only when it has been interrogated. If Master is selected, then the Modbus list will transmit data at the end of each cycle to a slave device.

8.2.1 Modbus List Page - Enron Mode

An Enron Modbus list contains 4 nodes on the Modbus tree. They are *Coils, Short Integers, Long Integers,* and *Floating Point*. Coils are Boolean data points - that is to say, they have a value of either 0 or 1. To that end, data points entered into the Coils node would usually be data points that are simple status indicators, indicating the status of a given alarm, input, or output. If the value of the data point is 0, the status of the logged alarm, relay, etc, would be off, and if the value is 1, the status would be on. Short integers are 16 bit whole numbers with either positive or negative sign. Long integers are 32 bit whole numbers with either positive or negative sign. Floating point values are also 32 bit numbers, but unlike the integers they do not have a sign, but they do have decimal points. Typically, they refer to concentration information.

The left column on the *Modbus List* page indicates the available points and the right column lists the items, the *Register* where the data is transmitted and the *Real Time Value* . If desired the user can indicate a Manual Set Value by clicking on the *Enable Manual Set Value* box and then entering the value in the adjacent field, then pressing the *Write to Analyzer* icon. As an example, the user might want to adjust the Hour field for the onset of daylight saving time .

A typical example of Short integers is presented in Figure 8-2 and an example of Floating Points is presented in Figure 8-3.

Items	Register	Real Time Value	Enable Manual Set Value	Manual Set Value
Modbus Items				
Coils				
Short Integers				
Last Run Stream Number	3034	2	☐	
Place Holder(Short)	3035	0	☐	
Current Month	3036	7	☐	
Current Day	3037	15	☐	
Current Hour	3039	7	☑	9
Current Minute	3040	31	☐	
Cycle Start Time - Month	3041	7	☐	
Cycle Start Time - Day	3042	15	☐	
Cycle Start Time - Hour	3044	7	☐	
Cycle Start Time - Minutes	3045	24	☐	
Place Holder(Short)	3046	0	☐	
Place Holder(Short)	3047	0	☐	
Place Holder(Short)	3048	0	☐	
Place Holder(Short)	3049	0	☐	
Place Holder(Short)	3050	0	☐	
Place Holder(Short)	3051	0	☐	
Place Holder(Short)	3052	0	☐	
Place Holder(Short)	3053	0	☐	
Place Holder(Short)	3054	0	☐	
Place Holder(Short)	3055	0	☐	
Place Holder(Short)	3056	0	☐	
Place Holder(Short)	3057	0	☐	
New Data Flag	3058	1	☐	
Cal/Analysis Flag	3059	1	☐	
Current Month	9006	7	☐	
Current Day	9007	15	☐	
Current Year	9008	2013	☐	
Current Hour	9009	7	☐	
Current Minute	9010	31	☐	
Current Second	9011	53	☐	
Current Day Of Week	9012	2	☐	

Figure 8-2: Enron Mode, Short Integers

Items	Register	Real Time Value	Enable Manual Set Value	Manual Set Value
⊟ Floating Points				
C6+	7001	0.02407313	☐	
Propane	7002	0.6507744	☐	
iso-Butane	7003	0.1749122	☐	
n-Butane	7004	0.1663135	☐	
neo-Pentane	7005	2.370617E-05	☐	
iso-Pentane	7006	0.05283501	☐	
n-Pentane	7007	0.0492929	☐	
Nitrogen	7008	4.073396	☐	
Methane	7009	89.77565	☐	
CO2	7010	0.481065	☐	
Ethane	7011	4.551667	☐	
GHV Real Dry	7033	1024.717	☐	
GHV Real Sat	7034	1007.23	☐	
gravity	7035	0.6138125	☐	
compress	7036	0.9977956	☐	
wobbe	7037	1307.935	☐	
Stream 1 GHV Real Dry D...	8200	1024.663	☐	
Stream 1 gravity Avg.	8201	0.6137841	☐	
Stream 1 C6+ Avg.	8202	0.02376424	☐	
Stream 1 Propane Avg.	8203	0.6518351	☐	
Stream 1 iso-Butane Avg.	8204	0.1747608	☐	
Stream 1 n-Butane Avg.	8205	0.1664784	☐	
Stream 1 neo-Pentane Avg.	8206	1.193721E-05	☐	
Stream 1 iso-Pentane Avg.	8207	0.05152414	☐	
Stream 1 n-Pentane Avg.	8208	0.04937418	☐	
Stream 1 Nitrogen Avg.	8209	4.074533	☐	
Stream 1 Methane Avg.	8210	89.77689	☐	
Stream 1 CO2 Avg.	8211	0.4807034	☐	
Stream 1 Ethane Avg.	8212	4.550104	☐	
Stream 2 GHV Real Dry D...	8213	1024.649	☐	
Stream 2 gravity Avg.	8214	0.6137764	☐	
Stream 2 C6+ Avg.	8215	0.02371872	☐	
Stream 2 Propane Avg.	8216	0.6519137	☐	
Stream 2 iso-Butane Avg.	8217	0.1747298	☐	
Stream 2 n-Butane Avg.	8218	0.1664412	☐	

Figure 8-3: Enron Mode, Floating Points

8.2.2 Modbus List Page – Modicon 16 Mode

A Modicon 16 Modbus list contains 4 nodes on the Modbus tree. They ***are Output Status, Input Status, Input Register,*** and ***Output Register.*** The Input and Output Status nodes contain Boolean data points. Data points in the Output Status node are able to be written to, so the Output Status node can contain data points such as stream requests. If the value in a given stream was changed from 0 to 1, the analyzer would then initiate that stream. Data points in the Input Status node are read-only, so this node would contain data points such as alarm, input, and output status that cannot be changed remotely. Input Registers are data points that are read-only outputs of analyzer data, such as calculated concentration. Please note that Modicon 16 only outputs data as 16 bit numbers, so the display of decimal points in this type of Modbus list is not possible. Output Register contains non-Boolean data points that can be written to remotely. These would include such things as tape length, calibration gas concentration, and gain factor.

8.2.3 Modbus List Page – Modicon with Floating Points

Modicon with Floating Point is similar to the Modicon 16, as it contains 4 main nodes on the Modbus tree. However, the Input and Output Registers contain sub-nodes. They are **Register** *Short, Register Long,* and *Register Float*. Thus, the input and output registers can output data in 16-bit, 32-bit, or 32-bit with floating point in the Modicon with Floating Point Modbus list.

8.3 Communication Ports

The *Communication Ports page* (Figure 8-4) is used to indicate the external ports through which Modbus data is exported.

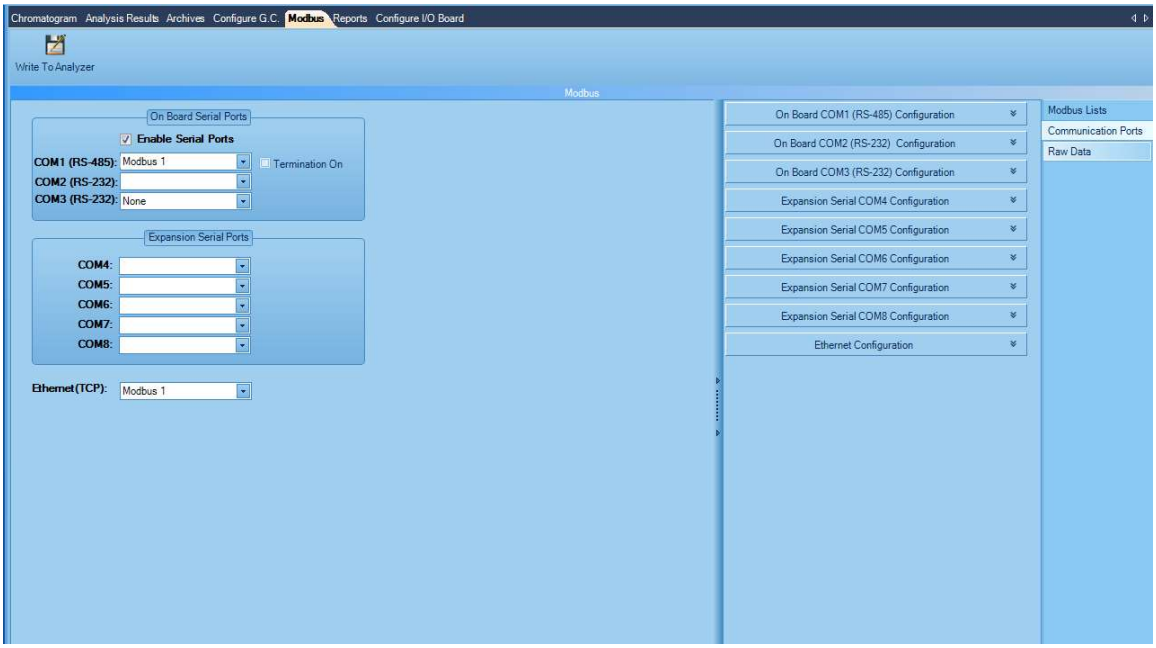


Figure 8-4: Communication Ports Page

There are two aspects to this page:

The *Enable Serial Ports*, *Expansion Serial Ports* and *Ethernet (TCP*) fields on the left are used to indicate the port through which the data is to be exported. Each item in these three regions can be toggled to either *Modbus 1* or *None*. Different Modbus lists can be assigned to different communication ports.

The Enable Ports check box should be selected if data is to be transmitted via a serial port.

The *Termination On* check box should be selected if a termination resistor is required for the RS485 serial port.

The right side of the page is used to configure the port(s) that are used to transmit data. The format of all ports except Ethernet Configuration is the same (Figure 8-5). The communication parameters should be entered.

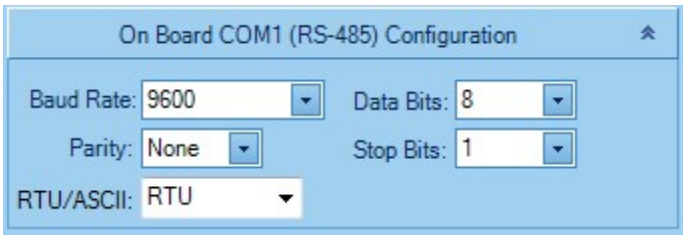


Figure 8-5: Setting Port Configuration

If the Ethernet Configuration is selected, the *Configuration* dialog box is as shown in Figure 8-6. The communication parameters should be entered.

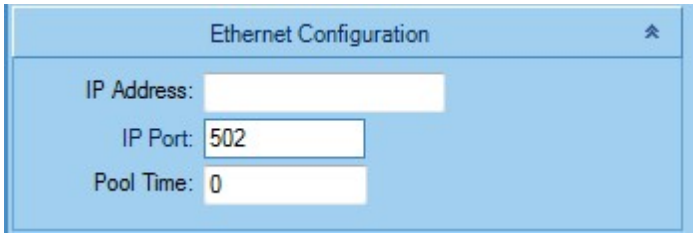


Figure 8-6: Setting Ethernet Configuration

When the parameters have been selected, press the Write to Analyzer icon
Enter the address, port and pool time.

Section 9 Maintenance

9.1 Overview

The AccuChrome Natural Gas Chromatograph is designed for automatic trouble-free operation and will provide reliable service with very little attention. This section describes a number of routine operations that will ensure maximum uptime including:

- Performing a weekly system check out (Section 9.2)
- Cleaning the System (Section 9.3)
- Replacing the He Cylinder (Section 9.4)
- Maintaining Flow Control (Section 9.5)
- Replacing Internal Components (Section 9.6)
- Checking the Column Temperature (Section 9.7)

A spare parts list is provided in Section 9.8. .

If difficulty is encountered performing any of the maintenance procedures outlined in this section, additional technical assistance may be obtained from:

Galvanic Applied Sciences, Inc,
7000 Fisher Road SE
Calgary, Alberta T2H 0W3 CANADA
Phone: (403) 252-8470
Fax: (403) 255-6287
E-mail: info@galvanic.com

9.2 Weekly Check-out Procedure

It is recommended that a weekly check-out procedure is performed to verify that the analyzer is operating according to specifications. The *Weekly Check-up Report* (Figure 9-1) should be filled in, dated and kept on file. These reports will give a record of the analyzer's performance over time and will be useful in planning gas bottle replacement and troubleshooting. The flows and pressures are recorded and should be adjusted as specified in the Configuration Report. The column temperature and baseline reading should also be recorded.

NOTICE **Do *not* adjust the helium pressure, as this will cause the retention times of the components to shift.**

ACCUCHROME Natural Gas Chromatograph Checkout Sheet

Date	
Checked by	
Analyzer Serial Number	
Helium Pressure	Found _____
Sample Pressure	Found _____ Set to _____
Sample Flow	Found _____ Set to _____
Column Temperature	
Baseline Reading	

Figure 9-1: ACCUCHROME Natural Gas Chromatograph Checkout Sheet

If any of the diagnostic parameters deviate from the specifications, consult the Troubleshooting section in this manual (Section 10) or contact Galvanic Applied Sciences.

9.3 Cleaning the ACCUCHROME

The exterior of the unit can be cleaned with a cleaner that is suitable for stainless steel. When cleaning the exterior of the unit, take care that the cleaning material does not enter the interior of the unit. Do not to submerse the unit in water, clean it with a hose or with excessive amounts of water

Do not attempt to clean any of the electronic equipment within the unit.

9.4 Replacing the Helium Cylinder

The helium cylinder should be replaced before it runs out. A large helium cylinder will typically last 3 - 6 months; this depends on the usage of the system. Galvanic Applied Sciences recommends using a two cylinder manifold system to minimize downtime.

Take care to ensure that the helium supply is replaced before the gas is depleted from the tank. If the helium supply does run out, it may be necessary to allow helium to flow thru the system for 24 hours to re-equilibrate the analyzer.

9.5 Maintaining Flow Control

Stable helium pressure is very important to maintain repeatable retention times of the components and a dual stage regulator is recommended. The pressure should be maintained at the reading indicated in the Configuration Report. For optimum operation of the system, UHP helium is required. If UHP helium is not readily available, HP helium can be used with a series of scrubbers. If scrubbers are employed with HP grade helium, please contact Galvanic Applied Sciences Inc for specific recommendations.

The sample pressure is not as critical as the helium pressure but should be maintained at a constant pressure between 10 and 100 psig.

Calibration gas pressure should be maintained at the same pressure as the sample gas so that the flow during calibration will match the flow during normal operation.

NOTICE

It is important to maintain the calibration gas at a relatively constant temperature. The temperature should be above 59°F (15°C) as heavier hydrocarbons may condense in the sample lines at lower temperatures.

9.6 Replacing Internal Components

The operator may be required to change the valve or columns, which are located in the upper compartment (Figure 9-2).

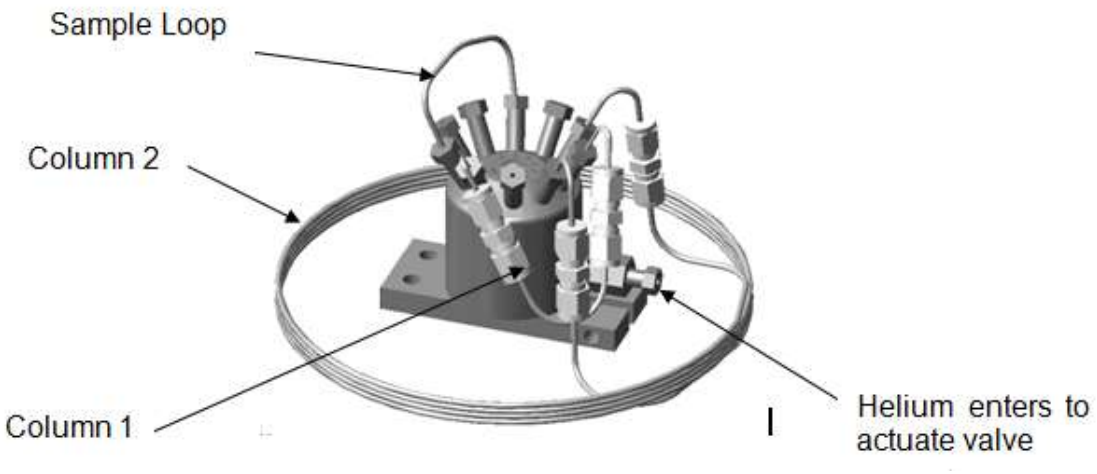


Figure 9-2: Columns and Valve

⚠WARNING

Make certain that the power is turned off before opening the compartment containing the valve, columns and detector.

⚠WARNING **The oven is set to 70°C. Take care that the user does not touch the heater elements. It is suggested that the system be powered down for 20-30 min before opening the compartment containing the valve, columns and detector.**

⚠ DANGER **Substitution of components may impair suitability for the Class I, Division 1 Classification. All replacement components should be obtained from Galvanic Applied Sciences to ensure compatibility.**

9.6.1 Replacing the Valve

NOTICE **The most common cause of failure of a chromatograph valve is particulate contamination in the sample or actuation gas. It is imperative that the sample is clean and dry.**

The chromatograph valve must be cleaned or replaced if it is found to leak. A leak in the injection valve will typically be characterized by any of the following symptoms:

- Elevated baseline,
- Poor analyzer repeatability
- Poor back flush peak shape,
- Shifted retention time of the back flush peak,
- The presence of a second peak immediately following any valve actuation.

A model of a Valco 10-port valve is shown in Figure 9-3.

To change a valve:

a) Turn the analyzer to the 'Halt' mode.

b) Turn off the sample gas flow to the analyzer.

c) Turn off the helium gas flow to the analyzer.

d) Undo all fittings that go into the ports of the valve, including the valve actuation line.

NOTICE **Remember which connections were made to which ports.**

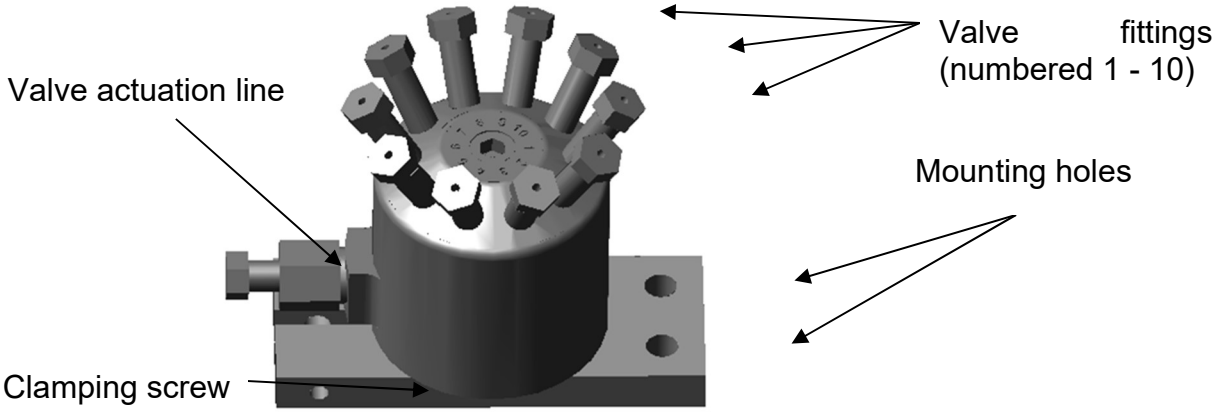


Figure 9-3: Valco 10-port Valve (some systems have 6-port valves)

e) Remove the valve by loosening the screws that hold down the valve-mounting bracket.

f) Replace the valve and the mounting screws.

g) Re-connect the ten fittings to the correct ports. Re-attach the actuation line. See the analyzer flow diagram in Section 2.1 for assistance.

h) Return the helium flow to the analyzer. At this point the analyzer should be allowed to stabilize for 24 hours and is then ready for analysis

The failed valve can then be cleaned or rebuilt and kept on hand as a spare for possible future valve replacement**.** Please contact Galvanic Applied Sciences Inc. if a leaky valve is suspected *before* attempting to replace a valve.

9.6.2 Replacing the Column(s)

The system has either one or two columns as described in Section 2. It may be necessary to replace the column(s) if they become contaminated with particulate matter or flooded with liquids. – note - if the columns are changed, it is likely the action list / component table will require adjustment as each set of columns is slightly different

To replace a column:

a) Turn off the Helium flow
b) Unscrew the nuts that connect the tubing from the column to be removed.
c) Ensure that the tubing from the valve is dry. If necessary, dry the tubing and all tubing in the system.
d) Install the new column. The nuts should be finger tight plus ¼ turn.
e) Check for gas leaks and slightly tighten the nuts if necessary. Do not over tighten the nuts.
f) Power up the system and allow the system to equilibrate for 24 hours.

9.7 Checking the Column Oven

The column and valve are temperature controlled at 60°C or 70°C ± 0.1°C by the column oven (heater). This oven is designed to maintain a stable temperature when the ambient temperature is between -18°C and +60°C. Operation outside these limits will decrease accuracy of the analyzer and is not recommended. Outdoor locations or installation in outdoor enclosures is not acceptable.
The temperature is measured with a 100-ohm RTD. Measuring the resistance of the RTD should result in a reading of approximately 100 ohms at ambient temperature.

9.8 NEMS C9 Module

For models with a NEMS C9 Module installed, please refer to the Operation Manual Addendum 1 – NEMS C9 Module (MA2963-A1). If this was not included with delivery of your unit, please contact our product support team. Their contact information is provided in the section 9.9.

9.9 Spare Parts

If spare ACCUCHROME parts are required, please contact:

Galvanic Applied Sciences, Inc,
7000 Fisher Road SE
Calgary, Alberta T2H 0W3 CANADA
Phone: (403) 252-8470
Toll free 1-866-252-8470
E-mail: support@galvanic.com

A list of common ACCUCHROME replacement parts are shown in Tables 9-1

Table 9-1: ACCUCHROME Class 1, Div 2 Parts List

Part #	Description
BA1910	HELIUM PRESSURE REGULATOR, 0-100 PSI
BA1924	2 INCH PRESSURE GAUGE, 0 -100 PSI
SA2961	KEYPAD
BA0071	FLOWMETER
BA2958	12 VDC LOW POWER SOLENOID
BA1587	RTD
VARIES	COLUMN SET - APPLICATION SPECIFIC
BA0946	6 PORT VALVE
BA1592	10 PORT VALVE
BA1734	6 OR 10 VALVE DIAPHRAM
BA1590	THERMAL CONDUCTIVITY DETECTOR (TCD)
PT2874	CONTROLLER BOARD
PT2890	LCD DISPLAY BOARD
PT2935	I/O BOARD
MA2963	ACCUCHROME OPERATION MANUAL

BA7430	RIBBON CABLE
Floor Stock	14 INCH ARCNET CABLE ASSEMBLY
Floor Stock	12 INCH POWER CABLE ASSEMBLY
SA2925	I.S. BARRIER (CL I, DIV1 VERSION ONLY)
SS-2F-LE	MICRON INLINE FILTER HOUSING
SS-2F-K4-7	7 MICRON INLINE FILTER ELEMENT

Section 10 Troubleshooting

10.1 Overview

Troubleshooting is the determination of the cause of a difficulty in the system. Typically, the operator will perform troubleshooting activities when the system is providing data that the operator believes to be incorrect, such as a dramatically lower signal for all compounds. It is important to recognize that the output from the system represents the condition of the entire analytical system, and the most critical step is to determine the component at fault.

As an example of this point, a noisy baseline could be due to:

a) the delivery of the sample

b) the column (the column could be contaminated)

c) the detector (there could be an electronic problem on a printed circuit board)

Troubleshooting and the amount of down time can be minimized by the following guidelines.

- In almost all cases, there is one and only one proximate cause for a problem.
- A fundamental knowledge of the role of each component of the system is very useful for diagnosing the problem.
- If any aspect of the sampling has changed, run a before and after test to make sure that the change is well understood. Do not consider any change as trivial. As an example, if the user has changed the pre-treatment of the sample, he/she should verify that the change does not affect the overall analytical process.
- The availability of critical spare parts to substitute in the system is extremely useful. If it is suspected that the fault lies in a component, replacing that part can quickly determine if that part was at fault.
- In many cases, the problem is sample related (rather than instrument related) and well-defined samples should be used monitor the performance of the system from time to time.

10.2 Potential Faults

10.2.1 Baseline Issues

Problem	Cause	Corrective action
High Baseline	TCD Excitation board baseline signal is set too high	Halt the analyzer, open the column oven, and adjust the screw marked ‘Baseline’ on the potentiometer on the electronics board inside the oven until the baseline reads lower. If the baseline continues to drift upwards after 24 hours, check the next troubleshooting tip.
	There is a leak	Check all fittings inside and outside the oven. Tighten up any loose fittings. If the problem persists, disassemble the valve (as shown in Section 15), and clean or replace the valve.
Baseline is unstable	There is a leak	Check all fittings. Ensure that helium pressure is stable at 60 psig.
	Temperature in the column oven is unstable.	Allow the temperature to stabilize inside the oven for 24 hours prior to carrying out another analysis.

10.2.2 Questionable Chromatographic Output

Problem	Cause	Corrective action
Incorrect readings	Peaks have shifted, integration parameters incorrect	Check that helium pressure is at 60 psig, and / or adjust retention times. Examine the chromatogram and determine if peaks have shifted or if integration parameters are not correct.
Analyzer reads 0.000	Analyzer is Halted or retention times have shifted.	Check *Analysis Control* to see if the analyzer is halted. Check the chromatogram to see if there is a problem with the integration of peaks.
Wrong Nitrogen/Methane readings	Poor Nitrogen/Methane separation	Check the chromatogram to see if the nitrogen/methane peak separation and integration parameters are correct. Check all fittings inside and outside the oven.
Two peaks observed in chromatogram immediately following a valve switch event.	The valve is leaking because it is dirty.	Disassemble the valve (see Section 15), and clean the valve. Alternatively, a new clean valve can be installed, and the dirty valve can be sent back to Galvanic Applied Sciences Inc. for cleaning.
Large unidentifiable peak.	Possible contamination	Clean all tubing and solenoids with Isopropyl Alcohol and let dry completely. If problem persists and is negatively affecting results, contact Galvanic for assistance.

10.2.3 Instrumental Issues

Problem	Cause	Corrective action
No flow when Cal. Is initiated.	Solenoid does not energize	Check that there is 24VDC at solenoid. Check that solenoid is wired to connector P5 terminals 1 and 2. If the solenoid still does not energize, replace solenoid.
Analyzer won't turn on.	No power	Check power termination connectors. Check display power from motherboard connector P15(motherboard)-red, black going to P10(display) –red, black
Communication Error is displayed on the personal computer	Communication setup is incorrect.	Select the Connect To Analyzer icon in the ACCUCHROME software. Select the correct "Log in Navigation" icon and follow the on screen prompts.
Erratic flow meter float	Flow meter tube is contaminated.	Clean flow meter tube with isopropyl alcohol and dry with clean, dry instrument air.

Section 11 Theory of Gas Chromatography

11.1 What is Gas Chromatography?

Gas chromatography is the separation and detection of a gaseous mixture of compounds (solutes) into its individual components. As described below, it can provide:

- Qualitative Analysis - what is in the sample
- Quantitative Analyses – what is the concentration of the various gases in the sample

This appendix describes:

- How a gas chromatograph operates (Section 11.3)
- The components of a chromatograph (Section 11.4)
- The role of the chromatogram (Section 11.5)

A discussion of the various equations that are used for quantization is presented in Section B.

11.2 How Does a Gas Chromatograph Separate the Compounds in a Sample?

The components (e.g. methane, ethane etc.) of a gas sample are separated in a gas chromatograph by distribution of the components between a 'mobile phase' and a 'stationary phase'. A mobile phase (carrier gas) is an inert gas such as helium, argon, or nitrogen which transports the sample through a column which contains the stationary phase. The stationary phase will adsorb and desorb the various components of the sample at different rates, depending on the nature of each compound.

Some compounds will have a greater affinity for the stationary phase than others. A compound with a strong affinity for the stationary phase will travel thru the column more slowly than a compound with a weak affinity. As a result of these differences in mobility, sample components will become separated from each other as they travel through the stationary phase in the column. The components will emerge from the column (elute) at different times. When the components reach the end of the column, they pass over the detector, where they are identified and their concentrations are determined. Figure 11-1 shows the separation process as the carrier gas moves the sample through the column.

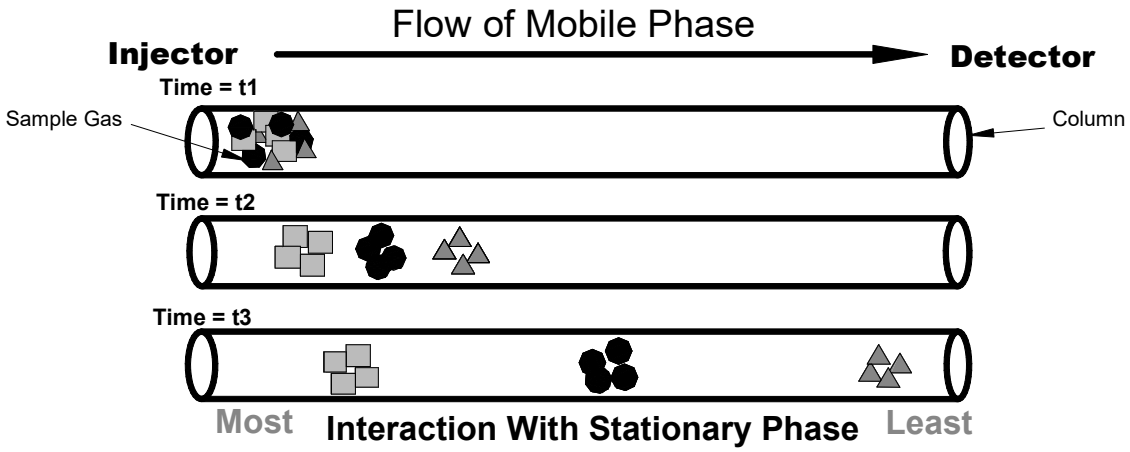


Figure 11-1: Separation of a Gas Sample via Gas Chromatography

11.3 Basic Parts of a Gas Chromatograph

A Gas Chromatograph (Figure 11-2) includes the following components:

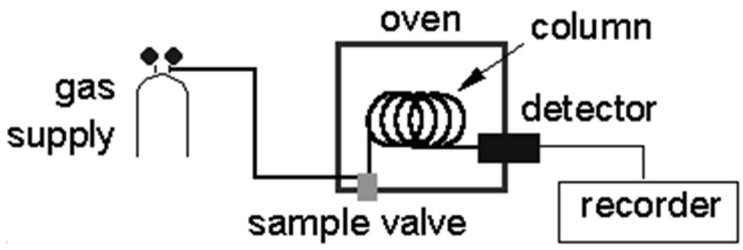


Figure 11-2: Components of a Gas Chromatograph

- *Gas Supply* – provides the carrier gas
- *Sample Valve* – injects a measured amount of sample gas into the carrier.
- *Carrier Regulator* – maintains a constant pressure of the carrier gas to ensure a constant carrier flow rate.
- *Column* – a glass or metal tube that contains the stationary phase. The sample gas passes through, and the components of the gas are separated within the column.
- *Detector* – senses the changes in a property being measured as the individual components elute from the column. It identifies and, with a response factor, quantifies the components of the sample (Section 8.4).
- *Oven* – The detector and column are maintained at a constant temperature by the oven. Constant temperature is essential to achieve proper separation of components.

11.4 How are the Components Detected and Quantified?

The purpose of a detector is to monitor the carrier gas as it emerges from the column and to generate a signal in response to variation in its composition due to eluted components. A Thermal Conductivity Detector (TCD) is used in the ACCUCHROME Gas Chromatograph.

The Thermal Conductivity Detector consists of four spiral wound filament wires supported inside cavities in a metal block. A constant DC current is applied to the filaments, which are arranged in a Wheatstone bridge configuration. When pure carrier and reference gas are flowing across the filaments, the heat loss, and thus filament temperature, is constant. This consistent filament temperature produces a constant filament resistance. The currents in the electronic bridge can be balanced to produce a zero signal level as a reference.

When a specific component enters the TCD with the carrier, the heat dissipated from the filaments on the measured side changes. The amount of change is dependent on the thermal conductivity of the gas, which is different for every component in the sample. This change in heat dissipation causes a change in electrical resistance, which leads to an imbalance in the electronic bridge. The resulting electrical signal is then used in conjunction with a Response Factor to measure the concentration of the component. Figure 8-3 shows an example of the TCD filament configuration.

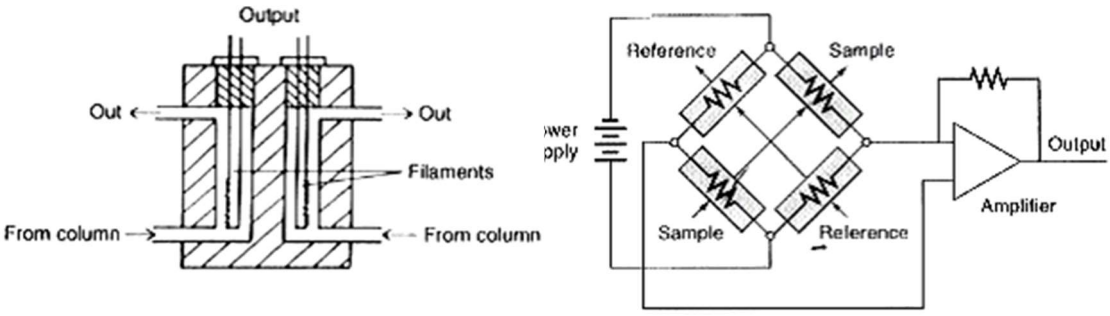


Figure 11-3: Design of a Thermal Conductivity Detector

11.5 The Chromatograph Output: The Chromatogram

The signal output by the TCD is used to generate a chromatogram, which is a graph of detector response against time. The presence of a component will generate a spike in the TCD's response, which appears as a 'peak' on the chromatogram. The components are identified by the microprocessor according to the length of time it takes them to elute from the column. The concentration of each component is calculated using a response factor determined during calibration with a certified standard. Figure 11-4 shows the different characteristics and definitions of a typical chromatogram, assuming two components called 'A' and 'B'.

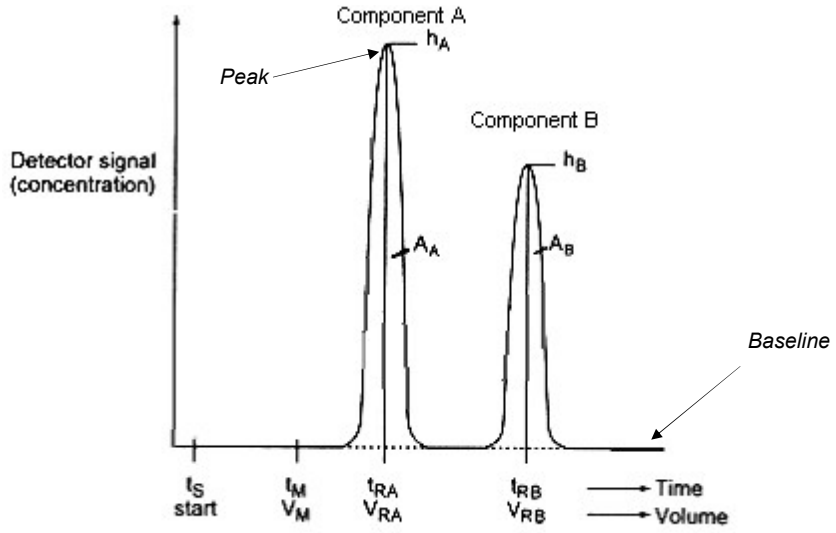


Figure 11-4: Chromatogram Description

t_M - *dead time:* time for non-retained species to move through the column.
V_M - *dead volume:* volume of mobile phase in the column.
t_R - *retention time:* the time it takes a component band to completely travel through the column. Each component will have a characteristic retention time.
V_R - *retention volume* - the volume of gas that passes through the column between the point of injection and the peak maximum of the component.
A - *peak area* - response is proportional to the concentration of the component.
h - *peak height* - the distance between the peak maximum and the baseline geometrically produced beneath the peak.

Section 12 **Wiring Book**

The Wiring book for the ACCUCHROME is described in Table 12-1. In addition to the figures presented in this section, the diagrams are provided on the distribution disk for the PC application program.

Table 12-1: Wiring Book – ACCUCHROME Gas Chromatograph

Wiring Diagram for	Connector	Figure
DC Power	P1	12-1
Relays	P2	12-2
Analog Outputs - 4-20 mA Loop Powered	P3,P4,P5,P6	12-3
Analog Outputs - Self Powered Mode	P3,P4,P5,P6	12-4
Isolated RS-485 Port Connections	P7	12-5
Isolated RS-232 Port Connections	P8	12-6
Analog Inputs - RTD Connections	P9	12-7
Analog Inputs - Pressure Transducer Connections	P9	12-8
Analog Inputs - 4-20- mA Connections	P9	12-9
Analog Inputs 4-20 mV TXR Connections	P9	12-10
Oven RTD and TCD Connections	P10,P100	12-11
Arcnet AC485 Twisted Pair Connections	P11	12-12
Oven Heater Connections	P12	12-13
GC Valves Connections	P14	12-14
Solenoids 5 to 10 Connections	P15	12-15
Solenoids 1 to 4 Connections	P16. P17	12-16
Digital Inputs Connections	P18	12-17
Cabinet Heater Connections	P19	12-18

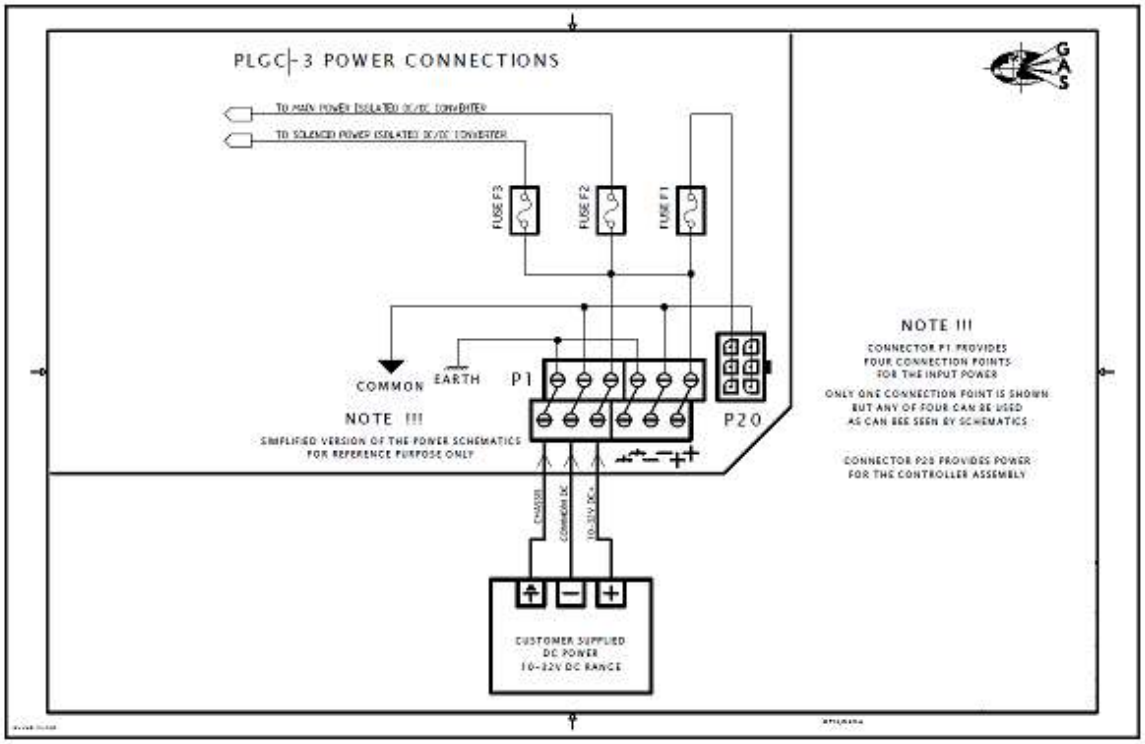


Figure 12-1: AccuChrome Power Connections

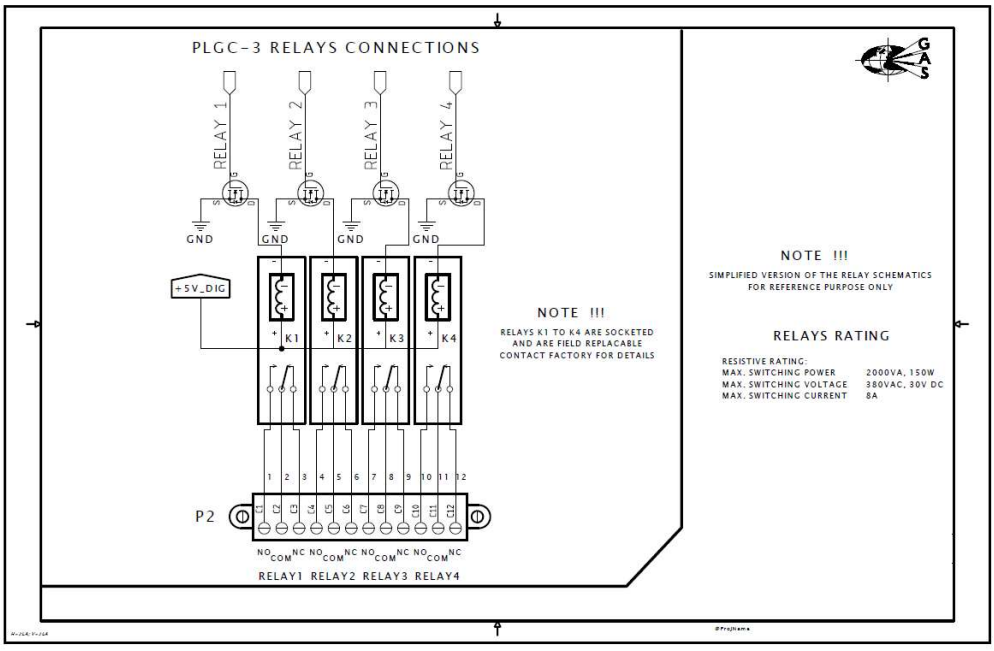


Figure 12-2: Relays Wiring Diagram

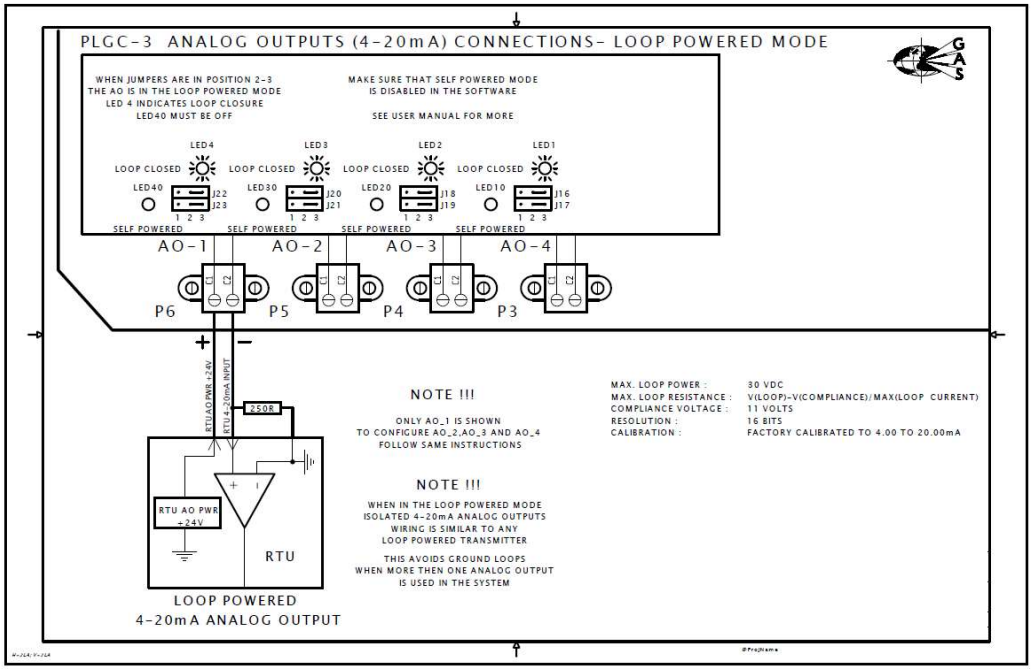


Figure 12-3: Analog Outputs – Loop Powered Mode

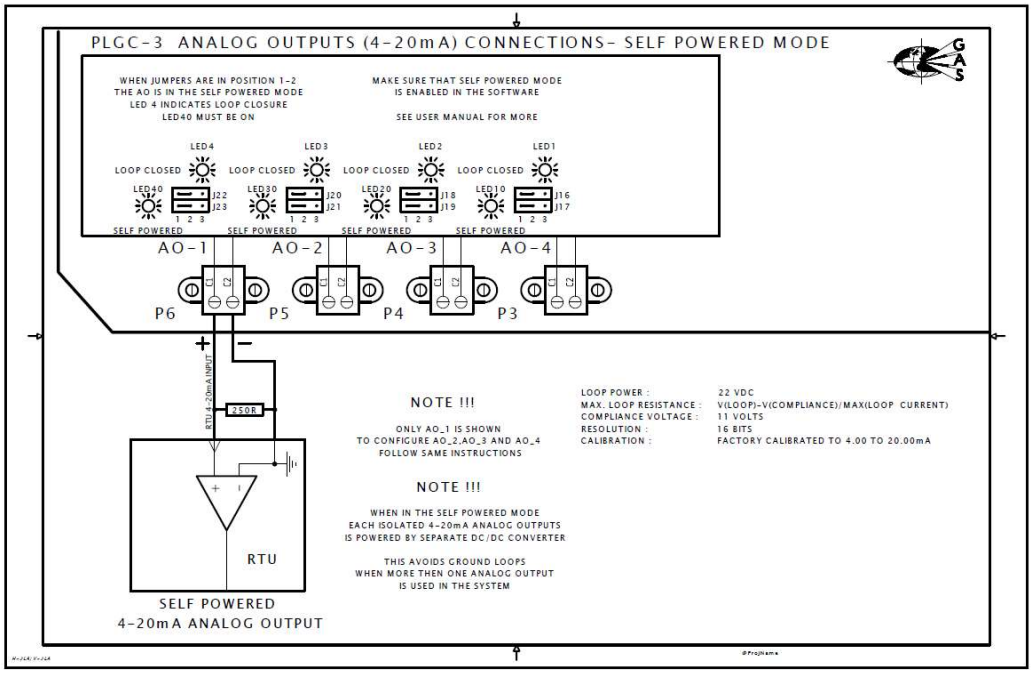


Figure 12-4: Analog Outputs – Self Powered Mode

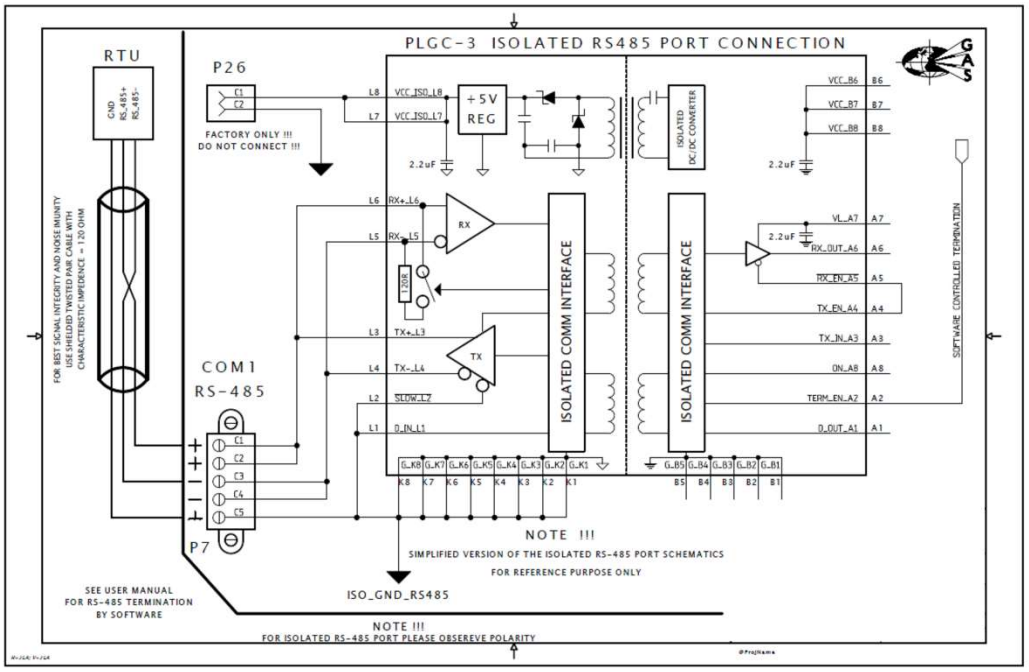


Figure 12-5: Isolated RS-485 Port Connection

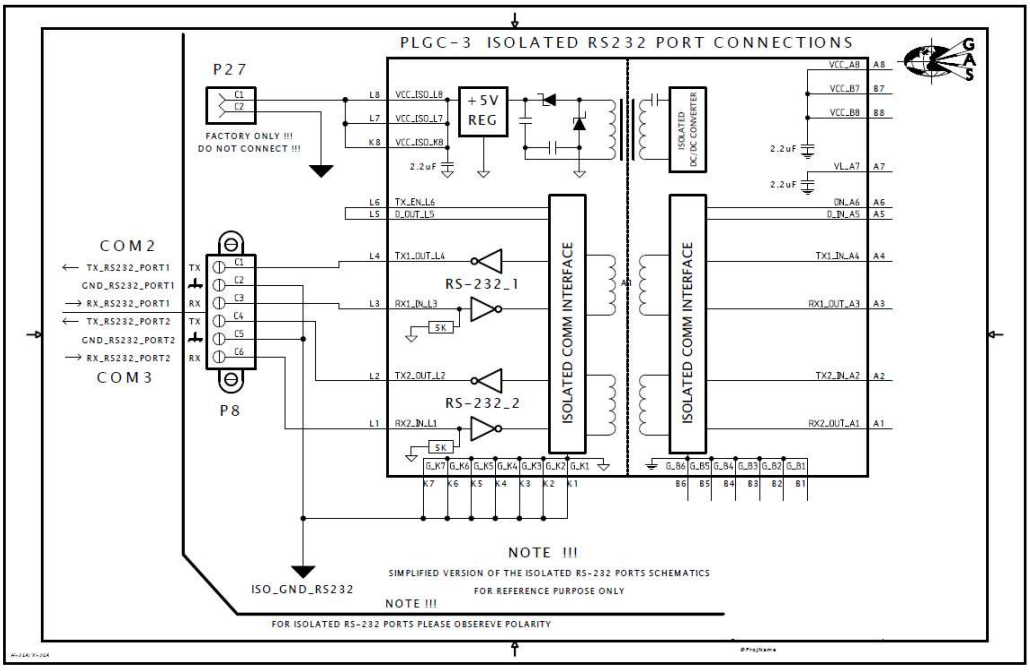


Figure 12-6: Isolated RS-232 Connections

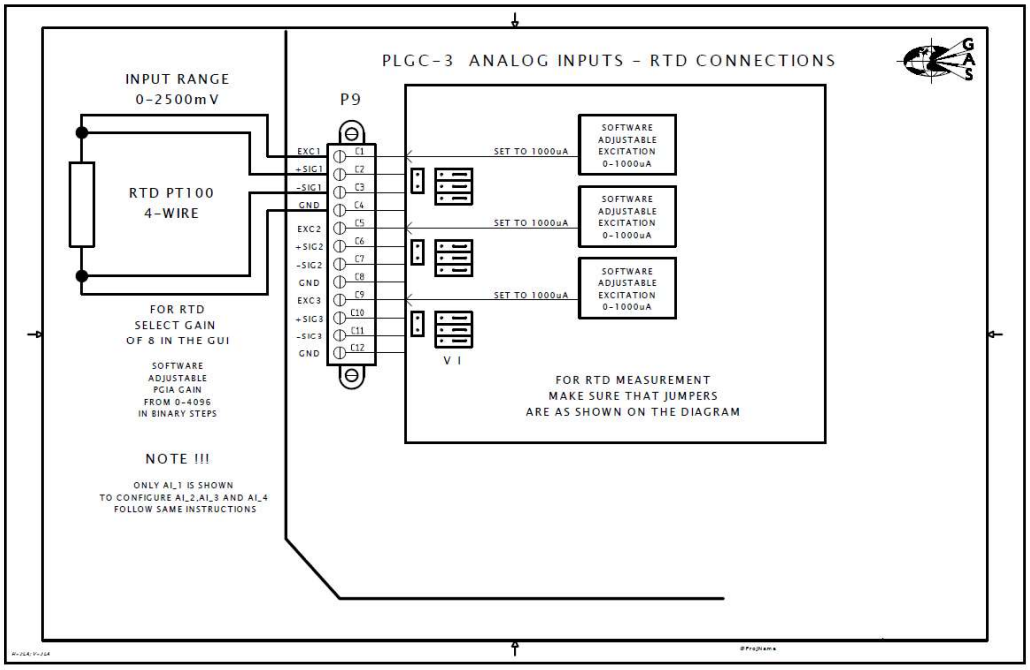


Figure 12-7: Analog Inputs – RTD Connections

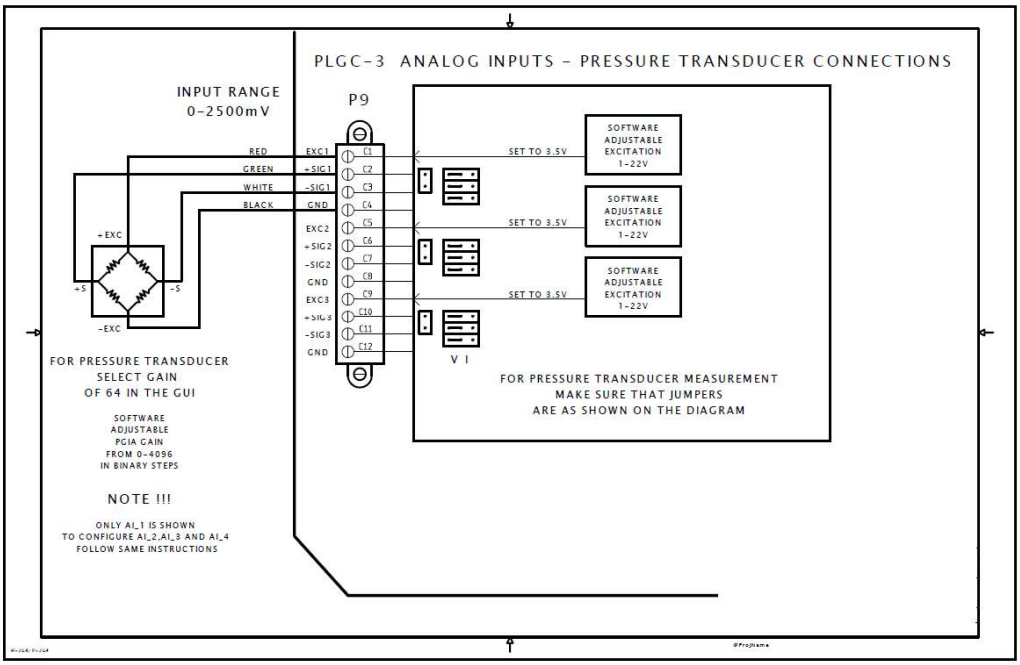


Figure 12-8: Analog Inputs – Pressure Transducer Connections

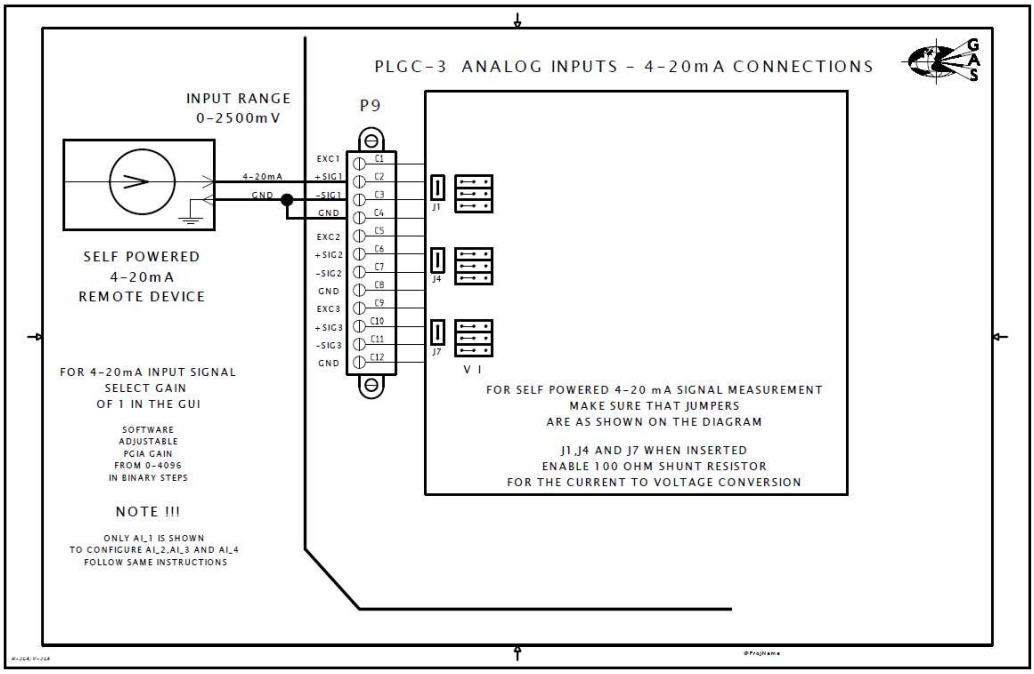


Figure 12-9: Analog Inputs – 4-20- mA Connections

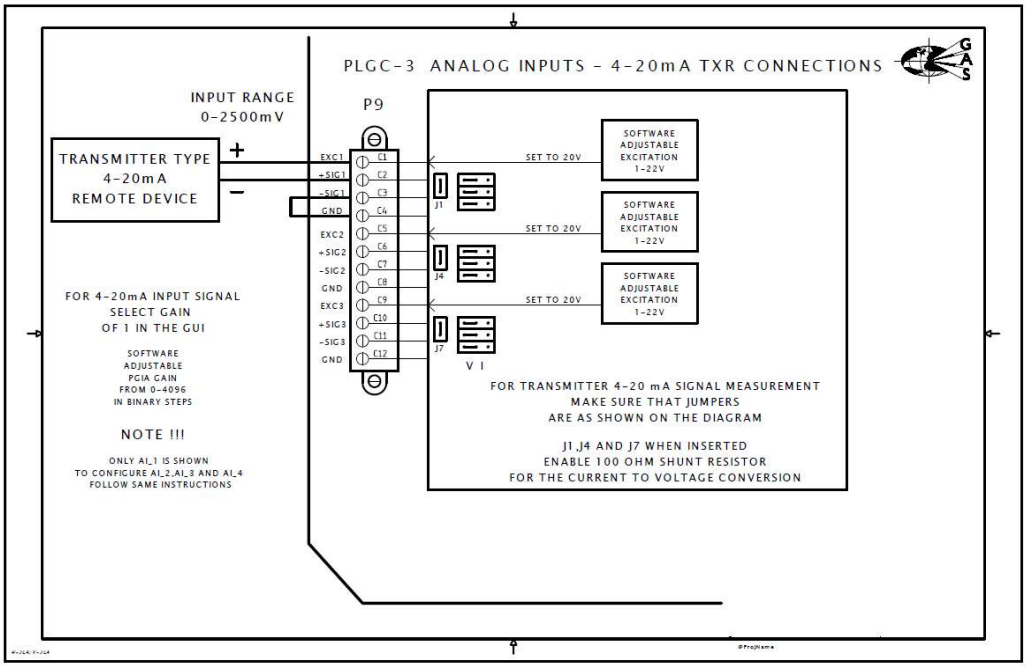


Figure 12-10: Analog Inputs 4-20 mV TXR Connections

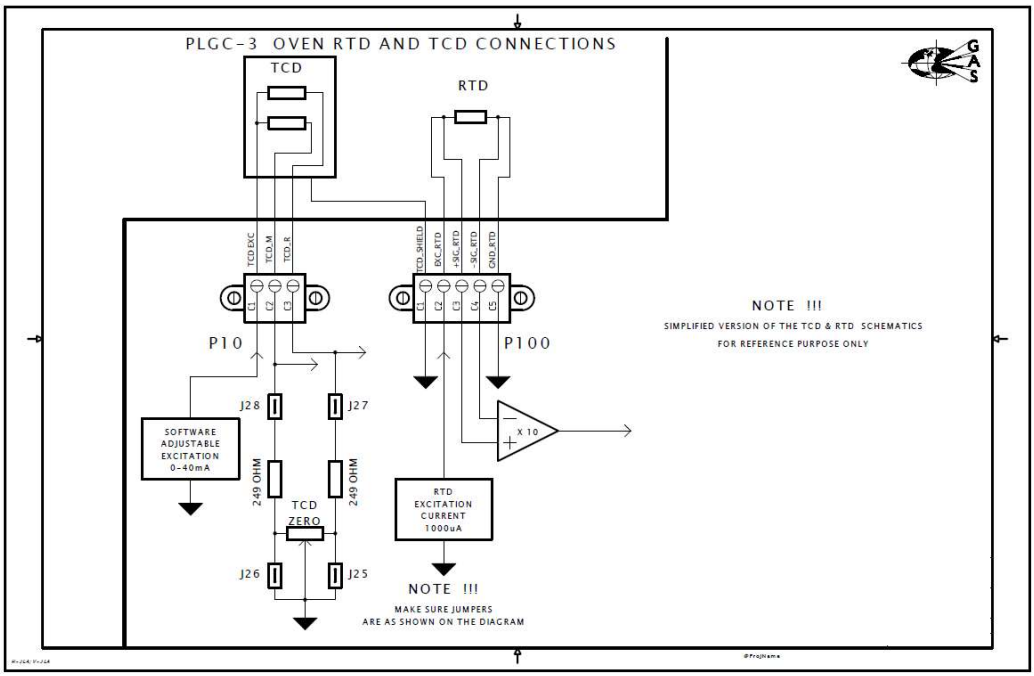


Figure 12-11: Oven RTD and TCD Connections

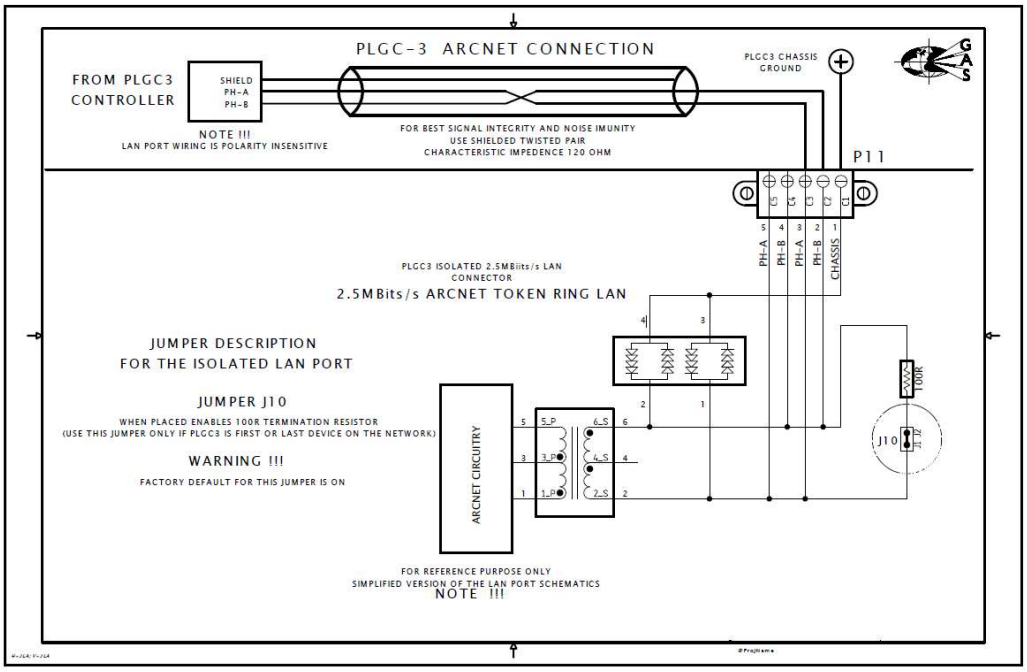


Figure 12-12: Arcnet AC485 Twisted Pair Connection

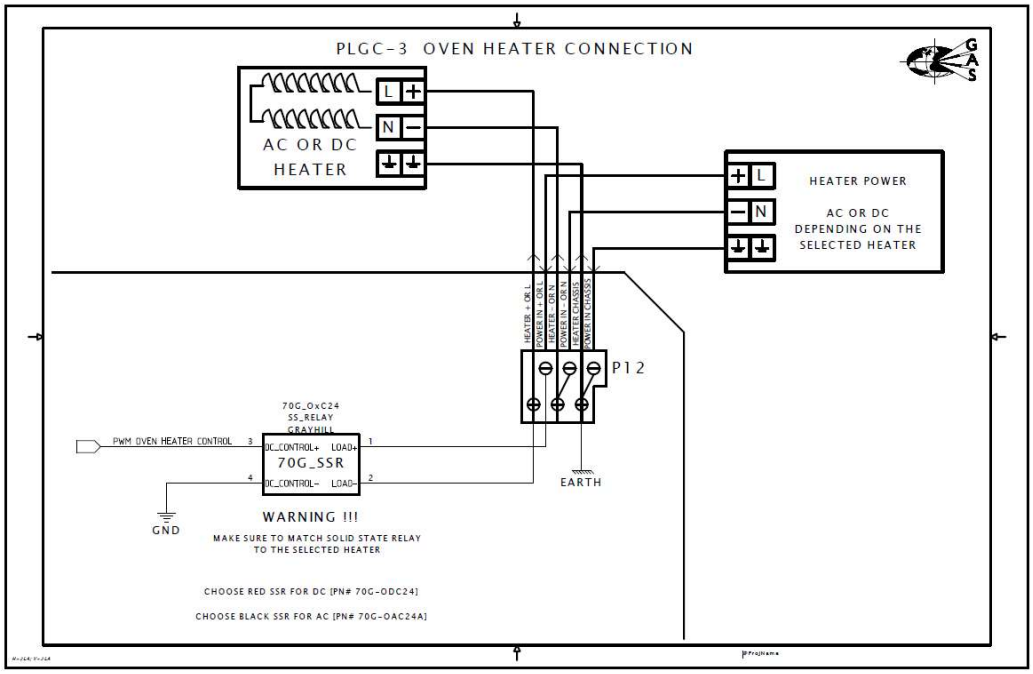


Figure 12-13: Oven Heater Connection

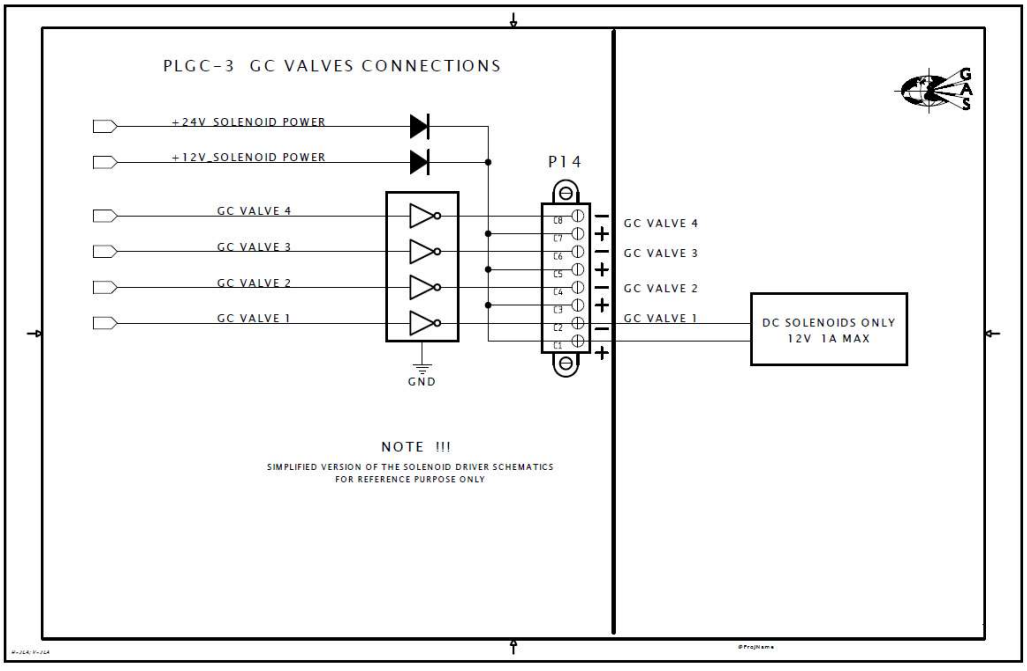


Figure 12-14: GC Valves Connections

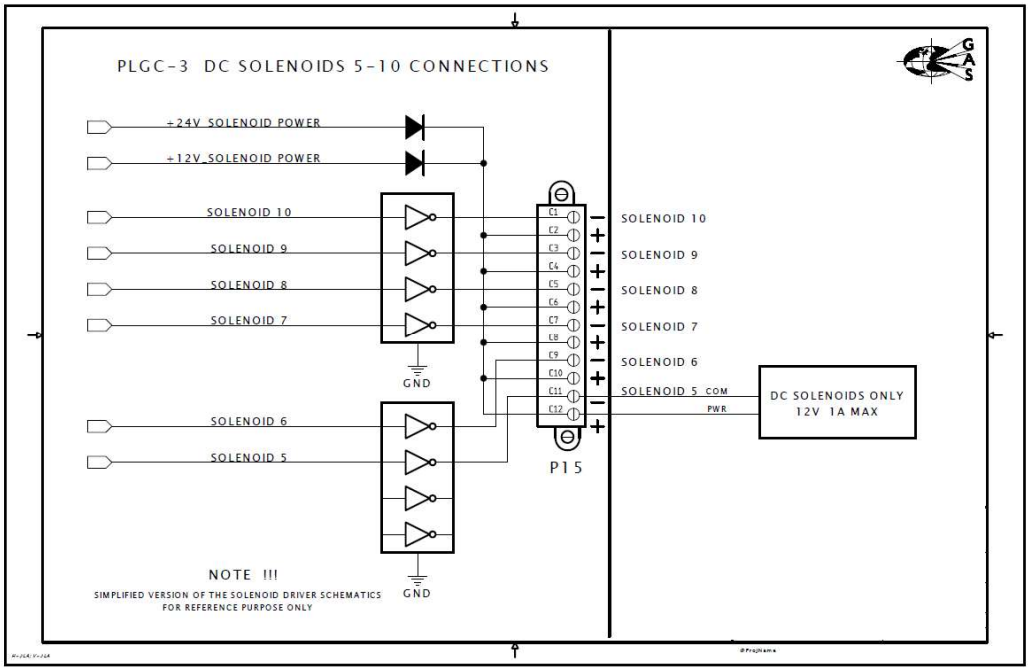


Figure 12-15: Solenoids 5 to 10 Connections

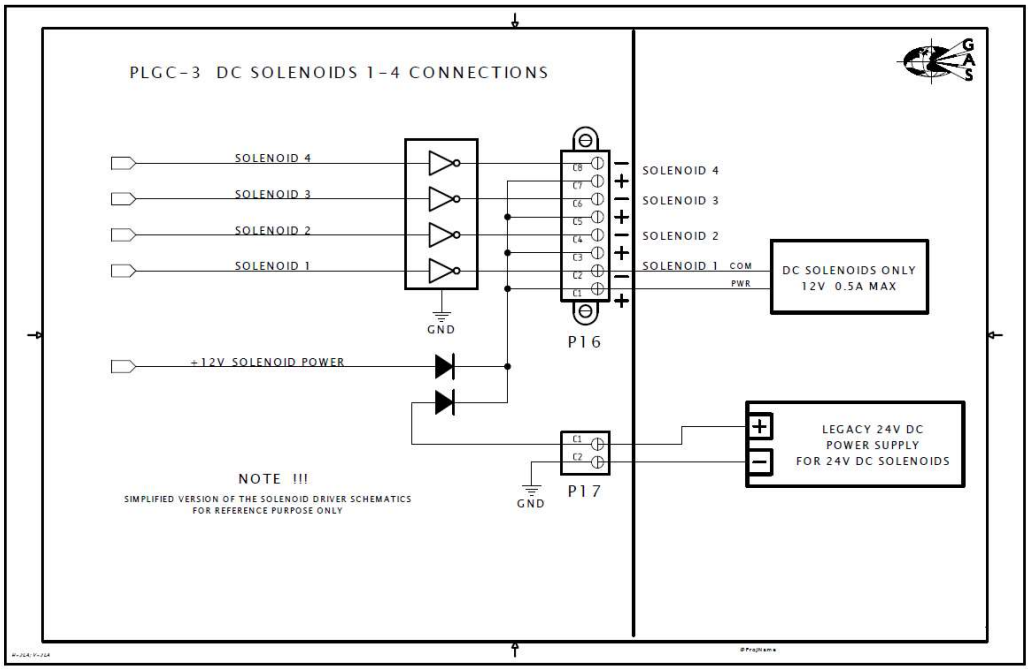


Figure 12-16: Solenoids 1 to 4 Connections

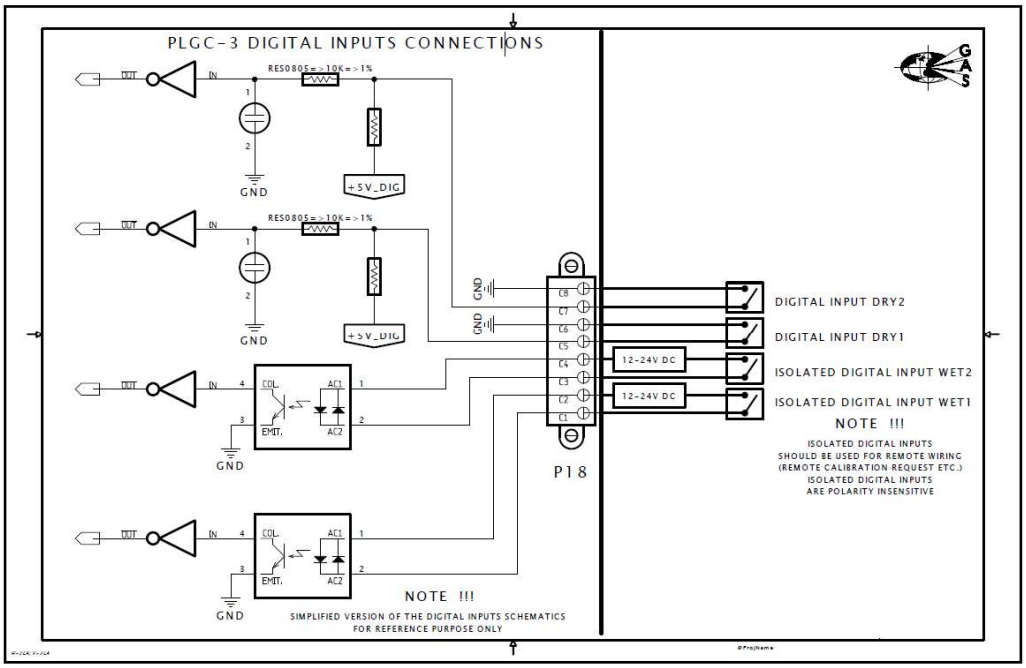


Figure 12-17: Digital Inputs Connections

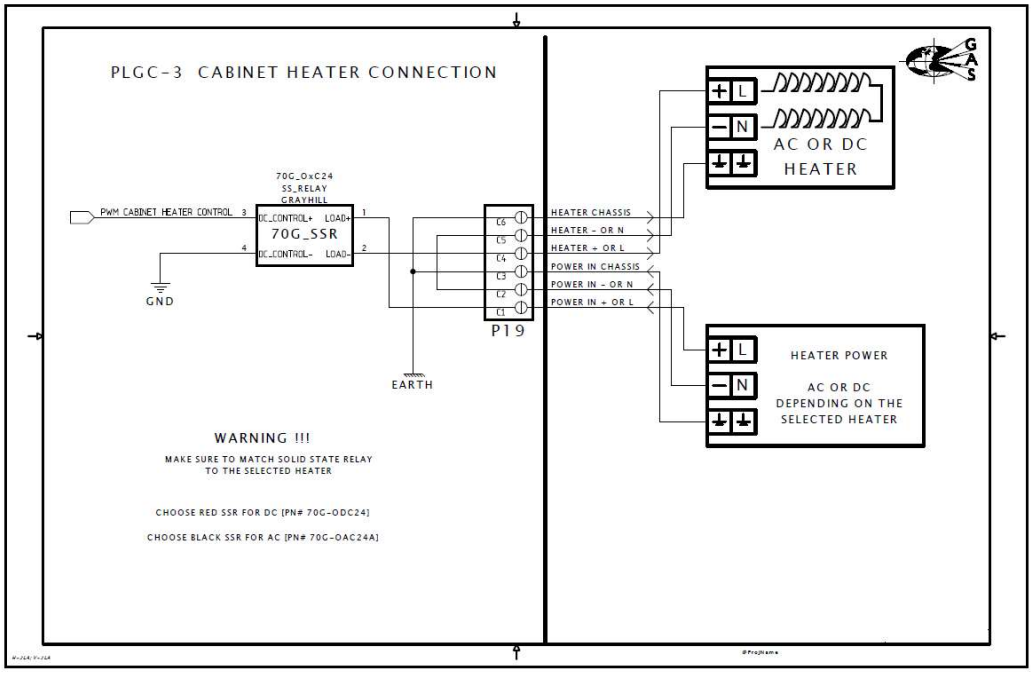


Figure 12-18: Cabinet Heater Connection

Section 13 Definitions and Formulas

13.1 Terms Commonly used in the Manual

This section provides the definition of a variety of terms that are used to describe the operation of the chromatograph and the calculations that are performed by the system.

Baseline:	A baseline is that portion of a chromatogram where no detectable sample components emerge from the column. It appears as a flat line along the bottom of the chromatogram.
BTU:	One “British Thermal Unit” is the quantity of heat that is required to raise one pound of water one degree Fahrenheit (° F) which is equivalent to 1.05506 x 10^{-3} Megajoules.
Chromatogram:	A chromatogram is the permanent record of a single analysis run. It can be stored on a PC using the user interface software or recorded on a chart recorder. It displays the component peaks during an analysis cycle.
Component:	Any one of several species that may appear in a sample. For example natural gas may contain several components such as Nitrogen, Methane, Carbon Dioxide, Ethane, Propane, n-Butane, iso-Butane, n-Pentane, iso-Pentane, and C6+.
Compressibility Factor:	The ratio of the actual volume of a given mass of gas to the volume calculated from the ideal gas law under given temperature and pressure.
Dry BTU:	The heating value of a standard cubic foot of gas saturated without water vapour.
Elution:	The process of moving the separated sample components through the stationary phase.
Normalization:	The process of multiplying the set of component concentrations by a constant factor to make their sum (or the sum of some related quantity) equal to 1. Normalization is simply the re-expressing of component concentrations in terms of percents.
Peak:	The measurement made by the ACCUCHROME involves injecting a fixed sample volume into a carrier stream, which carries it to the detector. The detector monitors the sample that is eluted (removed from the column) and produces an increased output that is approximately triangular in shape when a compound changes the thermal conductivity. This output can be viewed on the user interface software or a chart recorder and is referred to as a peak.
Peak Area:	Peak area is the sum of the detector readings from the start to the end of a peak minus the baseline. The peak area is used to calculate response factors and concentrations.

Response Factor:	The correction factor used to convert peak area into concentration.
Retention Time:	The time that elapses between the start of an analysis and the maximum height of a peak. Peak retention time is used to identify individual components in an analysis.
Saturated BTU:	The heating value of a standard cubic foot of gas saturated with water vapour.
Specific Gravity:	The ratio of the density of a substance to the density of air at the same temperature.
Standard Cubic Foot:	The quantity or volume of gas occupying a cubic foot of space at 60° F and 14.696 PSIA.
Wobbe Index:	The Wobbe Index is defined as the Gross Heating Value divided by the square root of the Specific Gravity of the gas. It is an indicator of the interchangeability between different natural gas compositions.

13.2 Calibration Formulas and Analyzer Calculations

A factory calibration is used to establish the response factors for each component and to determine the retention time for each compound. The results of this calibration are available in the Configuration Report. Since the thermal conductivity of the various components is different, a calibration gas containing all of the components expected in the sample is required.

Formulas for calculating the response factor, as well as other parameters measured by the ACCUCHROME, are as follows:

Response Factor

In calibration mode, the analyzer will measure the peak height (area) of several separations of a calibration standard. An average response factor will be calculated as shown in Section 13.1.

The *Response Factor* is used to calculate the concentration of the components in a run using equation 13-1.

$$\mathbf{Conc_n = RF_n \times Area_n} \qquad \textbf{13-1}$$

Where: $\mathbf{Conc_n}$ = concentration of components n
$\mathbf{RF_n}$ = response factor of components n
$\mathbf{Area_n}$ = area of peak produced by components n

Compressibility Factor (Z)

The Compressibility Factor is calculated by equation 13-2.

$$\mathbf{Z = 1 - (P_b \times \Sigma^{P}_{n=1}\ [Conc_n \times b_n])} \qquad \textbf{13-2}$$

Where: **Z** = Compressibility factor
P_b = Base pressure (psia)
$Conc_n$ = Normalized concentration of component n
b_n = 'Summation factors', as defined in GPA Standard 2172-96

Heating Values

The *Dry BTU*, *Connected Dry BTU*, *Saturated BTU* and *Corrected Saturated BTU* are calculated by equations 13-3 through 13-6.

Dry BTU

The energy content of the gas in BTU / cubic foot is calculated by equation 13-2.

$$\mathbf{Dry\ BTU / ft^3 = \Sigma^{P}_{n=1}\ [Conc_n * BTU / ft^3_n] / 100} \qquad \textbf{13-3}$$

Where: **Dry BTU / ft^3** = Dry BTU content per cubic foot of sample gas
$Conc_n$ = Normalized concentration of component
BTU/ft^3_n = BTU value of component n
P = Number of components in the analysis

Corrected Dry BTU

$$\mathbf{Corrected\ Dry\ BTU / ft^3 = (Dry\ BTU / ft^3) / Z} \qquad \textbf{13-4}$$

Saturated BTU

$$\mathbf{Sat\ BTU / ft^3 = Dry\ BTU / ft^3 \times 0.9826} \qquad \textbf{13-5}$$

Where: **Sat BTU /ft^3** = Saturated BTU content per cubic foot of sample gas
Dry BTU /ft^3 = Dry BTU content per cubic foot of sample gas

Corrected Saturated BTU

$$\mathbf{Corrected\ Sat\ BTU / ft^3 = (Saturated\ BTU / ft^3) / Z} \qquad \textbf{13-6}$$

Specific Gravity (or Relative Density)

The *Dry Specific Gravity* and *Saturated Specific Gravity* of the gas are calculated using equations 13-7 and 13-8:

Dry Specific Gravity

$$\textbf{Dry SG} = (\Sigma^{P}_{n=1}\ \textbf{Conc}_n \times \textbf{SG}_n) / 100 \qquad \textbf{13-7}$$

Where: **Dry SG** = Dry Specific Gravity of the sample gas
Conc_n = Normalized concentration of component n
SG_n = Specific Gravity value of component n
P = Number of components in the analysis

Saturated Specific Gravity

$$\textbf{Sat SG} = \textbf{Dry SG}*(1 - xw) + xw \times 0.62202 \qquad \textbf{13-8}$$

Where: **Sat SG** = Saturated specific gravity of the sample gas
Dry SG = Dry Specific Gravity of the sample gas
x_w = molar fraction of water

Wobbe Index

The *Wobbe Index* and *Saturated Wobbe* Index is calculated using equations 13-9 and 13-10.:

Dry Wobbe Index

$$\textbf{Dry Wobbe Index} = (\text{Corrected Dry BTU} / \text{ft}^3) / \sqrt{(\text{Dry SG})} \qquad \textbf{13-9}$$

Saturated Wobbe Index

$$\textbf{Sat Wobbe Index} = (\text{Corrected Sat BTU} / \text{ft}^3) / \sqrt{(\text{Sat SG})} \qquad \textbf{13-10}$$

14.1 GPA Parameters

Table 14-1: Parameters of Natural Gas Components (GPA)

	GPA 2145-03 14.696 psia 60 F		
Component	**Dry BTU Constant**	**S.G.**	**Summation Factor**
Nitrogen	0	0.96723	0.00442
Methane	1010	0.55392	0.0116
Carbon Dioxide	0	1.51960	0.0195
Ethane	1769.7	1.03820	0.0238
Propane	2516.2	1.52260	0.0349
iso-Butane	3252.0	2.00680	0.0444
n-Butane	3262.4	2.00680	0.0471
iso-Pentane	4000.9	2.49120	0.0572
n-Pentane	4008.7	2.49120	0.0603
C_6+	5276.5	3.3132	0.09305
Hydrogen Sulphide	637.11	1.1769	0.0242

The BTU value of the C6+ peak should reflect the composition of the sample.

Several standard compositions are shown.

C6	C7	C8	BTU	S.G.	Summation Factor
1.00000	0.00000	0.00000	4756.0	2.9755	0.0792
0.47466	0.35340	0.17194	5276.5	3.3132	0.09305
0.50000	0.50000	0.00000	5129.2	3.2177	0.08725
0.50000	0.25000	0.25000	5315.8	3.3387	0.093775
0.57143	0.28572	0.14285	5182.5	3.2522	0.089828

NOTICE **The Summation Factors are identical in the AGA and GPA Standards, and are independent of the Base Pressure (14.696psia, 14.73psia).**

14.2 AGA Parameters

Table 14-2: Parameters of Natural Gas Components (AGA)

Component	AGA 2145-00 14.696 psia 60 F Dry BTU Constant	S.G.
Argon	0.00	1.3793
Carbon Dioxide	0.00	1.5196
Ethane	1769.70	1.0382
Hydrogen Sulphide	637.13	1.1767
Helium	0.00	0.1382
Heptane	5502.60	3.4598
Hexane	4756.00	2.9755
Hydrogen	324.20	0.0696
Carbon Monoxide	320.50	0.9671
i-Butane	3251.90	2.0068
i-Pentane	4000.90	2.4912
Methane	1010.00	0.5539
n-Butane	3262.40	2.0068
neo-Pentane	3985.00	2.4912
Nitrogen	0.00	0.9672
n-Pentane	4008.70	2.4912
Octane	6248.80	3.9441
Nonane	6996.20	4.4284
Decane	7742.90	4.9127
Ethylene	1600.40	0.9686
Propylene	2333.70	1.4529
Propane	2516.20	1.5225

Component	AGA 2145-00 14.73 psia 60 F Dry BTU Constant	S.G.
Argon	0.00	1.3825
Carbon Dioxide	0.00	1.5231
Ethane	1773.79	1.0406
Hydrogen Sulphide	638.60	1.1794
Helium	0.00	0.1385
Heptane	5515.33	3.4678
Hexane	4767.00	2.9824
Hydrogen	324.95	0.0698
Carbon Monoxide	321.24	0.9693
i-Butane	3259.42	2.0114
i-Pentane	4010.16	2.4970
Methane	1012.34	0.5552
n-Butane	3269.95	2.0114
neo-Pentane	3994.22	2.4970
Nitrogen	0.00	0.9695
n-Pentane	4017.97	2.4970
Octane	6263.26	3.9532
Nonane	7012.39	4.4386
Decane	7760.81	4.9241
Ethylene	1604.10	0.9708
Propylene	2339.10	1.4563
Propane	2522.02	1.5260

Section 15 Valco 6 and 10 Port Valve Technical Information

15.1 Valve Operation Instructions

Technical Note 605

VICI Valco Instruments Co. Inc.

Operation Instructions – 2 Position Sample Injectors

Models DV-12 and DV-22 Diaphragm Valves

Installation

Although valve mounting orientation doesn't affect performance, valves are usually installed vertically or horizontally. The 3/4" boss at the base of the valve fits our CR4 clamp ring, facilitating a surface mount.

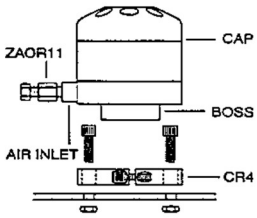


Figure 1:
Surface mount with a CR4

Use a 3-way (on/off) solenoid (VICI prod no: 31E1) to provide actuator air to the air inlet port on the side of the valve body. Actuating gas can be clean air or a pure gas. The 6 port and 4 port valves require 50 psig for actuation; the 10 port valve needs 60 psig.

The air inlet fitting provided (prod no: ZAOR11) is for 1/16" OD tubing. This fitting can be replaced with any fitting with 10-32 threads, such as a barbed fitting for 1/8" OD polymeric tubing (prod no: F-BF) or a compression fitting for 1/8" metal tubing (prod no: EAOR21).

Plumb the valve using any 1/16" OD tubing, with the nuts and ferrules provided. (Refer to Technical Note 503 for instructions on installing Valco zero dead volume fittings.) Make sure that the tube ends are clean, square cut, and burr-free. The sample loop, if required, goes at ports 3 and 6 on a 6 port valve, or 3 and 10 on a 10 port valve. Loops are available in volumes as small as 2 µl.

Operation

In the STANDBY mode (actuator air OFF), springs force the upper and lower pistons together. The plungers on the lower piston force the diaphragm against the cap, making a seal between ports 1 & 2, ports 3 & 4, and ports 5 & 6. In this mode, flow is permitted from port 2 to port 3, from 4 to 5, and from 6 to 1.

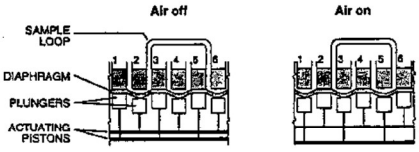


Figure 2: Diaphragm valve schematic

In the ACTUATED mode, (actuator air ON), air pressure from the air inlet port forces the upper and lower pistons apart. Plungers on the lower piston retract from the cap, permitting flow between ports 1 & 2, ports 3 & 4, and ports 5 & 6. At the same time, the upper piston is pushed up, forcing these plungers against the cap and effecting a seal between ports 2 & 3, ports 4 & 5, and ports 6 & 1.

In most situations, the valve should be in the OFF position most of the time, meaning that the pilot solenoid valve will be OFF most of the time. OFF is also the default position, to which the valve will return in a power outage.

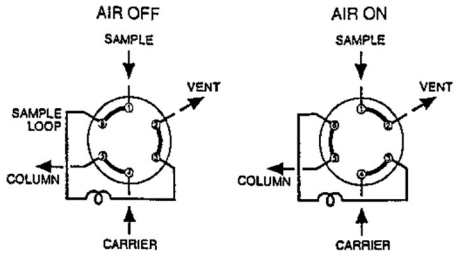


Figure 3: Sample injection with a 6 port

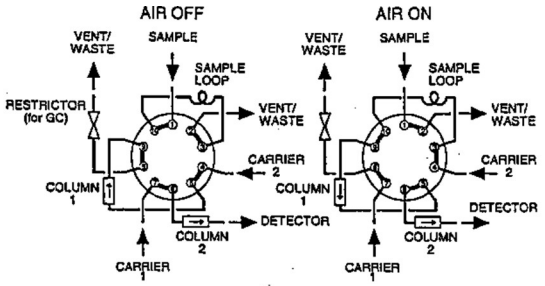


Figure 4: Typical 10 port application:
loop sampling with precolumn backflushed to vent

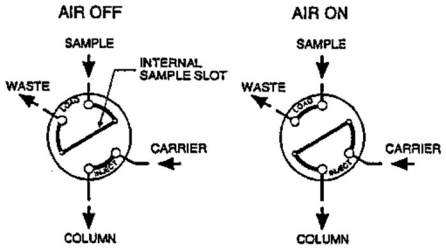


Figure 5: Sample injection with a 4 port

Note about 4 port internal sample injectors

The volume of the sample injected will vary in proportion to the sample inlet pressure; that is, as sample pressure increases, the sample volume will also increase. A 40 psi sample with a 0.5 µl valve provides a 0.5 µl injection, but the same valve with a 500 psi sample may inject as much as 0.8 µl. Therefore, the regulated inlet pressure of the sample and of the calibration standard should be equal.

Rev 12/98

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15.2 Valve Maintenance Instructions

Technical Note 606

VICI Valco Instruments Co. Inc.

Maintenance Instructions

Models DV-12 and DV-22 Diaphragm Valves

CAUTION: Do not disassemble the valve unless system malfunction is definitely isolated to the valve. Perform all other system checks first.

All disassembly operations must be performed in a clean, well-lighted area. Flush all hazardous or toxic materials from the valve before starting. Handle all internal parts with clean, dry hands in a dust free invironment.

Disassembly

1. Disconnect all the plumbing from the valve, including the air supply and exhaust line. Remove the valve from the system and place it on a clean surface.

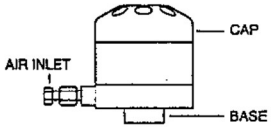

Figure 1

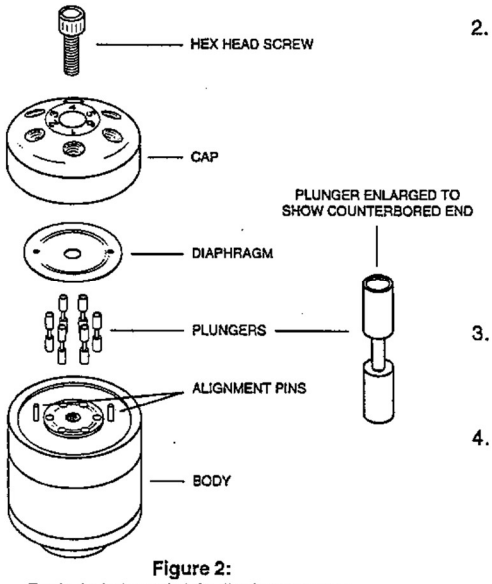

Figure 2:
Exploded view of VICI diaphgram valve

2. With a 9/64" hex wrench, remove the hex head screw from the center of the valve cap (refer to **Figure 2**), and lift the cap from the two alignment pins. Set the cap aside, with the polished side up so that it doesn't get scratched.

Do not unscrew the hex head screw in the center of the base. Service or replacement of the o-rings or springs must be performed at the factory.

3. Use a fingernail or knife blade under the edge of the diaphragm to carefully lift and work it off the alignment pins.

4. Note the plungers arranged in a ring on the raised diaphragm support. (The number of plungers varies depending on the valve type.) Gently tap the edge of the valve body on the work surface so that the plungers begin to slide out. Remove them completely and set them aside.

Reassembly

1. Set the valve on the table with the base down and the plunger holes up.

2. Examine the new plungers. Note that one end has a counterbore and the other end is flat. (**Figure 2**) Place the plungers in the holes with the counterbored end up (toward the diaphragm).

3. Remove the new diaphram from its packaging, holding it carefully by the edges. Note that it is slightly cupped, and that one side says "TOP". Slide it over the alignment pins with the "TOP" side toward the cap, away from the plungers.

4. The cap can go on two ways. Install it over the alignment pins with port number 1 opposite the air inlet. (**Figure 3**)

5. Reinstall the hex head screw in the center of the cap, and use the 9/64" wrench to tighten it firmly.

The valve is now ready to be reinstalled in your system.

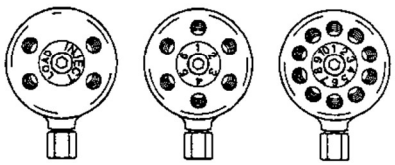

Figure 3:
Cap orientation

Troubleshooting

About all that can go wrong in this procedure is for the diaphragm or a piston to get installed upside down. If the diaphragm is installed incorrectly, flow will be reduced or eliminated entirely. If there is cross-port leakage, suspect an improperly oriented piston.

Rev 12/98

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Section 16 ACCUCHROME Specifications

PERFORMANCE	
Accuracy: By Component	±0.5%/F.S(Range≧50),±1%/F.S(5<Range<50),±2%/F.S(Range≦5%)
Accuracy: By Heating Value	+/- 0.25 Btu/scf per 1000 Btu/scf
Repeatability:	+/- 0.25 Btu/scf per 1000 Btu/scf
Sensitivity:	200 ppm
Linearity:	+/- 2% F.S.
Response time:	4 - 5 minutes
ENVIRONMENT	
Ambient temperature conditions:	-20 C to + 60 C (-4 F to 140 F)
Dimensions:	686 mm W x 838 mm H x 318 mm D (27" W x 33" H x 12.5" D)
Weight:	Division 1: AC: 61kg (135 lbs) DC: 54.4kg (120 lbs)
	Division 2: 38.6 kg (85 lbs)
UTILITIES	
Power &	24 VDC, 100 watts startup, 50 watts running
consumption:	90 - 240 VAC, 50/60 Hz 100 watts startup, 50 watts running
Sample flow:	100 cc/min, 1 barg (0.21 SCFH, 15 psig)
Air requirements:	NA
Gas requirements:	Helium or Hydrogen Carrier Gas 5.5 - 6.9 barg, 20 cc/min (80 - 100 psig, 0.042 scfh)
COMMUNICATIONS	
Communication:	Modbus RS232, Modbus RS485, Modbus TCP/IP
Digital Inputs:	2 dry contact, 2 wet contact (12/24 VDC)
analog Inputs:	3 universal inputs, user programmable (RTD, 4-20 mA, transducer)
Analog Outputs:	4 x 4-20 mA, user scalable, user selectable loop or self powered
Relays:	4 x SPDT relays, 8 amp @250 VAC
APPROVALS & CERTIFICATIONS	
	CSA (C, CUS) Class 1 Division 1, Groups BCD
	CSA (C, CUS) Class 1 Division 2, Groups BCD

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