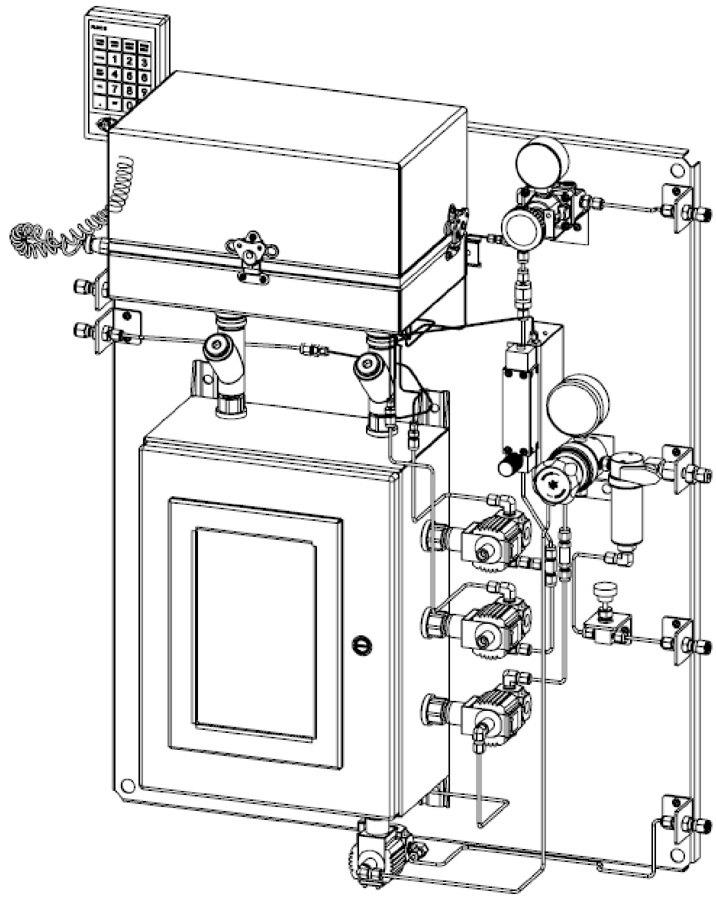
AccuChrome™

GAS CHROMATOGRAPH

Operation Manual

Revision 0 March 2023



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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 8.

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.

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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

⚠ DANGER	The Danger symbol indicates a hazardous situation that, if not avoided will result in death or serious injury.
⚠ WARNING	The Warning symbol indicates a hazardous situation that, if not avoided could result in death or serious injury.
⚠ CAUTION	The Caution symbol with the safety alert symbol indicates a hazardous situation that, if not avoided could result in minor or moderate injury.
NOTICE	The Notice symbol is used to highlight information that will optimize the use and reliability of the system.

Important Safety Guidelines for 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 **Use of unauthorized parts may impair suitability of the equipment for Class I Div. 1 or Class I Div. 2 or Ex locations.**

⚠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:

a) High Voltage Electrical Energy
b) Toxic and Explosive Gases
c) High Temperature Surfaces

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

The AccuChrome GC can be configured to be safely operated in a Class I Div.1, Group B, C and D area, or a Class I Div 2, Groups B, C. D area or Ex protection: II 2G, EEx d [ia] ia em II2B T3 (T_{amb}=50°) area. The certified designation will be indicated on the nameplate.

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.

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Section 1 Overview of the AccuChrome Gas Chromatograph

1.1 Analyzer General Description

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 AccuChrome 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 I Division 1 and Class I Division 2 models. Each of these models is also available with the option of AC or DC power.

1.2 General Mode of Operation of the AccuChrome

A detailed discussion of the theory of the separation and detection of the gases of interest via gas chromatography is presented in Section 10. 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 12. 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 diaphragm valves (6-port valve and 10 port valve), the chromatographic column(s), and the thermal conductivity detector (TCD) are described further in Section 2.2. 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. The lower compartment houses the control electronics.

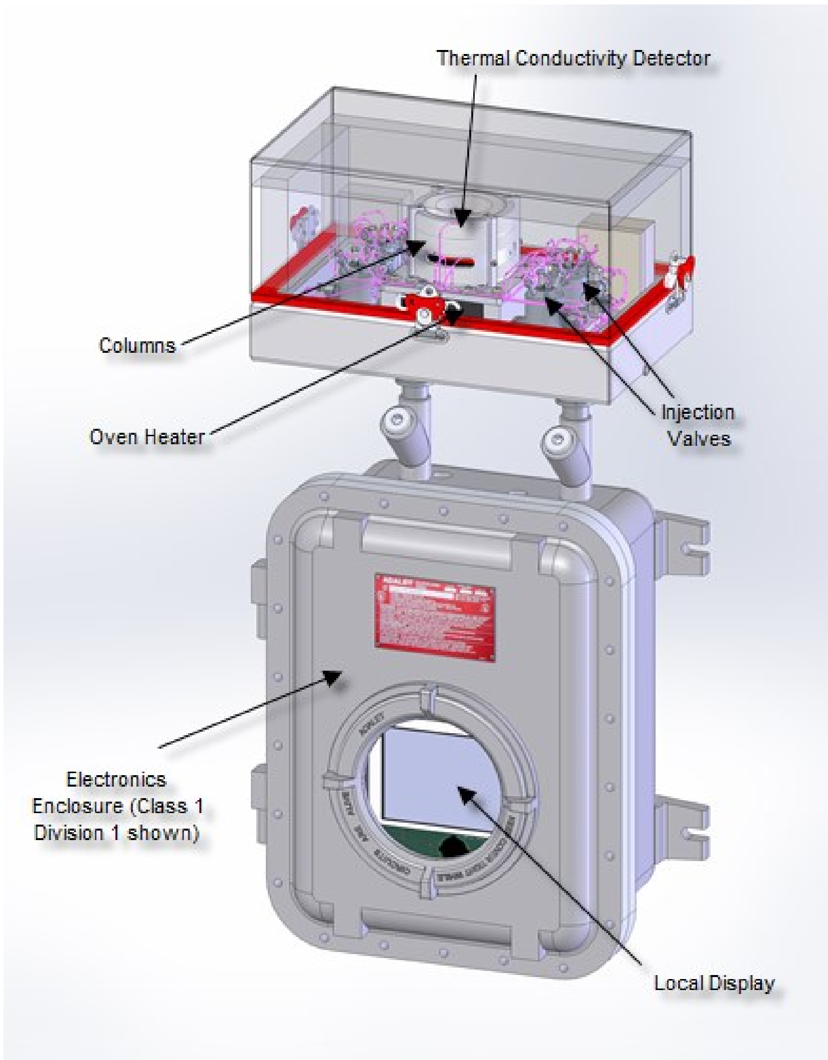

Figure 2-1: Main Components of the Accuchrome Gas Chromatograph Class I Div 1

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2.2 Chromatograph Oven

2.2.1 Injection/Switching Valves

The AccuChrome uses multi-port diaphragm injection/switching valves for directing the flow of carrier gas and sample gas within the chromatograph oven. See Section 14 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.

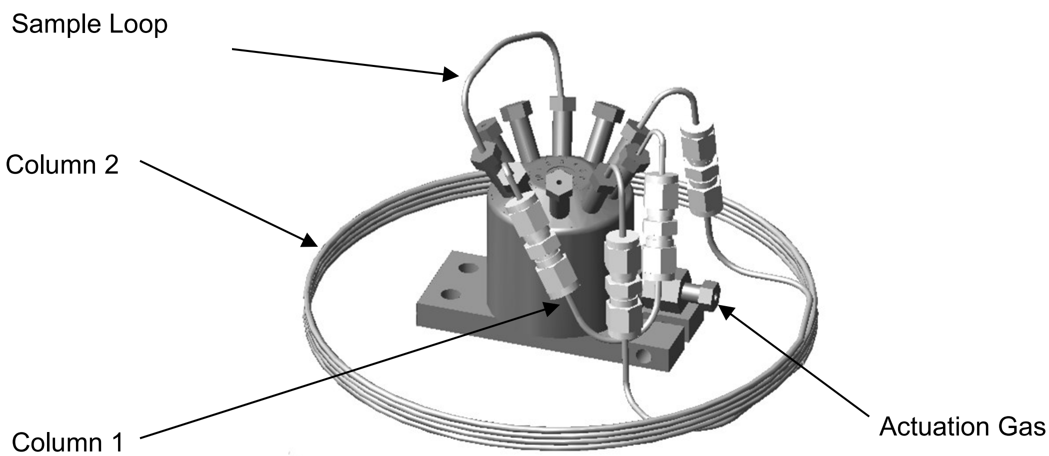

Figure 2-2: Chromatograph Valve and Columns

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.

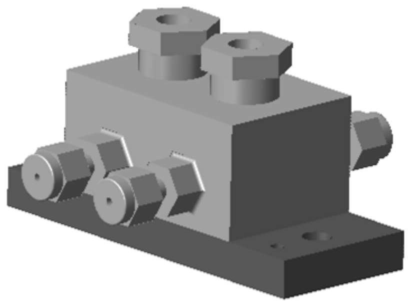

Figure 2-3: Thermal Conductivity Detector

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 I Division 1 models also have 2 intrinsic safety (IS) barrier boards. Figure 2-1 shows the Class I Division 2 model AccuChrome oven and electronics enclosure.

2.3.1 The Controller Board

Figure 2-4 shows the controller board. This board contains the microprocessor and communication ports. The display board in Section 0 mounts directly to the controller board. The I/O board in Section 2.3.2 communicates with the controller board via USB 2.0. The controller board performs all data analysis and parameter calculations. The USB ports are all functionally interchangeable and it does not matter the order of connecting peripheral devices. Ethernet connections are port specific. There is an Auxiliary port, local area network port and direct connection port as labelled in Figure 2-4.

- Auxiliary Ethernet port – Not normally used. Must be configured by Factory. Located closest to the USB ports. Labelled “GBE1” on circuit board.
- LAN Ethernet port – Used to connect to a local area network. Can either be automatically assigned an IP address of have it set manually, see Section 3.7. Located in the middle of the three ethernet ports. Labelled “GBE2” on circuit board.
- Direct Connect Ethernet port – Used to connect directly between a computer and the AccuChrome. Located closest to the RS232 terminal block. Labelled “GBE3” on circuit board.

⚠WARNING **Ethernet and USB ports cannot be accessed without opening the electronics enclosure. To open the electronics enclosure, the area must be proven non-hazardous.**

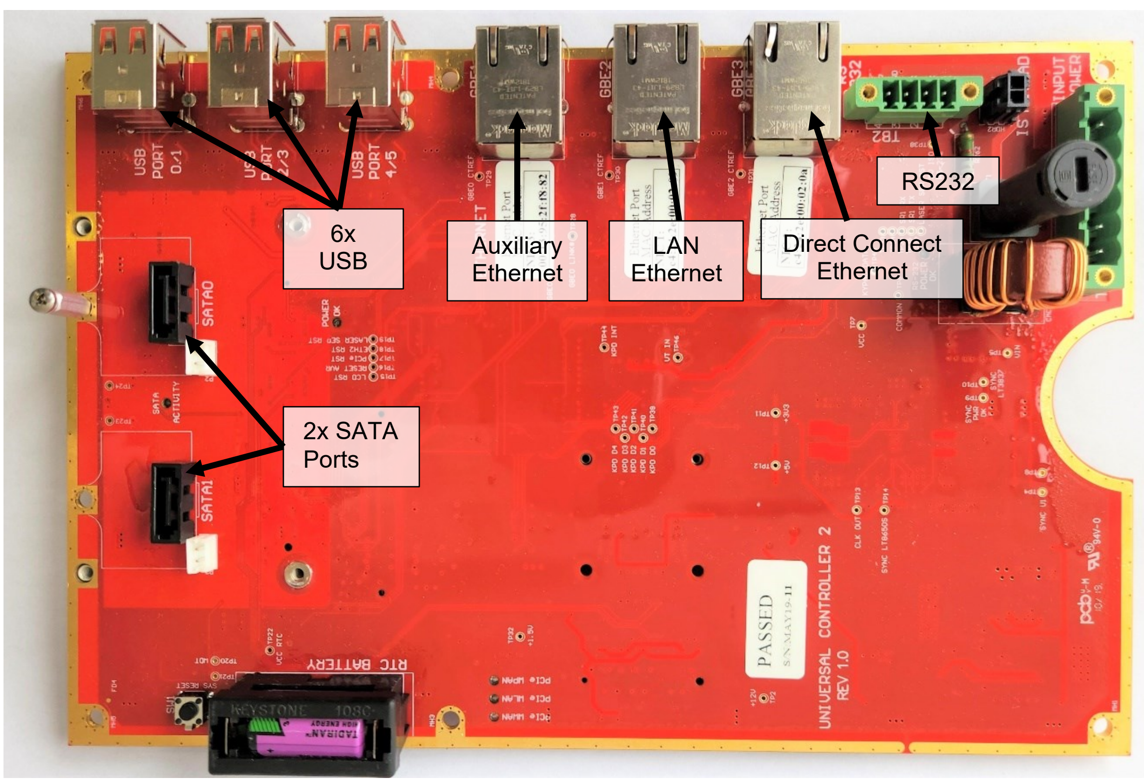

Figure 2-4: Universal Controller 2, PT3048. The processing unit is located on the reverse side.

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 11 for detailed descriptions of the connections.

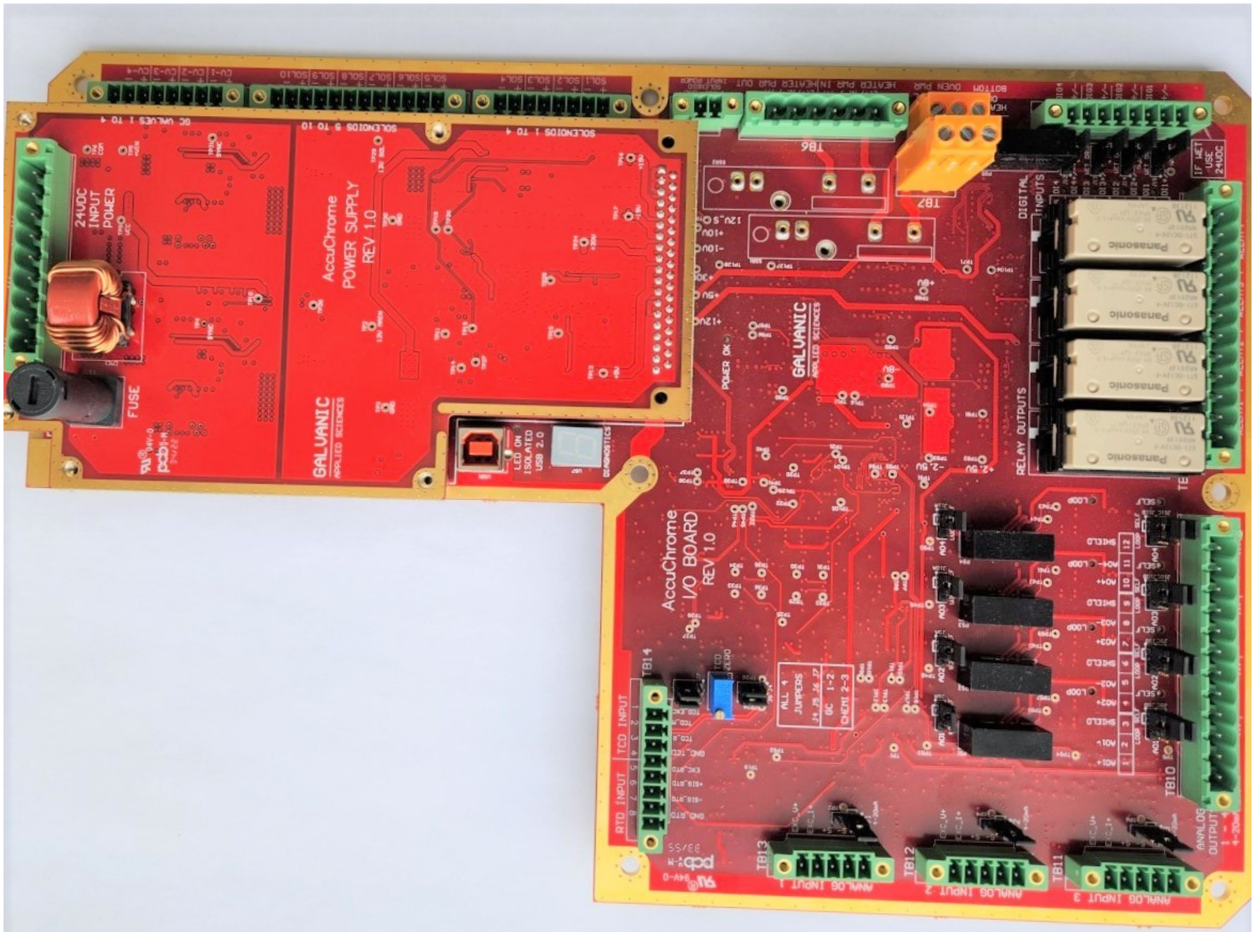

Figure 2-5: AccuChrome I/O board assembly, SA3184. Terminal block plugs not shown.

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 presents the Front Panel graphical user interface. A handheld keypad is required to interact with the Front Panel. Additional information about the Front Panel is found in Section 4.3. The display is an industrial VGA display with 640 x 480 resolution. It is sunlight readable.

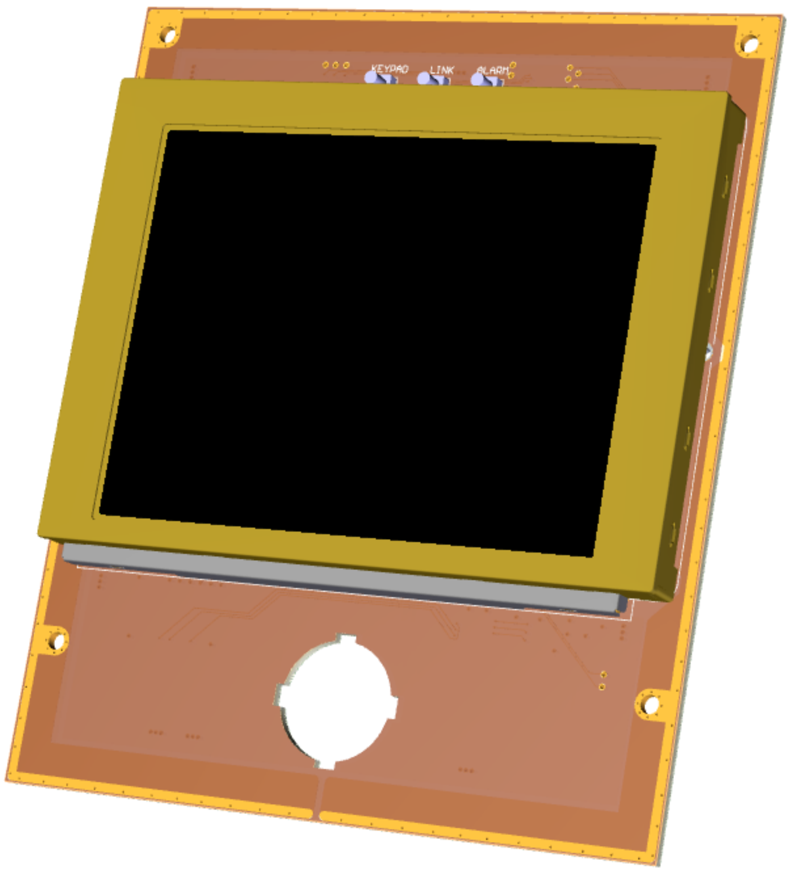

Figure 2-6: Universal Controller 2 display, PT3050. The display is full VGA LCD with a pixel resolution of 640x480.

2.3.4 The Intrinsic Safety (IS) Barrier

The IS barrier (Figure 2-7) is used in the Class I 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: Intrinsically safe barrier SA2925.

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 10-port diaphragm 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.

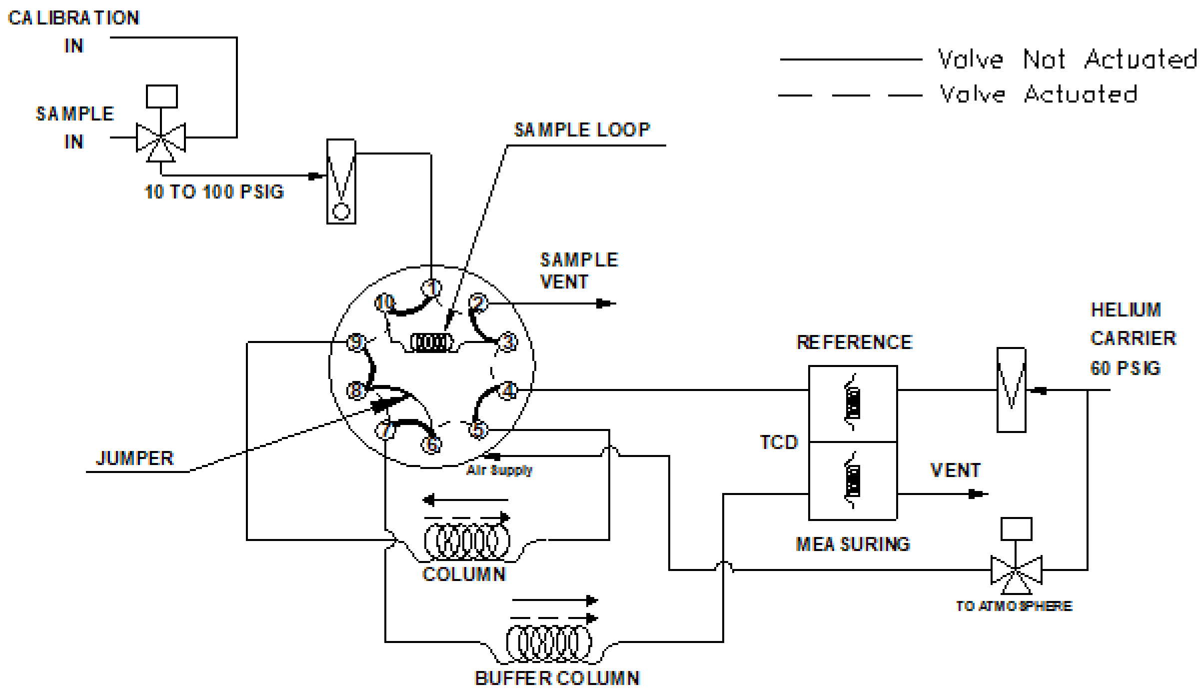

Figure 2-8: Single Column Flow Diagram

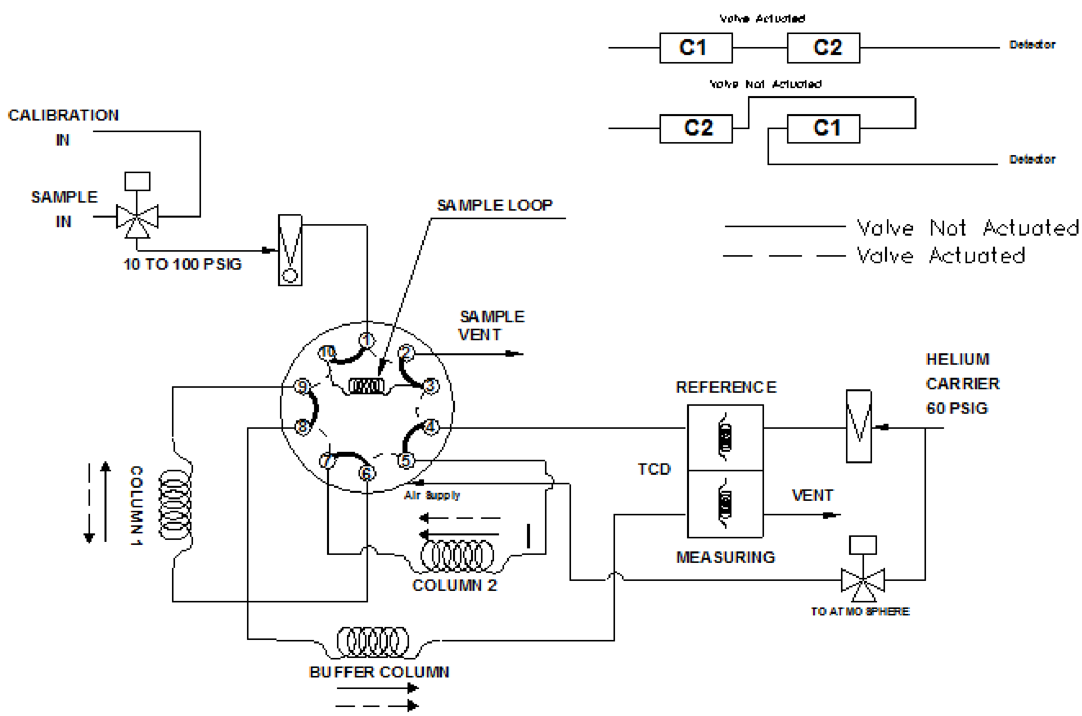

Figure 2-9: Two Column Flow Diagram

2.4.2 4-Minute Analysis Cycle

The oven compartment for a typical 4-minute cycle time AccuChrome system is composed of one 10-port diaphragm valve, one 6-port diaphragm 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.

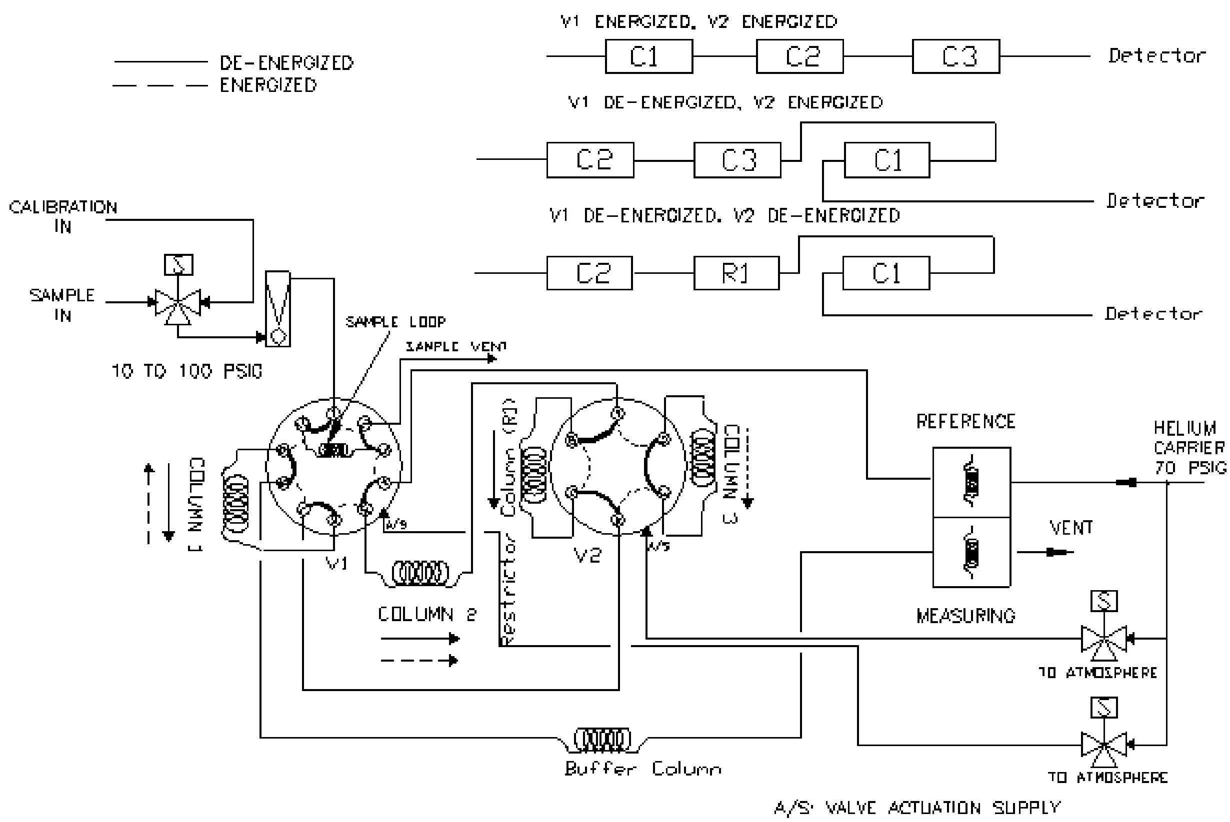

Figure 2-10: 4-Minute Analysis Flow Diagram

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 and Humidity

The AccuChrome Natural Gas Chromatograph is designed to be operated at ambient temperatures from -18^{o}C to +60 ^{o}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 and 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 Figure 3-1 and Figure 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 I Div 1	AC: 1219mm H x 686mm W x 343 mm D (48” x 27” x 13.5”) DC: 838mm H x 686mm W x 343mm D (33” x 27” x 13.5”)	AC: 61kg (135 lbs) DC: 54.4kg (120 lbs)
Class I Div 2	838 mm H x 686 mm W x 235 mm D (33” x 27” x 9.25”)	38.5kg (85 lbs)

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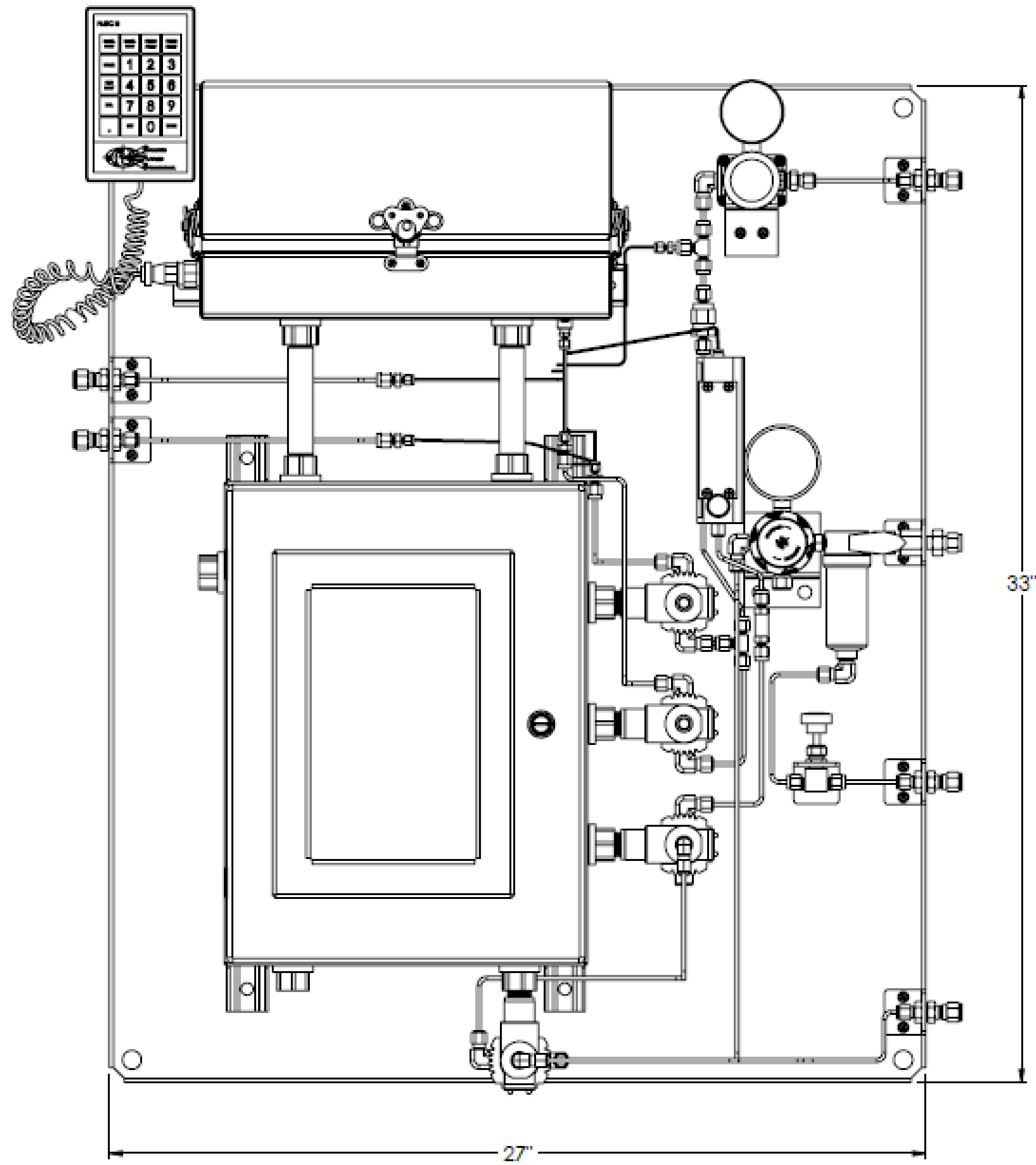

Figure 3-1: Physical Dimensions - Class I Div 2 AccuChrome Chromatograph

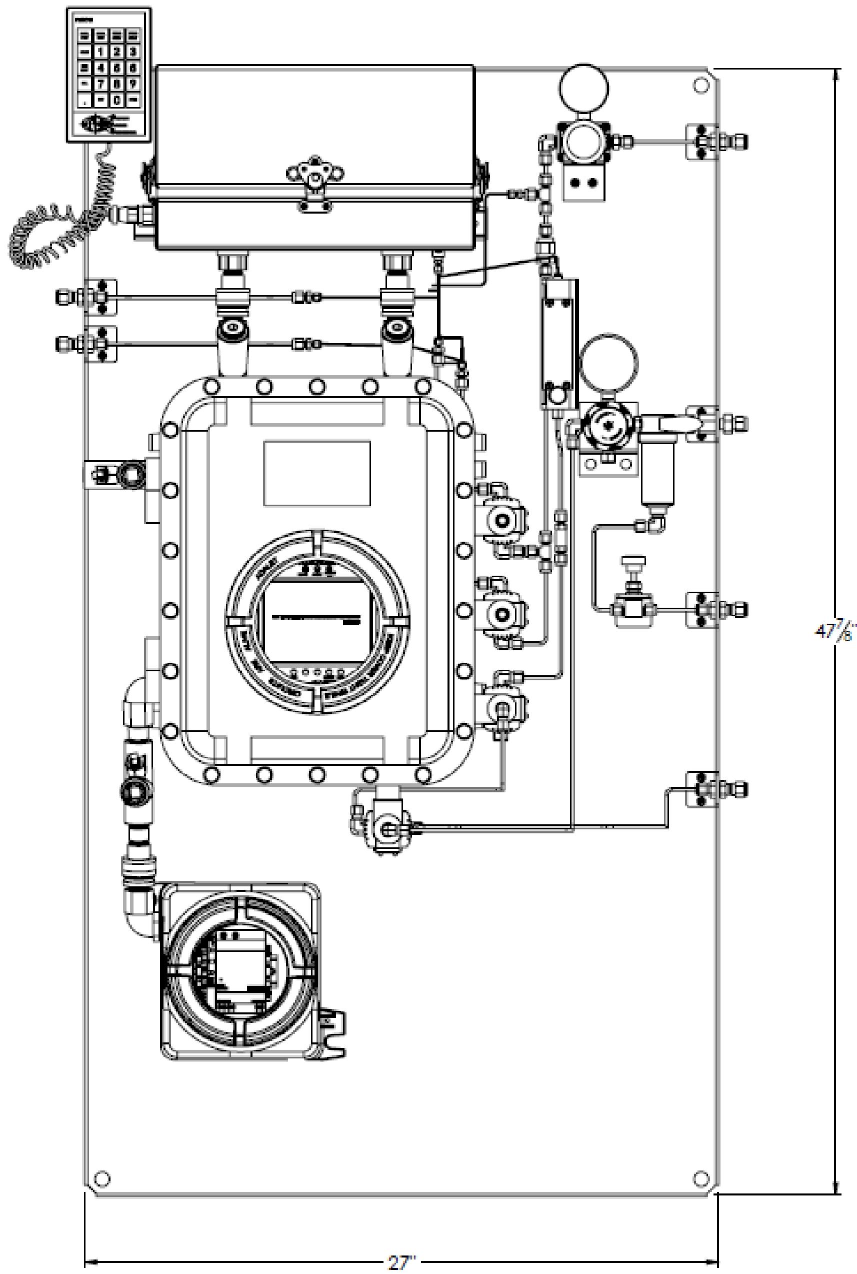

Figure 3-2: Physical Dimensions - Class I Div 1 Explosion Proof AccuChrome Chromatograph

⚠WARNING **Explosion Hazard – Substitution of components may impair suitability for Class I Division 1 or Class 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, 90-120 VAC power input or 220-240 VAC power input.

The power consumption is approximately 150 watts at start-up and approximately 100 watts when running at constant temperature.

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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.

3.6 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 I 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 I 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.

⚠WARNING **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.

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 11 for detailed wiring instructions to the terminal blocks in the electronics enclosure.

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.

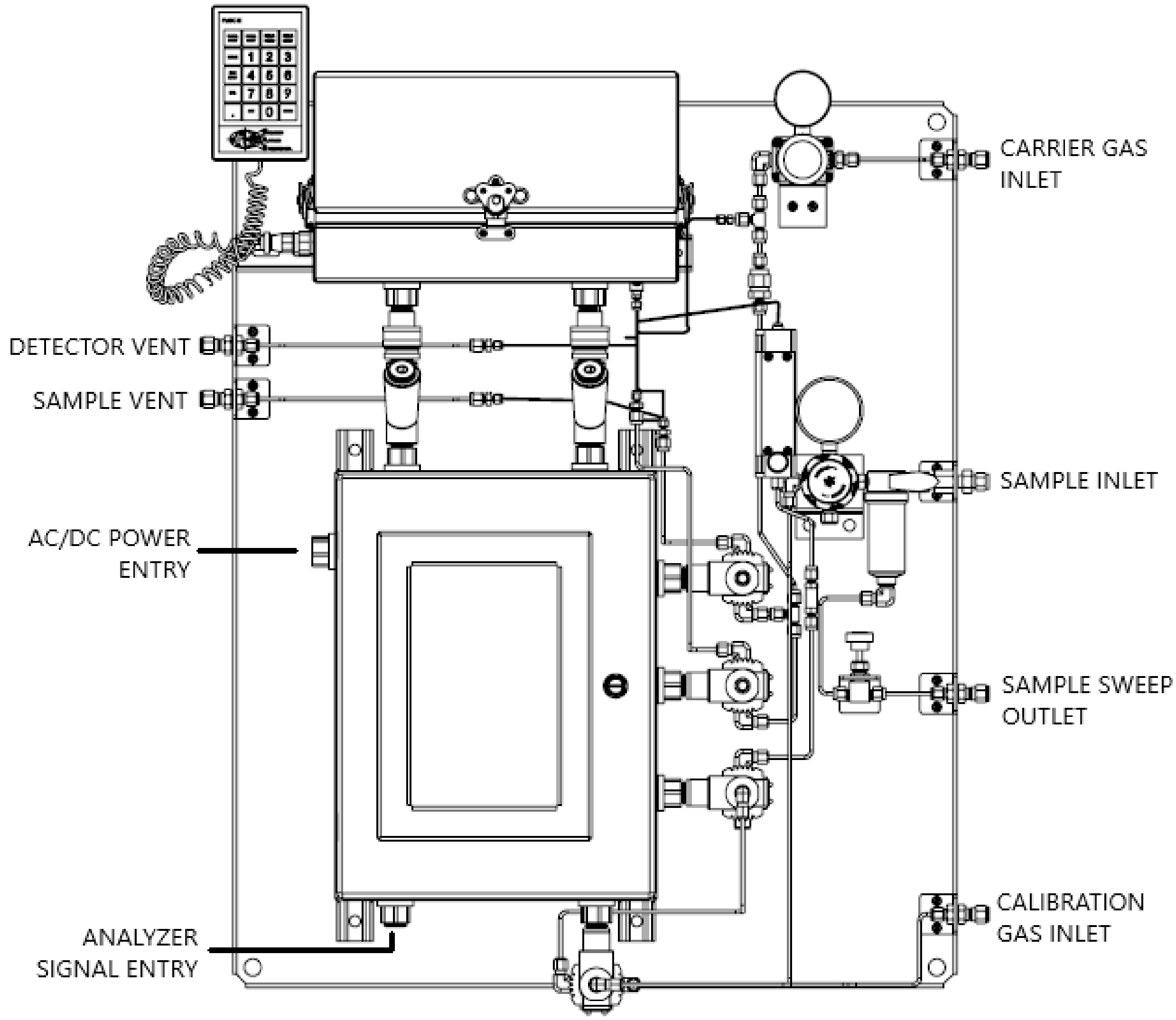

Figure 3-3: Gas tubing connections and cable entry, Class I Div. 2 system

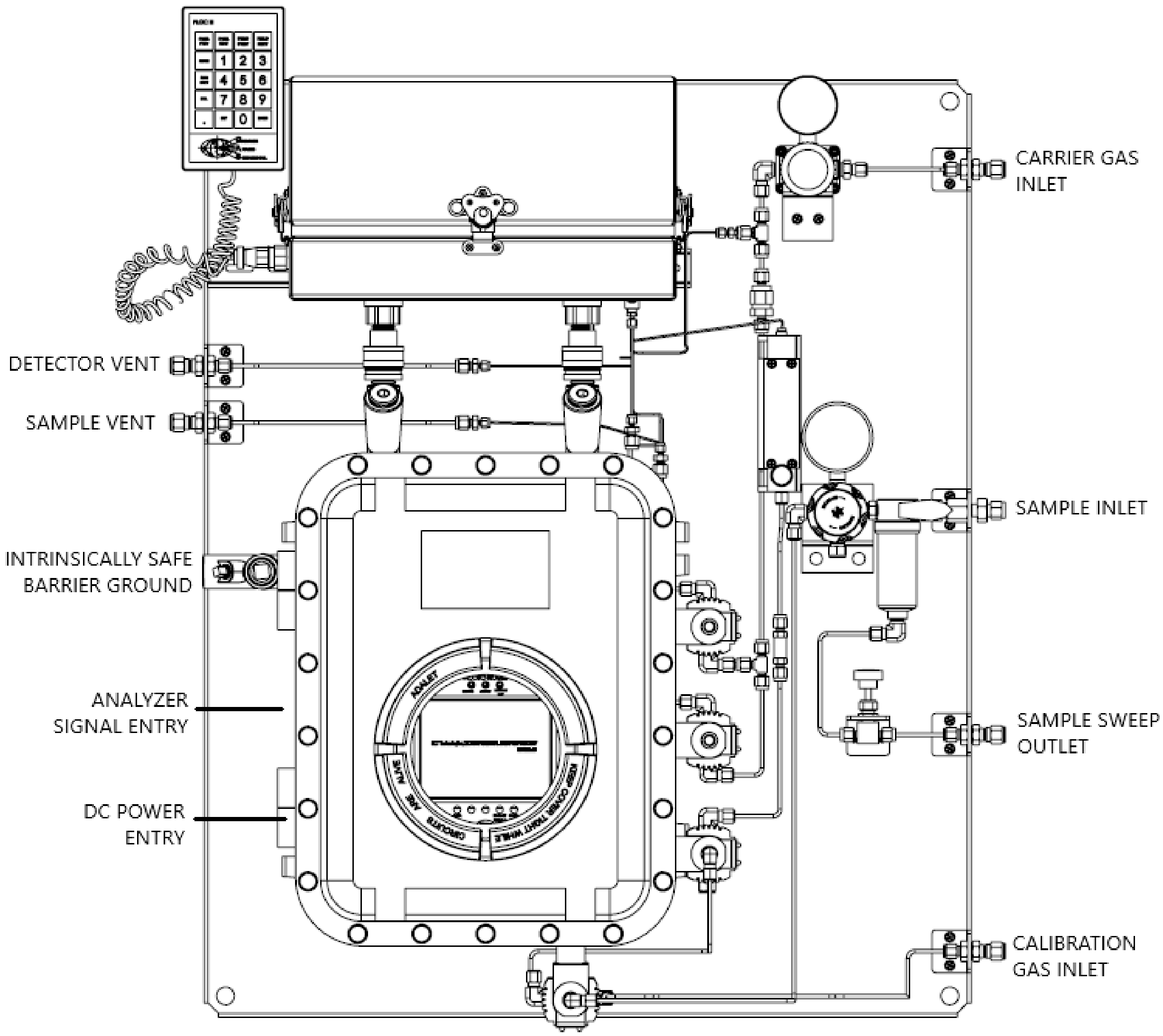

Figure 3-4: Gas tubing connections and cable entry, Class I Div. 1 system, DC power

3.7 Interfacing the AccuChrome to a Computer

The AcchChrome GC analyser can be connected to a computer by ethernet, serial port (RS232 or RS485). Ethernet connection may be made either directly into the AcchChrome or over local area network (LAN), see Section 2.3.1 for location of ethernet ports.

To connect to a Computer:

a) The AccuChrome must be connected to a LAN or have an ethernet cable connection to a computer. See Section 2.3.1 for location of appropriate ethernet ports.

b) Access the *System* tab on the AccuChrome Front Panel Display using the *Next Panel* key on the keypad (See Section 4.3.1 for more information on the keypad).

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

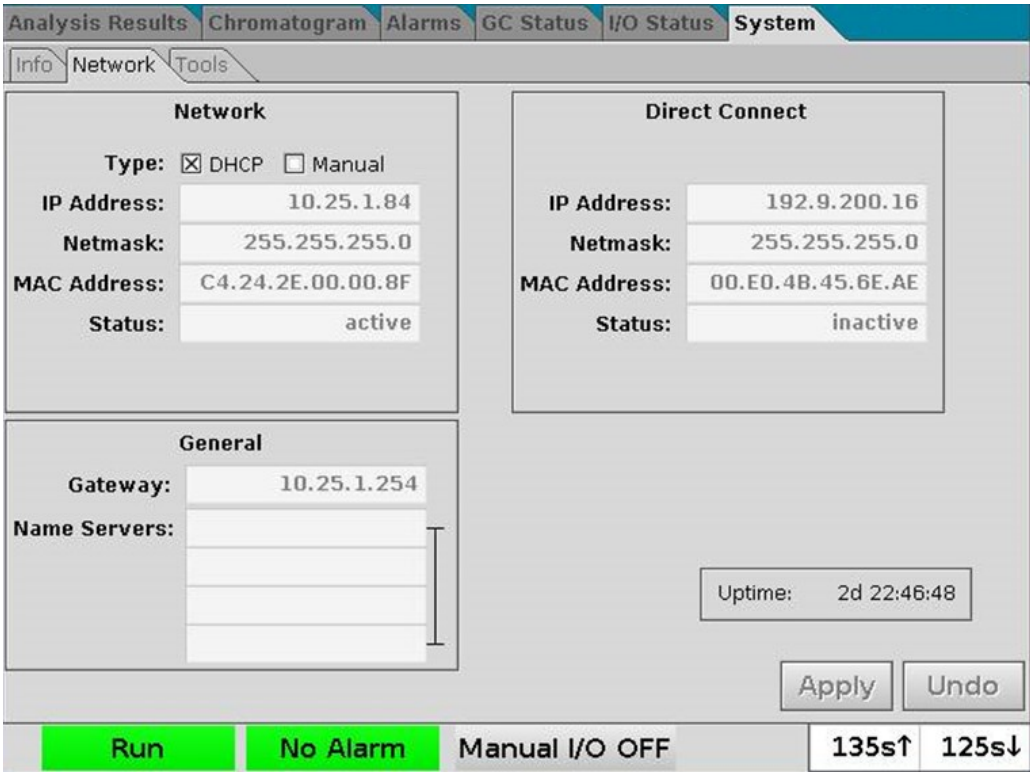

Figure 3-5: Network Sub-panel

NOTICE **Consult with your company's IT professionals to determine the correct network settings for your local area network.**

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) Click *Apply*.

3.8 Customer Connections

Connection to the analyzer can be made by ethernet, serial port (RS232 or RS485) or analog signal (4-20mA). Relay signals can also be connected for status monitoring.

Connecting by ethernet is required for the computer user interface application. Ethernet ports are provided inside the electronics enclosure for temporary access during periods where the immediate area is proven to be non-hazardous (see Section 2.3). If it is desired to have regular connection to a local computer, it is recommended to install a remote ethernet terminal so that the electronics enclosure does not need to be opened for access.

⚠WARNING **To access connection points inside the electronics enclosure, the area must be proven non-hazardous.**

Section 4 **AccuChrome User Interfaces**

4.1 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.

NOTICE

For this Section to be applicable, it is required that the system has been installed, appropriate gas lines have been fitted and all connections to external devices (e.g. alarms) have been made.

4.2 User Interfaces

The front panel display on the AccuChrome GC 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 4.3.

The PC-based application software 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 4.4 describes how to log onto the system. The application software is divided into two parts:

- *View* - used for routine operation of the AccuChrome (Section 0).
- *Edit* - used to establish the configuration. The configuration is transmitted to the system (0). A variety of configurations can be generated and downloaded as required to meet the needs of the facility.

Throughout Section 4 you will find details about routine operation of the system. Typical Operator activities are covered by the material in Section 4.4.4 while typical Technician activities are covered in Section 5. For a discussion on calibration, see Section 6.

4.3 AccuChrome Front Panel Display

The display (the default display is shown in Figure 4-2) on the AccuChrome Front Panel presents an overview of the system status and the concentration of the various components in the sample. The display is controlled and navigated using the keypad provided with the system. The front panel display consists of several screens as described below.

4.3.1 The Keypad Controller

The Keypad Controller (Figure 4-1) is used to navigate between the various screens of the display, enter data and initiate/terminate runs.

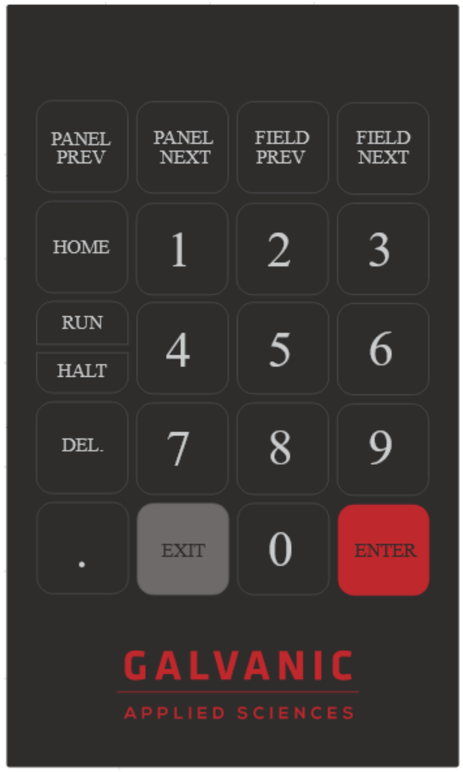

Figure 4-1: The Keypad Controller

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 4-2)

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.

4.3.2 The Analysis Results Tab

The *Analysis Results* tab (Figure 4-2) 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.

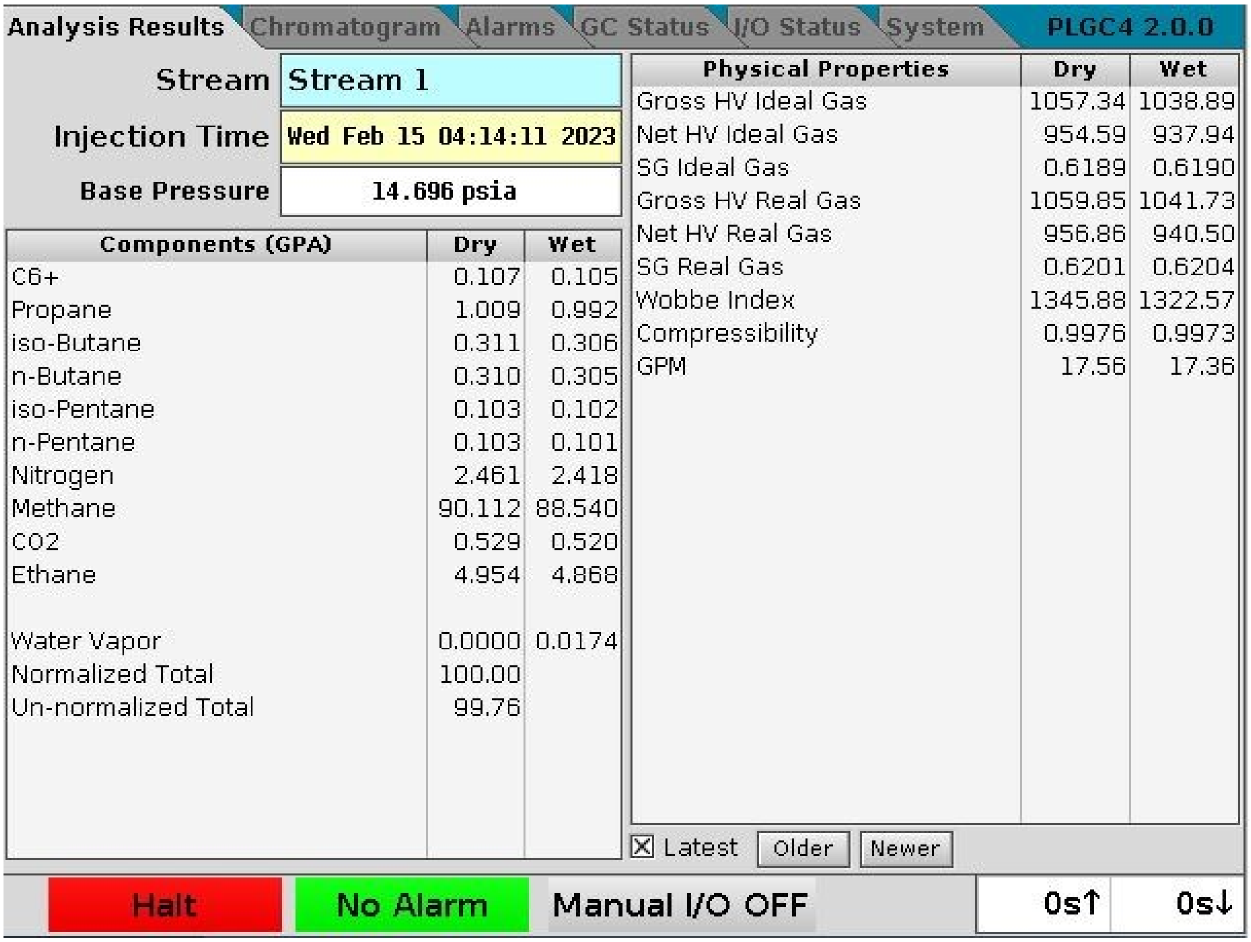

Figure 4-2: AccuChrome front panel home page is the Analysis Results tab

Common to all pages and tabs viewed on the front panel, the bottom line of the display indicates system status.

- The first field from the left will indicate one of either *Run*, *Halt Pending* or *Halt*, depending on the present status of the AccuChrome.
- The second field from the left indicates alarm status. If an alarm is present, the field will turn red and read *Alarm*.
- The third field from the left is used for maintenance and repair of the AccuChrome and must indicate *Manual I/O OFF* during normal operation.
- The right-most two values indicate the elapsed time and the remaining time of the present chromatograph run.

4.3.3 Chromatogram Tab

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

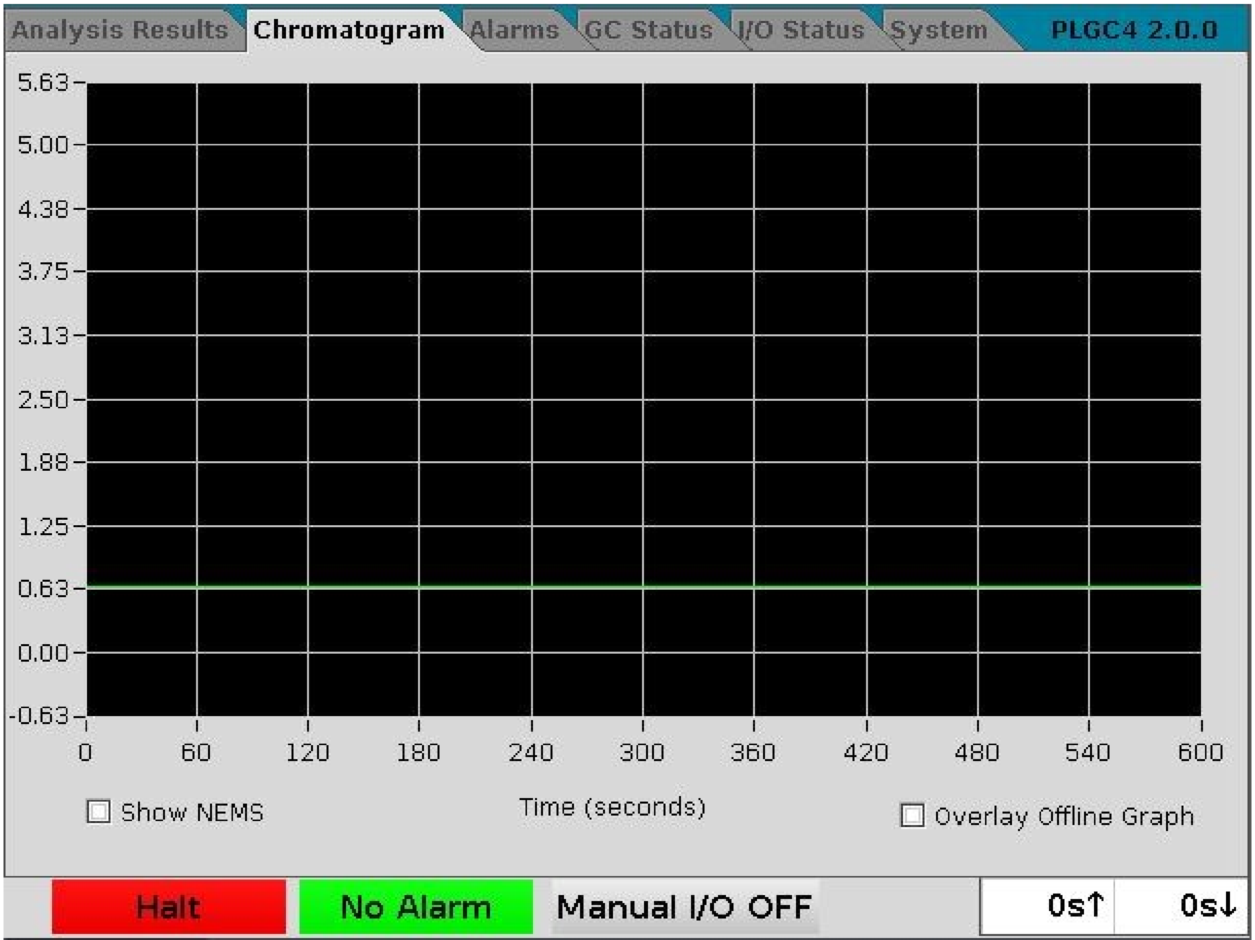

Figure 4-3: Chromatogram tab on the AccuChrome front panel

4.3.4 Alarms Tab

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

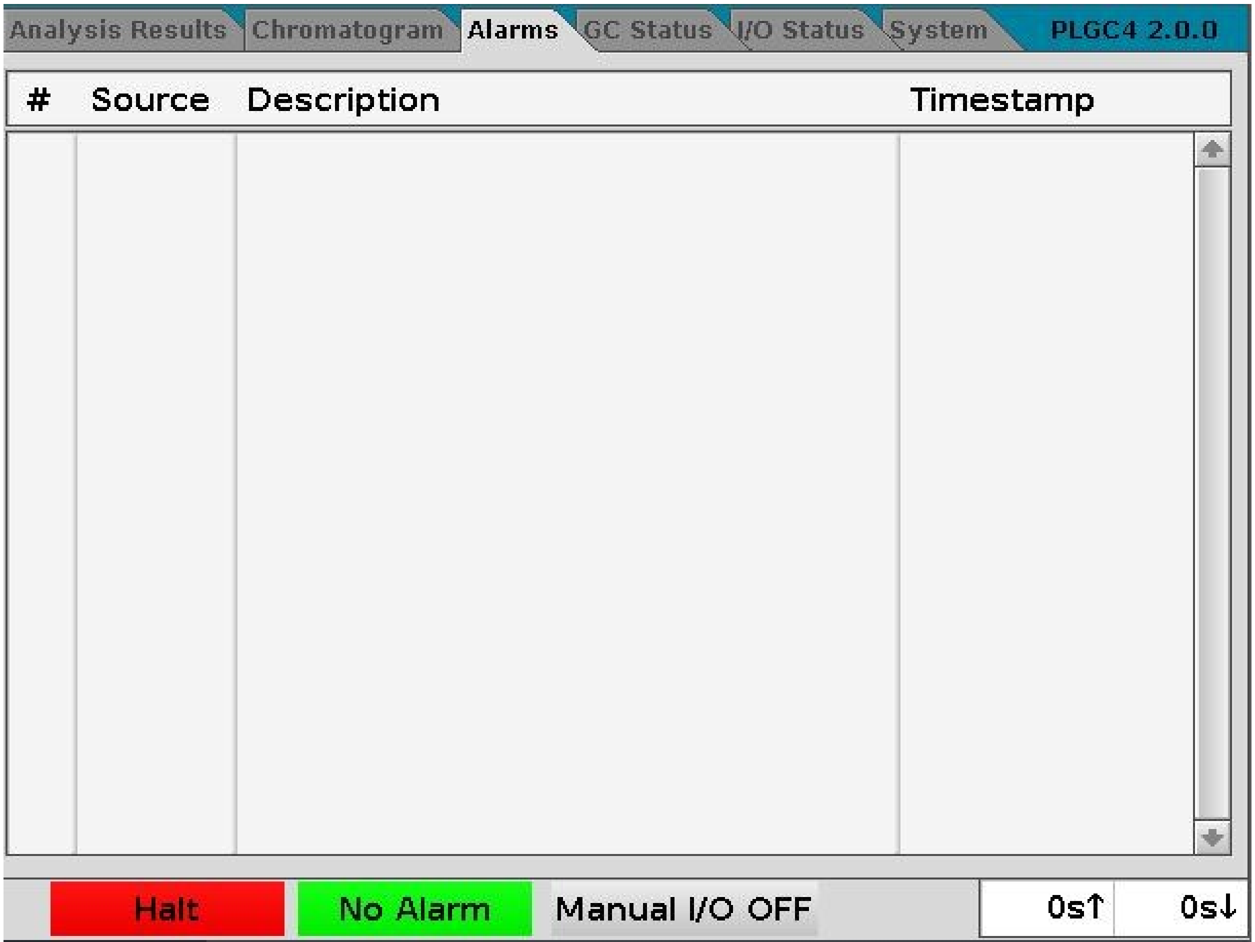

Figure 4-4: Alarms tab on the AccuChrome front panel

4.3.5 GC Status Tab

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

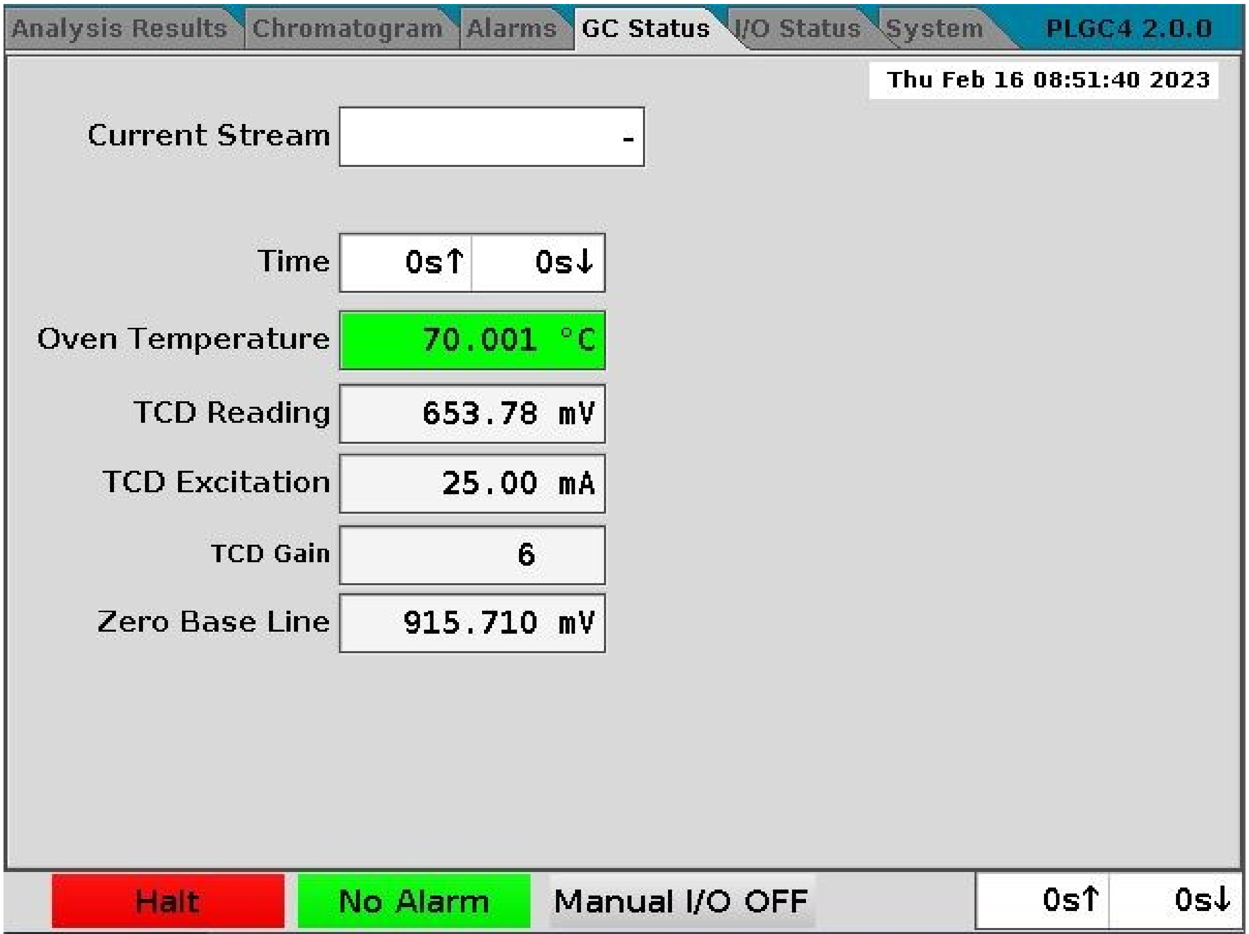

Figure 4-5: GC Status tab on the AccuChrome front panel

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4.3.6 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.

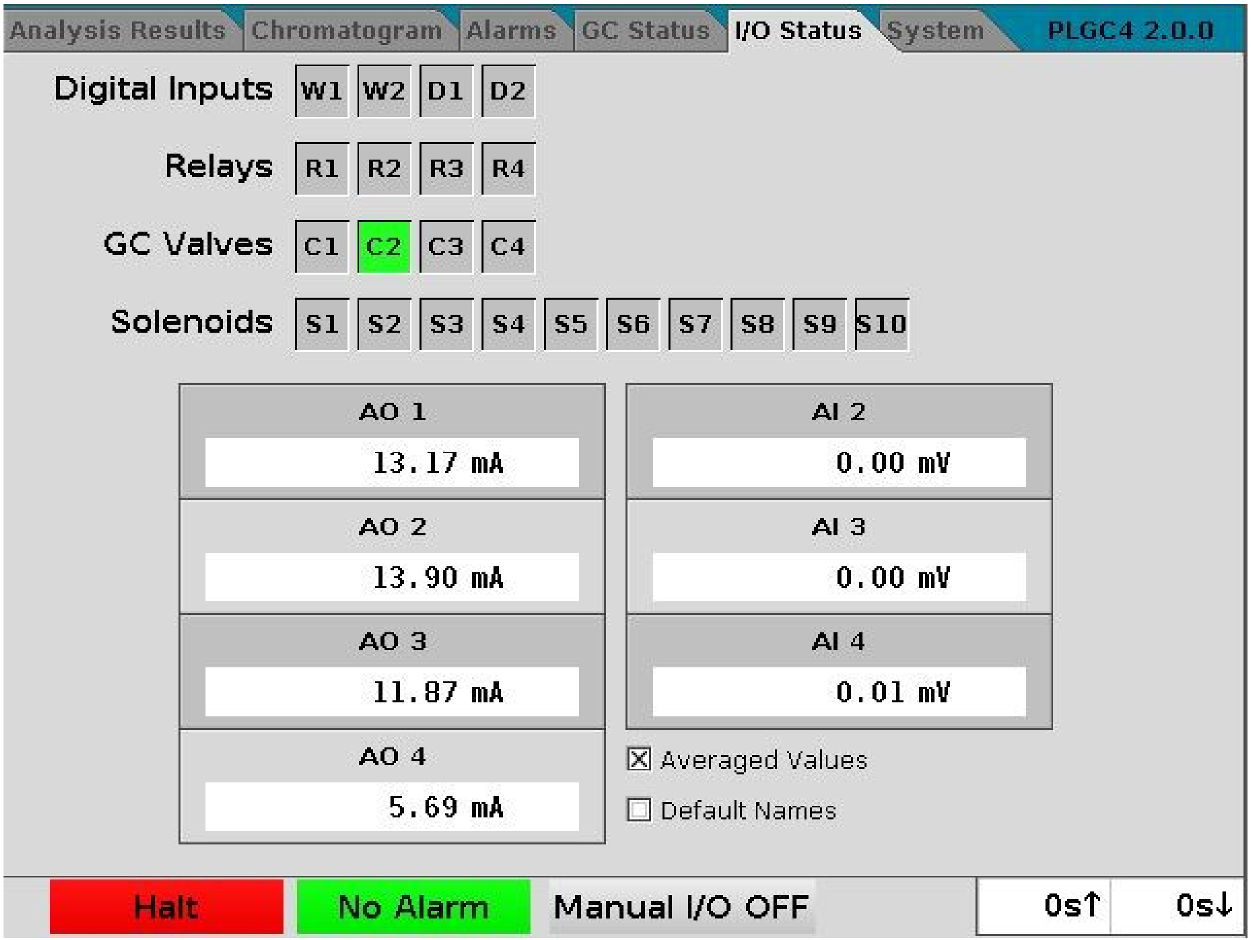

Figure 4-6: I/O Status tab on the AccuChrome front panel

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.

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4.3.7 System Tab

The System tab has 3 sub tabs.

4.3.7.1 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.

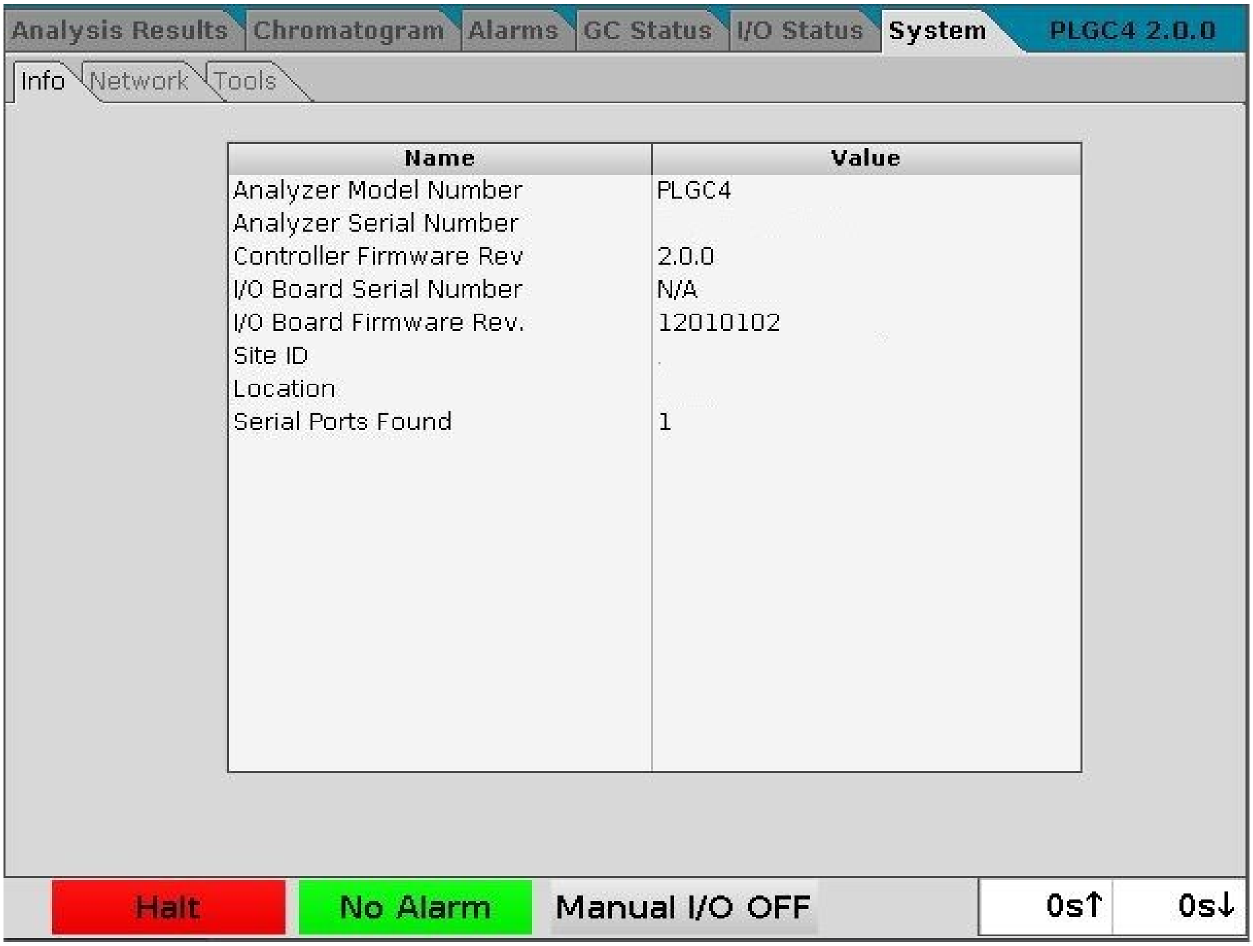

Figure 4-7: System Info Sub-tab on the AccuChrome front panel

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

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4.3.7.2 Network Sub-tab

The *Network* sub tab (Figure 4-8) is used to establish communication between the AccuChrome and the computer. A detailed discussion of this topic is presented in Section 3.7.

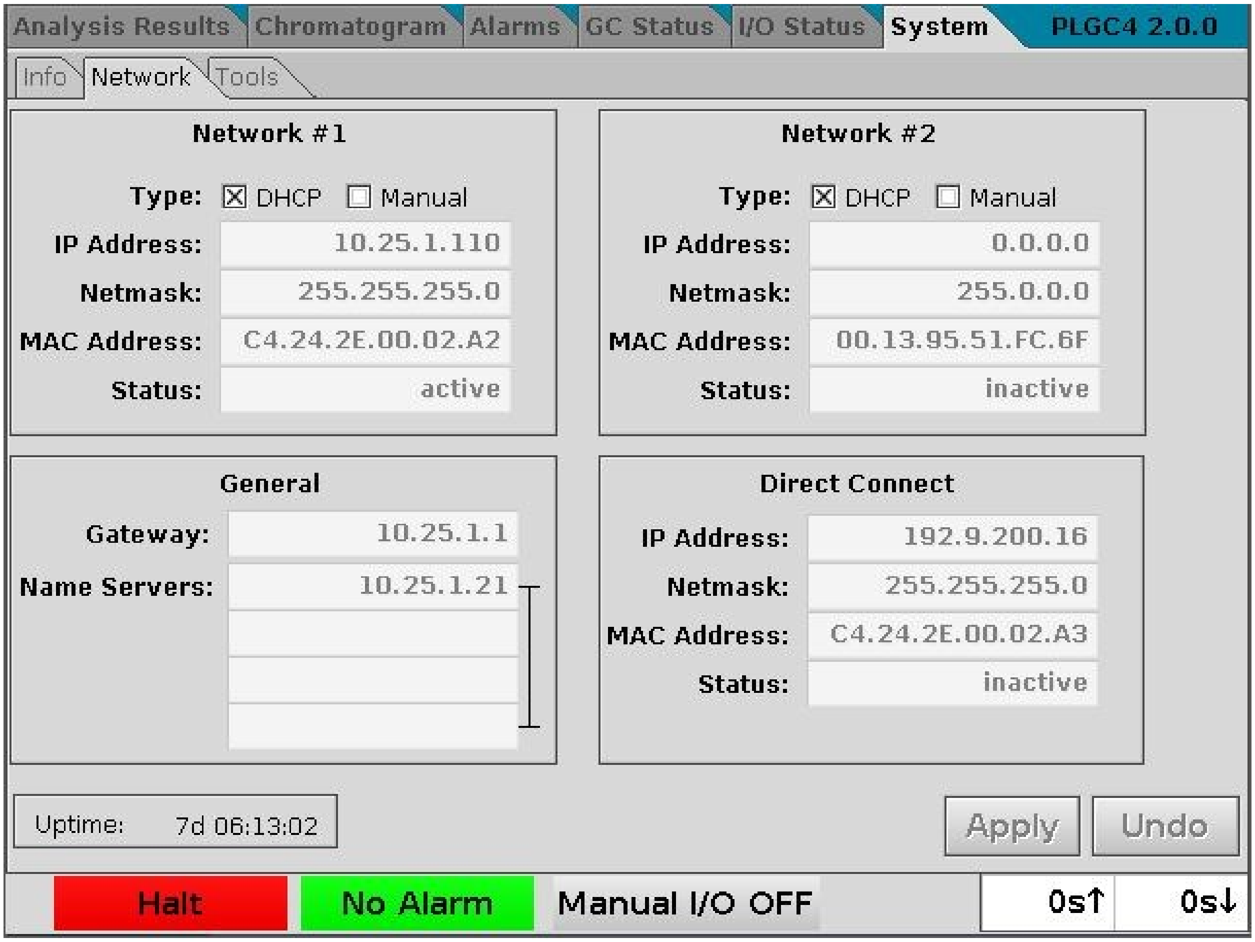

Figure 4-8: System Network Sub-tab on the AccuChrome front panel

4.3.7.3 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 0).

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.

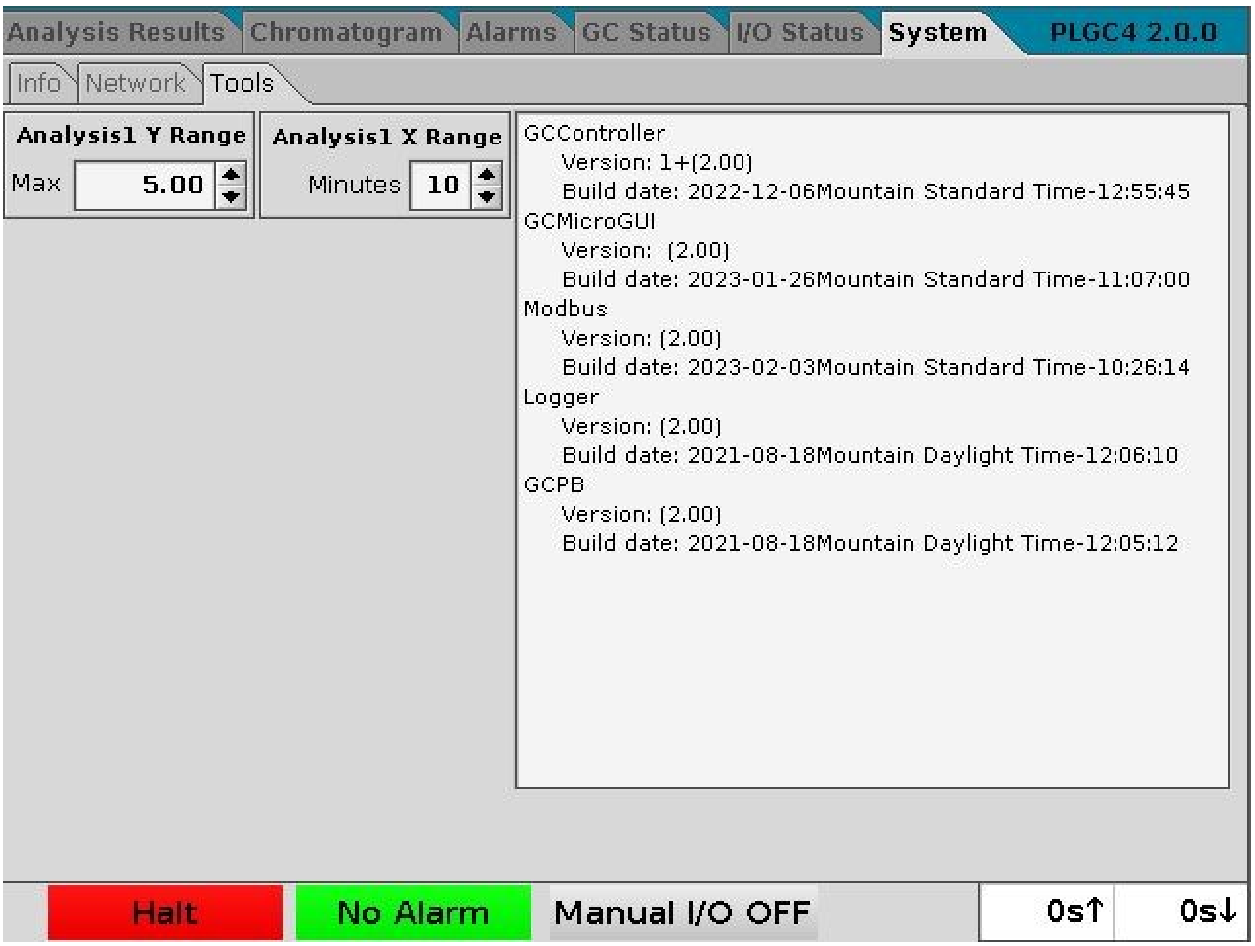

Figure 4-9: System Tools Sub-tab on the AccuChrome front panel

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4.4 AccuChrome PC Application Software

NOTICE **This discussion assumes that the computer and AccuChrome have been interfaced as described in Section 3.7.**

The AccuChrome PC Application is Microsoft Windows® (7, 8 or 10) compatible software used for remote access and in-field maintenance. The application can be used to read analysis results, download archive logs and change operating parameters of the AccuChrome. Remote connection is made through ethernet TCP/IP protocol and can be setup either through local area networks (LAN) or by direct ethernet cable connection.

4.4.1 Installing the PC Application

The AccuChrome PC Application installer is found on the USB key that is included with the analyzer and can be downloaded from the Galvanic AccuChrome product page[1]. The software can be installed on any computer running Microsoft Windows® (7, 8 or 10).

NOTICE **Old versions of the AccuChrome PC Application must be uninstalled prior to installing the newer version.**

To install the software:

1) Extract the contents of the compressed .zip file to a suitable file location on the target computer such as the *Downloads* folder.
2) Double click on “setup.exe”
3) Follow the prompts of the AccuChrome Setup Wizard by choosing ‘Cancel’, ‘< Back’ or ‘Next >’
4) Choose an appropriate installation location when prompted. Use the default folder location unless directed otherwise.
5) Allow the installer to run to completion.
6) Confirm successful installation by locating the shortcut icon (Figure 4-10) on the installation computer *Desktop*.

4.4.2 PC Application Connection Setup

Start the connection protocol by double clicking the AccuChrome shortcut icon on the desktop (Figure 4-10).

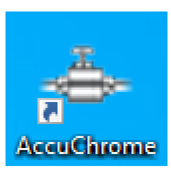

Figure 4-10: AccuChrome PC application shortcut icon

The *Login* window (Figure 4-11) will be presented (superimposed on the main window). The various connection options are described below. To enter offline mode, use the ✕ in the top right of the pop-up window. The Login window may be reopened at any time through the Quick Access Toolbar (Section 4.4.3.1).

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[1] https://www.galvanic.com/products/

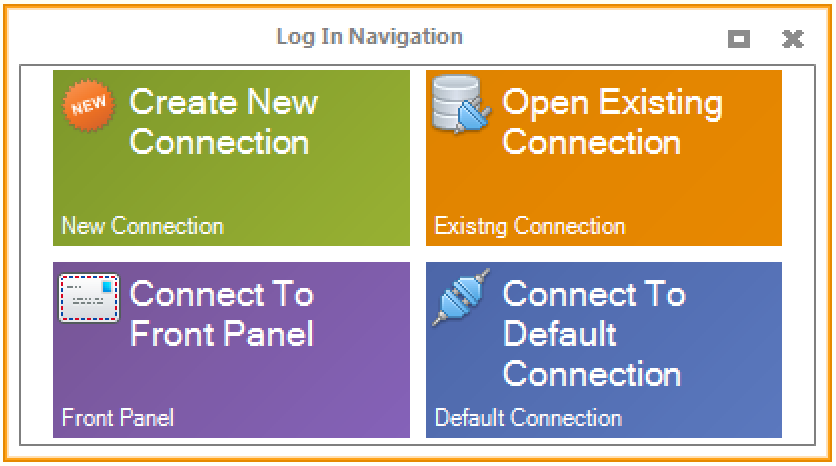

Figure 4-11: AccuChrome remote access connection setup dialog box on PC application

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 3.7 describes how to view an AccuChrome's IP address. Login parameter retry delay be set between 200 and 1000 ms.

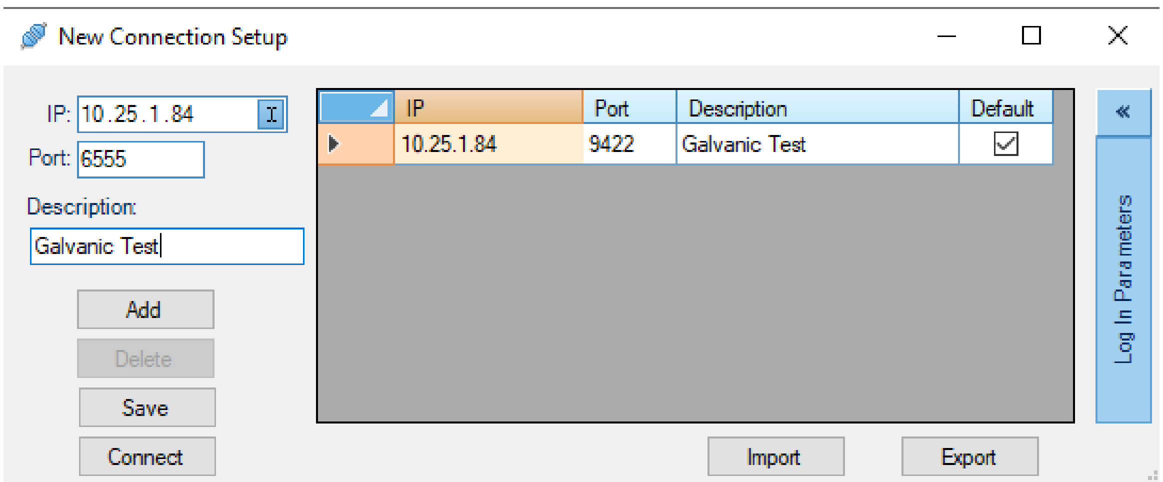

Figure 4-12: New connection setup dialog box on PC application

a) Enter the IP address for the AccuChrome, 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, the information will appear in the table. If you wish to set a default analyzer, place a check mark in the default column for that IP.

c) Click the *Save* button.

d) Confirm the values on the next pop-up window and click *Connect.*

Open Existing Connection - presents the *Existing Connection* dialog box (Figure 4-13), which is used to connect the computer to an AccuChrome that has previously been setup as a connection.

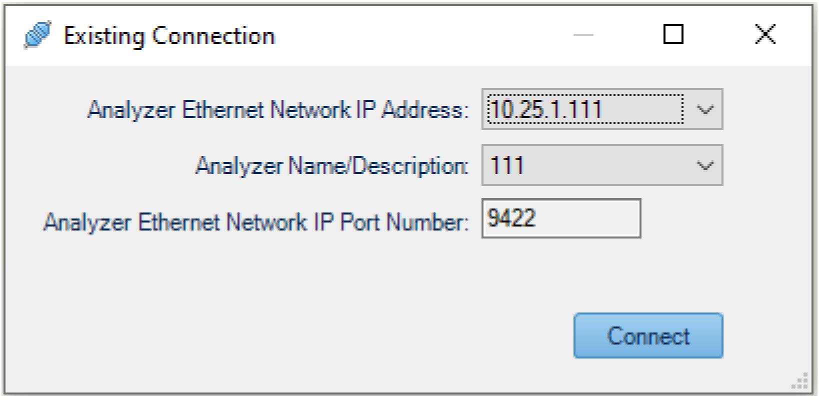

Figure 4-13: Existing connection dialog box on PC application

The IP address or description can be selected via the drop down menus. Press **Connect** when the appropriate IP address and name are indicated.

Connect to Front Panel - Allows for communication between a computer and the AccuChrome via the Direct Connect ethernet connection. This option is normally used when connecting to the analyzer in the field.

Connect to Default Connection - Automatically connects the computer to the default AccuChrome connection (See Figure 4-12).

4.4.2.1 Select User Access Mode

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

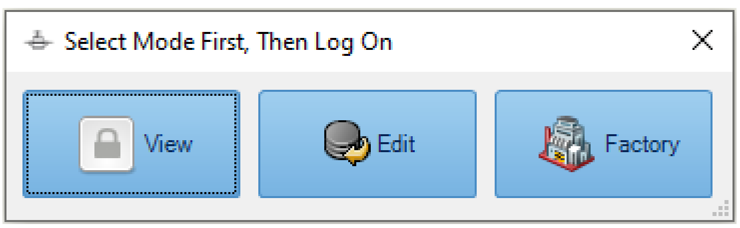

Figure 4-14: Select User access mode prompt on PC application

- *View* mode allows the user to collect, view and report data using the AccuChrome but does not permit changes to the analytical parameters. No password is required. View mode is described in Section 4.4.4.
- *Edit* allows the user to make changes to the analytical parameters of the analyzer. A certified technician will use Edit mode to define the data processing parameters, system configuration and schedule of analyses. If Edit mode is chosen, a dialog box will appear, prompting the user to enter a password. Edit mode is described in Section 5.1.
- *Factory* mode only for use by the Factory.

4.4.3 PC Application Main Screen

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

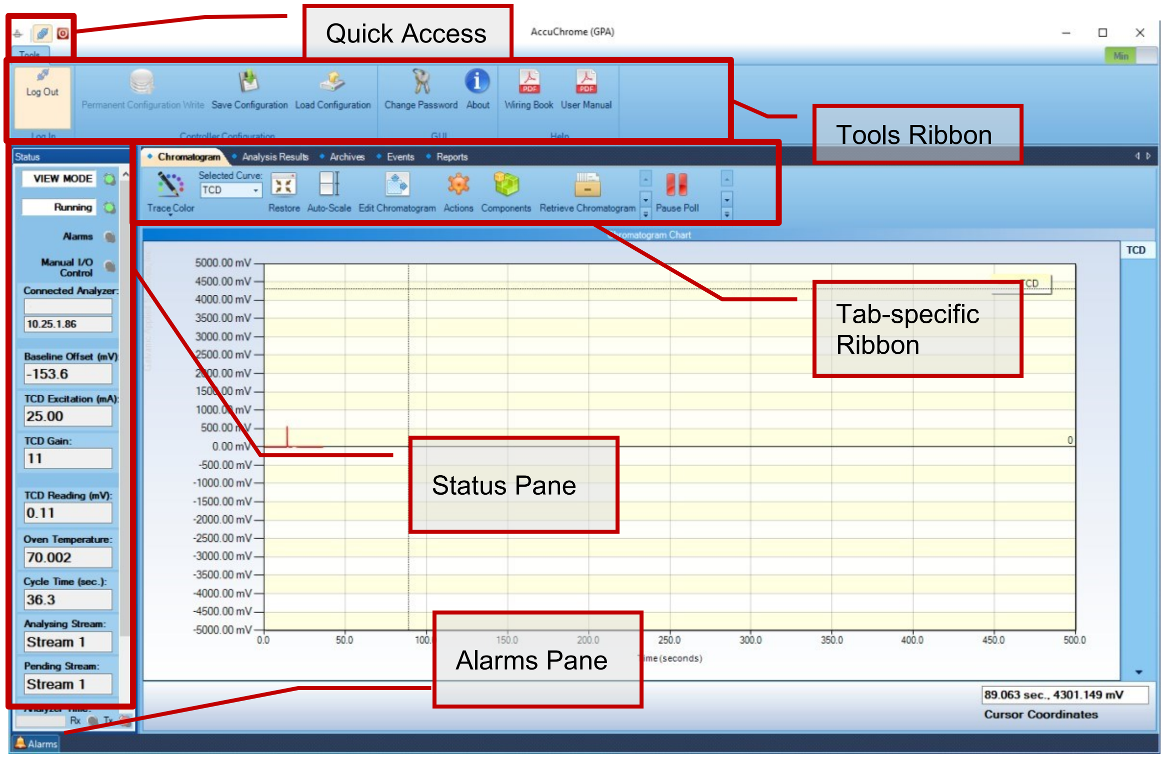

Figure 4-15: AccuChrome PC application main screen

a) Quick Access Toolbar (Section 4.4.3.1)

b) Tools Ribbon (Section 4.4.3.2)

c) Status Pane (Section 4.4.3.3)

d) Alarms Pane (Section 0)

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4.4.3.1 Quick Access Toolbar

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

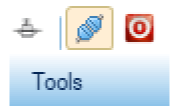


Figure 4-16: AccuChrome PC application Quick Access Toolbar

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

 - Toggles between *Connect to Analyzer* and *Disconnect from Analyzer*. This is used to initiate the analyzer connection 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.

4.4.3.2 Tools Ribbon

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

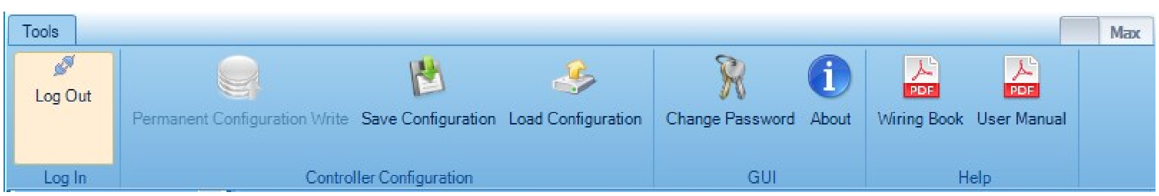


Figure 4-17: AccuChrome PC application Tools ribbon

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 AccuChrome.

Save Configuration - export the present configuration to the connected computer.

NOTICE

Use 'Permanent Configuration Write' in the Tools Ribbon to ensure any configuration changes will be remembered if the AccuChrome is power cycled or restarted for any reason. Regularly use 'Save Configuration' to make back-up copies of the latest configuration file.

Load Configuration – import a configuration from the connected computer.

Change Password - presents a dialog box to change the password for any one of three access profiles: *Update*, *Config IO Board* and *Factory*. To change the password, enter the existing password and the new desired password. The new password must be entered two times to verify the correct entry. The password for the *Update* profile changes the password for *Edit* mode.

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

Wiring Book – Opens the embedded Wiring Book PDF in the default PDF viewer.

User Manual – Open the embedded User Manual PDF in the default PDF viewer. The embedded file may not be the latest version. Please visit Galvanic's webpage www.galvanic.com for the latest User Manual.

Min / Max Toggle – This toggle on the top right side of the ribbon is used to either auto-hide the Tools ribbon or pin it open.

4.4.3.3 Status Pane

The left column of the window presents the status of the system and a variety of operating parameters (See Figure 4-18). These fields are updated once per second and cannot be edited by the operator.

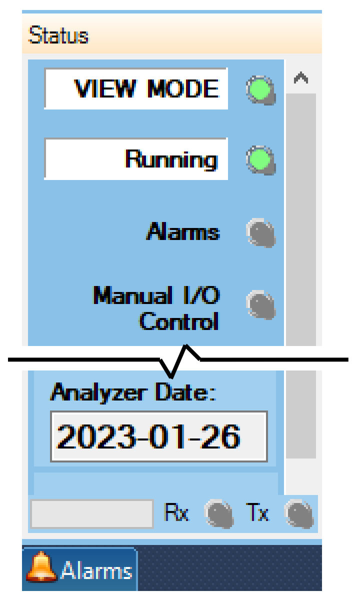


Figure 4-18: Reduced view of the system status pane. Shown is the: top line indicating the GUI connection status: OFFLINE, VIEW MODE or EDIT MODE; the second line indicates the status of the AccuChrome: RUNNING, HALT or HALT PENDING and; the data transfer indicators.

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

4.4.3.4 Alarm Pane

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.

Active alarms can be viewed through the AccuChrome PC application by clicking on the Alarms button at the bottom left edge of the window (See Figure 4-18**Error! Reference source not found.**). An Alarms pane will be opened along the bottom edge of the software window to display all active alarms (See Figure 4-19).

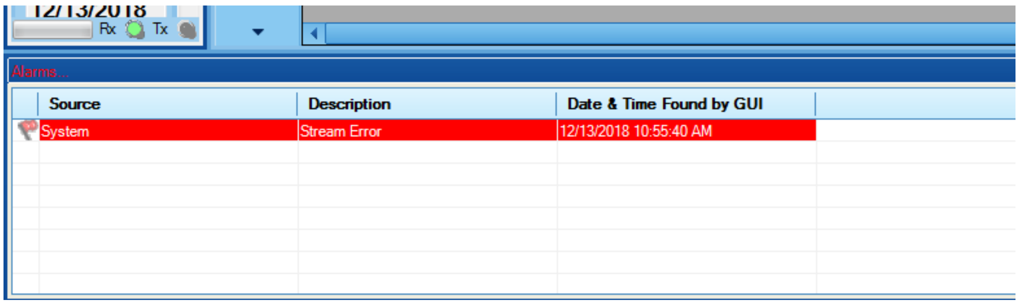


Figure 4-19: Example of Alarms pane at the bottom of the AccuChrome PC application

4.4.4 Pages Available in View Mode

Analytical data can be viewed and collected via the *View* mode. There are five tabbed pages in *View* Mode:

- *Chromatogram* – present chromatographic data and allow for data manipulation (Section 4.4.5).
- *Analysis Results* – presents a listing of analytical data from the AccuChrome (Section 4.4.6).
- *Archives* – presents a listing of stored analytical data (Section 4.4.7).
- *Events* – presents a list of the various activities that occurred during the separation (Section 4.4.8).
- *Reports* – provides access to various reports of information on the AccuChrome (Section 4.4.9).

4.4.5 The Chromatogram Tab

The *Chromatogram* tab (Figure 4-20) provides a live feed of the chromatographic data collected by the AccuChrome. The chromatogram presentation can be changed in the ribbon (Section 4.4.5.1) 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.

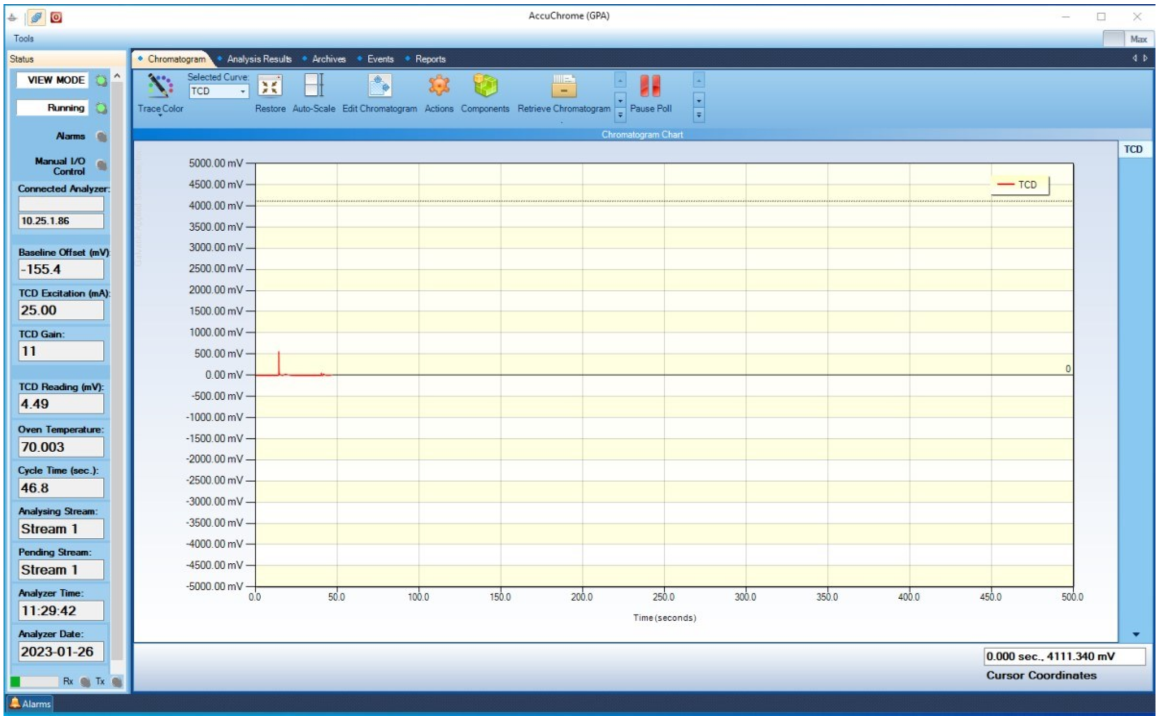


Figure 4-20: AccuChrome PC application Chromatogram tab

4.4.5.1 Chromatogram Ribbon

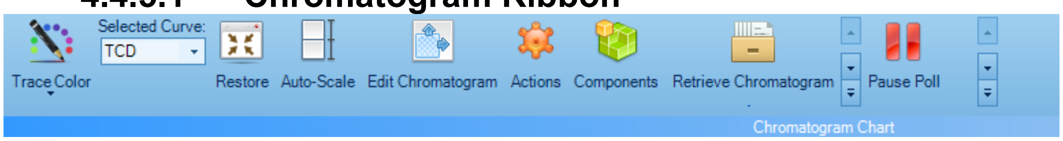


Figure 4-21: AccuChrome PC application chromatogram Ribbon

The *Ribbon Bar* on the chromatogram tab, as shown in Figure 4-21, provides access to a number of commands to present the chromatogram as desired.

- ***Trace Colour*** – presents a palette of colours (Figure 4-22). To select the desired colour for the TCD trace, move the cursor to it and press the mouse button. This function is a standard Windows feature.

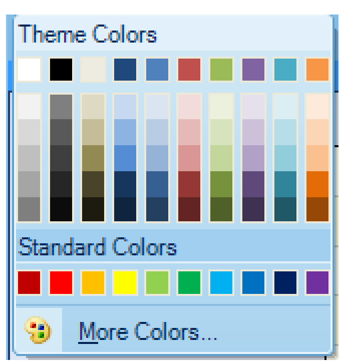


Figure 4-22: Chromatogram trace colour selection palette

- ***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 4-23).

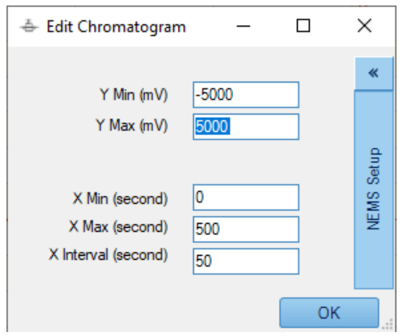


Figure 4-23: Edit Chromatogram Dialog Box

- ***Actions*** – Clicking on this tool in the Chromatogram ribbon with first prompt the User to select which Action List will be loaded. The selected Action List is displayed on the chromatogram (Figure 4-24) and can be edited in Edit mode.

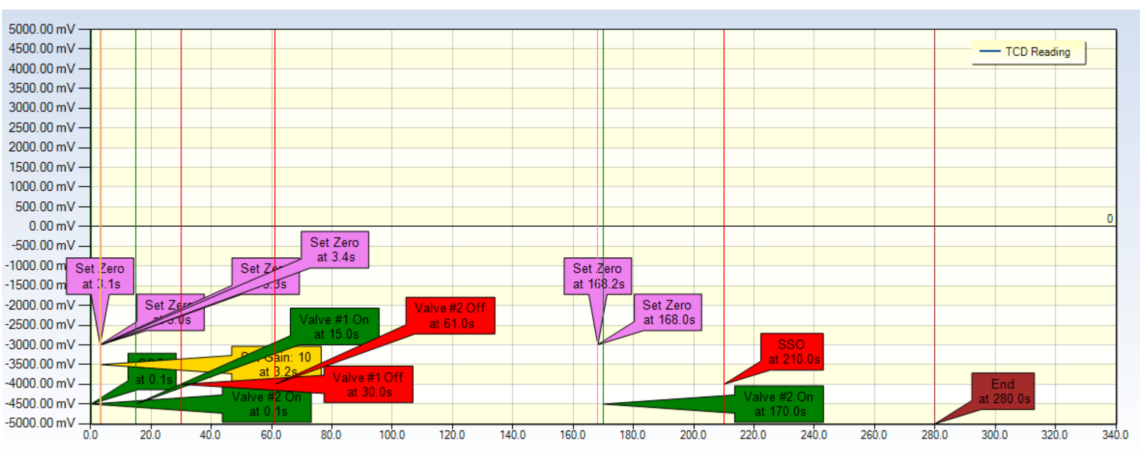


Figure 4-24: Chromatogram with Action List graphically overlayed

- ***Components*** – Clicking on this tool in the Chromatogram ribbon with first prompt the User to select which Component List will be loaded. Component integration window parameters are then displayed below the chromatogram as shown in Figure 4-25.

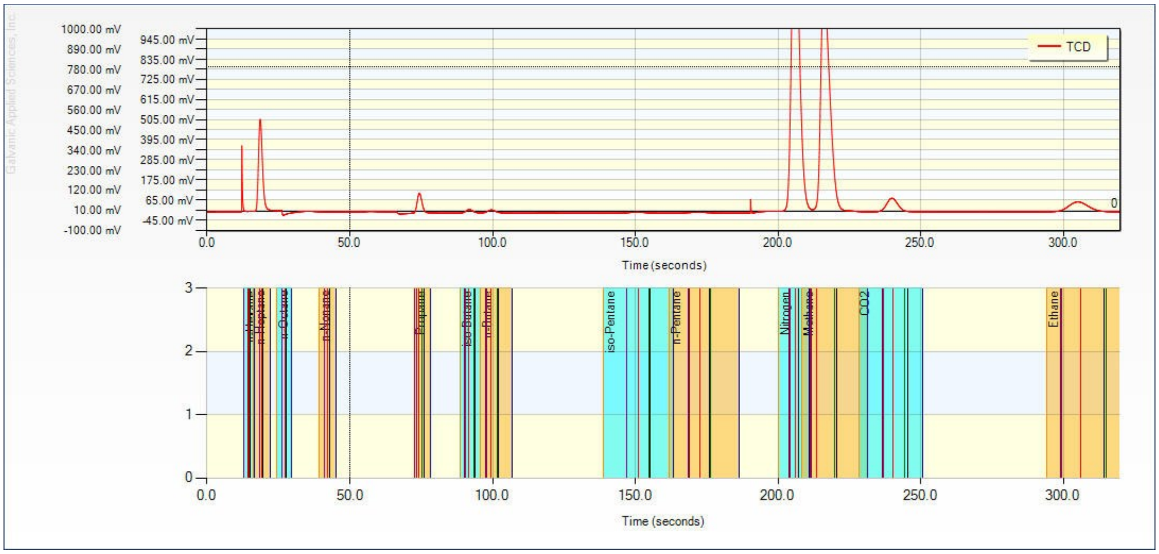


Figure 4-25: Components integration windows along with chromatogram

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 (See Figure 4-26).

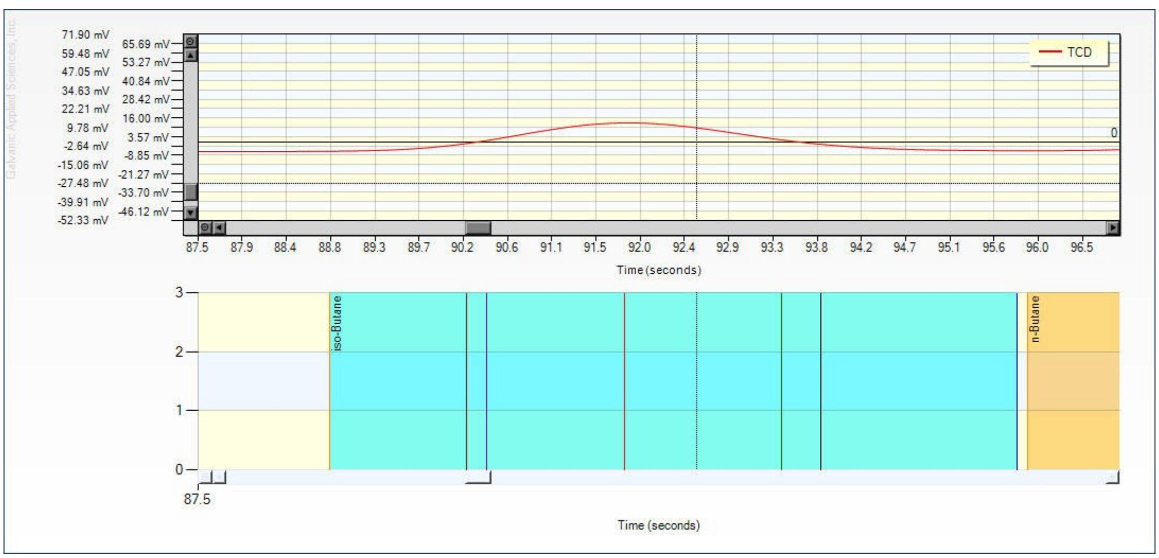


Figure 4-26: Individual component zoomed in

- ***Additional Functions*** -The icon and arrows directly to the right of the *Action* icon are used to access a variety of functions as seen in Figure 4-27. 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.

a) *Retrieve Chromatogram* – presents a standard file browser window. Browse to the desired save location and verify an appropriate file name to download chromatogram files from the AccuChrome (*.bin).

b) *Upload Chromatogram* - presents a standard file browser window. Browse to the correct file location to upload chromatogram files to the AccuChrome (*.bin).

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

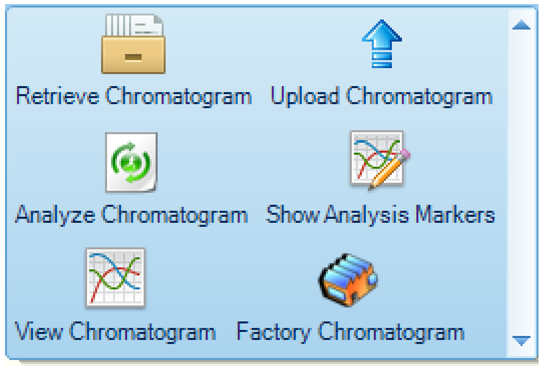


Figure 4-27: Additional functions of Chromatogram Ribbon

NOTICE **Retrieving and uploading 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

4.4.5.2 Right Clicking on the Plot

The *Chart* contextual menu is accessed by right-clicking anywhere on the Chromatogram grid.

• *Chart* contextual menu (Figure 4-28).

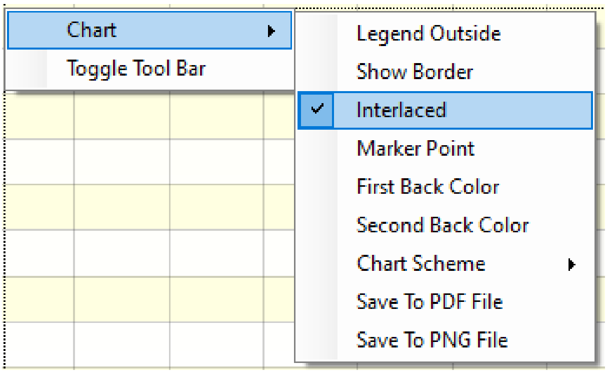


Figure 4-28: Chromatogram context menu Chart Commands

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 coloured not only half the boxes.

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

e) *First Back Colour* – presents a colour palette (Figure 4-22) to change the colour of the background (Figure 4-29).

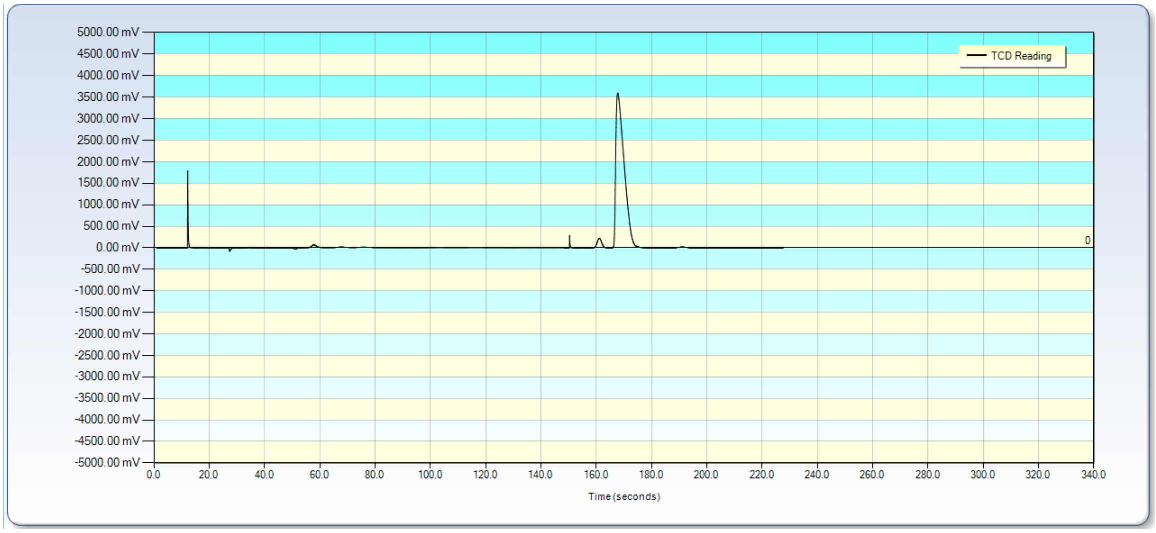


Figure 4-29: Colour after First Back Colour (also shows border)

f) *Second Back Colour* – presents a colour palette to change the colour of the background so that the positive and negative regions have different colouring.

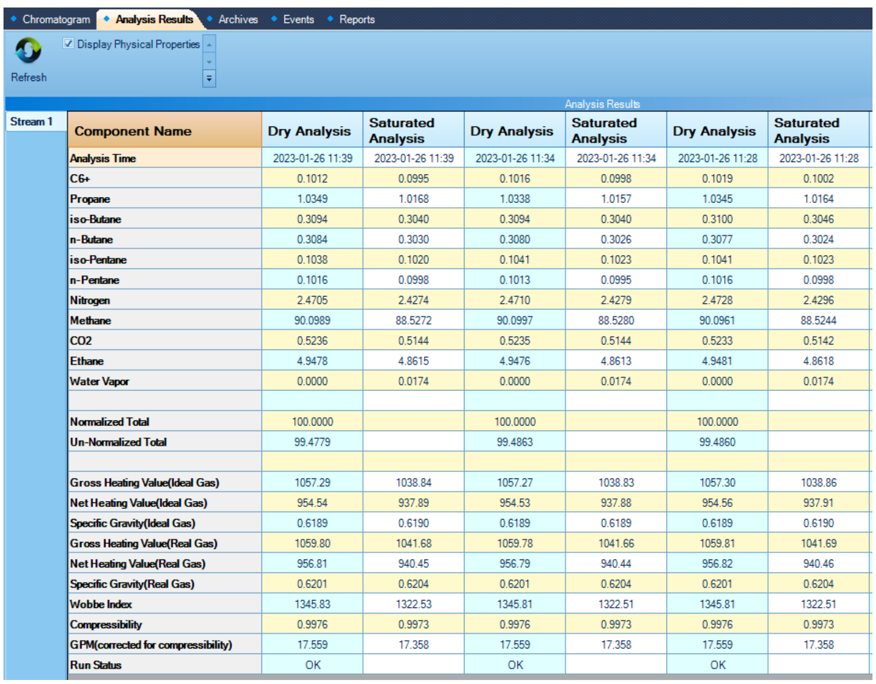
g) *Chart Scheme* – provides a secondary menu to select the colour around the chromatogram. There are three options, light blue, light gray or light brown.

h) *Save to File (PDF / PNG)* – Save the chromatogram plot to either a PDF or PNG image file.

4.4.6 Analysis Results Tab

The *Analysis Results* tab (Figure 4-30) presents a detailed listing of the most recent 10 runs. Stream, reference (Ref), and calibration (Cal) runs are separated and provided on their own sheet.

- The left column presents a list of streams for which data is available.
- The Refresh icon in the ribbon is used to update the data.
- The scroll bar along the bottom of the window is used to view recent data.
- Selecting the *Display Physical Properties* check box will display additional run data such as Gross Heating Value, Wobbe Index and Compressibility below the stream composition.



Component Name	Dry Analysis	Saturated Analysis	Dry Analysis	Saturated Analysis	Dry Analysis	Saturated Analysis
Analysis Time	2023-01-26 11:39	2023-01-26 11:39	2023-01-26 11:34	2023-01-26 11:34	2023-01-26 11:28	2023-01-26 11:28
C6+	0.1012	0.0995	0.1016	0.0998	0.1019	0.1002
Propane	1.0349	1.0168	1.0338	1.0157	1.0345	1.0164
iso-Butane	0.3094	0.3040	0.3094	0.3040	0.3100	0.3046
n-Butane	0.3084	0.3030	0.3080	0.3026	0.3077	0.3024
iso-Pentane	0.1038	0.1020	0.1041	0.1023	0.1041	0.1023
n-Pentane	0.1016	0.0998	0.1013	0.0995	0.1016	0.0998
Nitrogen	2.4705	2.4274	2.4710	2.4279	2.4728	2.4296
Methane	90.0989	88.5272	90.0997	88.5280	90.0961	88.5244
CO2	0.5236	0.5144	0.5235	0.5144	0.5233	0.5142
Ethane	4.9478	4.8615	4.9476	4.8613	4.9481	4.8618
Water Vapor	0.0000	0.0174	0.0000	0.0174	0.0000	0.0174
Normalized Total	100.0000		100.0000		100.0000	
Un-Normalized Total	99.4779		99.4863		99.4860	
Gross Heating Value(Ideal Gas)	1057.29	1038.84	1057.27	1038.83	1057.30	1038.86
Net Heating Value(Ideal Gas)	954.54	937.89	954.53	937.88	954.56	937.91
Specific Gravity(Ideal Gas)	0.6189	0.6190	0.6189	0.6189	0.6189	0.6190
Gross Heating Value(Real Gas)	1059.80	1041.68	1059.78	1041.66	1059.81	1041.69
Net Heating Value(Real Gas)	956.81	940.45	956.79	940.44	956.82	940.46
Specific Gravity(Real Gas)	0.6201	0.6204	0.6201	0.6204	0.6201	0.6204
Wobbe Index	1345.83	1322.53	1345.81	1322.51	1345.81	1322.51
Compressibility	0.9976	0.9973	0.9976	0.9973	0.9976	0.9973
GPM(corrected for compressibility)	17.559	17.358	17.559	17.358	17.559	17.358
Run Status	OK		OK		OK	

Figure 4-30: AccuChrome PC application Analysis Results Tab

4.4.7 Archives Tab

The *Archives* tab (Figure 4-31) presents a summary of recently performed analysis. It includes the time stamp, type of calculation (saturated or dry), any error messages associated with each run, calculated values, the concentration of each gas (mol%), the normalized total (mol%) and un-normalized total (mol%).

The data can be sorted within each column clicking on the column header. To unsort the data, click on the *Reload Downloaded Archives* button.

NOTICE **For more advanced table operations, such as re-ordering the columns, data must be exported to MS Excel file (.xls)**

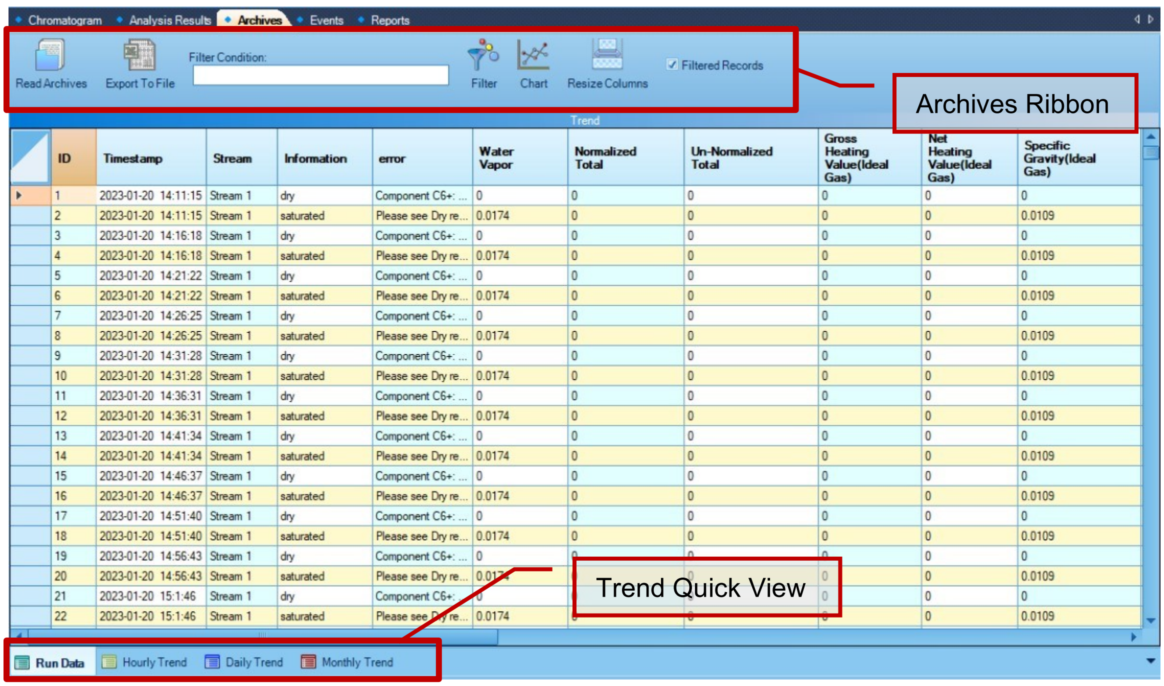


Figure 4-31: AccuChrome PC application Archive Tab

Functions in the Archives Ribbon:

- **Read Archives** – Must click on *Read Archives* to populated the Archives page or refresh with latest data.
- **Export to File** – Will export archive data to .xls-file. User will be prompted for save location.
- **Filter Condition** and **Filter** – Feature in development
- **Chart** – A chart will be generated using the archival data. See Figure 4-32.
- **Resize Columns** – All columns will be resized to fit contents.
- **Filtered Records** – Feature in development.

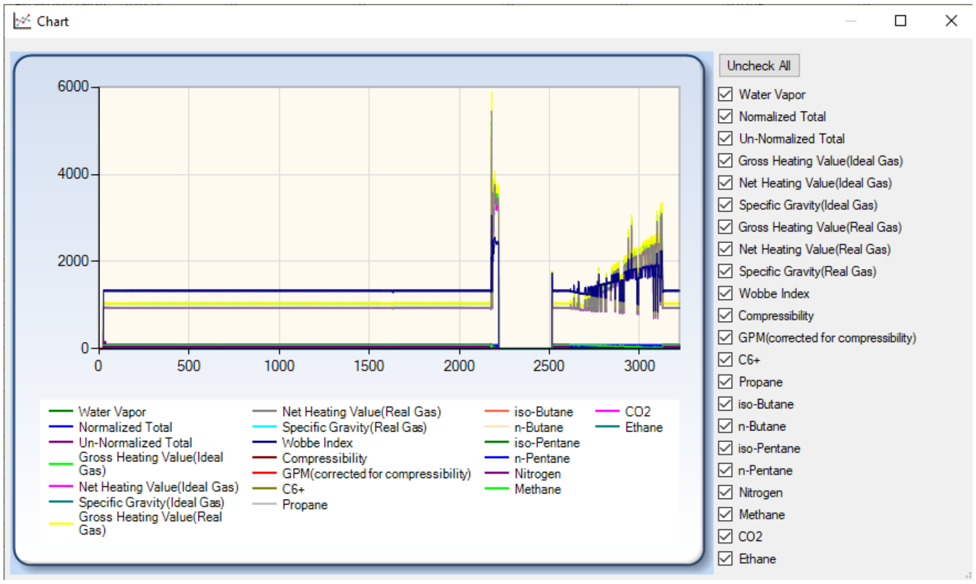


Figure 4-32: Chart generated from Archives data

Trend Quick View Functions:

After selecting the desired trend type, the User must *Read Archives* to reload the data.

- **Hourly Trend** – Generates a table with archive data averaged over 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.
- **Daily Trend** – Generates a table with archive data averaged over each day (e.g. July 22, 8:00 AM, July 21, 8:00 AM, July 20, 8:00 AM etc). Shows parameters such as the hourly minimum, hourly maximum and hourly mean.
- **Monthly Trend** – Generates a table with archive data averaged over each month. Shows parameters such as the daily minimum, daily maximum and daily mean.

NOTICE **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 *Edit* mode.**

4.4.8 Events Tab

The Events tab (Figure 4-33) presents a list of all of the events that have occurred during operation of the AccuChrome GC.

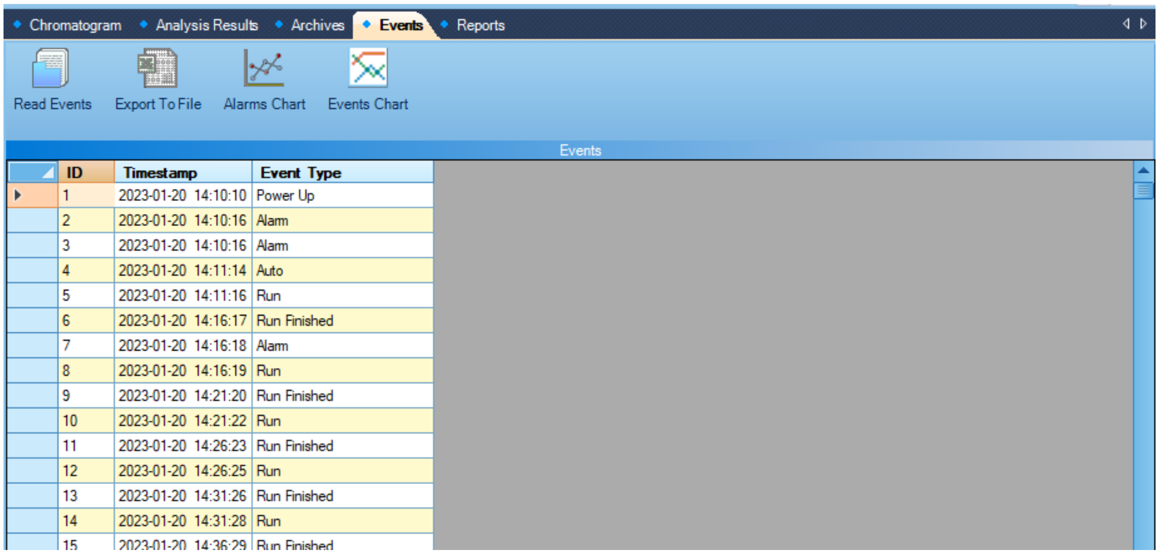


Figure 4-33: AccuChrome PC application Events Tab

Functions in the Events Ribbon:

- **Read Events** – Must click on *Read Events* to populated the Events page or refresh with latest data.
- **Export to File** – Will export archive data to .xls-file. User will be prompted for save location.
- **Alarms Chart** – A time-based bar chart will be generated to show the type of alarm, when it occurred and how long it remained in alarm state. To setup alarms, see Section 5.6.
- **Events Chart** – A time-based bar chart will be generated to show the type of event, when it occurred and how long it remained active (see Figure 4-34).

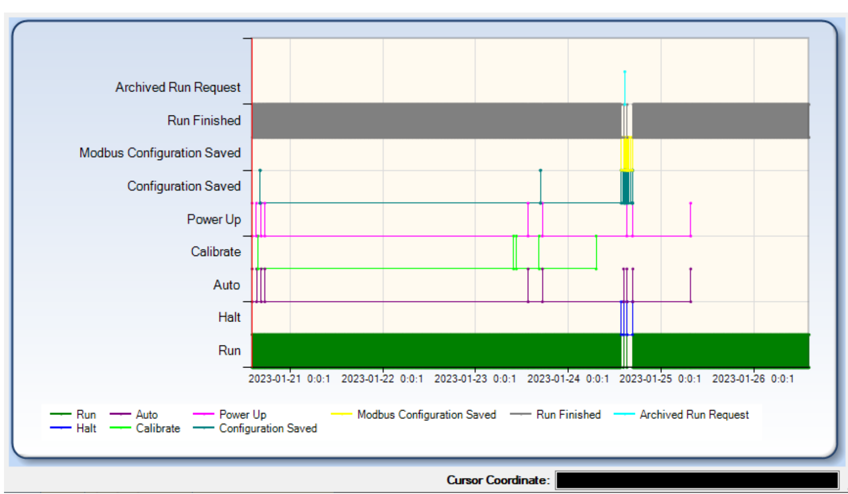


Figure 4-34: Events chart generated from Events Tab on AccuChrome PC application. Vertical lines within each row indicate the event type becoming active.

4.4.9 Reports Tab

The *Reports* tab (Figure 4-35) is used to generate various reports of analysis and calibration data.

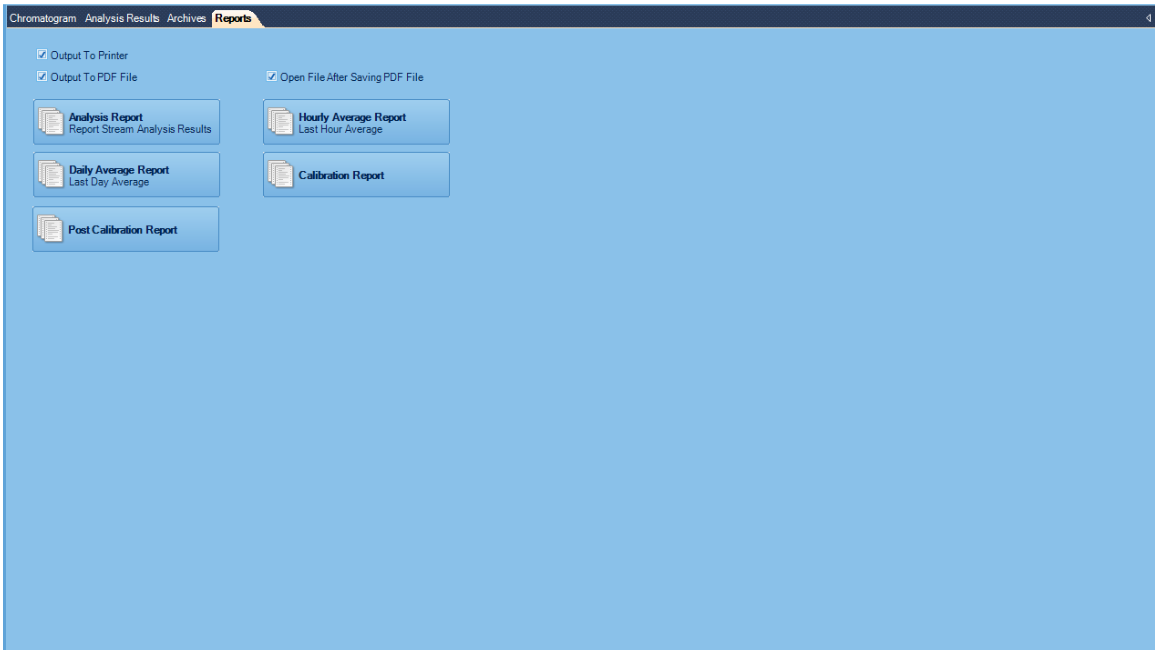


Figure 4-35: AccuChrome PC application Reports Tab

Select the desired report format (Print, PDF, Open File) and press the button that describes the report that you want. A sample report is shown in Figure 4-36.

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

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Figure 4-36: Sample Analysis Report from AccuChrome PC application

Section 5 **Configuration**

5.1 Pages Available in Edit Mode

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. 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 AccuChrome is not changed.

There are three additional tabbed pages in *Edit* Mode:

- *Configure G.C.* – Load, edit and Save configuration files for the AccuChrome (Section 5.2)
- *Modbus* – Setup the modbus protocol and data points for external communications (0)
- *Configure I/O Board* – Used for Factory setup and high-level troubleshooting. Only accessible by Galvanic-certified technician.

5.1.1 Accessing Edit Mode

Edit mode is required for configuring the AccuChrome GC and to setup modbus. This includes stream switching and scheduling, component identification and calibration, and system alarms and events.

To access *Edit* mode, the User must first logout of *View* mode using either the Quick Access Toolbar (Section 4.4.3.1) or Tools ribbon (Section 4.4.3.2). Log back into the AccuChrome GC and when prompted with the User access selection dialog box (Figure 4-14), click on "*Edit"*. Enter the password as prompted (the default password is 2222) and click "*OK*". It is recommended to change the password once the AccuChrome GC is installed and commissioned as described in Section 4.4.3.1.

⚠WARNING

After changes are made to the configuration the User should use the 'Write to Analyzer' button found in the ribbon. This will ensure that the changes are saved during the current session. If changes are to be made permanently to the AccuChrome GC, the User must select 'Permanent Configuration Write' from the Tools Ribbon described in Section 4.4.3.2.

5.2 Configure G.C. Tab

The analyzer configuration is a collection of parameters that define the operation of the chromatograph. Configuration files may be saved and loaded onto the AccuChrome GC when in Edit mode. The AccuChrome configuration is setup through the *Configure G.C.* tab as shown in Figure 5-1.

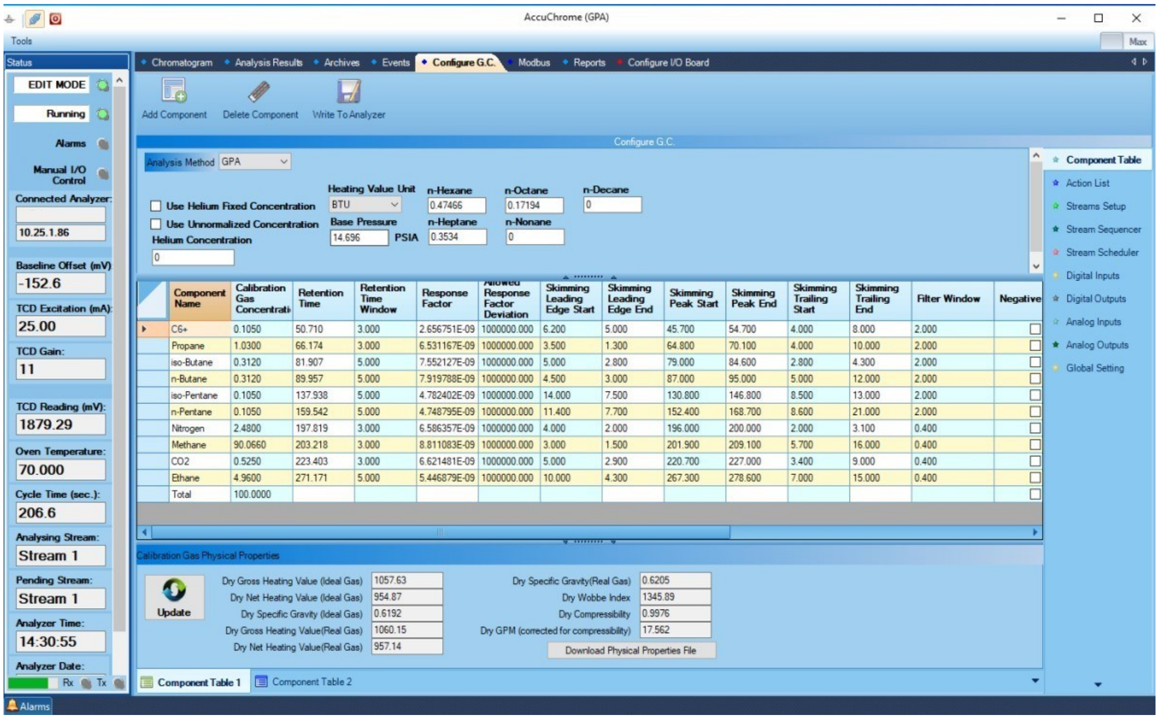

Figure 5-1: AccuChrome PC application Configure G.C. tab

NOTICE **When *Edit* mode is selected, User access is provided for the *Configure G.C.* tab, the *Modbus* tab (described in 0) and the *Configure I/O Board* tab (password protected for Galvanic-certified service technicians).**

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. 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 0) 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 **Error! Reference source not found.** and may require that some parameters on the *Component Table* be edited.

Configurations can be saved and retrieved as desired.

5.3 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 (See Section 5.1).

b) After a configuration is generated or edited through the PC Application, it must be saved and uploaded to the AccuChrome. The *Write to Analyzer* button is accessible from each page under the *Configure G.C.* tab and writes the configuration changes into temporary memory. Temporary saves will preserve changes when navigating to different pages, however, if analyzer power is lost, the changes made to the configuration will also be lost. To make the changes permanent a *Permanent Configuration Write* <u>must</u> be executed from the Tools Ribbon (Section 4.4.3.2).

c) A configuration can be stored onto a computer and uploaded back onto an AccuChrome as needed. Configuration files are saved as *.cfg files in the directory of your choice. Common configuration settings can be copied from one AccuChrome onto others by *Retrieving* the master configuration and *Uploading* it to other AccuChrome analyzers (see Section 4.4.5.1).

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.

5.4 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.

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 5.4.1.1 if the GPA or Liquid method is used, see Sections 5.4.1.2 and 5.4.1.3.
- A component list with chromatographic parameters (Section 5.4.2)
- A table that displays the calculated physical properties for the calibration gas. (Section 5.4.1)

5.4.1 Component Table Ribbon

The *Component Table Ribbon* (Figure 5-2) is used to add/remove a line from tables, send a configuration to the AccuChrome and enter values required for calculations. Some typical values for all components are found in the table in Section 13. The format of the ribbon is dependent on the *Method* that is employed.


Add Component – used to add a line to various tables as described below. For the Component Table, a new line is added directly below the selected row (indicated by ► in the first column).


Delete Component – is used to remove the selected row (indicated by ► in the first column).


Write to Analyzer – temporarily saves the present configuration to the analyzer.

Analysis Method - This field is used to select the standard of analysis method used for calculated properties of the sample stream. The User may select GPA, ISO, or Liquid. Some configuration parameters will change depending on which analysis method is selected. For description of parameters for ISO method, see Section 5.4.1.1. For description of parameters for GPA method, see Section 5.4.1.2. For description of parameters for Liquid method, see Section 5.4.1.3.

NOTICE **Do not use the Sulfur method unless configured by your Galvanic Service Representative.**

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.

Use Unnormalized Concentration - check box 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%)

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5.4.1.1 Analysis Method – ISO

The configuration parameters of the Component Table ribbon is presented in Figure 5-2 for the ISO analysis method.

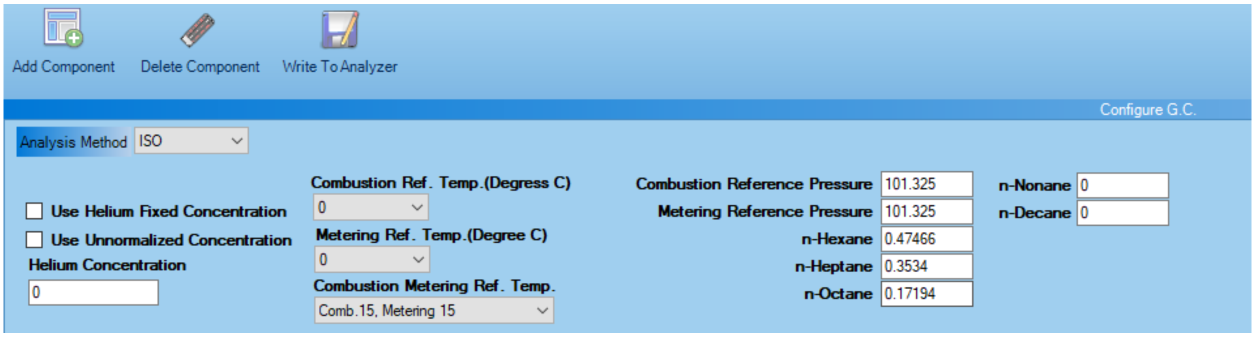


Figure 5-2: Component Table ribbon – ISO method

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.

5.4.1.2 Analysis Method – GPA

The configuration parameters of the Component Table ribbon is presented in Figure 5-3 for the GPA analysis method.

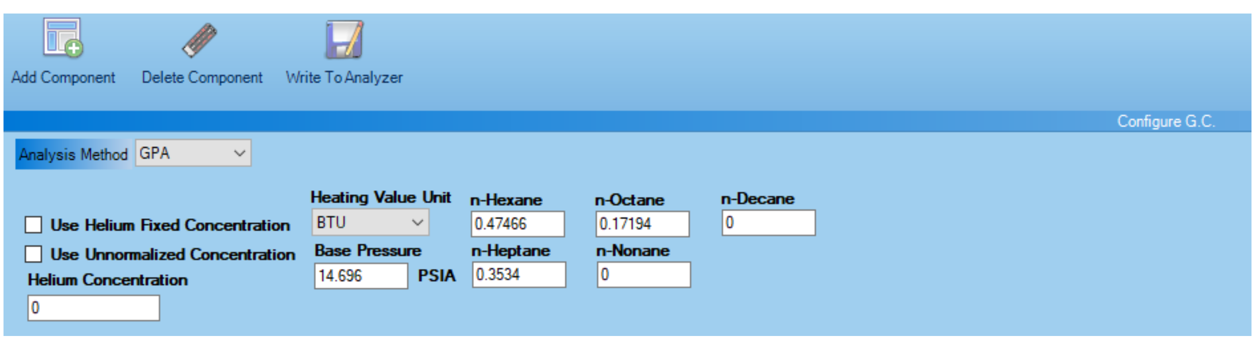


Figure 5-3: Component Table ribbon – GPA method

Heating Value Unit – Select the measurement units that you want the heating value displayed in. Options are British Thermal Units (BTU) or MJ/m³.

Base Pressure – Enter the desired pressure for the calculation in absolute PSI units.

NOTICE ***Base Pressure*** **is not the atmospheric pressure at the site.**

The sum of the following C6+ components must be 1.000:

n-Hexane – Enter the appropriate gas mol-fraction concentration.

n-Heptane – Enter the appropriate gas mol-fraction concentration.

n-Octane – Enter the appropriate gas mol-fraction concentration.

n-Nonane – Enter the appropriate gas mol-fraction concentration.

n-Decane – Enter the appropriate gas mol-fraction concentration.

5.4.1.3 Analysis Method – Liquid

The configuration parameters of the Component Table ribbon is presented in Figure 5-3 for the GPA analysis method. There are no additional configuration parameters unique to the Liquid method.

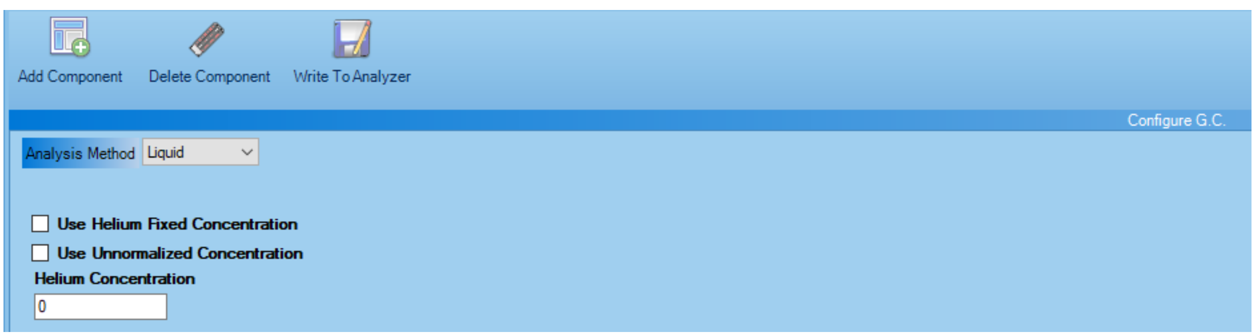


Figure 5-4: Component Table ribbon – Liquid method

The Liquid Analysis method is for Natural Gas Liquids (NGL) type samples. It will report the concentrations for each component in mol, volume and mass and will generate different set of physical properties related to NGL such as vapor pressure.

5.4.2 Component List with Chromatographic Parameters

5.4.2.1 General Parameters

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

When editing chromatographic parameters, it is recommended that several chromatograms from a gas of known composition are collected. From those chromatograms, determine the parameter for the compound(s) of interest using the average parameter from at least three runs. Integration windows are determined by the Skimming Parameters (Section 5.4.2.2).

NOTICE **Click 'Write to Analyzer' button in the ribbon after editing the Component Table and before navigating to a different page or your settings will be lost. Use 'Permanent Configuration Write' in the Tools Ribbon before logging off or navigating to a new Tab.**

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 5-5: Component Table

The *Component Table* contains the following:

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

NOTICE **Editing the names of the components already in the list may impact data archiving, reporting and modbus settings.**

- 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.

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

Where: **$Conc_n$** = concentration of component **n**

RF_n = response factor of component **n**

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 5.4.2.2) and Fitting (Section **Error! Reference source not found.**). The Fitting option is not active at this time.

5.4.2.2 Skimming Parameters

If *Skimming* is selected for the Integration method, use the following definitions and the graphical representation shown in Figure 5-6 to complete the integration setup for each component. An example of using *Skimming Parameters* is provided at the end of this section.

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.

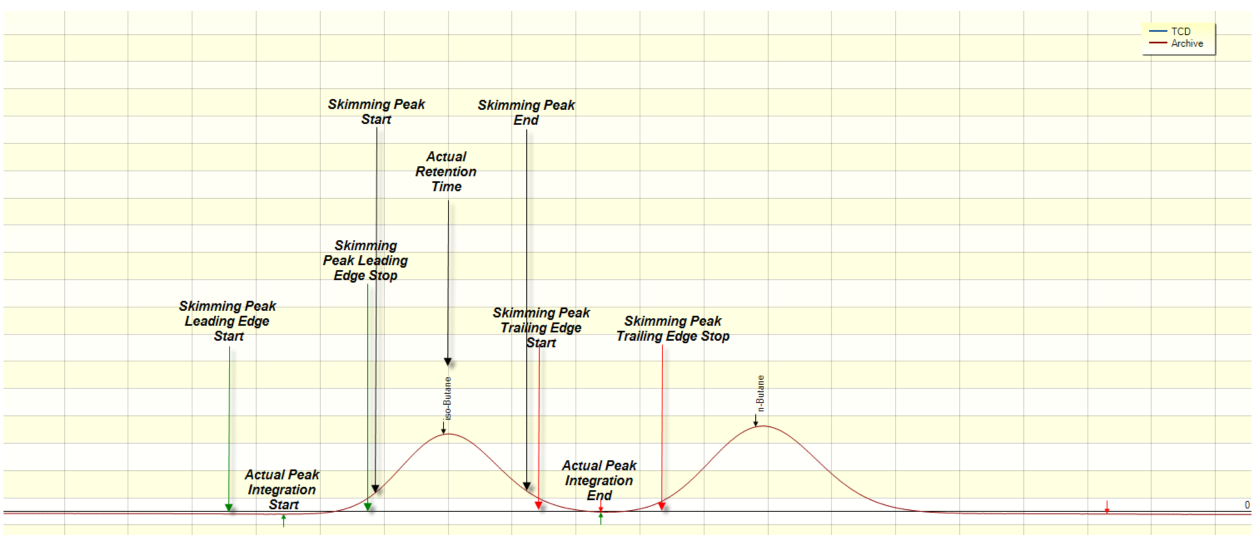


Figure 5-6: Definition of Skimming Parameters for determining the integration window.

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

⚠CAUTION **Do not adjust the *Filter Window* values.**

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.

Example – Determine if the Peak is Valid:
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.

5.4.2.3 Editing Components from the Chromatogram Tab

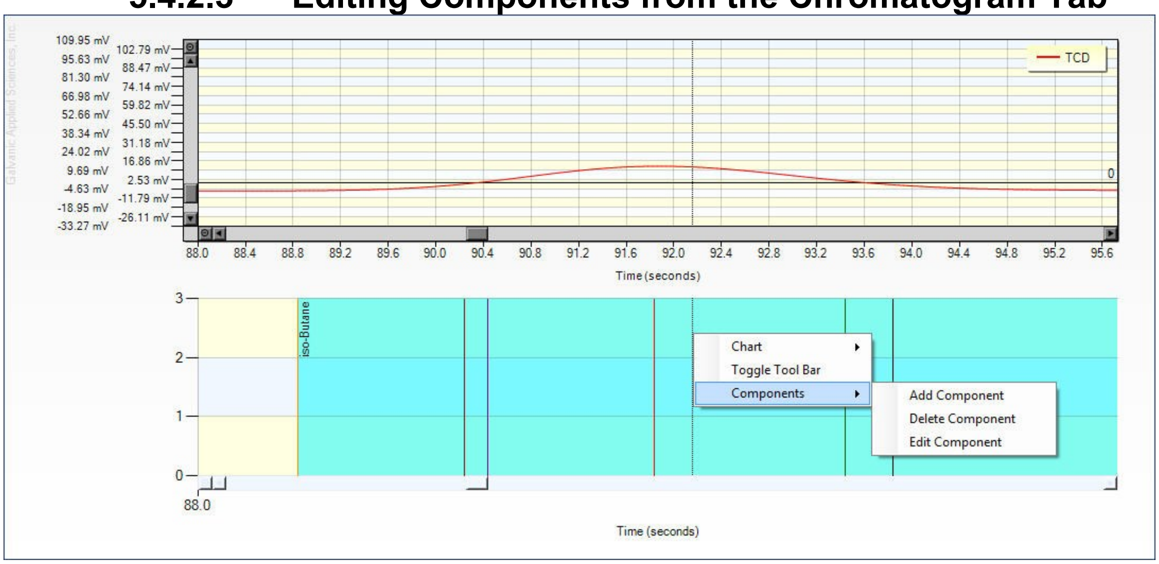


Figure 5-7: Component editing on AccuChrome PC application Chromatogram Tab

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 (See Figure 5-7).
A component properties window will be opened. Edit the desired parameter and submit the changes by clicking "OK" (see Figure 5-8).

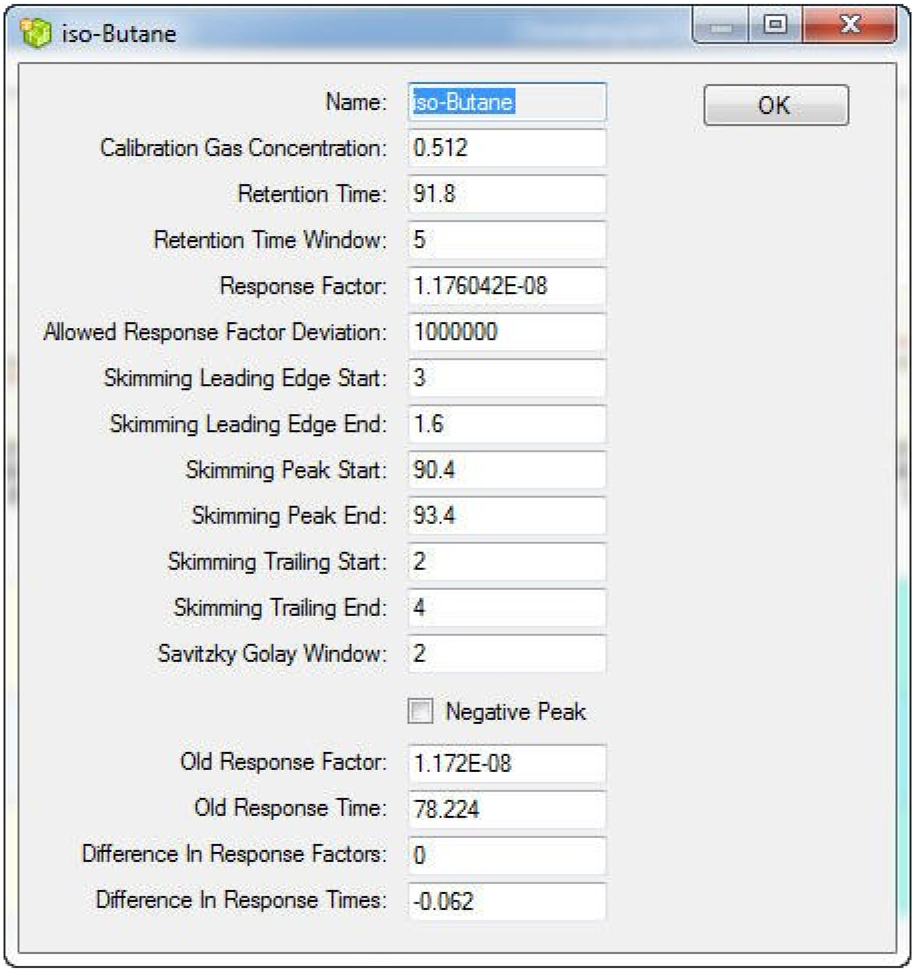


Figure 5-8: Component edit window accessed on the Chromatogram Ribbon

5.4.1 Physical Properties of the Calibration Gas

The *Physical Properties of the Calibration Gas* pane (Figure 5-9) 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. A .csv file of the physical properties may be downloaded by clicking on "Download Physical Properties File". Two files are downloaded, one for GPA method, the other for ISO method.

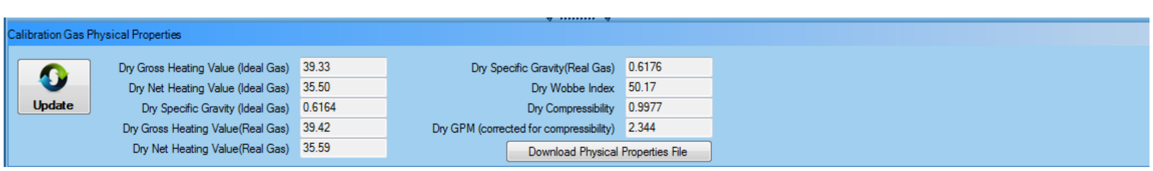
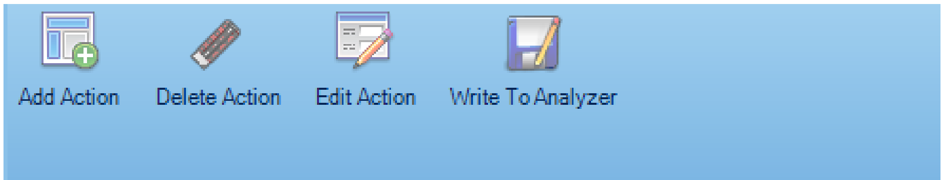


Figure 5-9: Physical Properties of the Calibration Gas

5.5 Action List

The *Action List* (Figure 5-10) 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.



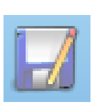
Action Type	Value	Time (sec.)
Set Gain	1	0
Valve On	SSO	0.1
Valve On	CV2	0.1
Set Zero	0	3
Set Zero	0	3.1
Set Gain	13	3.2
Set Zero	0	3.3
Set Zero	0	3.4
Valve On	CV1	12
Valve Off	CV1	27
Valve Off	CV2	50
Set Zero	0	148
Set Zero	0	148.2
Valve On	CV2	150
Valve Off	SSO	200
End Of Analysis	0	285

Figure 5-10: Sample of Action List page with tools on Configure G.C. tab

 *Add Action* – Adds a row to the Action List. New action is inserted at the time selected in the *Add Action* dialog box (Figure 5-11).

 *Delete Action* – is used to remove the selected row (indicated by ► in the first column).

 *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* – temporarily saves the present configuration to the analyzer.

NOTICE **Click 'Write to Analyzer' button in the ribbon after editing the Action List and before navigating to a different page or your settings will be lost. Use 'Permanent Configuration Write' in the Tools Ribbon before logging off or navigating to a new Tab.**

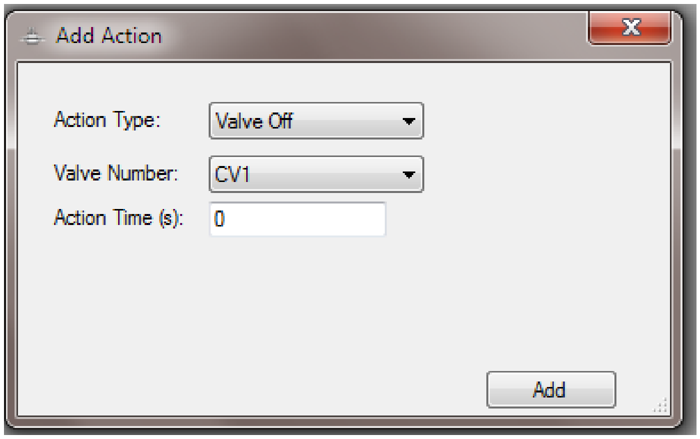


Figure 5-11: Add Action dialog box accessible from Action List toolbar.

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 5-12 is presented.

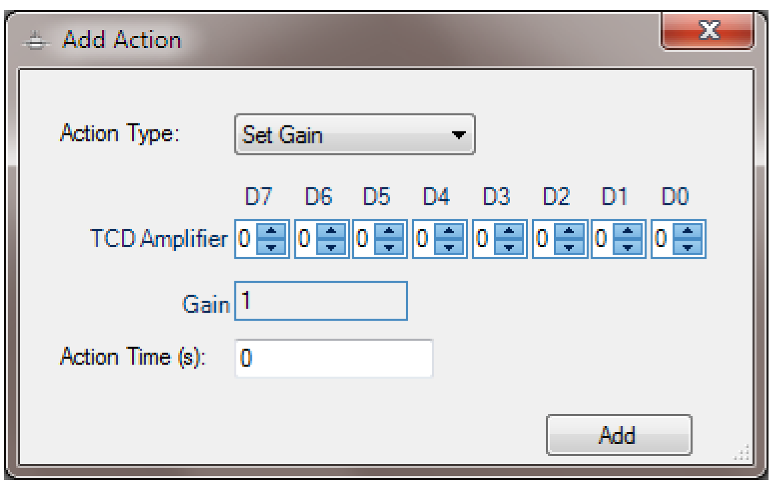


Figure 5-12: Set Gain action dialog box accessible from Action List toolbar

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

NOTICE **Actions may be edited from the Chromatogram Tab only if the User is in Edit mode.**

Actions can be edited from the Chromatogram Tab (see Section 0) after an Action List has been graphically loaded by dragging the Action callouts or by right clicking in the Action callouts as shown in Figure 5-13.

Figure 5-13: Context menu to edit the Action List from the action description box on the Chromatogram Tab.

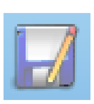
Clicking on the Action button in the Chromatogram Ribbon (Section 4.4.5.1) will prompt the User to write the change to the analyzer. This is a way of editing the Action List from the Chromatogram Tab.

5.6 Streams Setup

The *Streams Setup* screen (Figure 5-14) is used to set a variety of parameters that define the individual streams that are connected to the system.

 *Add Run* – Adds a new stream page. Find in stream selection at bottom of window as shown in Figure 5-14.

 *Delete Run* – Deletes the selected stream from the stream selection.

 *Write to Analyzer* - temporarily saves the present configuration to the analyzer.

NOTICE **Click 'Write to Analyzer' button in the ribbon after editing the Streams Setup and before navigating to a different page or your settings will be lost. Use 'Permanent Configuration Write' in the Tools Ribbon before logging off or navigating to a new Tab.**

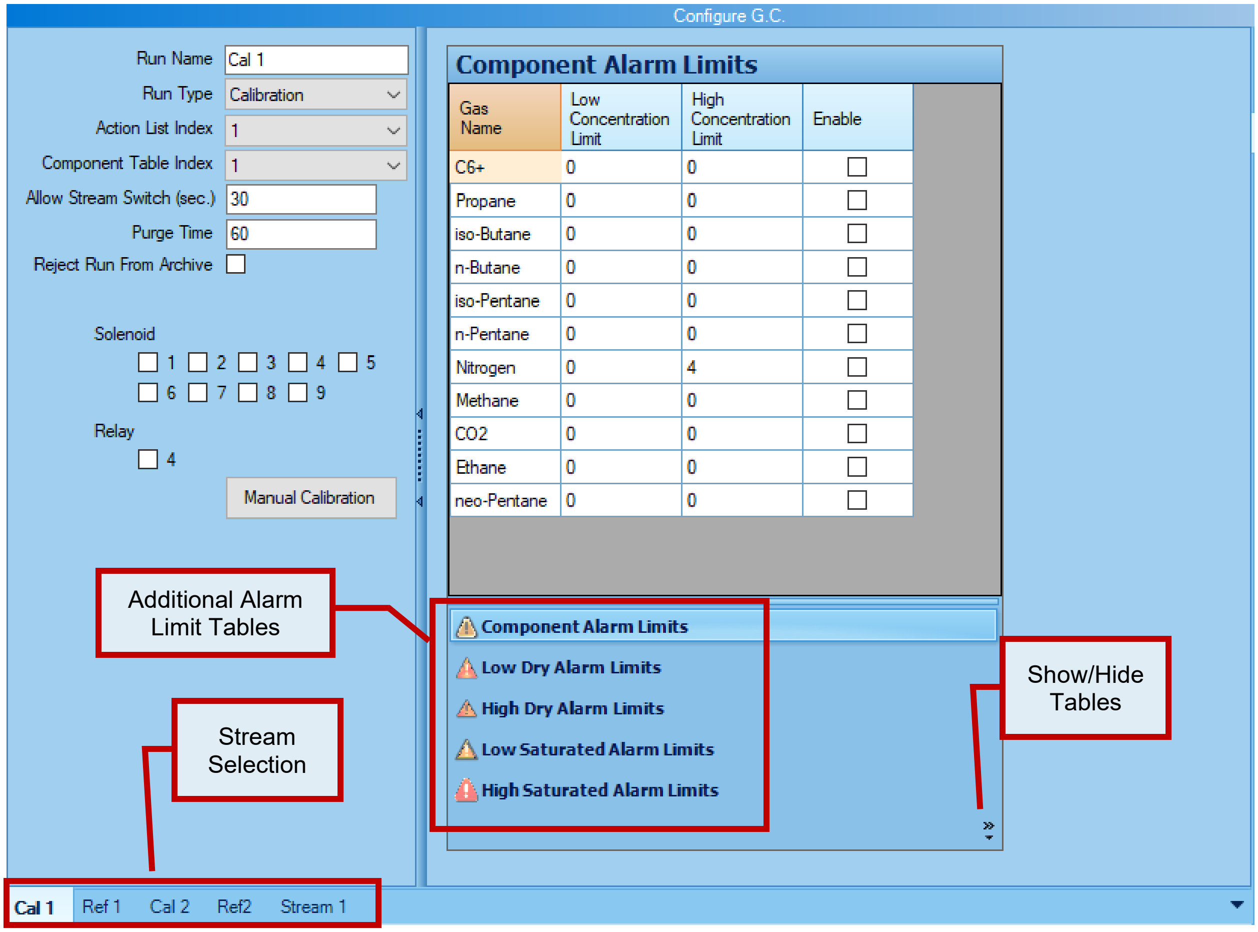


Figure 5-14: Sample of Streams Setup page on Configure G.C. tab

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.

Component Alarms Limits - Table used to indicate the high and low value which activate a system alarm. Enter the desired values and check the *Enable* box if the limits should be used

Additional tables are available for *Low Dry Alarm Limits*, *High Dry Alarm Limits*, *Low Saturated Alarm Limits*, and *High Saturated Alarm* Limits. Dry alarms are triggered by the values of the Dry analysis and saturated alarms are triggered by the values of the Saturated analysis (See Section 4.4.6) A typical table is presented as Figure 5-15 (the format and function of all of these tables is similar).

Low Dry Alarm Limits

Name	Limit	Enable
Gross Heating Value (Ideal Gas)	1100	☐
Net Heating Value (Ideal Gas)	0	☐
Specific Gravity (Idea Gas)	0	☐
Compressibility	0	☐
Specific Gravity(Real Gas)	0	☐
Gross Heating Value(Real Gas)	0	☐
Net Heating Value(Real Gas)	0	☐
GPM (corrected for compressi...	0	☐
Wobbe Index	0	☐

Figure 5-15: Low Dry Alarm Limits table on Streams Setup page.

5.7 Stream Sequencer

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


Add Sequencer – Adds a new sequencer page. Find in sequencer selection at bottom of window as shown in Figure 5-16.


Delete Sequencer – Deletes the selected sequencer from the sequencer selection.


Write to Analyzer - temporarily saves the present configuration to the analyzer.

NOTICE

Click 'Write to Analyzer' button in the ribbon after editing the Stream Sequencer and before navigating to a different page or your settings will be lost. Use 'Permanent Configuration Write' in the Tools Ribbon before logging off or navigating to a new Tab.

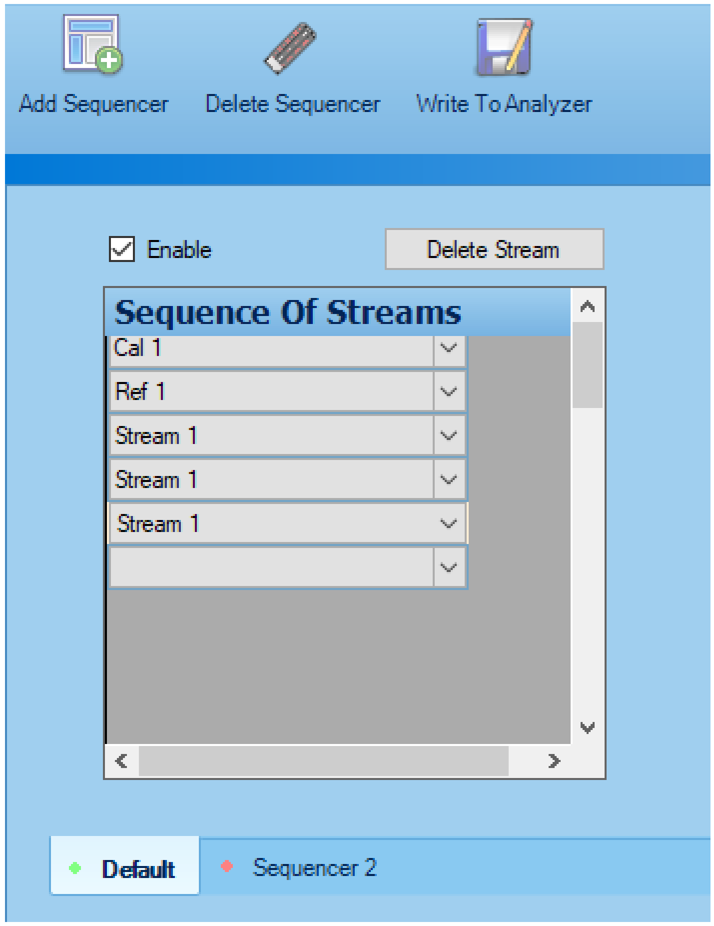


Figure 5-16: Sample of Streams Sequencer page on Configure G.C. tab

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.

Enable – check this checkbox for the Sequencers that the User desires to deploy.

Delete Stream – removes selected stream from the sequencer.

5.8 Stream Scheduler

The *Stream Scheduler* (Figure 5-17) 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.

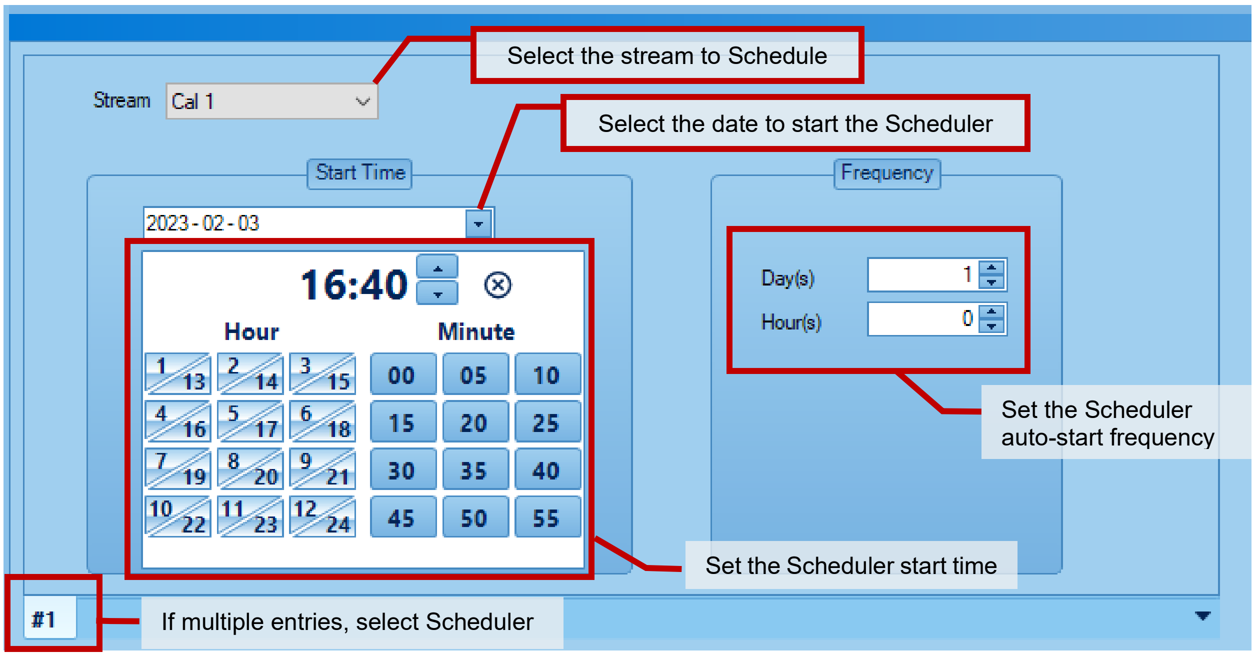


Figure 5-17: Example of Stream Scheduler entry

To set the start time for a stream:

a) Select the stream for which the Scheduler is to be set using the drop down menu.

b) Use the Start Time date drop down menu to select the month and day to start the Scheduler. (Click the ▼ adjacent to the date).

c) Click on the desired hour and minute in the time field. Click on the desired start time hour button (24h clock) and the start time minute (15 minute increments). You may make fine adjustments to the start time by using the up and down arrows beside the Time (▼ and ▲ buttons).

d) To reset the time, click on the encircled ✕-symbol beside the fine adjustment arrows.

If desired, repetitive runs for a given stream can be auto-scheduled by editing the *Days* and *Hours* fields of the *Frequency* region. The scheduler can be set to occur every X number of days and/or every Y number of hours.

NOTICE **Click 'Write to Analyzer' button in the ribbon after editing the Stream Scheduler and before navigating to a different page or your settings will be lost. Use 'Permanent Configuration Write' in the Tools Ribbon before logging off or navigating to a new Tab.**

5.9 Digital Inputs

The *Digital Inputs* screen (Figure 5-18) 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, temporarily save them to the AccuChrome using the *Write to Analyzer* button.

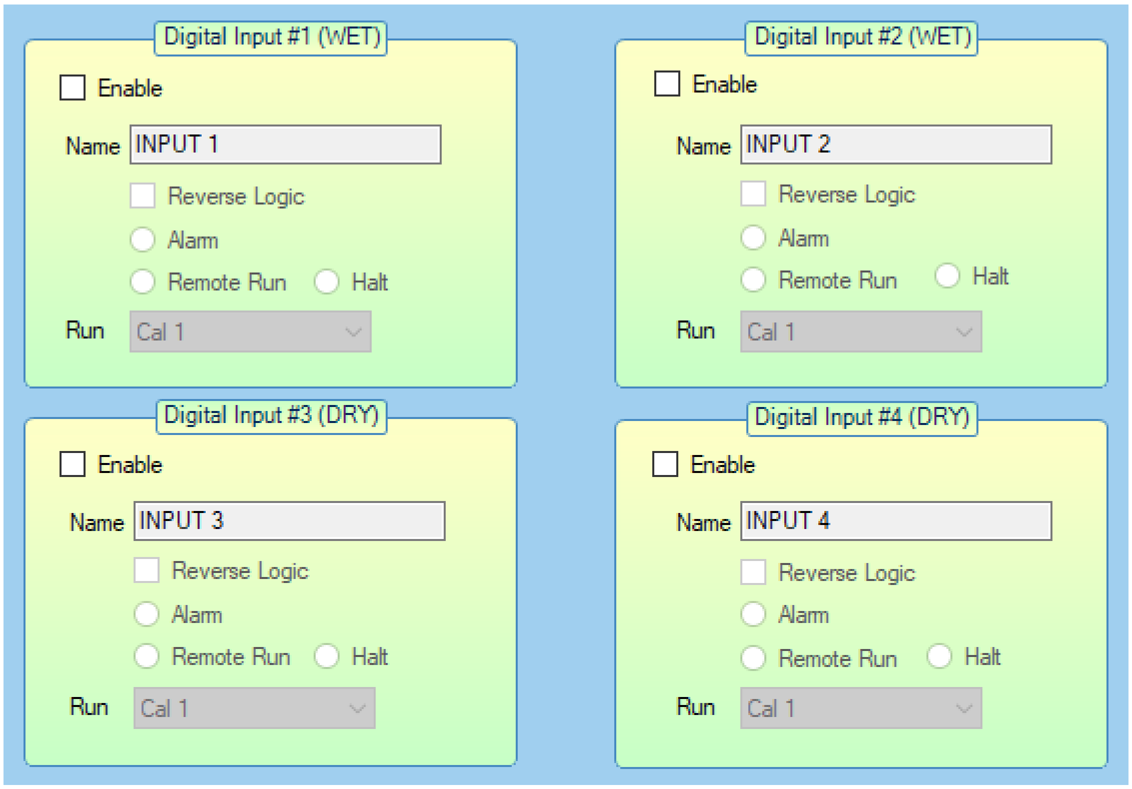


Figure 5-18: Configuring digital inputs

NOTICE

Click 'Write to Analyzer' button in the ribbon after editing the Digital Inputs and before navigating to a different page or your settings will be lost. Use 'Permanent Configuration Write' in the Tools Ribbon before logging off or navigating to a new Tab.

5.10 Digital Outputs

The *Digital Outputs* screen (Figure 5-19) is used to assign the various available alarms to specific digital outputs. Once the parameters are set, temporarily save them to the AccuChrome using the *Write to Analyzer* button.

Alarm or Event	Relay #1	Relay #2	Relay #3
Run/Halt	☑	☐	☐
Oven Temperature High - Analog Input 0	☑	☐	☐
Oven Temperature Low - Analog Input 0	☑	☐	☐
Analog Input 1 High	☑	☐	☐
Analog Input 1 Low	☑	☐	☐
Analog Input 2 High	☑	☐	☐
Analog Input 2 Low	☑	☐	☐
Analog Input 3 High	☑	☐	☐
Analog Input 3 Low	☑	☐	☐
Digital Input 1 Alarm	☑	☐	☐
Digital Input 2 Alarm	☑	☐	☐
Digital Input 3 Alarm	☑	☐	☐
Digital Input 4 Alarm	☑	☐	☐
Peripheral Board Comm Fail	☑	☐	☐
Calibration Fail	☑	☐	☐
Reference Fail	☑	☐	☐
Stream Error	☑	☐	☐
Reverse Logic	☐	☐	☐

Figure 5-19: Configuring digital outputs

NOTICE

Click 'Write to Analyzer' button in the ribbon after editing Digital Outputs and before navigating to a different page or your settings will be lost. Use 'Permanent Configuration Write' in the Tools Ribbon before logging off or navigating to a new Tab.

5.11 Analog Inputs

The *Analog Inputs* screen (Figure 5-20) is used to define the role of the four analog inputs. The alarm limits should be set and the appropriate check boxes selected to enable alarms. Once the parameters are set, temporarily save them to the AccuChrome using the *Write to Analyze*r button.

Figure 5-20: Configuring analog inputs

NOTICE

Click 'Write to Analyzer' button in the ribbon after editing Analog Inputs and before navigating to a different page or your settings will be lost. Use 'Permanent Configuration Write' in the Tools Ribbon before logging off or navigating to a new Tab.

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5.12 Analog Outputs

The *Analog Outputs* screen (Figure 5-21) 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 5-21: Configuring analog outputs

NOTICE

Click 'Write to Analyzer' button in the ribbon after Analog Outputs and before navigating to a different page or your settings will be lost. Use 'Permanent Configuration Write' in the Tools Ribbon before logging off or navigating to a new Tab.

5.13 Global Settings

The Global Setting tab (Figure 5-22) is used to display system identification to the User. Most of the information displayed on the Global Setting tab is set in the Factory and is not configurable by the User.

NOTICE **Provide the information on the Global Settings tab when requesting support.**

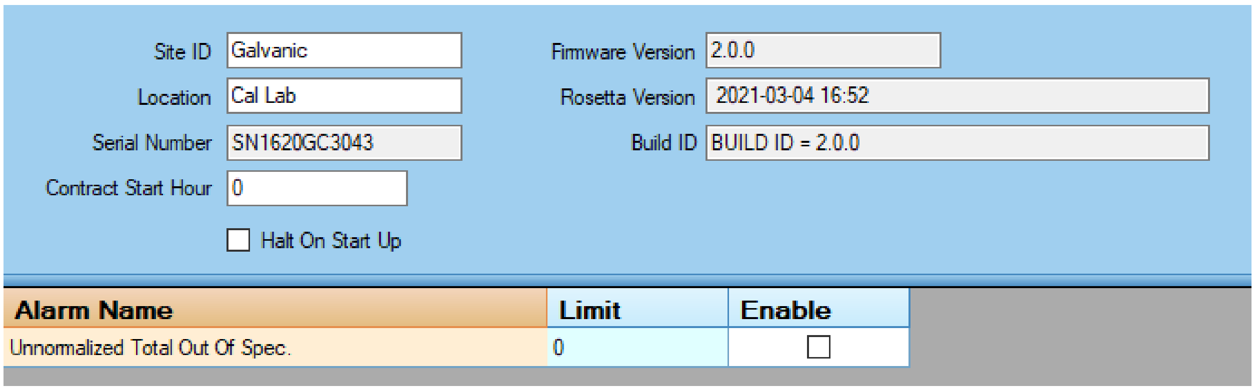

Figure 5-22: AccuChrome GC Global Settings

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%.

NOTICE **Click 'Write to Analyzer' button in the ribbon after editing any field on Global Settings and before navigating to a different page or your settings will be lost. Use 'Permanent Configuration Write' in the Tools Ribbon before logging off or navigating to a new Tab.**

Section 6 **Validation and Calibration**

6.1 Overview

The reference validation process involves analyzing a known gas mixture (calibration gas) and comparing the analyzer results to the certified analysis of the gas. The validation process is also used to assess the status of the AccuChrome and may be useful in indicating the presence of potential problems such as worn chromatograph valves or contaminated columns (see Section 6.5 for how to assess performance). As an example, if there 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.

The AccuChrome calibration must be validated on a monthly basis or on the required frequency of the User, whichever is more stringent. A reference validation must also be run before any re-calibration.

The calibration gas is a mixture of all the gases the AccuChrome is required to measure and proportionally similar to the composition of the sample stream. The composition of a typical calibration blend is shown in Table 6-1 for a C6+ measurement of natural gas. The calibration gas must be obtained with a Certificate of Analysis.

Table 6-1: Composition of a typical natural gas calibration gas

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 %

6.2 Role of the Calibration Stream and the Reference Stream

The calibration stream and the reference stream are both supplied from the calibration gas but are handled differently in the application software. In the *Stream Sequencer* screen, the User must indicate the nature of the gas to be analyzed.

- **Calibration Stream** - If the *Calibration Stream* is selected, the calibration gas is injected into the GC to recalculate new response factors for compounds in the *Component Table*. Only compounds in the certified composition of the calibration gas will be updated to generate a new calibration for the AccuChrome.

- **Reference Stream** - If the *Reference Stream* is selected, the calibration gas is injected into the GC to validate that the existing calibration is good and the AccuChrome GC is reporting acceptable results. The analysis results will be determined using the existing calibration response factors. The AccuChrome will not make any adjustment to the response factors.

- **Sample Stream -** If the *Sample Stream* is selected, the process sample gas will be injected into the GC. The composition of the gas will be determined using the latest calibration response factors.

6.3 Performing a Reference Validation

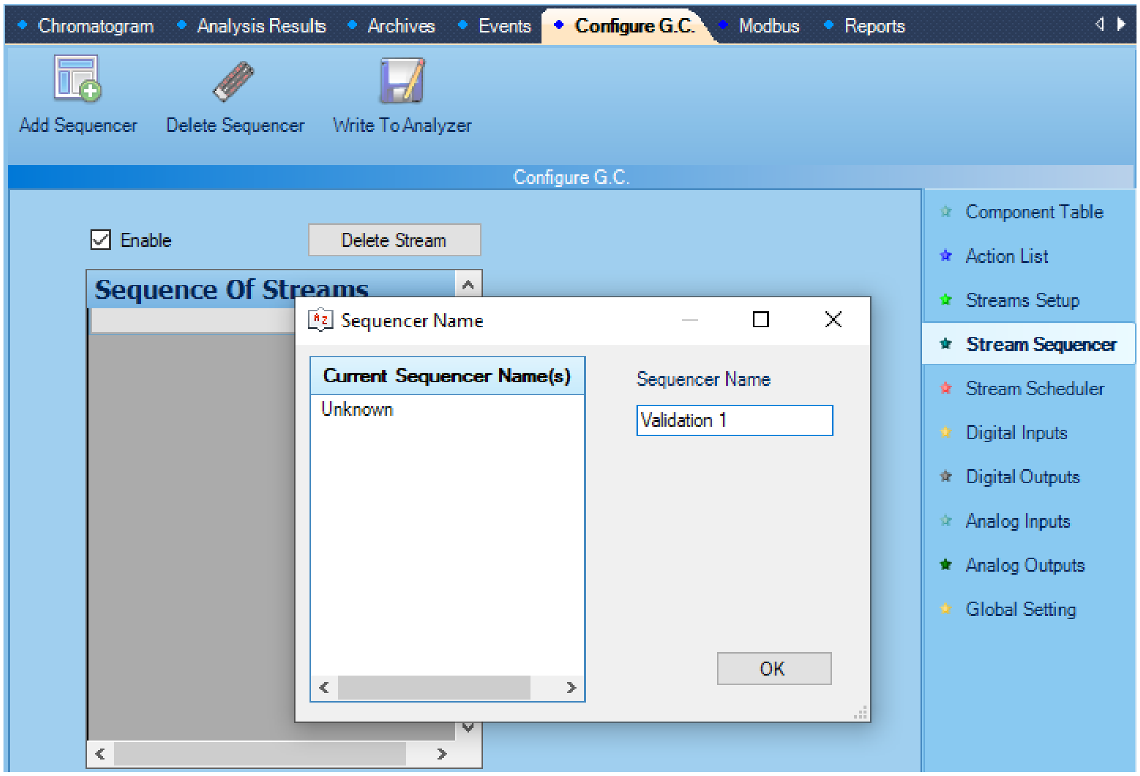

Figure 6-1: Creating a new validation sequence in the Stream Sequencer

NOTICE **You must be in Edit mode (Section 5.1.1) to manually run reference validations and calibrations or setup new automated sequencers.**

a) Generate a sequence specific for reference validation if one does not already exist. In the *Stream Sequencer* selection of the *Configure G.C.* tab, add a new Sequencer from the ribbon (see Section 0 for more detail).

b) A pop-up prompt will ask the User to give the new Sequencer an appropriately descriptive name as shown in Figure 6-1. Once complete, click OK.

c) Set the top entry in *the Sequence of Runs* field to Ref 1 (or Ref 2 as required) and then check the Enable checkbox.

d) Temporarily save the changes by clicking the *Write to Analyzer* icon at the top of the window. Once the new Sequencer has been uploaded, the AccuChrome will complete the run it is performing and then switch the appropriate solenoid to flow calibration gas to the analyzer.

e) Once the run is complete the results for the analysis can be viewed on the *Analysis Results* tab by selecting ‘Ref 1’ on the left side of the page.

NOTICE **The analyzer will continue to run the reference validation sequencer until the User changes the Stream Sequencer back to the process stream(s).**

The AccuChrome can be set up to run a reference validation daily. In this case the results of the analysis of the calibration gas are reported and the User should compare the results to the Certificate of Analysis to determine if the AccuChrome is operating correctly.

6.4 Performing a Calibration

NOTICE **If a reference stream is not analyzed before a calibration stream, it is possible that an invalid calibration will be generated. Running a reference validation allows the User to identify any problems and correct them.**

NOTICE **You must be in Edit mode (Section 5.1.1) to manually run reference validations and calibrations or setup new automated sequencers.**

a) To calibrate the analyzer it is recommend that a validation be performed first to identify and correct any potential problems with the analysis.

b) A calibration sequence can be initiated by clicking on the Manual Calibration button on the Streams Setup page. The calibration sequence consists of three analysis runs. The first one is discarded and not reported. The last two are average together to generate new response factors and retention times for each component. Once the calibration sequence is completed a reference run will be executed and can be used to validate the calibration.

A daily calibration can be set up to perform the calibration automatically using the Stream Scheduler (see Section 0). The AccuChrome will automatically adjust the response factors within limits set by the user in the *Allowable Response Factor Deviation* entry of the *Configure G.C*. table (see Section 5.4.2.1).

6.5 Determining if the AccuChrome is Functioning in an Acceptable Manner

There are several analysis results that can be checked to see if the system is functioning properly:

a) Compare the analysis results of the calibration gas Certificate of Analysis. 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 AccuChrome with respect to the theoretical heating value of the calibration gas. The calculated heating value should typically be within +/- 0.25 BTU.

6.6 Optimizing the Calibration

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 appropriate. Skimming parameters are used to indicate the integration window. For details on *Skimming Parameters* see Section 5.4.2.2

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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 after n-Pentane has eluted from Column 1, but before Hexane. To find the correct timing, run the chromatograph with successively decreasing *CV1 OFF* until the n-Pentane peak disappears. Then perform chromatograph runs with the *CV1 OFF* timing delayed in 1 second intervals. For each run, observe the area for the C6+ peak and the area for the n-Pentane peak. Delay the *CV1 OFF* timing 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 pass through the detector. Ideally, CV2 should be turned off right after Ethane has eluted into Column 3 to isolate Propane 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 Ethane peak. 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 peak. To find the correct timing, run the chromatograph with successively decreasing *CV2 OFF* times until the Ethane peak disappears. Then perform chromatograph runs with the *CV2 OFF* timing delayed in 1 second intervals. For each run, observe the area for Ethane peak and Propane peak. Delay the *CV2 OFF* timing until the Ethane peak area no longer increases and the Propane peak does not decrease.

Section 7 **Modbus**

7.1 Overview

NOTICE **You must be in Edit mode (Section 5.1.1) to access the Modbus tab.**

The *Modbus* tab allows the user to set up the AccuChrome to output data in 3 varieties of the Modbus communication protocol - Enron, Modicon 16, and Modicon 32. The Modbus configuration is fully customizable for any and every end-use requirement. As there are a large number of possible configurations for Modbus this manual will only cover the basics of Modbus configuration. Please contact your Galvanic Service Representative if additional assistance is required to set up a Modbus configuration.

When the *Modbus* selected, the main *Modbus* page (Figure 7-1) is opened. There are three pages to the tab, which are accessed on the right side of the screen

- Modbus Lists (Section 7.2) - presents the available points and items
- Communication Ports (Section 7.3) - lists the various ports and allows the user to configure the ports used for Modbus communication.
- Modbus Monitor (Section 7.4)

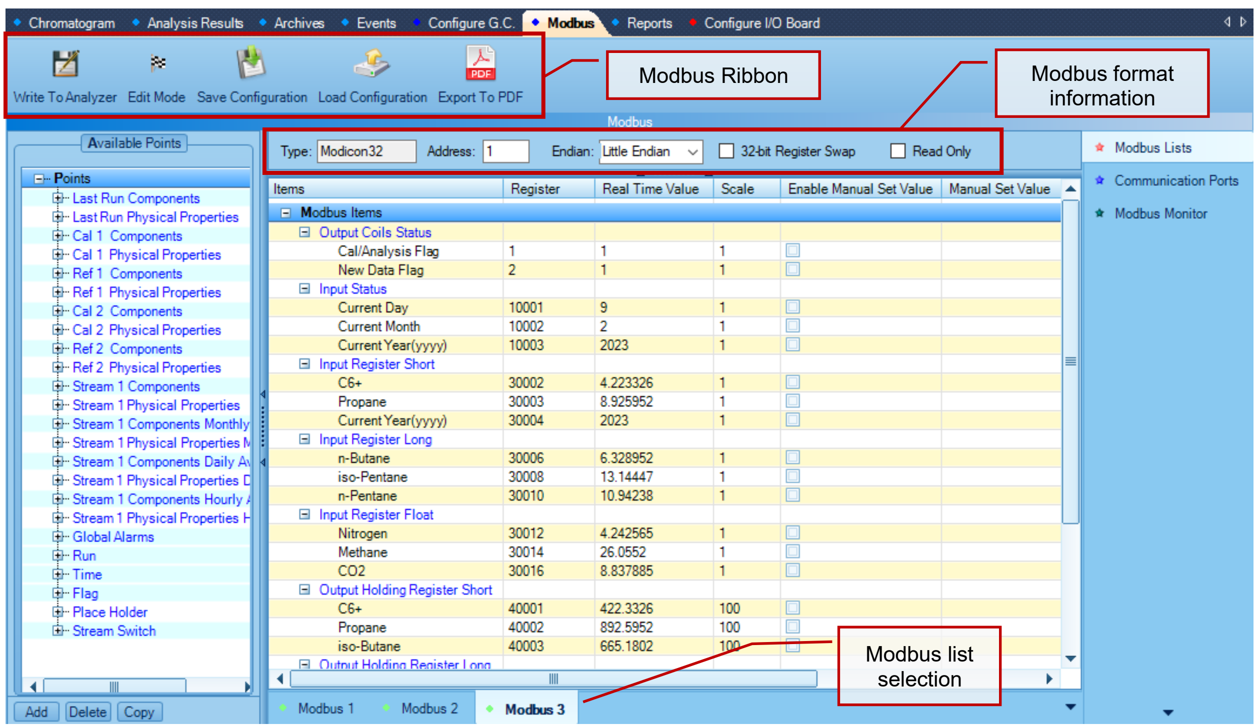

Figure 7-1: AccuChrome PC application Modbus tab – Modbus Lists page

7.1.1 Modbus Ribbon

The *Modbus Ribbon* is used to temporarily save new Modbus configurations to the AccuChrome, enable editing and import/export Modbus configurations. The same ribbon buttons are available on all pages under the Modbus tab.

 *Write to Analyzer* – temporarily saves the present Modbus configuration to the analyzer.

 *Edit Mode* – Enables the User to add, remove and edit Modbus Lists

 *Save Configuration* – Export the Modbus configuration (.cfg-file) to the connected computer.

 *Load Configuration* – Import a Modbus configuration (.cfg-file) from the connected computer.

Export to PDF – Export a report of the displayed Modbus List (.pdf-file).

NOTICE **Click 'Write to Analyzer' button in the ribbon after editing any field on the Modbus Lists page and before navigating to a different page or your settings will be lost. Use 'Permanent Configuration Write' in the Tools Ribbon before logging off or navigating to a new Tab.**

7.2 The Modbus List Page

The *Modbus List* page allows the User to view the setup of each Modbus list. There are several fields on the Modbus Lists page.

On the left-hand side of the *Modbus List* page is a collapsed list of data points available to be added to a Modbus list. In the centre area of the page, the Modbus Items displays data points that are setup on the selected Modbus list and grouped under appropriate nodes. The Modbus Items indicates for each data point, the *Register to* where the data is transmitted, the *Real Time Value* and a scaling value (default is '1'. If desired the User can indicate a *Manual Set Value* by clicking on the *Enable Manual Set Value* checkbox and then entering the value in the adjacent field. This data point will be fixed at the value entered. As an example, the user might want to adjust the Hour field for the onset of daylight-saving time.

NOTICE **Modbus *Edit Mode* must be enabled through the Modbus ribbon before the User is permitted to add, remove or edit any Modbus list.**

7.2.1 Modbus Format Information

Type - There are three Modbus types: Enron (Section 7.2.2), Modicon16 (Section 7.2.3) and Modicon32 (Section 7.2.4). Categorization of the Modbus items will change depending on the Modbus type specified.

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 message is transmitted first.

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

Read Only – Forces the Modbus list to be read-only. It will only be able to transmit messages but not receive.

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.

7.2.2 Modbus List Page - Enron Type

An Enron Modbus list contains 4 nodes on the Modbus Items tree.

- **Coils** - Coils are Boolean data points, they have a value of either 0 or 1. Any item added under the Coils node are communicated as simple status indicators for an input, output, or alarm. If the value of the data point is 0, the status of the logged alarm is *OFF*. If the value of the data point is 1, the status would be *ON*.
- **Short Integers** - Short integers are 16-bit whole numbers with either positive or negative sign.
- **Long Integers** - Long integers are 32-bit whole numbers with either positive or negative sign.
- **Floating Point** - Floating point values are 32-bit numbers, but unlike the integers they do not have a sign and have decimal points. Floating points are typically used for composition values..

A typical example of Short integers is presented in Figure 7-2 and an example of Floating Points is presented in Figure 7-3.

Type: Enron Address: 1 Endian: Little Endian ☐ 32-bit Register Swap ☐ Read Only

Items	Register	Real Time Value	Scale	Enable Manual Set Value
⊟ Modbus Items				
⊞ Coils				
⊟ Short Integers				
Current Month	3036	2	1	☐
Current Day	3037	9	1	☐
Current Year(yyyy)	3038	2023	1	☐
Current Hour	3039	7	1	☐
Last Run Stream Number	3006	1	1	☐
Current Day Of Week	3007	5	1	☐
Cycle Start Time - Month	3008	2	1	☐
Cycle Start Time - Day	3009	9	1	☐
Cycle Start Time - Year	3010	2023	1	☐
Cycle Start Time - Hour	3011	14	1	☐
Cycle Start Time - Minutes	3012	50	1	☐
Place Holder(Short)	3013	0	1	☐
Current Year(yyyy)	9006	2023	1	☐
Current Month	9007	2	1	☐
Current Day	9008	9	1	☐
Current Hour	9009	7	1	☐
Current Minute	9010	56	1	☐
Current Second	9011	59	1	☐
Current Day Of Week	9012	5	1	☐
New Data Flag	3022	1	1	☐
Cal/Analysis Flag	3023	1	1	☐
⊞ Long Integers				
⊞ Floating Points				

Figure 7-2: Enron-type Modbus list - short integers example

Type: Enron Address: 1 Endian: Little Endian ☐ 32-bit Register Swap ☐ Read Only

Items	Register	Real Time Value	Scale	Enable Manual Set Value
⊟ Modbus Items				
⊞ Coils				
⊞ Short Integers				
⊞ Long Integers				
⊟ Floating Points				
C6+ 1	7001	2.743517	1	☐
Propane 1	7002	4.075714	1	☐
iso-Butane 1	7003	11.74594	1	☐
n-Butane 1	7004	7.793467	1	☐
iso-Pentane 1	7005	20.60684	1	☐
n-Pentane 1	7006	9.674831	1	☐
Nitrogen 1	7007	6.841749	1	☐
Methane 1	7008	9.839329	1	☐
CO2 1	7009	6.915763	1	☐
Ethane 1	7010	19.76284	1	☐
C6+	7016	2.743517	1	☐
Propane	7017	4.075714	1	☐
iso-Butane	7018	11.74594	1	☐
n-Butane	7019	7.793467	1	☐
iso-Pentane	7020	20.60684	1	☐
n-Pentane	7021	9.674831	1	☐
Nitrogen	7022	6.841749	1	☐
Methane	7023	9.839329	1	☐
CO2	7024	6.915763	1	☐
Ethane	7025	19.76284	1	☐
GHV Real Dry	7026	2599.967	1	☐
GHV Real Sat	7027	2556.001	1	☐
gravity Real Dry	7028	1.767014	1	☐
compress Dry	7029	0.9788345	1	☐
wobbe Dry	7030	1955.905	1	☐
Stream 1 C6+ Daily Avg.	7031	2.191088	1	☐
Stream 1 Propane Daily A...	7032	5.380273	1	☐
Stream 1 iso-Butane Daily...	7033	7.237975	1	☐
Stream 1 n-Butane Daily A...	7034	6.337882	1	☐
Stream 1 iso-Pentane Dail...	7035	10.85205	1	☐
Stream 1 n-Pentane Daily...	7036	12.57899	1	☐
Stream 1 Nitrogen Daily A...	7037	5.876032	1	☐
Stream 1 Methane Daily A...	7038	19.45185	1	☐
Stream 1 CO2 Daily Avg.	7039	11.20621	1	☐
Stream 1 Ethane Daily Avg.	7040	18.88764	1	☐

Figure 7-3: Enron-type Modbus list - floating points example

7.2.3 Modbus List Page – Modicon16 Type

A Modicon16 Modbus list contains 4 nodes on the Modbus tree.

- **Output Coils Status** – Output Coils Status are read/write enabled Boolean data points; they have a value of either 0 or 1. Data points in the Output Status nodes should contain data points such as stream requests. If the value for a stream was changed from 0 to 1, the AccuChrome would then initiate a run for that stream.
- **Input Status** - Input Status nodes are read-only Boolean data points; they have a value of either 0 or 1. Data points in the Input Status nodes should contain data points such as alarm, input, and output status that cannot be changed remotely.
- **Input Register** - Input Registers are read-only 16-bit data points. The values provided are 16-bit whole numbers with either positive or negative sign. Typically used for time stamp and calculated concentration values.
- **Output Holding Register** - Output Register are read/write 16-bit data points and can be written to remotely. These would include such things as calibration gas concentration and gain factor.

An example of a Modicon16 list is provided in Figure 7-4.

Type: Modicon16 Address: 1 Endian: Little Endian ☐ 32-bit Register Swap ☐ Read Only

Items	Register	Real Time Value	Scale	Enable Manual Set Value	Manual Set Value
⊟ Modbus Items					
⊟ Output Coils Status					
New Data Flag	1	1	1	☐	
Cal/Analysis Flag	2	1	1	☐	
⊟ Input Status					
Current Second	10001	5	1	☐	
Current Minute	10002	54	1	☐	
Current Hour	10003	7	1	☐	
Current Day	10004	9	1	☐	
Current Month	10005	2	1	☐	
Current Year(yyyy)	10006	2023	1	☐	
⊟ Input Register					
Current Year(yyyy)	30001	2023	1	☐	
Current Month	30002	2	1	☐	
Current Day	30003	9	1	☐	
C6+	30004	5.990879	2	☐	
Propane	30005	7.448732	3	☐	
iso-Butane	30006	40.69781	4	☐	
⊟ Output Holding Register					
C6+	40001	299.5439	100	☐	
Propane	40002	248.2911	100	☐	
iso-Butane	40003	1017.445	100	☐	

Figure 7-4: Modicon16-type Modbus list - example nodes

7.2.4 Modbus List Page – Modicon32 Type

Modicon32 is similar to the Modicon 16, Output Coils Status and Input Status nodes operate the exact same, but it expands on the Input and Output Registers with several node sub-types.

- **Input Register Short** - read-only 16-bit data points. The values provided are 16-bit whole numbers with either positive or negative sign.
- **Input Register Long** - read-only 32-bit data points. The values provided are 16-bit whole numbers with either positive or negative sign.
- **Input Register Float** - read-only 32-bit floating data points. The values provided are 32-bit un-signed integers with decimal places.
- **Output Holding Register Short** - read-only 16-bit data points. The values provided are 16-bit whole numbers with either positive or negative sign.
- **Output Holding Register Long** - read-only 32-bit data points. The values provided are 16-bit whole numbers with either positive or negative sign.
- **Output Holding Register Float** - read-only 32-bit floating data points. The values provided are 32-bit un-signed integers with decimal places.

An example of a Modicon16 list is provided in Figure 7-5.

Type: Modicon32 Address: 1 Endian: Little Endian ☐ 32-bit Register Swap ☐ Read Only

Items	Register	Real Time Value	Scale	Enable Manual Set Value	Manual Set Value
⊟ Modbus Items					
⊟ Output Coils Status					
Cal/Analysis Flag	1	00.00	1	☐	
New Data Flag	2	00.00	1	☐	
⊟ Input Status					
Current Day	10001	00.00	1	☐	
Current Month	10002	00.00	1	☐	
Current Year(yyyy)	10003	00.00	1	☐	
⊟ Input Register Short					
C6+	30002	00.00	1	☐	
Propane	30003	00.00	1	☐	
Current Year(yyyy)	30004	00.00	1	☐	
⊟ Input Register Long					
n-Butane	30006	00.00	1	☐	
iso-Pentane	30008	00.00	1	☐	
n-Pentane	30010	00.00	1	☐	
⊟ Input Register Float					
Nitrogen	30012	00.00	1	☐	
Methane	30014	00.00	1	☐	
CO2	30016	00.00	1	☐	
⊟ Output Holding Register Short					
C6+	40001	00.00	100	☐	
Propane	40002	00.00	100	☐	
iso-Butane	40003	00.00	100	☐	
⊟ Output Holding Register Long					
n-Butane	40004	00.00	1000	☐	
iso-Pentane	40006	00.00	1000	☐	
n-Pentane	40008	00.00	1000	☐	
⊟ Output Holding Register Float					
Nitrogen	40010	00.00	1	☐	
CO2	40012	00.00	1	☐	
Ethane	40014	00.00	1	☐	

Figure 7-5: Modicon32-type Modbus list - example nodes

7.3 Communication Ports

The *Communication Ports page* (Figure 7-6) is used to indicate the external ports through which Modbus data is exported. Modbus data can be sent from the AccuChrome through RS-232 or TCP. An optional serial expansion card provides an additional two RS-232 outputs and two RS-485 outputs. The Communication Ports page will auto-populate with the available output ports.

On the left-hand side of the Communication Ports page, Modbus Lists can be assigned to each available output port. For serial Modbus to function, the *Enable Serial Ports* checkbox must be checked. The *Termination On* check box should be checked if a termination resistor is required for the RS485 serial port.

On the right-hand side of the Communication Ports page, Modbus output ports can be configured as required. The recommended settings for serial output are shown in Figure 7-7.

NOTICE **Click 'Write to Analyzer' button in the ribbon after editing the Communication Ports and before navigating to a different page or your settings will be lost. Use 'Permanent Configuration Write' in the Tools Ribbon before logging off or navigating to a new Tab.**

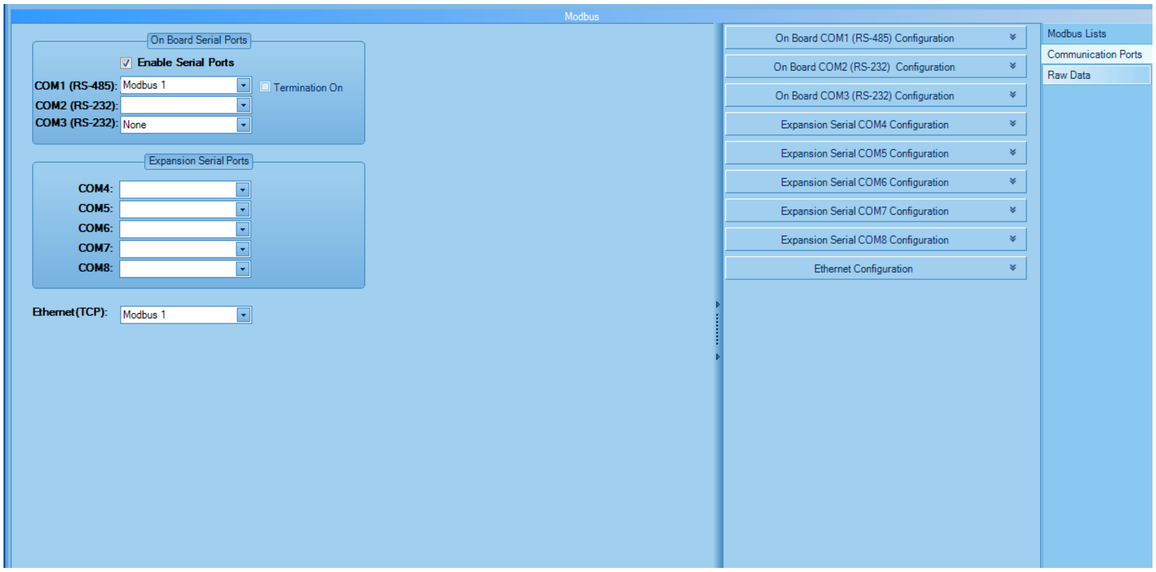

Figure 7-6: AccuChrome PC application Modbus tab – Communication Ports page

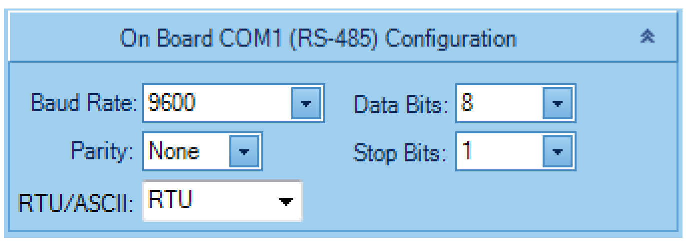

Figure 7-7: Serial Modbus output recommended port configuration

7.4 Modbus Monitor

The Modbus Monitor (Figure 7-8) is an optional tool provided to verify data sent from the AccuChrome over the Modbus channels. Select the desired Modbus channel from the drop-down menu and then click *Start Display*. You should see received messages (Rx) in yellow and transmitted messages (Tx) in blue. COM1 through to COM8 as well as TCP channels may be selected.

NOTICE **A device must be polling the AccuChrome via Modbus for any messages to appear in the monitor window. The analyzer will not transmit any messages if it has not received a request.**

Use *Stop Display* to stop viewing messages for the selected Modbus channel. Before selecting another Modbus channel in the same session, use the *Clear Display* button to remove information from the message monitor pane.

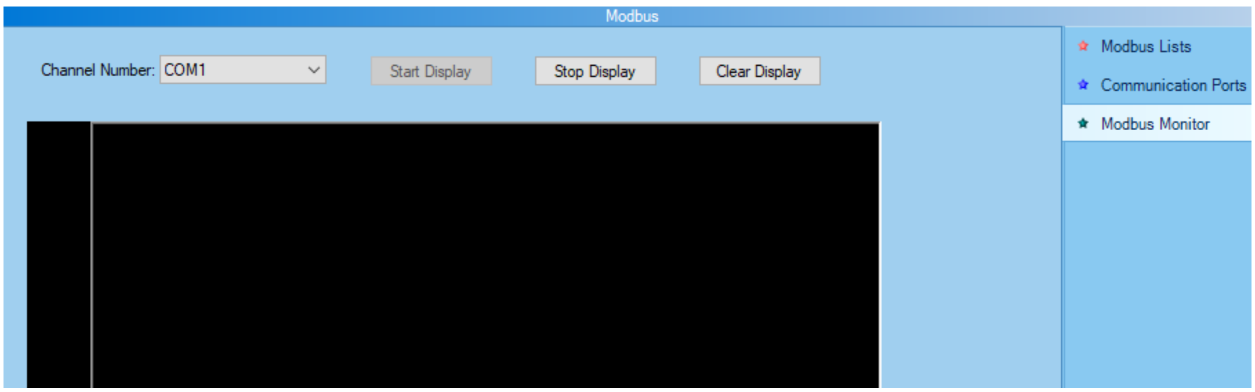

Figure 7-8: AccuChrome PC application Modbus tab – Modbus Monitor page

Section 8 **Maintenance**

8.1 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 8.2)
- Cleaning the System (Section 8.3)
- Replacing the Helium Cylinder (Section 8.4)
- Maintaining Flow Control (Section 8.5)
- Replacing Internal Components (Section 8.6
- Checking the Column Temperature (Section 8.7)
- Checking the NEMS C9 Module (Section 8.8)
- Ordering Spare Parts (Section 8.9)

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

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

8.2 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 8-1) 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 8-1: AccuChrome Natural Gas Chromatograph Checkout Sheet

If any of the diagnostic parameters deviate from the specifications, consult the Troubleshooting section in this manual (Section 9) or contact Galvanic Applied Sciences.

8.3 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

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

8.4 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.

NOTICE **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.**

8.5 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 59ºF (15°C) as heavier hydrocarbons may condense in the sample lines at lower temperatures.**

8.6 Replacing Internal Components

The operator may be required to replace the valve or columns, which are located in the upper compartment. Maintenance information for valves is provided in 0.

⚠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 70ºC. 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.**

8.6.1 Replacing the Injection 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 model of a 10-port diaphragm valve is shown in Figure 8-2.

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.

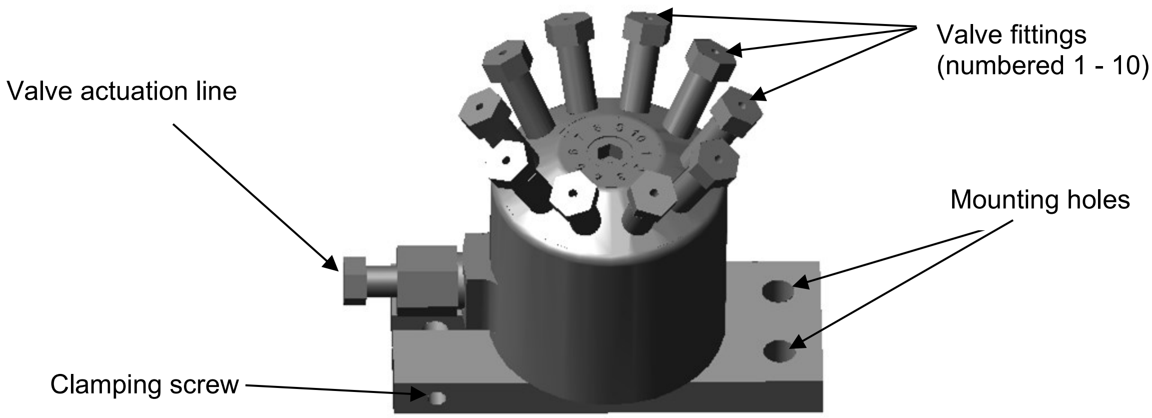

Figure 8-2: Example of 10-port diaphragm valve (some systems also have 6-port valves)

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.**

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 2.4 or Section 14 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.

8.6.2 Replacing the Column(s)

The system has either one or two columns as described in Section 2.2.2. 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.

8.7 Checking the Oven Temperature

The column and valve are temperature controlled at either +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 AccuChrome and is not recommended. Outdoor locations or installation in outdoor enclosures without climate control 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.

8.8 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 Section 8.9.

8.9 Spare Parts

If spare AccuChrome parts are required, please contact:

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

A list of common AccuChrome replacement parts are shown in Table 8-1.

Table 8-1: Spare parts list for AccuChrome GC

Part #	Description
BA0071	FLOWMETER
BA0946	6 PORT VALVE
BA1592	10 PORT VALVE
BA1734	6 OR 10 VALVE DIAPHRAM
BA1587	RTD
BA1590	THERMAL CONDUCTIVITY DETECTOR (TCD)
VARIES	COLUMN SET - APPLICATION SPECIFIC
BA1910	HELIUM PRESSURE REGULATOR, 0-100 PSI
BA1924	2 INCH PRESSURE GAUGE, 0 -100 PSI
BA2958	12 VDC LOW POWER SOLENOID
BA7430	DISPLAY RIBBON CABLE
BA3178	1.6FT USB CABLE ASSEMBLY
Floor Stock	NEMS CABLE ASSEMBLY
Floor Stock	12 INCH POWER CABLE ASSEMBLY
PM2613	90-120 VAC OVEN HEATER RELAY
PM2614	24 VDC OVEN HEATER RELAY
PM2615	200-240 VAC OVEN HEATER RELAY
PT3044	4-PORT SERIAL EXPANSION CARD
PT3048	CONTROLLER BOARD
PT3050	LCD DISPLAY BOARD
SA3149	NEMS C9 MODULE
SA3184	I/O BOARD ASSEBMLY
SA2925	I.S. BARRIER (CL I, DIV1 VERSION ONLY)
SA2961	KEYPAD
SS-2F-K4-7	7 MICRON INLINE FILTER ELEMENT
SS-2F-LE	MICRON INLINE FILTER HOUSING

NOTICE

This parts list is not fully backwards compatible with a AccuChrome PLGC3. If you would like to upgrade AccuChrome PLGC3 analyzers to the latest AccuChrome GC4, please contact your Galvanic Service Representative.

Section 9 Troubleshooting

9.1 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.

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9.2 Potential Faults

9.2.1 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 14), 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.

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9.2.2 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 14) 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 the problem persists and is negatively affecting results, contact Galvanic for assistance.

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9.2.3 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.

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Section 10 **Theory of Gas Chromatography**

10.1 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 Separates a Sample into its Components (Section 10.2)
- Basic Parts of a Gas Chromatograph (Section 10.3)
- How Components are Detected and Quantified (Section 10.4)
- The Chromatogram (Section 10.5)

A discussion of the various equations that are used for quantization is presented in Section 12.

10.2 How a Gas Chromatograph Separates a Sample into its Components

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 10-1 shows the separation process as the carrier gas moves the sample through the column.

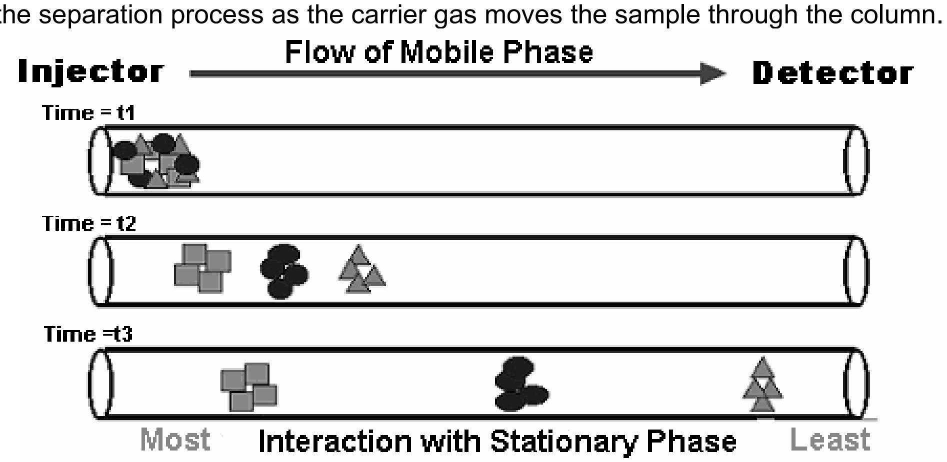

Figure 10-1: Separation of components within a gas sample as it passes through a chromatographic column.

10.3 Basic Parts of a Gas Chromatograph

A Gas Chromatograph (Figure 10-2) includes the following components:

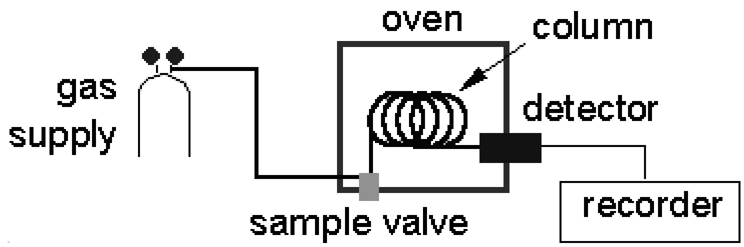

Figure 10-2: Primary components of a gas chromatograph

- *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 quantifies the components of the sample.
- *Oven* – The detector and column are maintained at a constant temperature by the oven. Constant temperature is essential to achieve proper separation of components.

10.4 How Components are 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 10-3 shows an example of the TCD filament configuration.

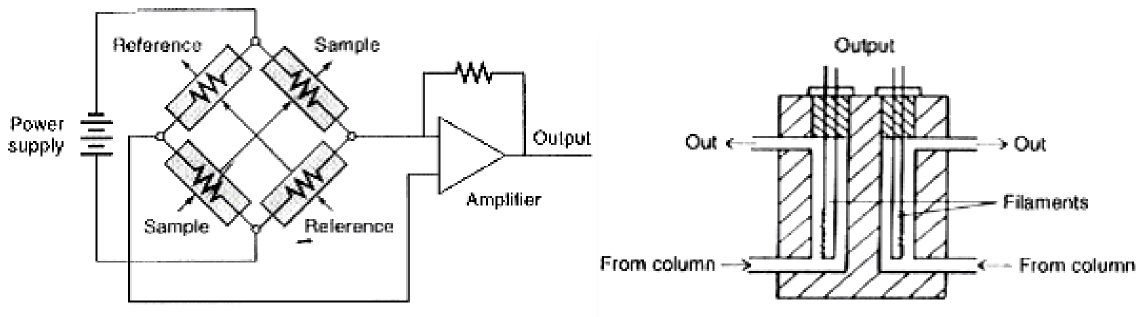

Figure 10-3: Typical design of a thermal conductivity detector (TCD)

10.5 The Chromatogram

A chromatogram is the primary output of a chromatograph. 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'.

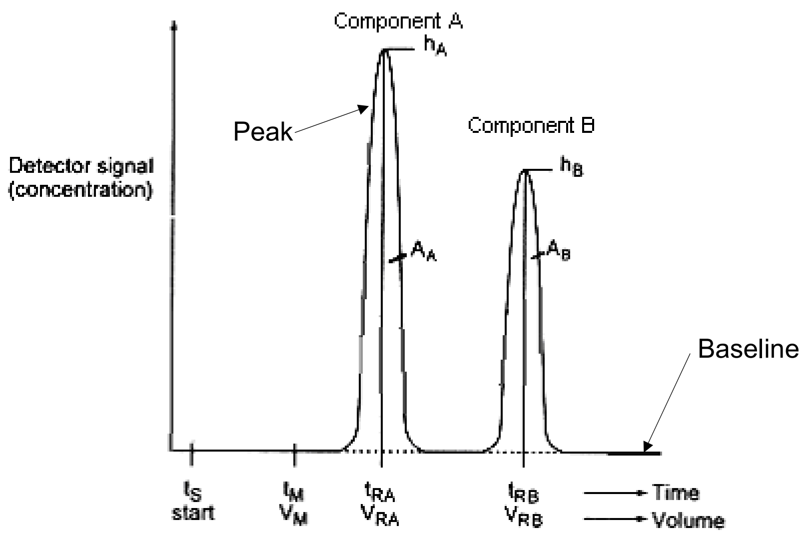

Figure 10-4: Key features of a chromatogram

$\mathbf{t_M}$ - *dead time:* time for non-retained species to move through the column.
$\mathbf{V_M}$.- *dead volume:* volume of mobile phase in the column.
$\mathbf{t_R}$ - *retention time:* the time it takes a component band to completely travel through the column. Each component will have a characteristic retention time.
$\mathbf{V_R}$ - *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 11 **Wiring Book**

The Wiring book for the AccuChrome is described in Table 11-1. In addition to the figures presented in this section, the diagrams are provided on the distribution disk for the PC application program.

Table 11-1: AccuChrome wiring book index

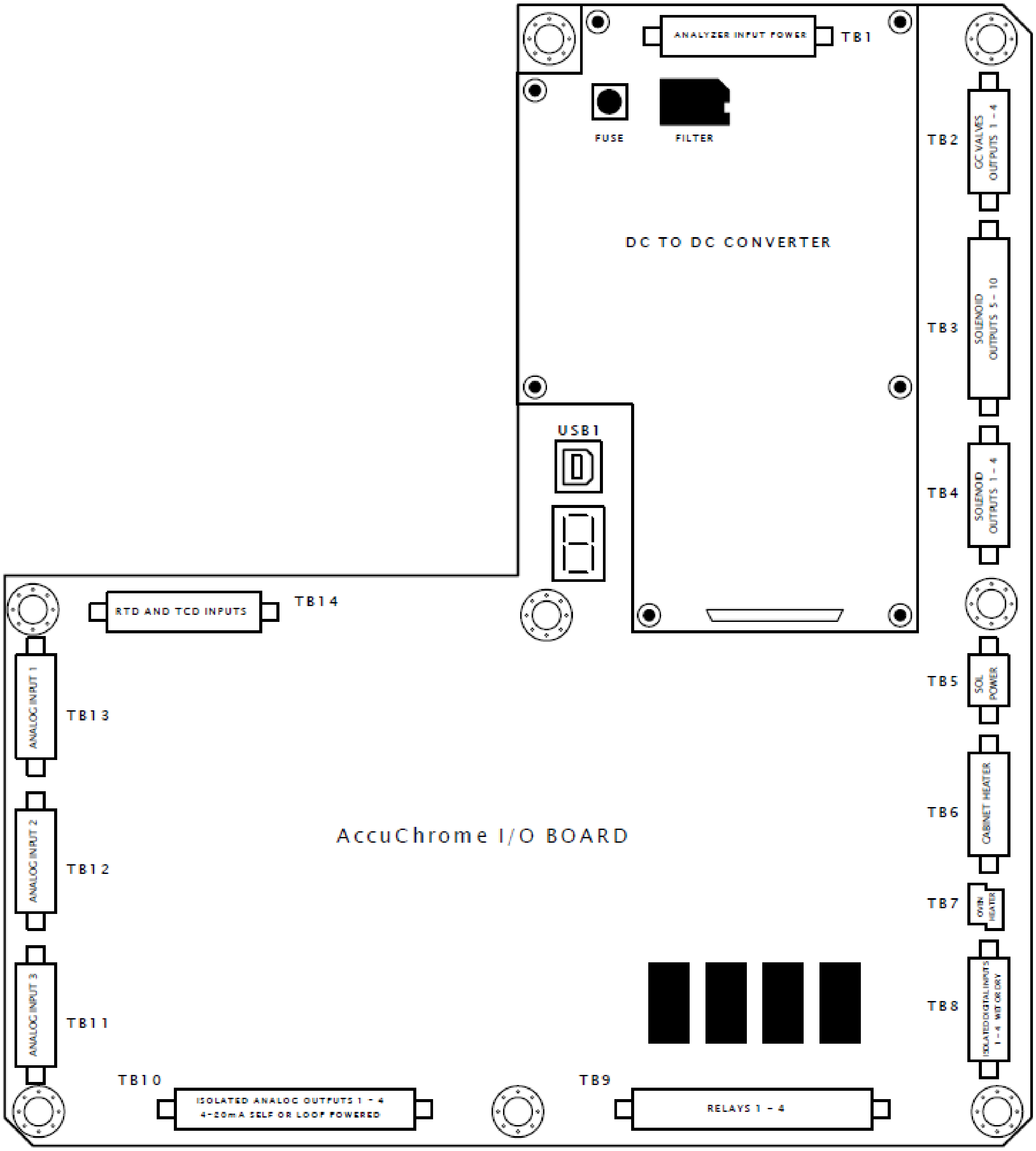

Figure 11-1: AccuChrome terminal block locations on SA3184

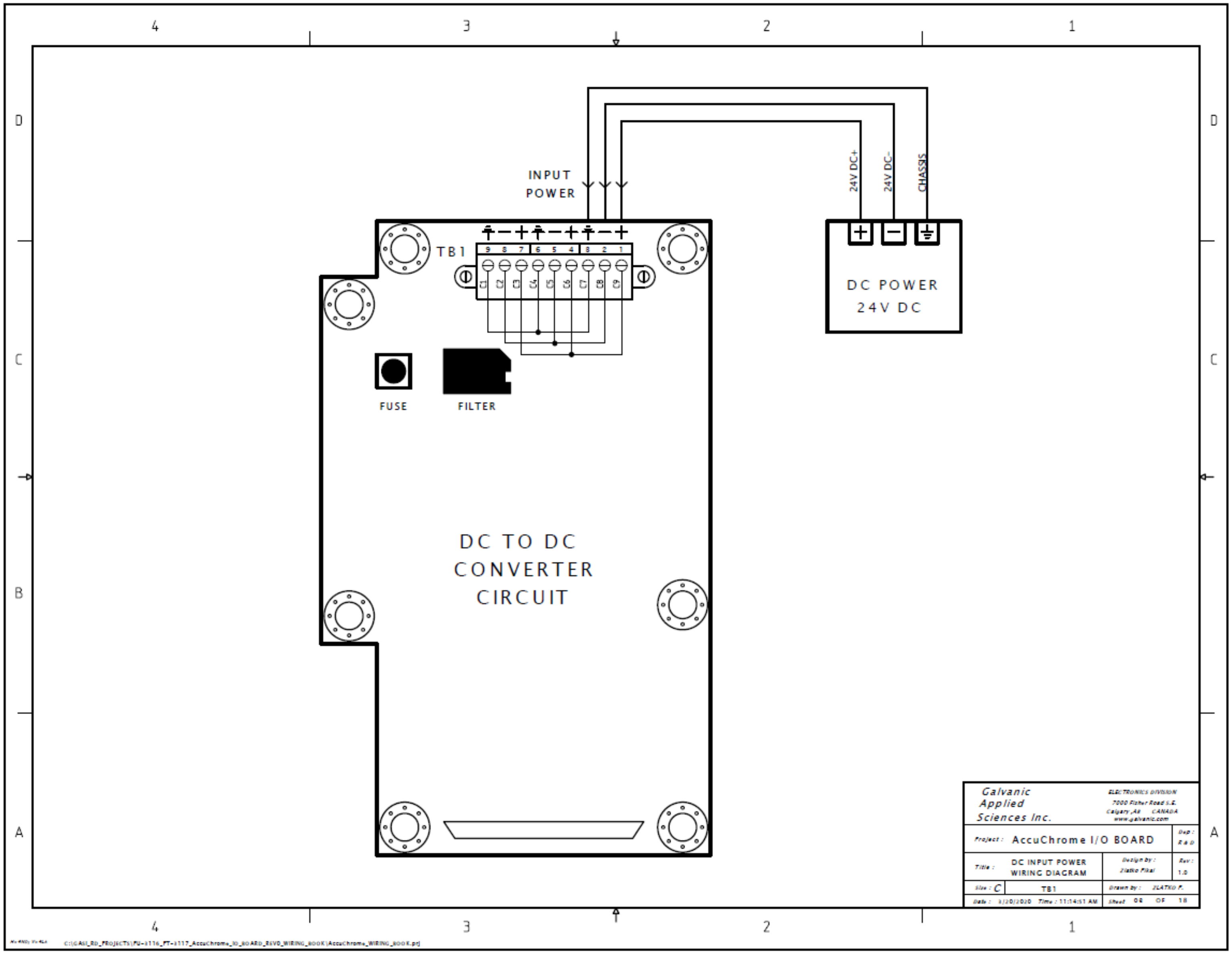

Figure 11-2: DC input power wiring diagram

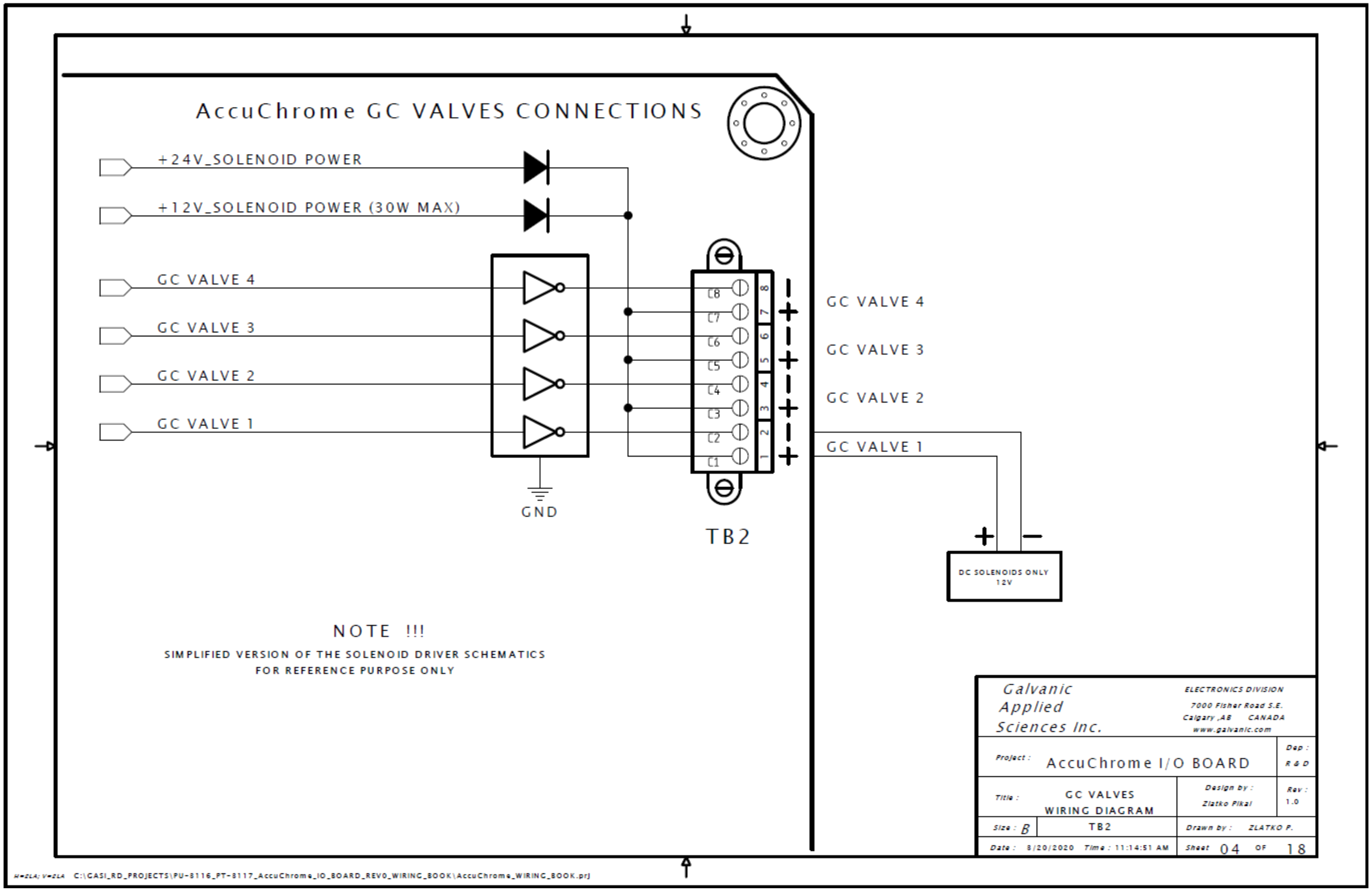

Figure 11-3: GC valves wiring diagram

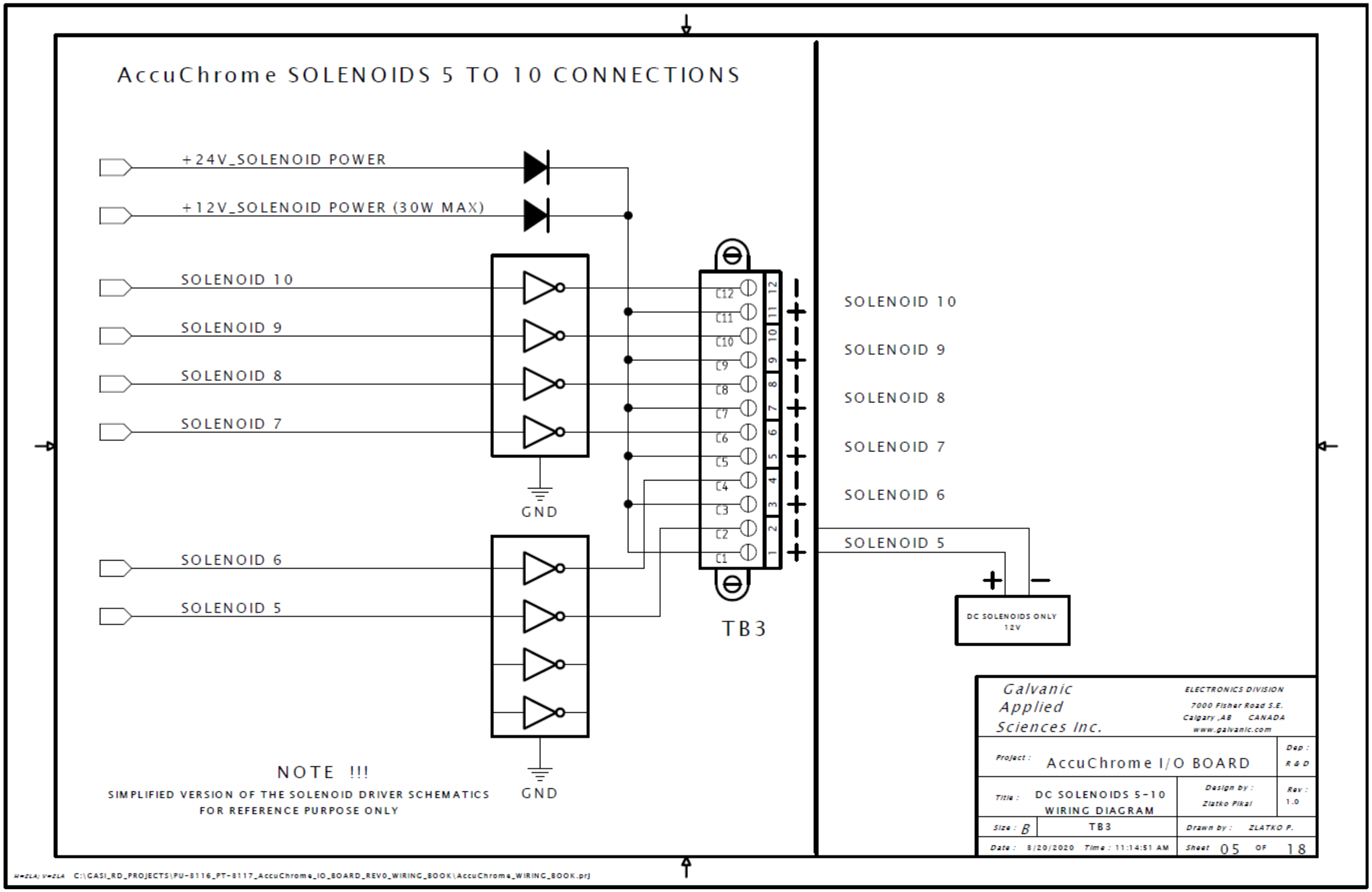

Figure 11-4: DC solenoids 5-10 wiring diagram

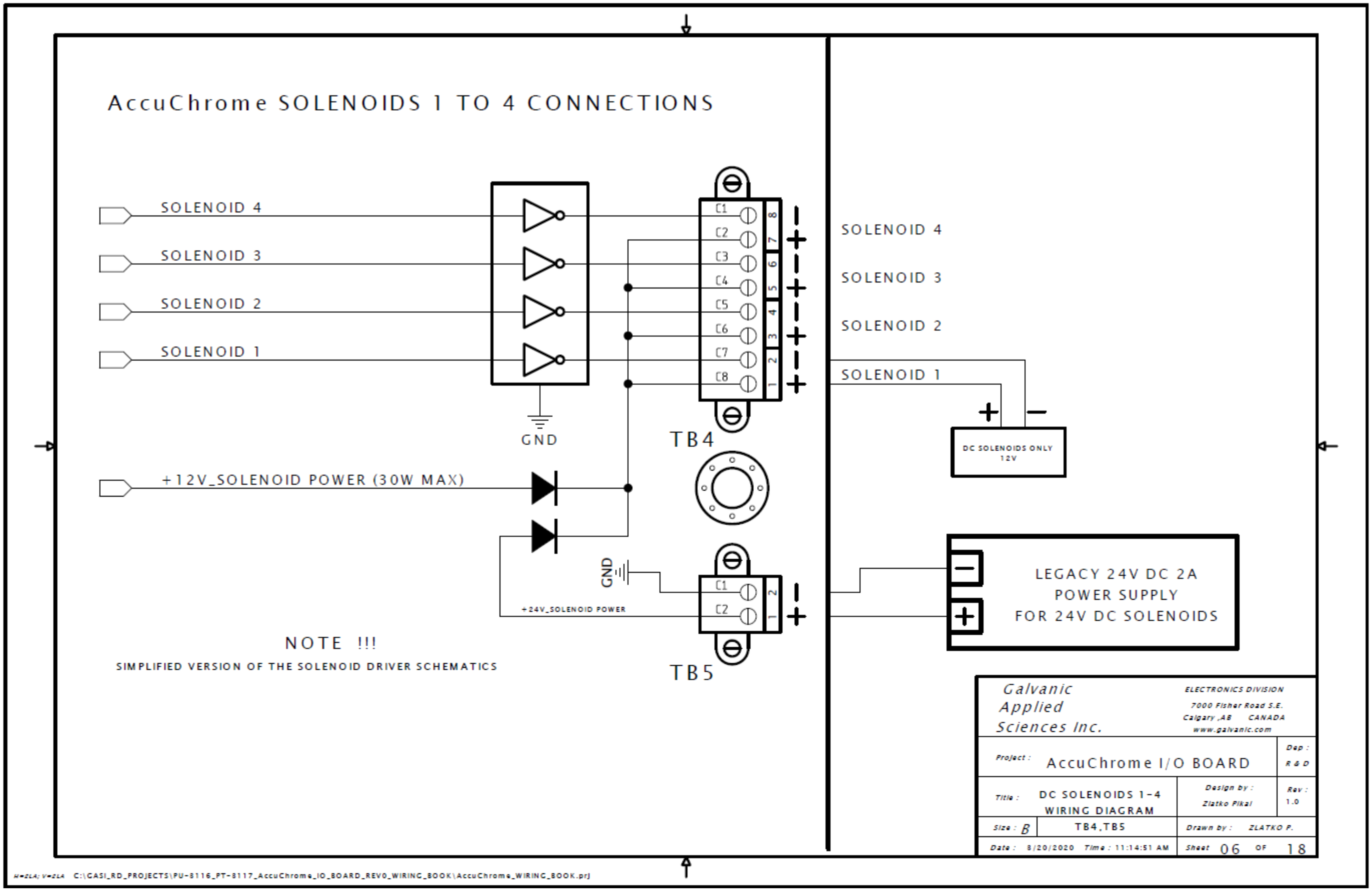

Figure 11-5: DC solenoids 1-4 wiring diagram

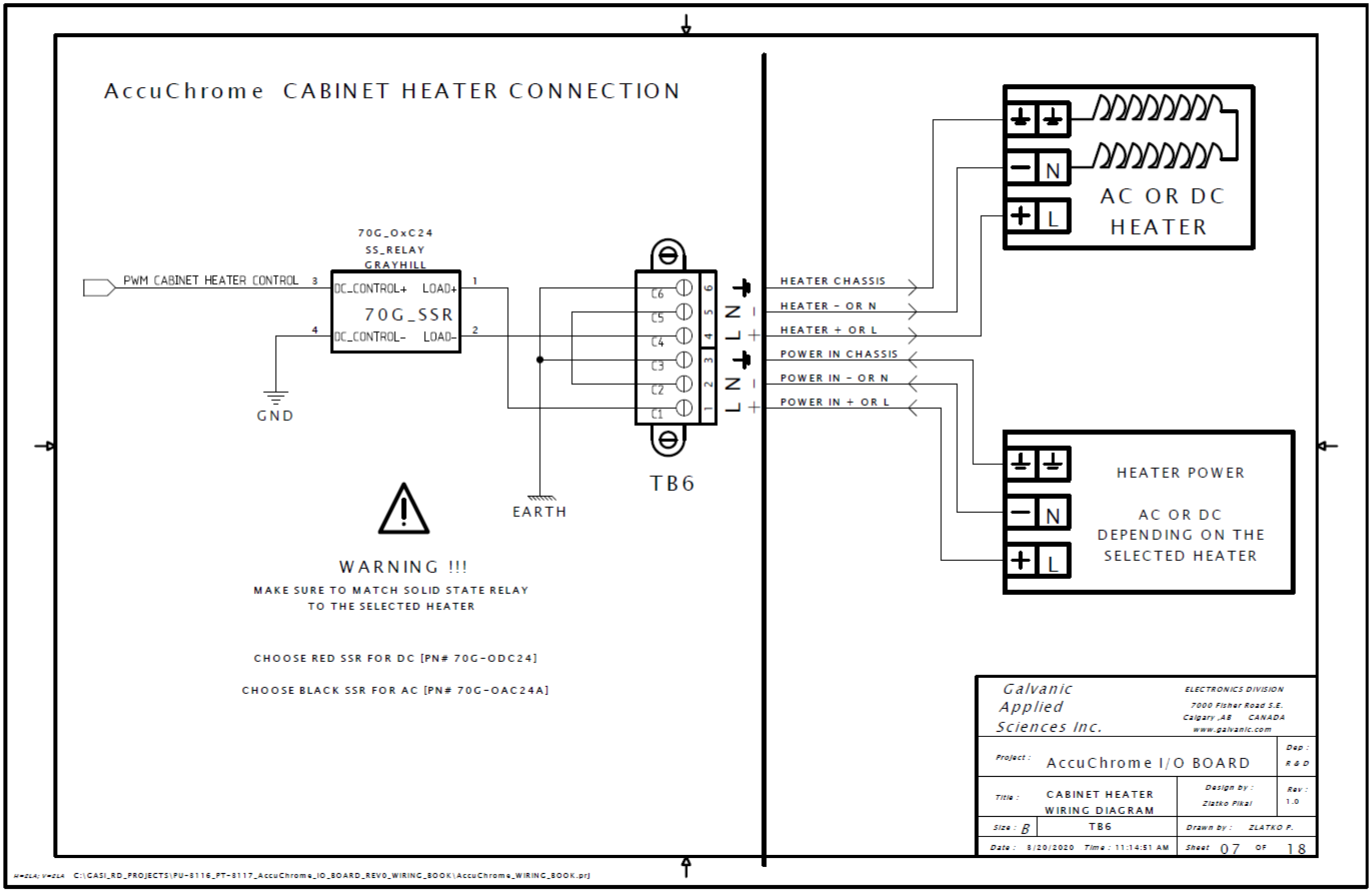

Figure 11-6: Cabinet heater wiring diagram

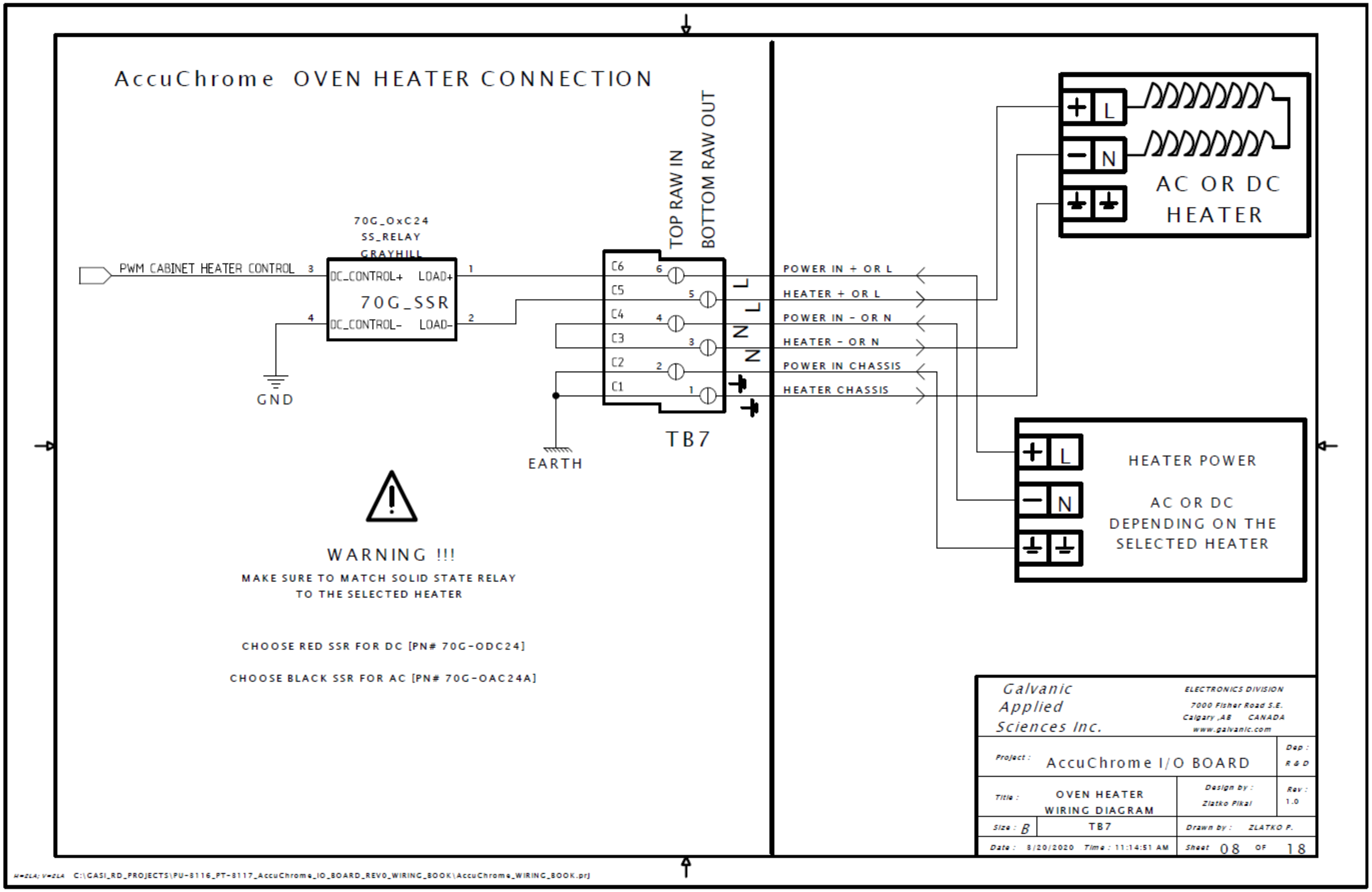

Figure 11-7: Oven heater wiring diagram

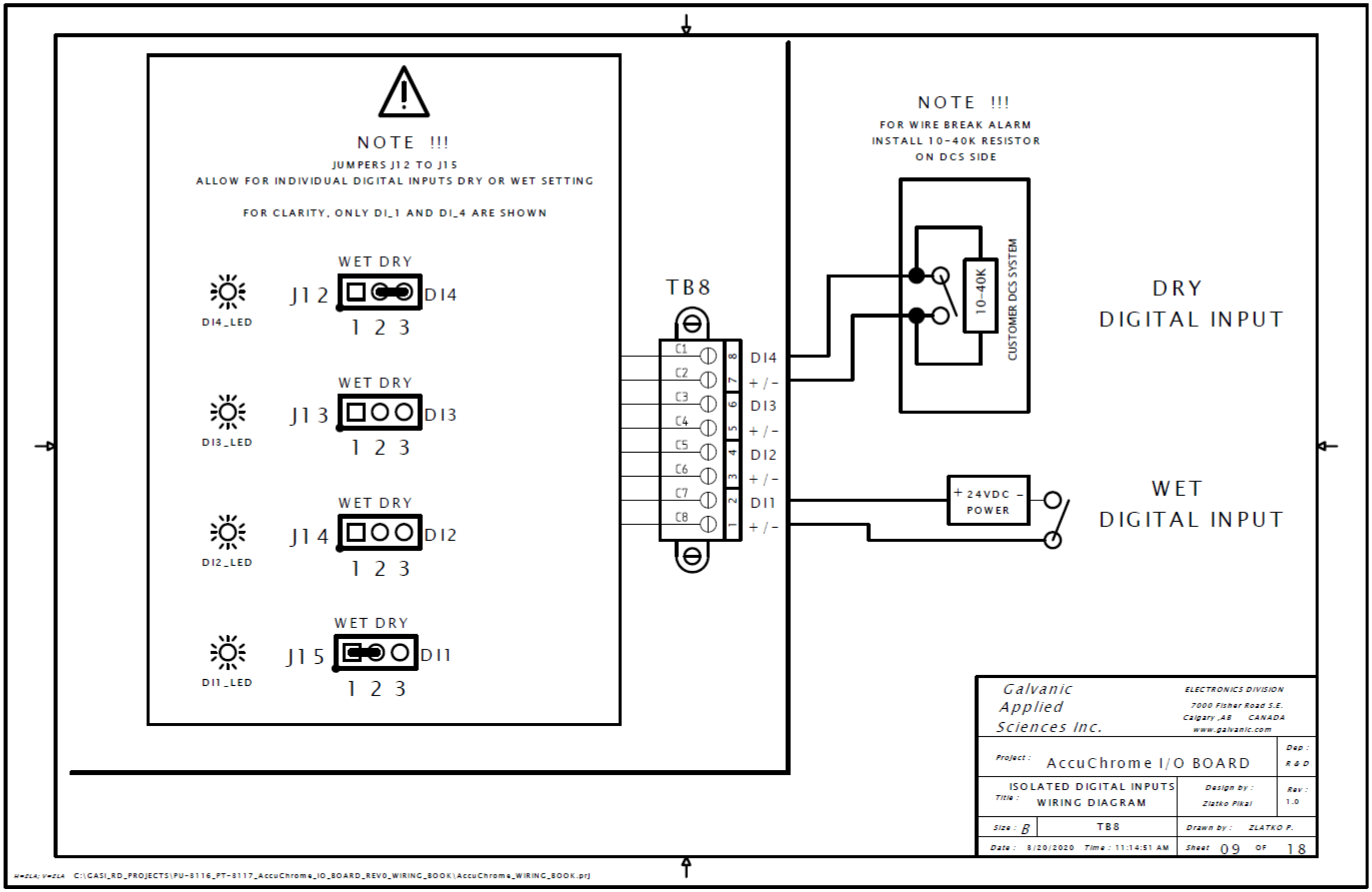

Figure 11-8: Isolated digital inputs wiring diagram

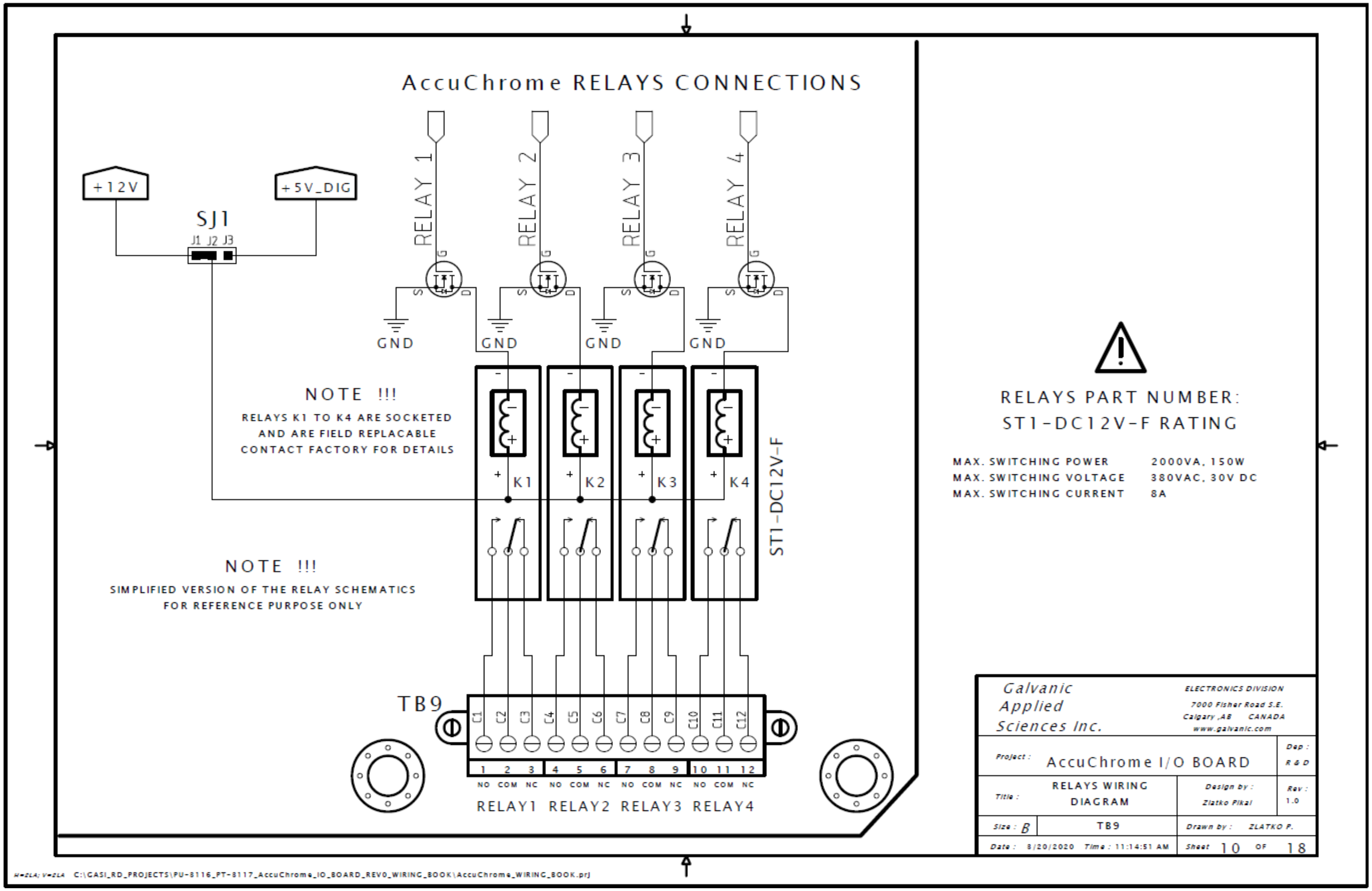

Figure 11-9: Relays wiring diagram

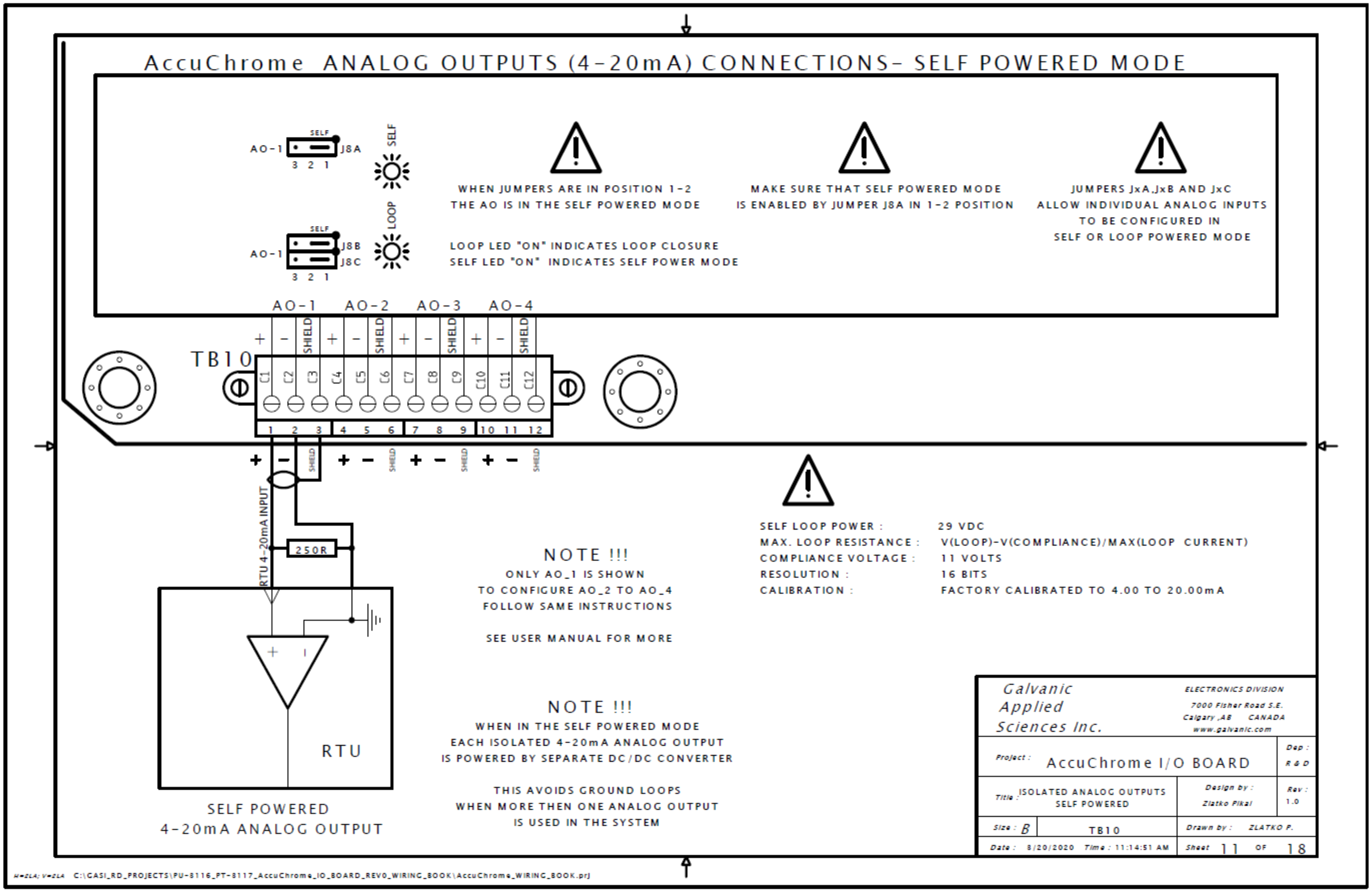

Figure 11-10: Isolated analog outputs self powered wiring diagram

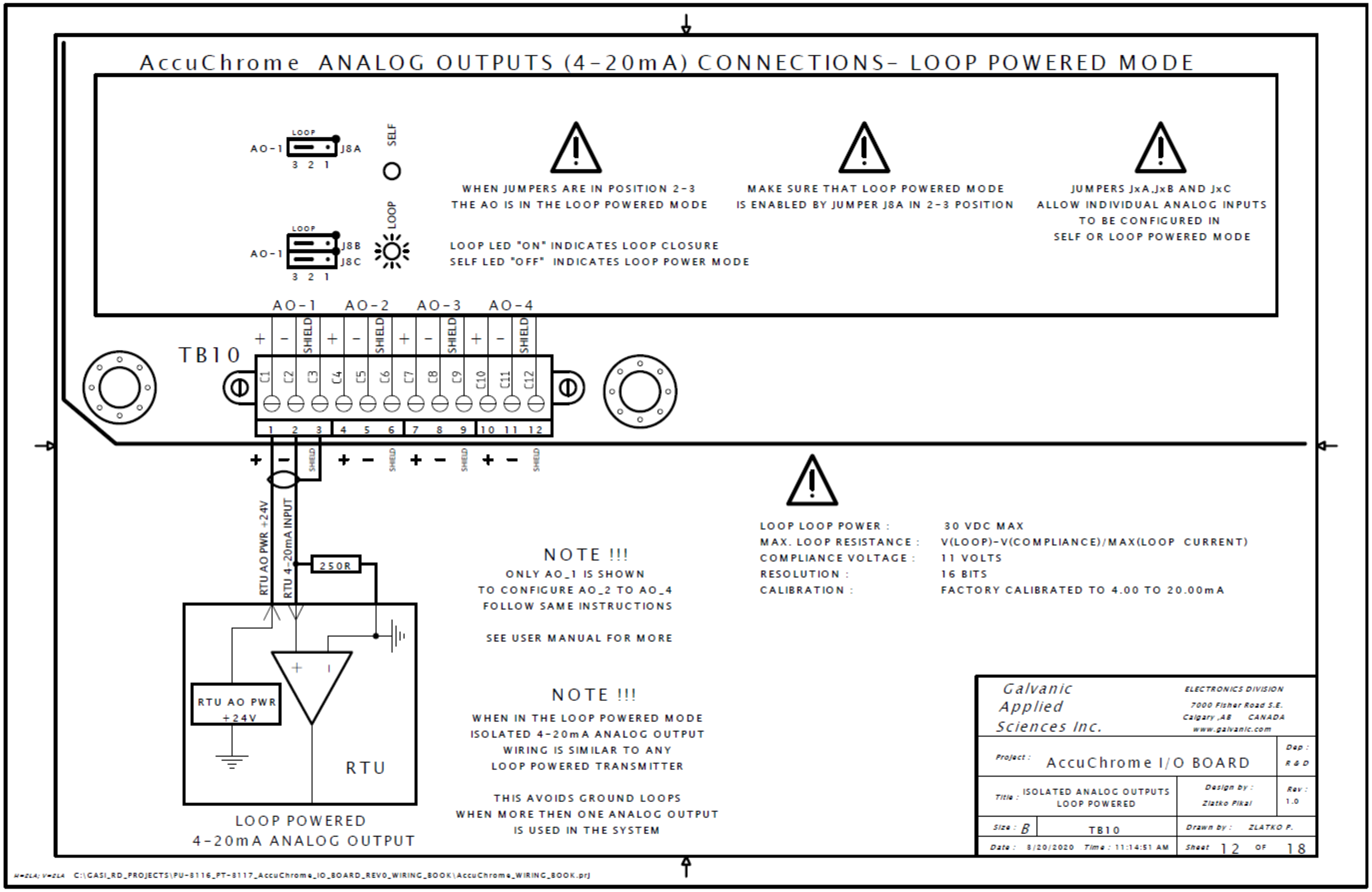

Figure 11-11: Isolated analog outputs loop powered wiring diagram

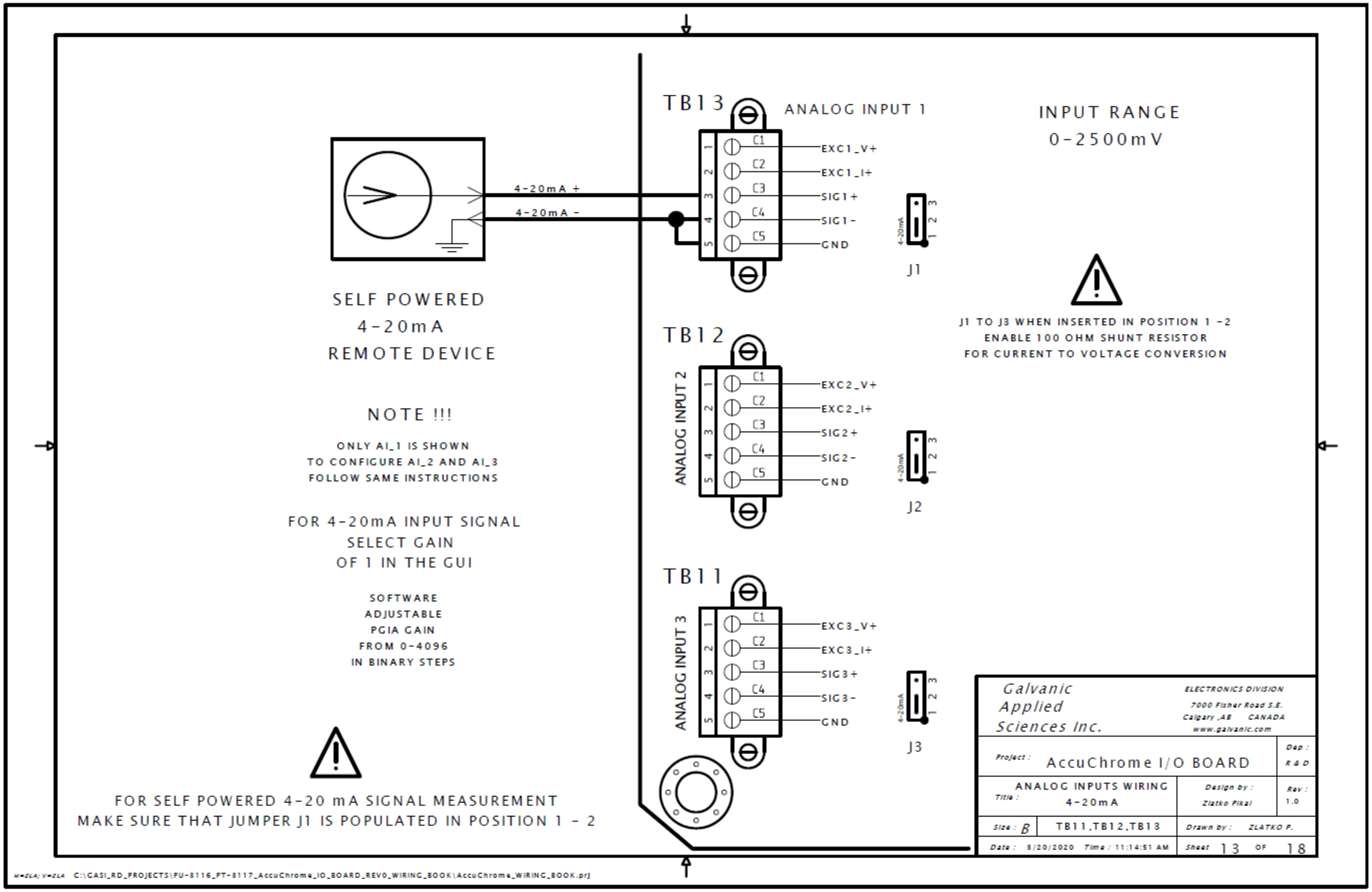

Figure 11-12: Analog inputs wiring diagram 4-20mA

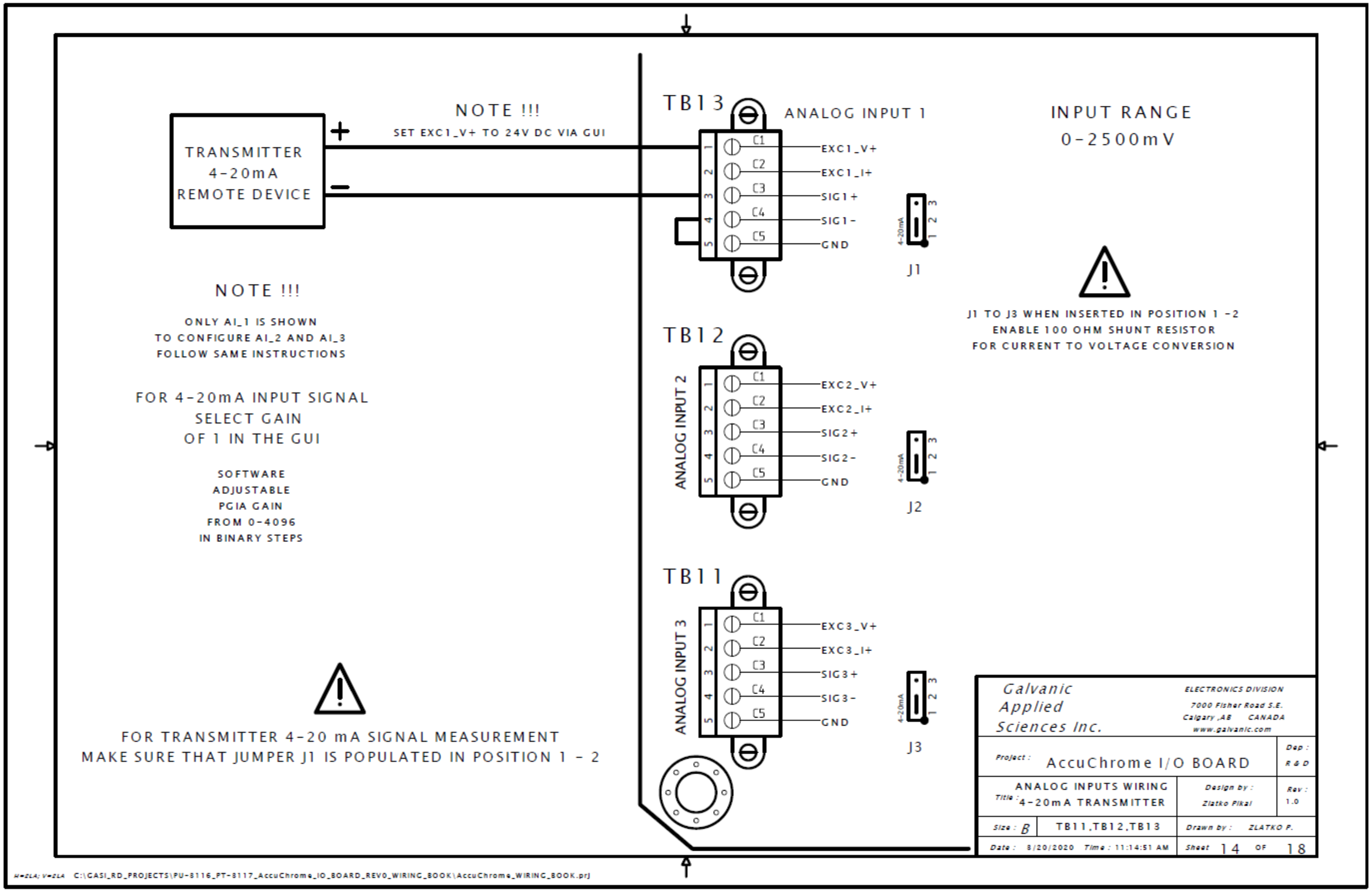

Figure 11-13: Analog inputs wiring diagram 4-20mA transmitter

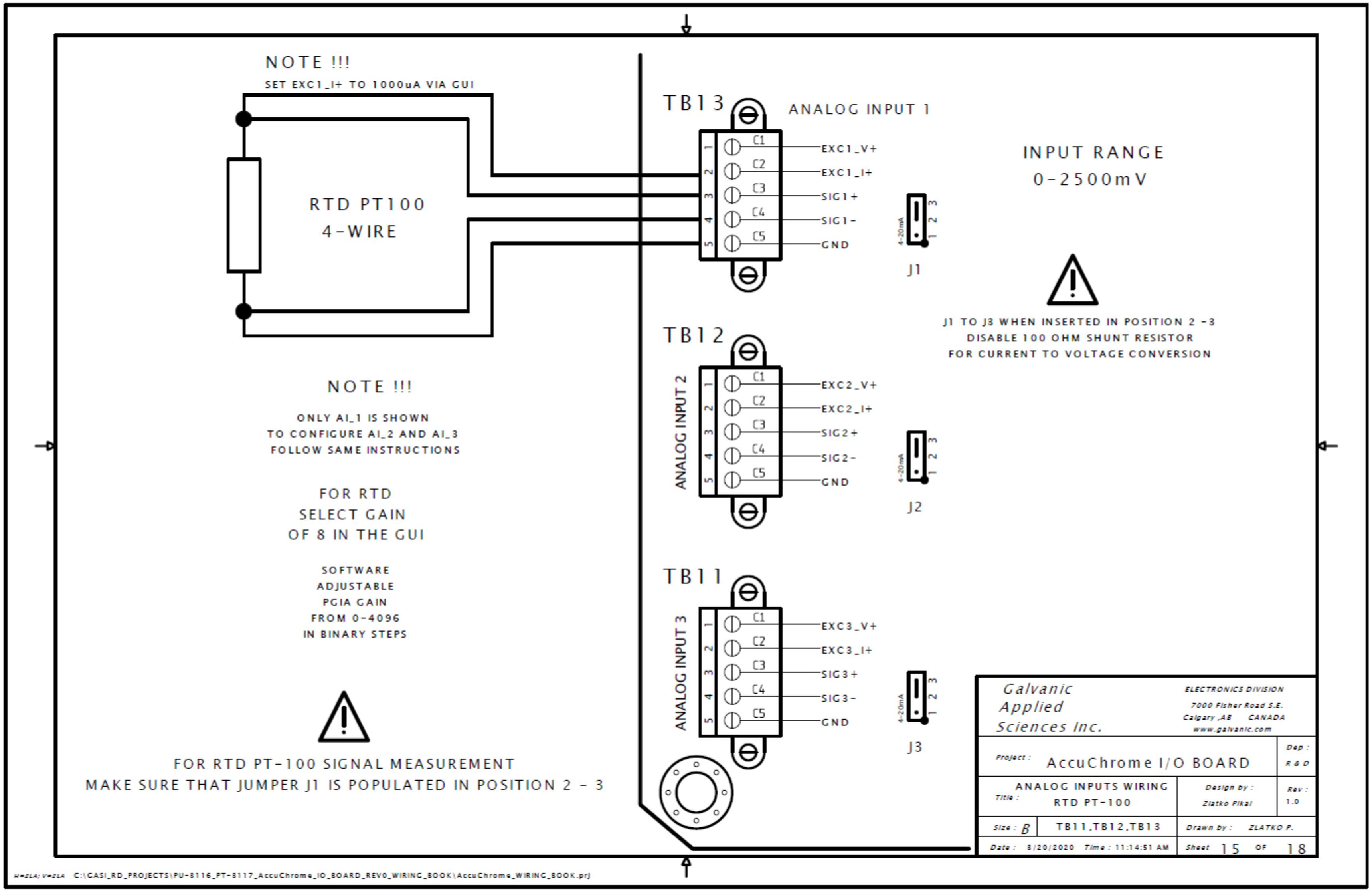

Figure 11-14: Analog inputs wiring diagram RTD Pt-100

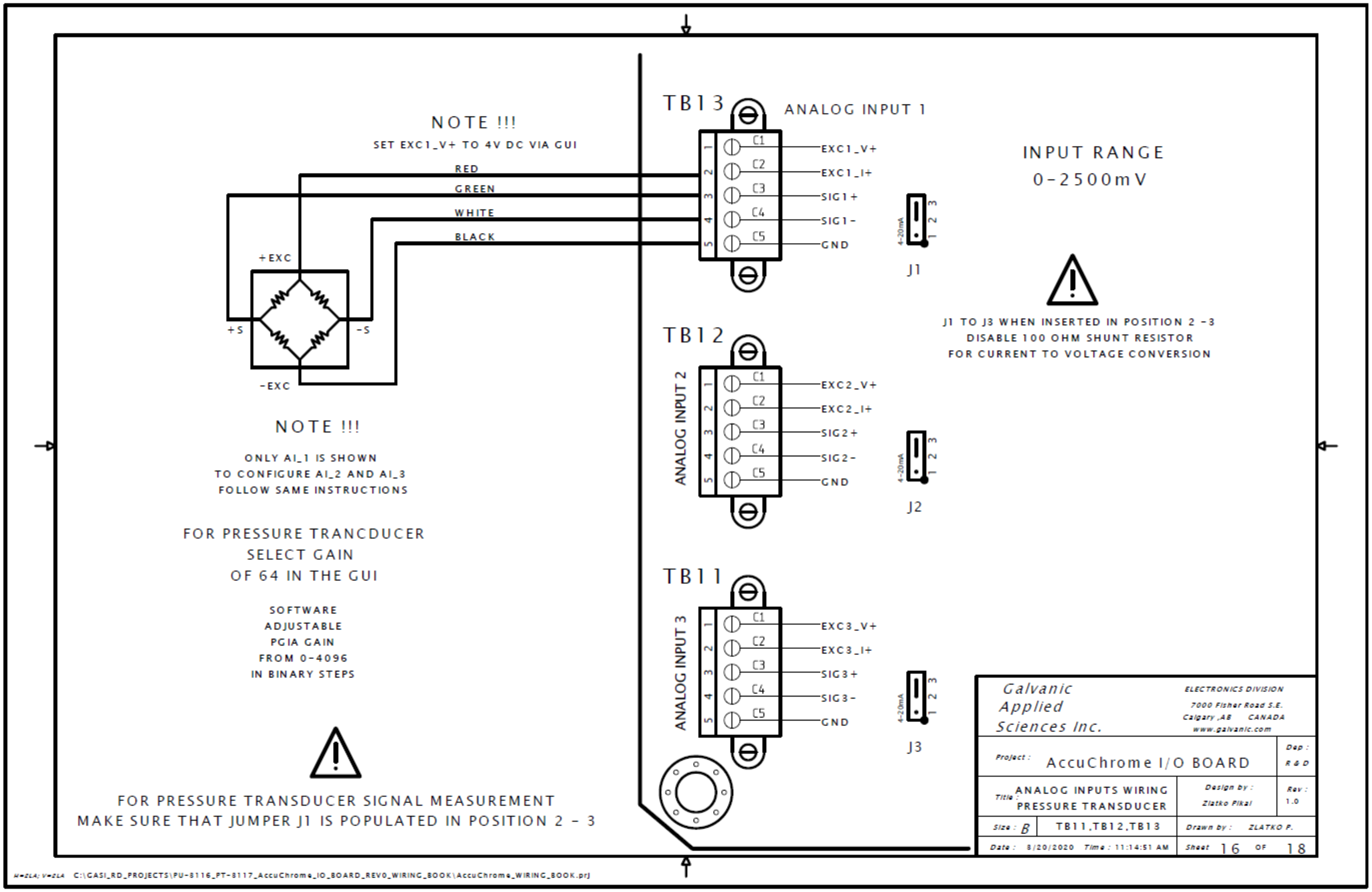

Figure 11-15: Analog inputs wiring diagram pressure transducer

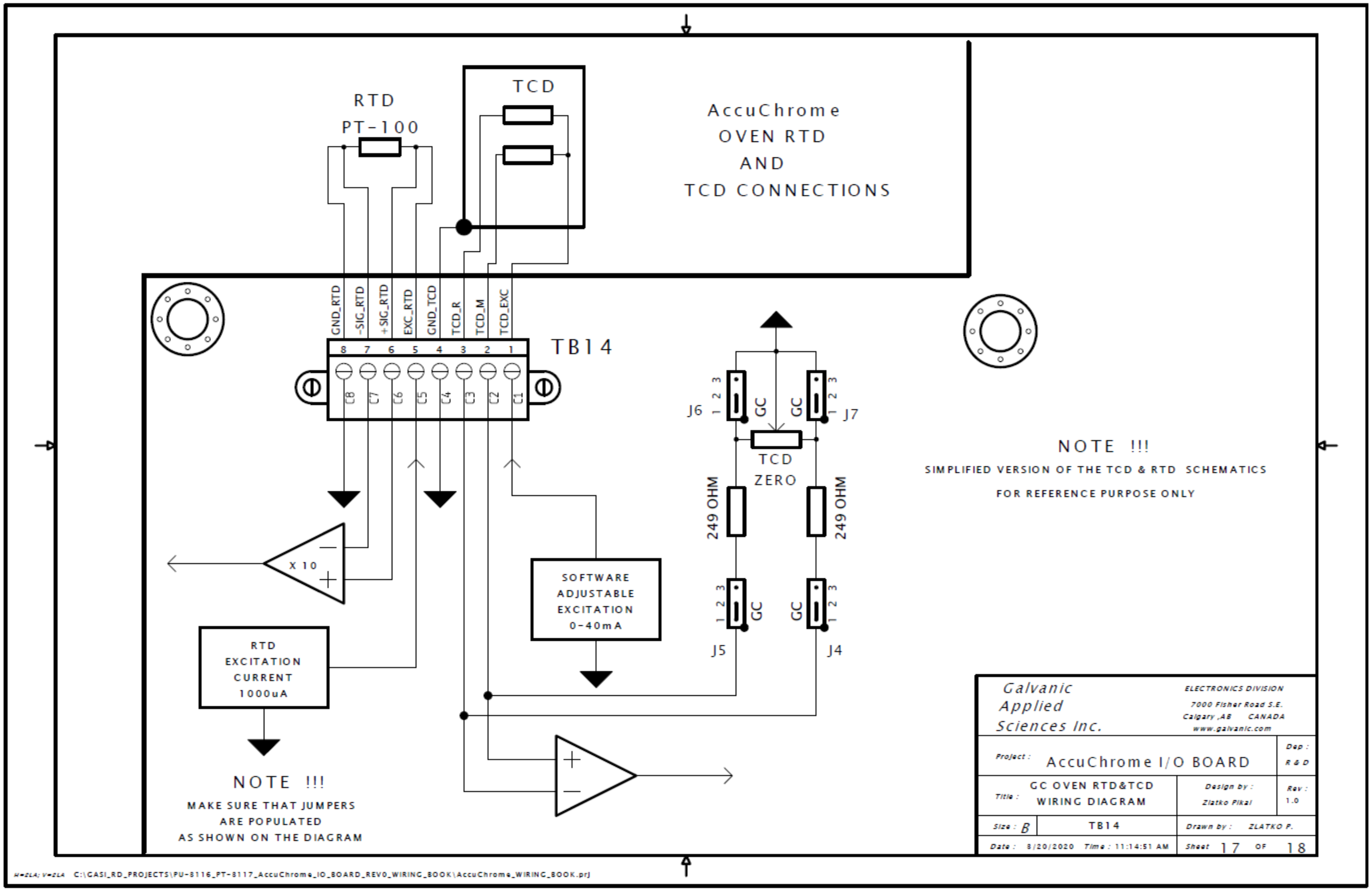

Figure 11-16: GC oven RTD & TCD wiring diagram

Section 12 **Definitions and Formulas**

12.1 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 1.05506×10^{-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.

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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.

12.2 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:

12.2.1 Response Factor (RF_n)

In calibration mode, the analyzer will measure the peak height (area) of several separations of a calibration standard.

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

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

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

12.2.2 Compressibility Factor (Z)

The Compressibility Factor is calculated by equation 13-2.

$Z = 1 – (P_b \times \Sigma^P_{n=1}\ [Conc_n \times b_n])$ **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

12.2.3 Heating Values (BTU)

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.

$Dry\ BTU / ft^3 = \Sigma^P_{n=1}\ [Conc_n * BTU / ft^3_n] / 100$ **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

$Corrected\ Dry\ BTU / ft^3 = (Dry\ BTU / ft^3) / Z$ **13-4**

Saturated BTU

$Sat\ BTU / ft^3 = Dry\ BTU / ft^3 \times 0.9826$ **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

$Corrected\ Sat\ BTU / ft^3 = (Saturated\ BTU / ft^3) / Z$ **13-6**

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12.2.4 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

Dry SG = ($\Sigma^{P}_{n=1}$ Conc$_n$ x SG$_n$) / 100 **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

Sat SG = Dry SG*(1 – xw) + xw × 0.62202 **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

12.2.5 Wobbe Index

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

Dry Wobbe Index

Dry Wobbe Index = (Corrected Dry BTU / ft^3) / √(Dry SG) **13-9**

Saturated Wobbe Index

Sat Wobbe Index = (Corrected Sat BTU / ft^3) / √(Sat SG) **13-10**

Section 13 Typical Parameters of Natural Gas Components

13.1 GPA Parameters

Table 13-1: Select properties 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).**

13.2 AGA Parameters

Table 13-2: Select properties of natural gas components (AGA)

	AGA 2145-00 14.696 psia 60 F	
Component	**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

	AGA 2145-00 14.73 psia 60 F	
Component	**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

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Section 14 **Diaphragm Valves Technical Information**

14.1 Diaphragm Valve Maintenance Instructions

There are several potential diagram valves used in the AccuChrome. Section 14.1.1 is applicable to Valco valves and Section 0 is applicable to AFP valves.

14.1.1 Valco Diagram Valve Maintenance

Diaphragm Replacement

Models DV-12 and DV-22 Diaphragm Valves

CAUTION:

Service or replacement of the o-rings, plungers, or springs must be performed at the factory. 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 environment.

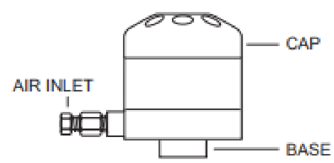


Figure 1

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.

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 in a safe, clean spot, with the polished side up so that it doesn't get scratched.

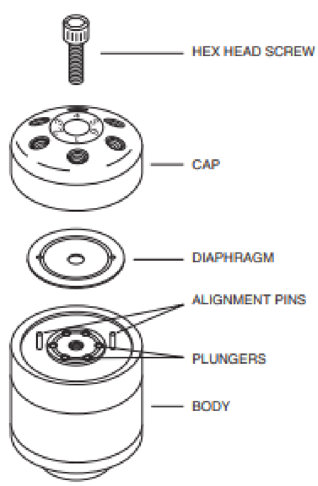


Figure 2:
Exploded view of VICI diaphgram valve

CAUTION:

Do not unscrew the hex head screw in the center of the base.

3. Use tweezers or a knife blade under the edge of the diaphragm to carefully lift and work it off the alignment pins. Be careful that you don't tilt the valve and let the plungers fall out.

4. Set the valve on a clean surface, with the base down and the plungers up.

5. Wearing powder-free rubber gloves, remove the new diaphram from its packaging. Hold it carefully by the edges so that the surface is not contaminated or damaged. 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.

5. Clean the cap thoroughly with an appropriate solvent and a clean tissue or cotton sway, taking care not to scratch the surface.

6. Blow with clean compressed gas to remove any lint left by the tissue or swab.

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

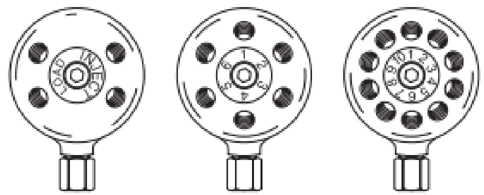


Figure 3:
Cap orientation

8. Reinstall the hex head screw in the center of the cap, and use a torque wrench with a 9/64" hex attachment to tighten it to 45 inch-pounds.

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

Troubleshooting

About all that can go wrong in this procedure is for the diaphragm to get installed upside down. If the diaphragm is installed incorrectly, flow will be reduced or eliminated entirely.

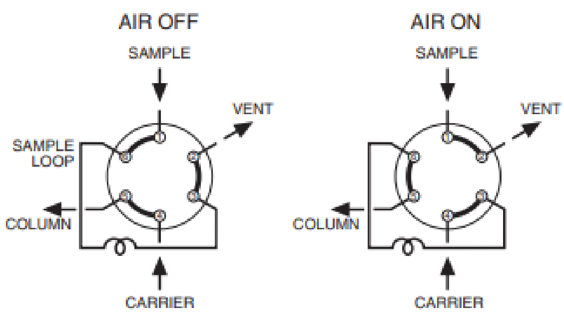


Figure 3: Sample injection with a 6 port

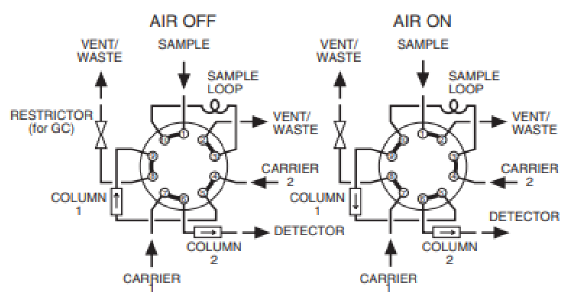


Figure 4: Typical 10 port application:
loop sampling with precolumn backflushed to vent

14.1.2 AFP Diaphragm Valve Maintenance

Part #3

Removing the relief pins from cylinder body

Another unique feature is that the valves are delivered with relief pins. These pins remove the pressure done by the plungers on the diaphragm by pulling them down. The first aim of this feature is to allow an easy replacement of the diaphragm. Since all plungers are down, it is easy to match the diaphragm process groove with the cylinder body recess.

The second purpose of these relief pins is to allow long term valve storage or instrument shut down. This way, valve performances will be the same many months after its delivery, or when the instrument is ready to be re-started. Please see diaphragm replacement procedure for more information.

Once actuation tubing has been set up and pressure has been adjusted as per valve specification sheet, actuate the valve and remove the relief pins (i.e. allow actuating gas to flow in it). You may need to increase the pressure a little to ease hand removal of the pins. Remember, make sure to properly readjust the actuating operating pressure after removing the pins, if you had to change it.

Keep these pins in a safe place. You may want to re-use them for valve maintenance. It is a good practice to re-install the relief pins in all the valves of a system before shipping the unit to your customer.

Part #4

Re-installing the relief pins into cylinder body

Actuate the valve by pressurizing the actuator (on position); when the actuator is pressurized, insert the relief pins into their respective holes as shown in figure 3.You may need to slightly increase the actuation pressure to ease the pins in. When the pins are properly inserted, depressurize the actuator (off position). This step make sure all plungers are down, making it easier to install the diaphragm and properly align it.

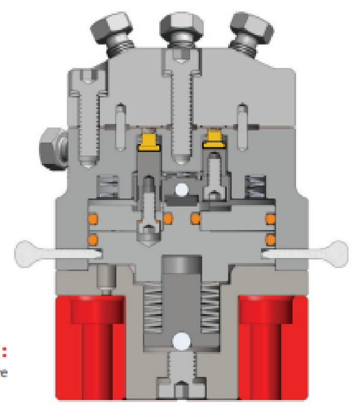


FIGURE 3 :
Relief pins installed on the valve

Part #5

Connnecting the purging ports

The purging feature of this valve is a very powerful one. It allows a very higher sensitive application to be done with complete elimination of atmospheric interferences. It eliminates diffusion and permeation related problems. Safe operation and vacuum sampling or GC/MS interface are easier to implement with success. See Figure 4 for typical installation to supply a purge gas to the valve.

The purging gas is normally supplied to the valve through a simple flow orifice. This orifice can be made of a short piece of 1/16" OD tubing. The tube is generally pinched with the help of pliers in order to let around 5 sccm of gas flow through it. The flow could be measured with a bubble flow meter or any appropriate and accurate gas flow measuring device. The measuring flow device used to tune the orifice must have his outlet vent at atmospheric pressure. This is to make sure that there is flow of purge gas into the valve. The purge gas source and type are dependent of the application. Most of the time, the purge gas is the same as the carrier gas. So, the gas is teed off of the carrier gas inlet, and then the flow orifice is tuned at the carrier gas pressure level.

In most applications, the carrier could and should be used for actuating and purging gas. This is a good strategy mainly if the carrier gas is high purity helium and the detector has a high sensitivity, like helium ionization detector. Very little flow is required to actuate the valve. See application note AN-04 for more information about using the purging feature. See also the warning notice to avoid a hazardous situation. If your system is made of several valves with purge, the best is to connect them in parallel. However, if carrier gas supply is a problem, you may connect the valve purging network in series. If you do so, don't connect more than 5 valve purges in series. This is to make sure that internal valve purging system will not become pressurized.

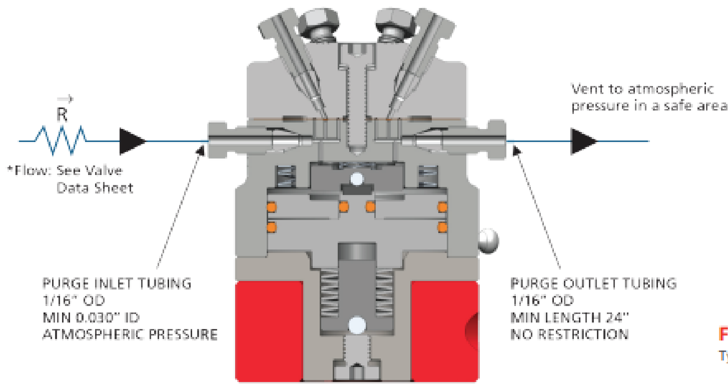


FIGURE 4 :
Typical purge tubing set-up

Part #6

Diaphragm replacement procedure

The diaphragm replacement procedure is the same for the six and ten ports valve.

Shut off carrier and sample gas before proceeding. If hydrogen, oxygen or other hazardous gases are flowing into the valve, evacuate them by allowing inert gas to flow through the valve. Make sure that no toxic or hazardous gas leak into your working area.

NOTE :

A visual inspection is necessary and recommended while the valve head and the diaphragm are removed from the valve body. If there is any trace of contaminent on the valve head wetted surface it must be cleaned using solvent that are suitable for your application.

STEP 1

Actuate the valve by pressurizing the actuator (ON position). When the actuator is pressurized, insert the relief pins into their respective holes as shown in figure 5. You may need to slightly increase the actuation pressure to ease the pins in. When the pins are properly inserted, depressurize the actuator (OFF position). This step is to assure that all the plungers are down, making it easier to install the diaphragm and properly align it.

STEP 2

Unscrew first the three screws mounted on the outer edge of the valve head and then unscrew the middle screw.

NOTE :

The screw mounted in the middle of the valve head is longer than the other ones. It must be re-installed at the same place.

STEP 3

Carefully lift up the valve head.

NOTE :

Don't touch the valve head surface with your fingers.

STEP 4

With the help of a small and clean plastic tweezer remove the used diaphragm.

STEP 5

Remove the new diaphragm from the lint free bag. With the help of a small and clean plastic tweezer install the diaphragm in place. Make sure that the diaphragm groove is aligned with the recess in the cylinder body. The diaphragm could be placed only in one position due to the special position of the dowel pins.

NOTE :

Manipulate the diaphragm only by its edge. Don't touch the process area with your fingers or dirty tools. This will affect the detector baseline and/or contaminate the column.

STEP 6

Re-install the valve head on the cylinder body by aligning the cylinder dowel pins with valve head corresponding holes and gently depose the valve head on the diaphragm. Make sure that the counter bore on the valve head and that the screws are aligned with the threads in the cylinder body.

NOTE :

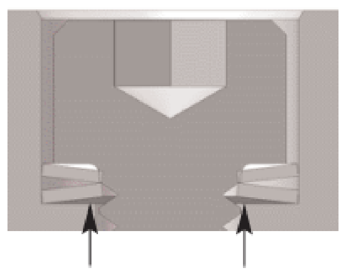
If you feel any resistance, you may not be aligned properly.

STEP 7

Re-install the four mounting screws by beginning with the longer one that must be installed in the center hole of the valve head. Tighten this screw to 5 lb-in (0.6 N-m) using a proper torquing tool supplied in our tool kit (TK-01) and then continue with the 3 other ones.

NOTE :

Make sure to have two compression washers per screw installed in the proper position.



STEP 8

Tighten first the center screw to exactly 20 lb-in (2.3 N-m) using a proper torquing tool and then, continue with the 3 other ones.

STEP 9

Re-pressurize the actuator and remove the relief pins.

STEP 10

Depressurize the actuator.

STEP 11

The valve is now ready to be used.

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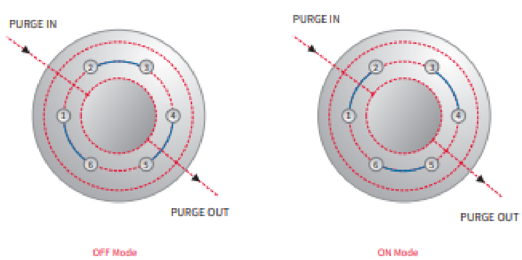
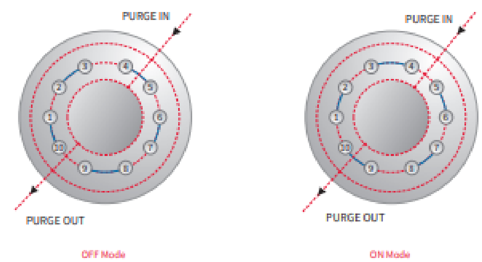
CONVENTIONAL FLOW PATH

The conventional flow path is the most common one used in gas chromatography. The main benefit of this configuration is to never interrupt the fluid, upon normal operation. So, fluid is continuously flowing in all ports, whether the valve is actuated or not. This particularity comes from the fact that actuation plungers are stopping the flow between the ports, instead of acting directly on the port.

MDVG-6



MDVG-10



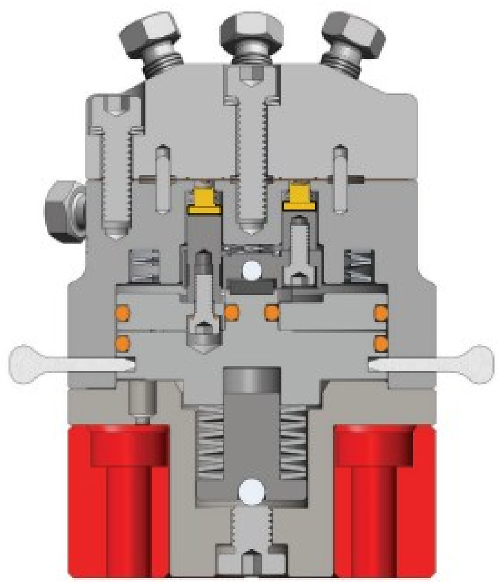


FIGURE 5

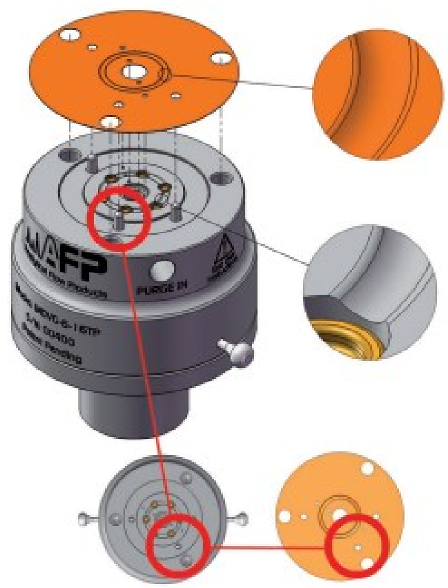


FIGURE 6

Section 15 AccuChrome Specifications

PERFORMANCE	
Accuracy (Component)	±0.5%/F.S(Range≧50),±1%/F.S(5<Range<50),±2%/F.S(Range≦5%)
Accuracy (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:	D1 models S-C6+, AC power: 1219 mm (48") H x 686 mm (27") W x 343 mm (13.5") S-C6+, DC power: 838 mm (33") H x 686 mm (27") W x 343 mm (13.5") D C9: 1397 mm (55") H x 857 mm (33.75") W x 254 mm (10") D D2 models S-C6+: 838 mm (33") H x 686 mm (27") W x 343 mm (13.5") D C9: 1397 mm (55") H x 857 mm (33.75") W x 254 mm (10") D
Weight:	D1 models S-C6+, AC power: 56kg (125 lbs) S-C6+. DC power: 45kg (100 lbs) C9: 86kg (190lbs) D2 models S-C6+: 39 kg (85 lbs) C9: 73kg (161 lbs)
UTILITIES	
Power & consumption:	24 VDC, 150 watts startup, 100 watts running 90 - 240 VAC, 50/60 Hz 150 watts startup, 100 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 TCP/IP, Modbus RS485 with add-on
Digital Inputs:	4 dry or 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 I Division 1, Groups BCD CSA (C, CUS) Class I Division 2, Groups BCD

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Section 16 **Index**

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Section 17 **Figures and Tables**

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