Gas Chromatograph

User's Manual

Models: 131S & 132S
Alternative Models: 131S-T4 and 132S-T4

Envent
Knowledge by **Analysis**

Last Updated: December 8, 2022
Revision: 8.2

Table of Contents

Table of Figures

1.0 INTRODUCTION

1.1 About This Manual

This manual provides all information necessary for the installation, operation, maintenance, and basic troubleshooting of the Envent Engineering 131S and 132S Gas Chromatograph analyzer.

This manual contains information essential to the safe and efficient operation of the 131S & 132S. This manual should be read by all personnel who will be installing, operating, or otherwise interacting with these models.

This manual focuses on the analyzer as a stand-alone unit. However, the sample gas must be conditioned before entering the analyzer to prevent erroneous readings and/or damage to the analyzer. This manual includes a recommended standard sample conditioning system configuration that would ensure proper operation of the analyzer. The exact sample conditioning system used will depend on the customer's requests at time of purchase. Refer to the analyzer's documentation for more information.

This manual will be referring to models 131S and 132S. However, the information applies equally to the 131S-T4 and 132S-T4, unless otherwise stated. To clarify, the difference between an "S" models and a "S-T4" models is the "S" models are certified for temperature code T3 whereas the "S-T4" models are certified for temperature code T4.

1.2 Warranty and Liability Statements

Products produced and supplied by the manufacturer (Envent Engineering Ltd), unless otherwise stated, are warranted against defects in materials and workmanship for up to 18 months from the shipping date or up to 12 months from the start-up date (whichever comes first). During the warranty period the manufacturer can choose to either repair or replace products which prove to be defective. The manufacturer or its representative can provide warranty service at the buyer's facility only upon prior agreement. In all cases, the buyer has the option of returning the product for warranty service to a service facility designated by the manufacturer or its representative. The buyer shall prepay all shipping charges for products returned to a service facility. The manufacturer or its representative shall pay all shipping charges for the return of products to the buyer. The buyer may also be required to pay round-trip travel expenses and labour charges (at prevailing labour rates) if the warranty has been violated. The warranty may be considered violated for any of the reasons listed below.

1.2.1 Limitation of Warranty

The foregoing warranty shall not apply to defects arising from:

- Improper or inadequate maintenance of the product by the user.
- Improper unpacking or installation procedures.
- Inadequate site preparation.
- Unauthorized modification or misuse of the product.
- Operation of the product in unfavorable environments such as elevated temperatures, high humidity, or in corrosive atmospheres.
- Operation of the product outside of the published specifications.

Envent Engineering Ltd carries no responsibility for damage caused during transportation or unpacking, unless otherwise specified in the incoterms.

An extended warranty may be available with certified start-up. Contact Envent Engineering Ltd for details.

Envent Engineering Ltd reserves the right to change the product design and specifications at any time without prior notice.

1.2.2 Disclaimer

No other warranty is expressed or implied. The manufacturer specially disclaims the implied warranties of merchantability and fitness for a particular purpose. The sole remedy of the buyer shall in no case exceed the purchase price of the analyzer. The manufacturer shall not be liable for personal injury or property damage suffered in servicing the product. The product should not be modified or repaired in any manner differing from procedures established by the manufacturer.

1.3 Safety Information

The procedures and settings outlined in this manual constitute what is considered proper use of the equipment in question. The equipment was designed and tested under the assumption that these procedures and settings will be adhered to. Applying values outside of the provided ranges (such as permitting excessive pressures) or modifying provided procedures is considered improper use of the equipment. Envent Engineering Ltd is not responsible for any injury or property damage caused by improper use of the equipment. Once in the field, the user is solely responsible for the safe operation of the equipment.

1.3.1 Key Symbols

The following symbols are used throughout the manual to call attention to vital information. We recommend familiarizing yourself with them before reading further.

Indicates a potential hazard that, if not properly addressed, could result in damage to the equipment or injury to the operator.

Caution: Hot surface.

Indicates additional information intended to help clarify an earlier statement or to aid in the reader's understanding of a given topic.

2.0 EQUIPMENT OVERVIEW

2.1 Theory of Operation

2.1.1 Important Definitions

Carrier	A gas which pushes the sample through the columns for analytical separation (also known as the "mobile phase").
Chromatogram	The output of a Chromatograph. A record of the output from the GC Detector crucial to determining mole percent concentration; typically represented as a graph or chart.
Chromatograph	A device designed to separate a mixture into individual components.
Column	An analytical device which causes components, in a sample, to separate from one another through physical interaction (also known as the "stationary phase")
Component	Any one of the multiple chemicals which make up the sample, whether it is of interest to analyze or as a contaminant.
Contaminant	A component which is not desired to be analyzed; may or may not cause interference.
Elute	The action of a component exiting a column.
Integrator	Hardware/Software responsible for computing the output of the detector into a chromatogram.
Response Factor	A factor important to determining an analyte's concentration - created during calibration.
Retention Time	The time at which the most concentrated part of a component elutes from the column and is detected, usually referenced from the start of analysis or the start of sample injection.
Sample	A mixture containing one or more components which the analyzer will measure.
TCD	Thermal Conductivity Detector.
Thermal Conductivity	A measurement of a material's ability to conduct heat.
Thermistor	A device which reacts to temperature changes with a change in resistance.

Wheatstone Bridge An electrical circuit designed to measure an unknown electrical resistance by balancing two legs of a bridge circuit.

2.1.2 Gas Chromatography

Gas Chromatography is achieved by separation of a mixture (a sample) into its individual components so that the concentration of each component can be measured. There are three basic parts to chromatography: (1) The sample; (2) the mobile phase (also known as the "carrier" (typically Helium or Hydrogen)); and (3) the stationary phase (the analytical columns). Separation occurs when the carrier pushes the sample through the columns; the analytical columns are designed such that the components of the mixture move at different rates. In this theory, the components are separated and elute from the column at different times. Detection of the separated components is done using a Thermal Conductivity Detector (TCD). The integrator (electronics) takes the output from the TCD and turns it into a graph (millivolts over time) which has peaks representing the time, and intensity, of each component eluting from the column. This output is called a chromatogram and is the basis of concentration readings and subsequent calculations that need to be performed.

2.1.3 Thermal Conductivity Detector (TCD)

The TCD block consists of two heat-sensitive thermistor beads mounted to individual chambers. Thermistors respond to a change in temperature with a change in resistance. These beads are wired together as part of a balanced wheatstone bridge, where one bead is designated as the "reference" and the other as the "measurement". As seen in Figure 1, the reference thermistor receives carrier only, while the measurement thermistor receives the carrier as well as the eluted components from the sample.

When both the thermistor beads are receiving carrier gas only, the resistance of the wheatstone bridge system remains unchanged and so the voltage measured by the integrator does not change; this state provides the GC with the baseline measurement. Alternatively, when a component elutes from the analytical column, its individual thermal conductivity will slightly change the temperature in the measurement cell which changes the resistance balance of the bridge – this change causes the integrator to detect a millivolt difference and a peak is generated on the chromatogram.

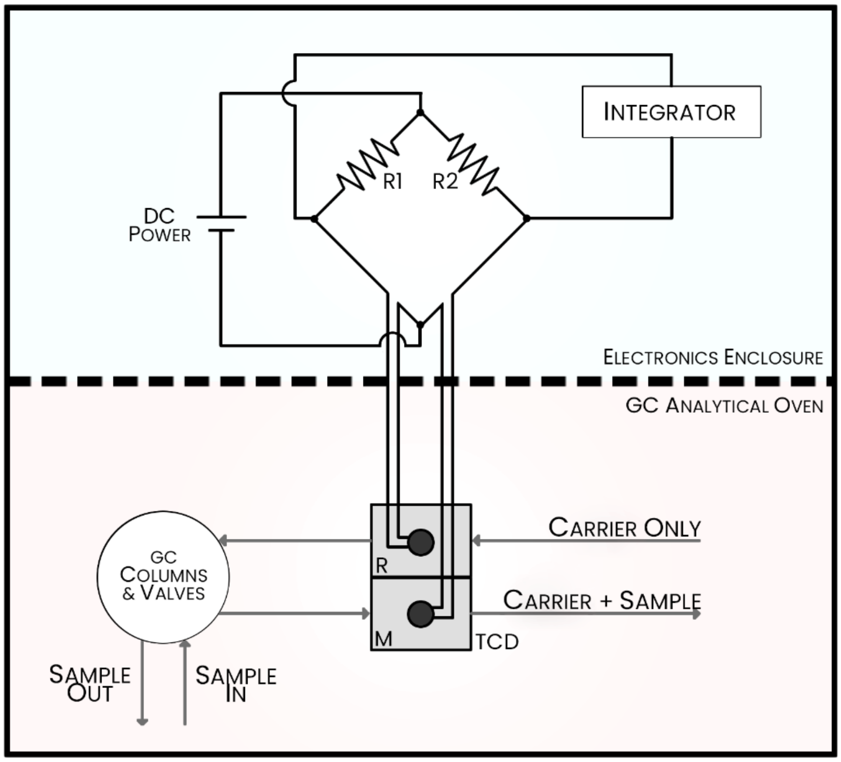


Figure 1: Diagram of the Wheatstone Bridge and TCD

2.1.4 Chromatogram Output

When a resistance change occurs between the two thermistors, and the bridge becomes unbalanced, the millivolt signal is detected, and the integrator interprets this as a peak. The peak is displayed on a chromatogram (see Figure 2), where the peak's relative size (height and width) is correlated to the concentration of the component in the sample.

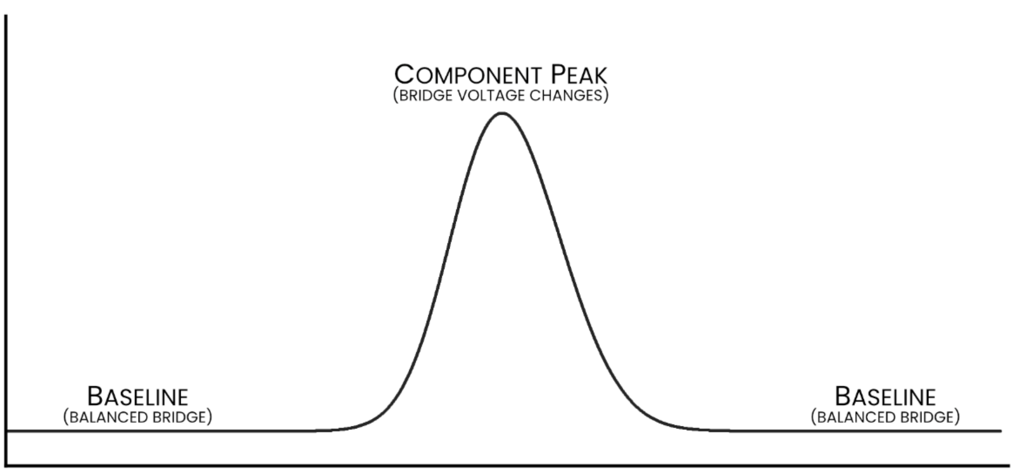


Figure 2: Labeled Diagram Depicting a Chromatogram Peak

2.1.5 Computational Analysis

Integration is performed on the peaks of the chromatogram to determine the area of each peak. The area of a peak is directly correlated to the concentration of the component in the sample, by mole percent. For the integrator to compute the mole percent concentration of a component, two factors are required: the response factor (RF) and the retention time (RT). The retention time is the time at which the peak's apex occurs (usually in seconds), in relation to the start of the chromatogram – this factor is important to identify which component belongs to which peak.

Calibration, of the analyzer, is required to determine the response factor for each component in the sample. The response factor of a component is equal to its peak area divided by the mole percent concentration of the calibration standard.

The response factor is calculated as such:

$$RF_n = \frac{A_n}{Cal\ \%_n}$$

Where,

RF_n	Response Factor of component "n"
A_n	Area of component "n"
$Cal\ \%_n$	Calibration standard's listed mole % of component "n"

During analysis, component concentrations are determined by the following calculation:

$$Mole\ \%_n = \frac{A_n}{RF_n}$$

Where,

$Mole\ \%_n$	Concentration of component "n" by mole percent
A_n	Area of component "n"
RF_n	Response factor of component "n" determined during calibration

After the concentration of each component is determined (by mole percent), the total un-normalized mole percent is calculated with the following calculation, which sums the mole percent concentrations of all the analyzed components:

$$Mole\ \%_T = \sum_{n=1}^{k} Mole\ \%_n$$

Where,

$Mole\ \%_T$	Total un-normalized mole percent
K	Number of components included in the total
$Mole\ \%_n$	Individual mole percent concentration of component "n"

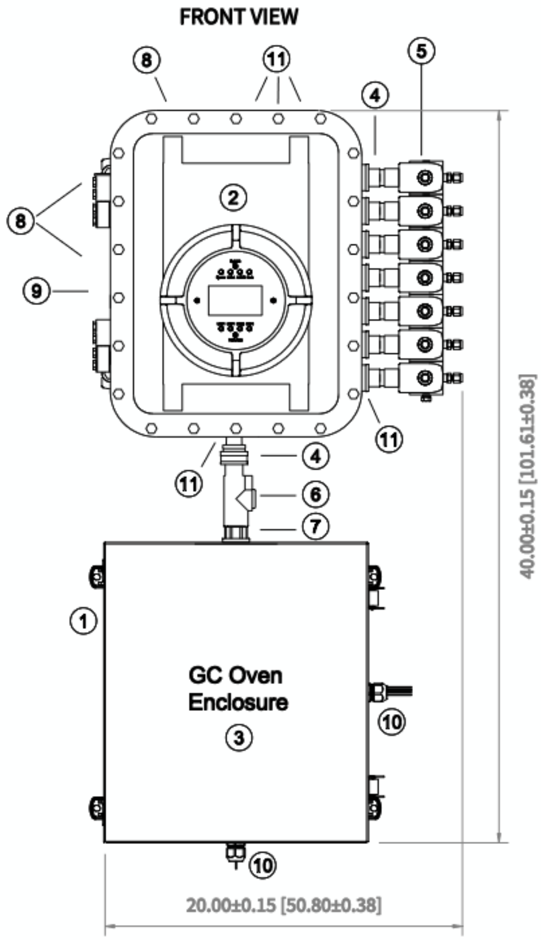
Normalization is the process by which the results of the chromatogram are adjusted such that the mole percent total equals one hundred percent. This computation is useful when the un-normalized concentration total does not equal one hundred percent – this will almost always be the case as there are always variances which affect the summed total. These variances typically stem from minor changes due to environmental effects (temperature, humidity, pressure), electrical noise differences, and/or minor contaminants or impurities in the sample or carrier. Normalization should not be used as a tool to combat inherently poor chromatography (some examples include inefficient sample conditioning, major contaminants or interference in the readings, and changes in pressure or flow of the sample or carrier). Each component's concentration is normalized using the following calculation:

$$NMole\ \%_n = \frac{Mole\ \%_n}{Mole\ \%_T} \times 100\%$$

Where,

$NMole\ \%_n$	Normalized concentration (by mole percent) of component "n"
$Mole\ \%_n$	Un-normalized concentration (by mole percent) of component "n"
$Mole\ \%_T$	Total un-normalized mole percent

2.2 External Components & Dimensions/Clearances



1. ETL cETLus nameplate
2. Upper XP enclosure for electronics
3. Lower Stainless-Steel enclosure for GC Oven
4. Male to Female Aluminum Union
5. Solenoid Valves
6. Vertical mounted seals
7. 1/2'' Myer hubs
8. 3/4'' NPT entries
9. External Ground Connection
10. Cable Gland
11. 1/2'' NPT entries

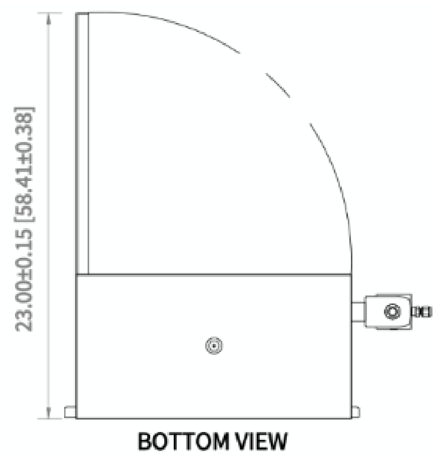
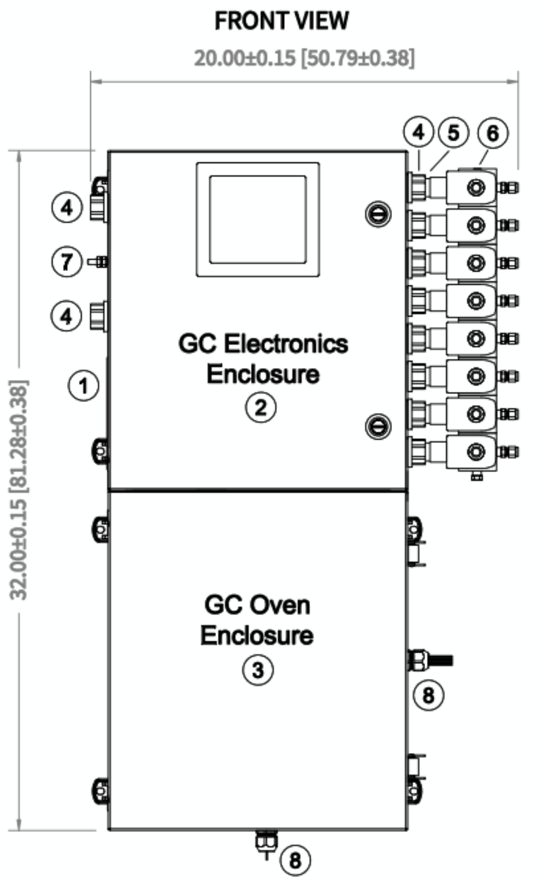


Figure 3: Model 131S External Components & Dimensions/Clearances Inches [cm]



1. ETL cETLus nameplate
2. Upper enclosure for electronics
3. Lower Stainless-Steel enclosure for GC Oven
4. 1/2'' Myer hubs
5. Rigid Conduit Nipples
6. Solenoid Valves
7. External Ground Connection
8. Cable Gland

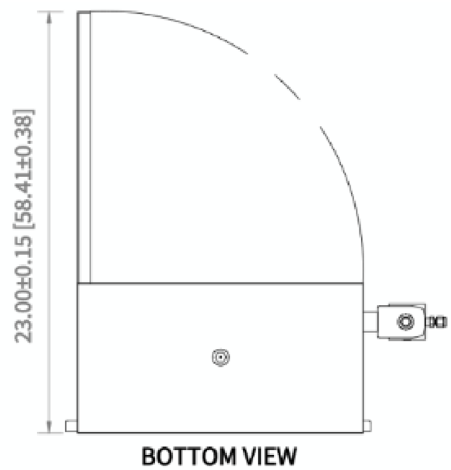


Figure 4: Model 132S External Components & Dimensions/Clearances Inches [cm]

2.3 Technical Specifications

Analyzer Specification	
Mounting	Wall-mount (Standard), Free-standing (Optional)
Supply Voltages	100-240 VAC 50/60 Hz (40 Watts running, 50 Watts Start-up) Fuse Rating: 5 Amps, 250V, Slow blow, Size: 0.201'' Dia x 0.787'', Package/Case: 5 mm x 20 mm
Certification	**Model 131S:** cETLus Class I, Division 1, Groups BCD Temp Code T3 or T4 for model "131S-T4". Ambient temperature -20 to +55 °C (-4 to +122 °F) – For indoor use only. **Model 132S:** cETLus Class I, Division 2, Groups BCD Temp Code T3 or T4 for model "132S-T4". Ambient temperature -20 to +55 °C (-4 to +122 °F) – For indoor use only. *Note: GC analyzer rated T4 are built with an alternative oven heater T4 rated.
Oven	Airless heat sink, maximum 84 °C (183.2 °F)
Display	Graphic Liquid Crystal Display: menu is scrolled by internal button or magnetic wand (131 Model)
Valves	6-port and 10-port diaphragm valves
Carrier Gas	Typically, UHP helium 7 to 20 cc/min (typical flow rates). Offering 12-14 Months operation in C6+ BTU applications (2 Column App). 6-8 Months operation in C6+ BTU applications (3 Column App). Inlet pressure to GC Carrier Port(s) is minimum 120 PSIG, maximum 250 PSIG. Dual carrier bottles recommended, with an automatically switching regulator station set at 120 PSIG outlet.
Sample Gas	For BTU/NGL applications, analyzer must be supplied a maximum 25 PSIG vapor sample, above the dewpoint temperature of the product. For Liquid Injection applications, sample pressure/flow are determined at time of application design.

Actuation Gas	Actuation supply must be a non-explosive gas (instrument air, compressed nitrogen, or compressed helium are typical). Maximum pressure to GC Actuation Port is 145 PSIG. Recommended pressure to GC Actuation Inlet is 100 PSIG when the GC is fitted with an on-panel actuation regulator (typical design). If the GC is not fitted with an on-panel actuation regulator, actuation supply must be regulated at 65 PSIG (optional design).
Calibration Gas	Calibration gas cylinder(s) must always be maintained at ambient conditions such that condensation does not occur in the cylinder or the tubing leading to the analyzer. A cylinder with sufficient pressure should be selected to keep the product above the dewpoint pressure/temperature and maintain a vapor state. A bottle heater and rubber pad (to raise the cylinder off the floor) are strongly recommended. Maximum pressure to the GC Calibration Port(s) is 25 PSIG, regulated pressure. Typical flow rate of calibration standard is 10 – 30 mL/min, per calibration stream. If the auto-calibration option is selected, calibration gas will flow for 15-30 minutes per day. Otherwise, typical usage varies depending on calibration frequency.
Calibration Liquid (if equipped)	A high-pressure, constant-pressure, liquid piston cylinder may be used for calibration standard on NGL/Liquid Injection applications. Siphon-type liquid calibration standards are not recommended, as they may cause cross-contamination. Maximum pressure to the calibration port(s) of the GC is 3500 PSIG. Recommended pressure setting of the constant-pressure liquid piston cylinder may vary per manufacturer but is typically 1000 PSIG head pressure. A high-pressure cylinder of UHP (grade 5.0 or better) helium, equipped with a high-pressure regulator, is required to pre-charge the liquid piston cylinder.
Detector	Thermal Conductivity Detector (TCD)
Gating Options	Fixed-time, auto-slope detection with automatic gating of peaks on calibration or analysis
Streams	Up to 8 streams (including calibration stream)

Electronics	Envent designed ARM7 CPU based analyzer platform
Analog Inputs	Three sensor inputs filtered with transient protection
Analog Outputs	Dual isolated 4-20 mA (2 wire standard, loop powered)
Communications	RS-232, RS- 485, TCP/IP
Modbus	Enron, Modicon 16, Modicon 32

3.0 INSTALLATION

3.1 Unpacking

CAUTION: The 131S Model GC analyzer weighs approximately 68 kg (150 lb) and the 132S Model GC analyzer weighs approximately 36 kg (80 lb) (13.6 kg (30 lb) added with sample conditioning system). Unpacking and transporting requires a minimum of two persons.

Upon arrival, the packaging should be immediately inspected for any external damage that may have occurred during shipping. If any damage is present, please contact Envent Engineering Ltd and request that the carrier's agent be present when the analyzer is unpacked. If a disagreement arises, the incoterms agreed to by the seller and the customer will overrule any dispute.

Once the integrity of the packaging has been confirmed open the shipping container and remove the packing materials from the shipping box. Remove all provided components from the shipping container and inspect them for any damage that may have been sustained during shipping. Compare the provided components to the shipping manifest to ensure that all parts are present.

3.2 Mounting Requirements

CAUTION:

1. **i. The 131S is designed for cETLus Class 1, Division 1 (132S for Division 2), Groups BCD, Temp Code T3 or T4 (for models 131S-T4 & 132S-T4) Tamb -20°C to +55°C. These models are designed for indoor use only. Ensure that the analyzer received is suitable for the electrical classification of the installation site.**

ii. The analyzer should be mounted in an enclosed area in which it is not exposed to vibrations, excessive pressures, temperatures, or environmental variations.

iii. The selected installation site should provide adequate room for maintenance and repair procedures.

iv. The installation site should be as close as possible to the process stream being measured. The sample delivered to the analyzer must be representative of the stream and as such, should be taken from a point as close as possible to the analyzer. This proximity will prevent lag times and sample degradation in the lines.

v. A bypass sweep is recommended to reduce sample lag time if the sample lines are longer than 4.6 m (15 ft) or if they are being kept at high pressure (2758 kPag (400 psig) and above). If the line pressure is over 2758 kPag (400 psig), a heated regulator is recommended.

vi. All connections must be leak tight to ensure the safety of the user and the operation of the analyzer.

vii. Sample should not exceed 172 kPag (25 psig) in sample system. Damage to sample system may result.

viii. Model 131S only:
- No modifications or repairs to the flame paths are permitted.
- Substitution of components may impair flameproof safety and suitability for Class I, Division 1.
- All NPT thread entries must meet the minimum engagement of 5 threads.
- XP enclosures must have conduit plugs installed for unused conduit entries.
- Conduit seal(s) must be installed at a minimum distance of 18'' from any XP enclosure's conduit entries.
- Conduit seals must be poured after wiring is completed and before powering up the unit. Refer to Appendix D for more information on the conduit sealing compound.

3.3 Electrical Connections

WARNING:

i. For 120 – 240 VAC powered analyzer: A disconnect device rated 240 VAC and 5A max is required and is to be installed in accordance with local electrical codes.

ii. Do not disconnect equipment unless the power has been switched off or the area is known to be non-hazardous.

iii. External ground wiring must be 12-10 AWG (3.31 – 5.26 mm2).

iv. External IS Ground wiring must be 22 AWG (0.33 mm2) green insulated conductor.

v. Power supply wiring must be rated for a minimum of 90 °C (194 °F) above surrounding ambient temperature.

vi. Relay Outputs on Mainboard (Relay 1 to 4) P7, are limited to 120VAC max, or used as dry contacts.

The 4-20 mA output requires a 24 VDC power loop which can be supplied by the analyzer.

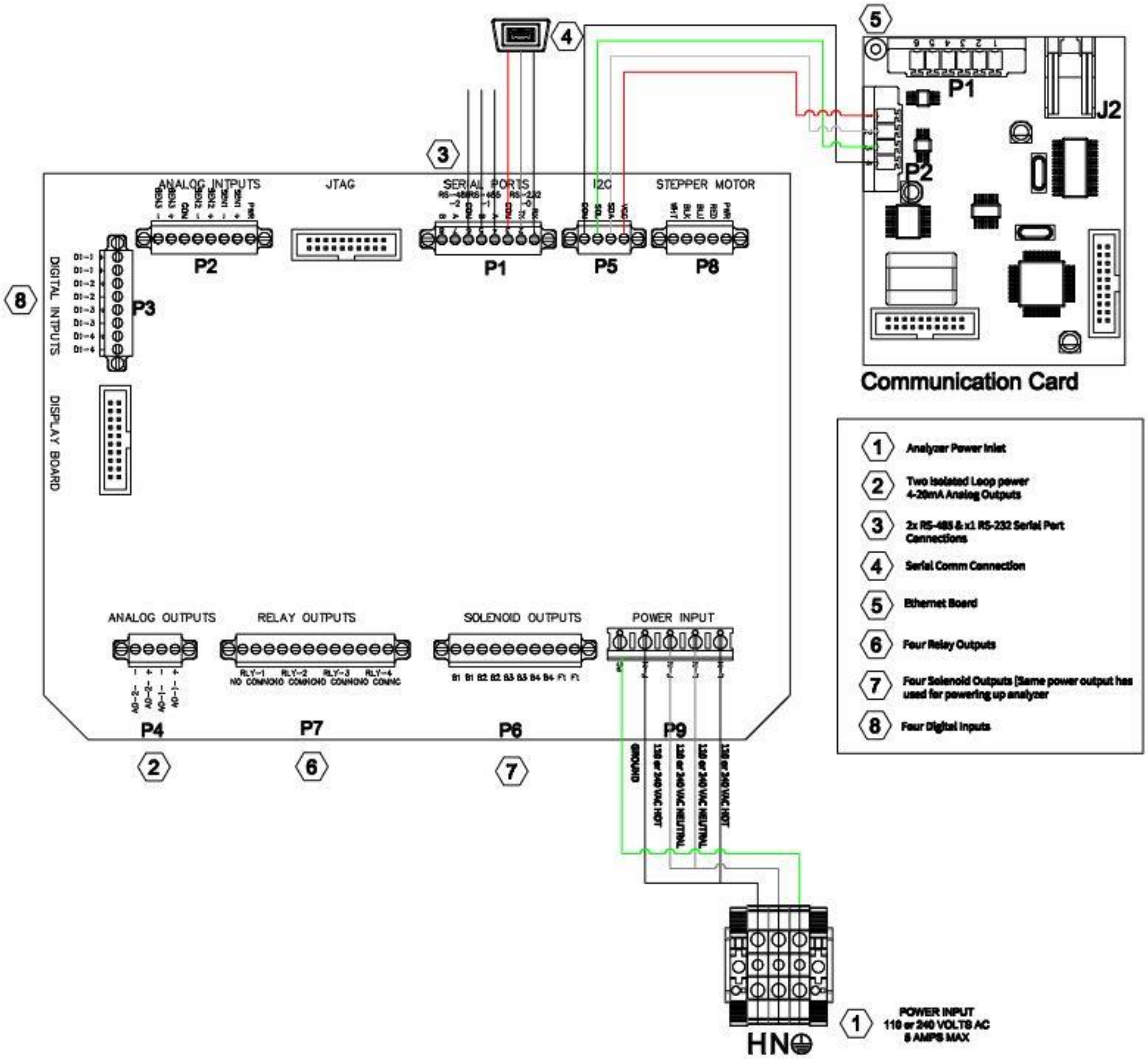


Figure 5: Electrical Customer Connections

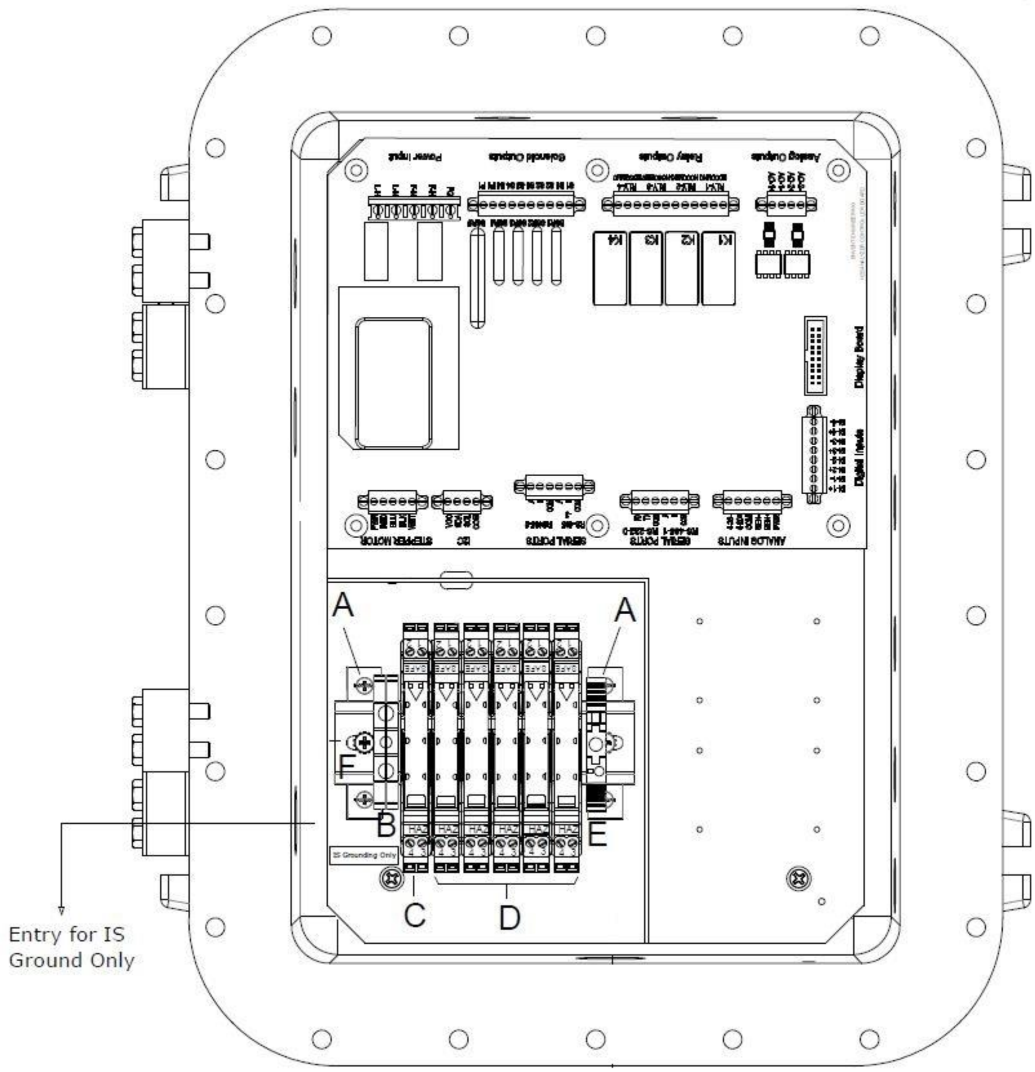


Figure 6: IS Ground Customer Connections

4.0 OPERATION

4.1 Start-Up Procedure

Oven temperature can exceed 84 °C (183 °F). Caution should be taken when touching the inside surfaces of the GC Oven.

CAUTION:

i. **Before commencing the start-up procedure for the analyzer, please ensure that all sections within "Installation" (Section 3.0) have been understood and addressed. Do not proceed until this is done as significant safety hazards can arise if the analyzer is not properly set-up prior to start-up.**

ii. **During start-up, it is possible that the analyzer and/or the SCS will be contaminated with undesired liquids/solids (such as a scavenger solution). The flow meter should be inspected for liquids to ensure that the ball moves freely. Check all filters to ensure no contaminants will be forced into the analyzer after introduction of pressurized product.**

iii. **Excessive temperature and environmental variations may affect the integrity of the calibration gas. Should heavier components condense into the liquid phase, the composition of the bottles could change. Calibration cylinders should be installed with a cylinder riser to keep the bottle off the floor. For high heating value cylinders, a heated bottle blanket may be required to ensure the contents do not condense.**

Step 1. Ensure that the analyzer power supply and range are suitable for the application.

Step 2. Check that the hazardous location rating is suitable for the installation location.

Step 3. Select an installation location that is close to the sample point.

Ensure that the selected installation site provides adequate room for maintenance and repair.

Step 4. Bolt the analyzer to the wall or secure Unistrut to a solid surface. 3/8" x 1" bolts are recommended for installation.

Step 5. Wire power, analog outputs, discrete inputs & outputs, and communications to the GC

Step 6. Check to ensure all bottles are securely fastened to wall mount brackets, leak tested, and regulators are installed on each bottle.

Dual stage regulators must be installed on the carrier gas, usually Helium. Single stage regulators can be installed on the calibration gas and process gas streams.

Step 7. Tube the sample inlet(s), calibration inlet(s), sample sweep(s), sample vent and carrier vent lines to the GC.

i. **1/4" 316 stainless steel tubing is recommended for the sample tubing.**

ii. **1/8" 316 stainless steel tubing can also be used if the response time of the analyzer is of particular concern.**

iii. **All fittings in the sample and vent lines must be 316 stainless steel.**

iv. **The sample vent line should be tubed in 3/8" stainless steel tubing to a maximum of 6'.**

v. **1/2" 316 stainless steel tubing should be used for vent lines exceeding 6'.**

vi. **The tubing should be installed with a slight downward slope and should be as short as possible.**

vii. **The sample vent line can be tubed to atmosphere, low pressure flare or returned to process. If returning to process or low pressure flare a 1/3 psi check valve should be used.**

viii. **The carrier vent line must be tubed to atmospheric pressure only.**

ix. **The ARV (Atmospheric Reference Valve) vent line must be tubed to atmospheric pressure only.**

x. **For systems with stream selectors installed, double-block-and-bleed vent must be tubed to atmospheric pressure only.**

Step 8. With the sample pressure turned off (sample inlet valve closed). Apply power to the GC. The display will illuminate.

Step 9. Turn on carrier pressure from bottle. Ensure the carrier tubing (from cylinder(s) to analyzer) is properly purged such that it is free from entrained air/moisture and primed with carrier gas. Perform a Carrier Leak Test using a positive pressure test on the whole carrier system (from bottle to analyzer outlet(s)), or by using a digital leak detector. Do not use snoop or other liquid leak detection on the carrier gas system. Factory plugs are installed on the carrier inlet/outlet lines to protect the columns from contaminants during shipping – remove these plugs when carrier gas is ready for the analyzer.

Step 10. Turn on carrier pressure from bottle and verify GC carrier pressure regulator is set to the desired pressure as outlined in the Factory Calibration Certificate provided with the GC.

Step 11. Once the GC oven is at the set point (1-2 hours), turn on calibration gas and sample gas to all stream inlets. Set flows and pressures according to the requirements of the system (typically a label on the back-pan or refer to drawings).

Calibration lines need to be properly purged to remove entrained air/moisture. To purge the lines, pressurize the system, increase the sample loop flow rate to max, close the bottle and allow the pressure to drop to 2-3 psi, open the bottle to re-pressurize the system. Repeat this 2-3 times to purge the system. Then reset the flow rate back to default and check the system for leaks.

Step 12. Connect serial cable to the GC from Laptop or a PC.

Step 13. Load Envent ICE onto a laptop or PC.

Step 14. Log onto the GC and validate communications.

Step 15. Check the certified component concentrations (not target mixtures) on the calibration bottle and configure the component table (Configuration > Components) in ICE. The values on the calibration bottle must be entered into the GC component table EXACTLY as printed on the calibration bottle in Mole % (if a component lists "balance", then it must be calculated (100% minus the sum of all other components)) (if a component lists ppm, calculate the mole percent (100% x ppm / 1000000).

Step 16. Run the calibration gas as an unknown through the GC for startup.

Navigate to the Control Screen (Operations > GC Control) and select the checkbox for the calibration gas stream. This will analyze the calibration gas without performing the calibration functions (This operation will not update the RF & RT values for each component)

Step 17. Navigate to Operations > Chromatogram and open a new chart file, or retrieve archived calibration runs from the analyzer

Step 18. Gate all peak Retention Time values in the Calibration Table.

i. **Continue to analyze calibration gas as an unknown while observing the chromatograms displayed in the diagnostics menu.**

ii. **Note the time at the top of each peak - This is referred to as the Retention Time (RT)**

iii. **Write down all RT values for each component and compare them to the RT values in the factory calibration sheet provided.**

iv. **If the values have all increased or decreased the user can either:**
  a) **Edit the component table with the correct values.**
  b) **Adjust carrier pressure slightly to line up values and edit from that point.**

v. **If they are randomly above or below the values in the factory calibration data, then the user must configure the component data to match the values on the Chromatogram without changing the carrier gas pressure.**

Step 19. Once all RT values are correct and the chromatogram compares favorably with the factory original, the user can calibrate to the calibration stream. To MANUALLY calibrate the GC: See section 4.2 (Calibration Procedure).

Step 20. Compare final calibration results to factory calibration and ensure that all RF and RT values are within the Deviation limits and that the calibration was noted as successful in the final calibration report.

Step 21. Repeat steps 15-20 for each calibration table as required.

Step 22. Edit the stream sequencing as required to ensure the desired stream sequencing is configured into the GC.

i. **Go to Configuration > Components.**
ii. **Click the desired Stream tab (bottom-half of this screen).**
iii. **In the Activation section, select the desired activation intervals.**
  a) **Check-box – Checked items allow the stream to run.**
  b) **Run numbers – Number next to check box runs this stream for "n" cycles**
  c) **Event – Event type is defined here (ex. "Continuous (Always Set)")**

Step 23. Note the chromatogram, raw data, and analysis reports for each stream for approximately 2 hours.

i. **It may be advisable to enter the calibration gas into the stream sequencing as a check on the stream-to-stream purge efficiency.**
ii. **Each stream should be completely purged from the sample loop prior to injection and subsequent analysis of the next stream in sequence.**
  a) **To check this stream-to-stream purge, enter the cal. gas into the stream sequence and configure the stream sequence for two consecutive analyses of each stream prior to switching to the next stream in sequence (i.e. 1,1,2,2,3,3,4,4 etc.)**
  b) **With two analyses of each stream, note the repeatability for each analysis on a given stream, pay particular attention to the reported results of N2 and the back flush peak (usually C6+)**

c) **If all streams are being analyzed correctly with repeatable results the stream sequencing and stream to stream purging is set up correctly. If not, then increase the sample rotameter flow rate from 2 to 3 or 4 and repeat the procedure until results are repeatable for each stream.**

Step 24. Confirm manual calibration using the calibration reports.

Step 25. Remove the second analysis and calibration gas from the stream sequencing and configure as desired for online operations.

Step 26. Save all device files and chart files to an appropriate location on the hard drive-in addition to factory calibration data for future reference.

4.2 Calibration Procedure

The number of calibrations required by the analyzer will depend on the application in question. It is recommended that a calibration is performed every 3 – 4 months (at minimum) to ensure accuracy and functionality. A calibration is performed at the factory prior to shipping.

WARNING:

i. **When performing maintenance on the Gas Chromatograph the operator should carry a personal H2S monitor, wear a hard hat, hearing protection (if applicable), safety glasses, hand protection, and steel toed boots. Depending on the location, a breathing device may be required. Examples of such devices include SCBAs (Self-contained Breathing Apparatus) and SABAs (Supplied Air Breathing Apparatus)**

ii. **Incorrect configuration of the analyzer may cause errant operation. Injury to the operator and/or damage to the facilities may occur. The analyzer's functionality should be verified if any configuration changes have been made. Consult Envent Engineering Ltd.**

iii. **All connections must be leak tight to ensure the safety of the user and the operation of the analyzer.**

iv. **To access the display menu, the display XP enclosure lid must be removed while the analyzer is powered on. Do so only when the area is known to be non-hazardous. Alternatively, a magnetic pen is included to access the menus while the enclosure lid is attached.**

The calibration functions are under the operations menu in ICE. There are three types of calibrations available:

Automatic Calibration - Based on time to initiate calibration to update RF & RT values for each component, provided that all new values fall within the limits identified in the component table.

Manual Calibration - Same as automatic calibration except initiated by operations personnel logged onto the GC with ICE PC based software. Manual calibration is not time based. To start a manual calibration, navigate to Operations > GC Control > Analysis Sequence and click the box for the calibration stream that requires calibration. Do not click the "continuous" checkbox, only the gray button which surrounds the continuous check box.
Forced Calibration - The forced calibration function is available only under the right click mouse functions in the analyzer Chromatogram menu for use when viewing chromatograms. Because a calibration should only make minor adjustments to response factors and retention times there are limits that are set in the component table to allow for minor adjustments only. If major adjustments are required, it is likely that other factors are causing problems that need to be remedied before a calibration is performed. Forced calibration allows users to bypass these safeguards. Other than the RF and RT deviation limits forced Calibration is the same as same as manual/automatic calibration.

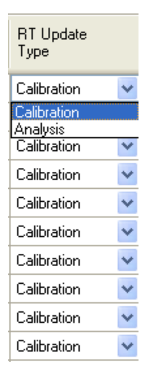
- Users should use CAUTION when using forced calibration and accept new values only after careful review of the relevant chromatograms and raw data to ensure all peaks are properly identified based on RT and concentrations reported are reasonable based on peak areas reported in raw data reports and the calibration concentrations used in the calibration standard.

The primary purpose of a calibration is to update response factors for each component listed in the component table. Responses factors determine the concentration of each component. Retention times identify each component by name. Mole % concentrations are determined with the following calculation:

$$\boldsymbol{RF = A/CalGas\%}$$
$$\boldsymbol{Mole\% = A/RF}$$

Where:
RF = Response Factor
A = Peak integrated Area
CalGas% = Calibration Gas Mole %
Mole% = Measured Mole % of component

A secondary purpose of calibration is to update the retention time for each component listed in the component table. The user can update RT based on analysis or calibration. This is configured



in the component table shown below under RT Update.
All calibrations will generate a calibration report and update response factors for each component at the completion of the final calibration. Calibration runs (consecutive analysis of calibration gas) can be configured for numerous runs with the final calibration calculations and reporting resulting in the average RF and RT values for each calibration run. These averaged values are then checked against the deviation limits for each component listed in the component table to determine if they will be accepted in manual or auto calibration mode. If any single component has a deviation beyond the defined limits for RF or RT the calibration results will not be updated, and the previous values will be retained. Forced calibration will allow these new values to be accepted independent of the deviations between updated and previous factors.

Ensure a suitable calibration gas and a single stage stainless steel regulator with the correct CGA fitting is available. Ensure the regulator is rated for calibration cylinder pressure.

Recommended calibration gas for calibration purposes should specify Primary or (certified) mixtures with all components representative of the stream compositions. The Application Data Sheet contains "Target" mixtures for calibration gas based on the individual application (for trace components it is recommended that the calibration concentration be higher than the typical concentrations found during normal operations).

Validating the Calibration - As mentioned in above the GC calibration is performed either manually automatically or by forced calibration under the Chromatogram menu. Once the calibration has been completed, the user needs to review the calibration's status ("PASS" or "FAIL"). If calibration is unsuccessful, a secondary review of the following is recommended:

- Review sample flow and carrier gas pressures relative to original factory calibration data.
- Review RT Dev. and RT Dev. for each component.
- Use Chromatogram overlay functions to compare new calibration chromatograms to factory original OR user-saved "Good Chromatograms" from the same GC from previous calibrations.
- Analyze cal. gas or additional reference gas as an unknown to compare with certified "as found" OR "as analyzed" results on the bottle.
- Contact Envent Engineering Ltd. if problems persist.

4.3 Modbus Specification

The Model 131S and 132S Gas Chromatograph support two Modbus modes (User Modbus and SIM2251). The default hardware configuration allows for three Modbus interfaces: RS485 (Port 1), RS485 (Port 2), and Ethernet (Modbus TCP). Each of the RS485 ports can be individually configured for either User Modbus or SIM2251, as well as individual speed and framing. The Ethernet Port can be configured for either User Modbus or SIM2251.

SIM2251 Specification

The SIM2251 specification is a modern, universal, Modbus mapping structure which is understood natively by modern flow computers. The data structure is pre-defined and is shown in the following table (note: this data structure is specific to the SIM2251 specification, the 131S/132S Gas Chromatograph may not use registers in all the SIM2251 ranges). See the next section for the built-in mapping and some description on how to use the registers.

Registers	Data Type	Data Size
1000 - 2999	Boolean / Coil	1 BIT
3000 - 4999	Unsigned Integer	16 BIT
5000 - 6999	Unsigned Long	32 BIT
7000 - 8999	IEEE Floating Point	32 BIT
9000 - 9999	Unsigned Integer	16 BIT

User Modbus

The Model 131S and 132S Gas Chromatograph allows for user-defined Modbus mapping. This mapping follows the Modbus/Modicon specification (see below table for details). When transmitting 32-bit data (such as Long Integers or IEEE Floating Point data), the data takes up two 16-bit registers.

Reference the Envent Gas Chromatograph Software Manual for instructions on configuring the User Modbus (Section 4.12 – User Modbus).

Registers	Data Type	Data Size
00001 - 09999	Coils	1 BIT
10001 - 19999	Discrete Inputs	1 BIT
30001 - 39999	Input Registers	16 BIT
40001 - 49999	Holding Registers	16 BIT

4.4 SIM2251 Modbus Table and Usage

The following table outlines the pre-defined SIM2251 Modbus Map. The raw register numbers are listed in the **Register Number** column; if an offset is required, it is listed in the **Register Offset** column (may be required depending on the end device's design and configuration); the **Data Type** column indicates the data's formatting; the **Variable** column indicates which Gas Chromatograph variable is stored in the register; and the **Access** column indicates whether the register is read only or read and write capable.

Register Number	Register Offset	Data Type	Variable	Access
3001	3002	UINT (16 BIT)	Last Analysis Cmp. Code (US) [1 - COMP. 1]	READ ONLY
3002	3003	UINT (16 BIT)	Last Analysis Cmp. Code (US) [1 - COMP. 2]	READ ONLY
3003	3004	UINT (16 BIT)	Last Analysis Cmp. Code (US) [1 - COMP. 3]	READ ONLY
3004	3005	UINT (16 BIT)	Last Analysis Cmp. Code (US) [1 - COMP. 4]	READ ONLY
3005	3006	UINT (16 BIT)	Last Analysis Cmp. Code (US) [1 - COMP. 5]	READ ONLY
3006	3007	UINT (16 BIT)	Last Analysis Cmp. Code (US) [1 - COMP. 6]	READ ONLY
3007	3008	UINT (16 BIT)	Last Analysis Cmp. Code (US) [1 - COMP. 7]	READ ONLY
3008	3009	UINT (16 BIT)	Last Analysis Cmp. Code (US) [1 - COMP. 8]	READ ONLY
3009	3010	UINT (16 BIT)	Last Analysis Cmp. Code (US) [1 - COMP. 9]	READ ONLY
3010	3011	UINT (16 BIT)	Last Analysis Cmp. Code (US) [1 - COMP. 10]	READ ONLY
3011	3012	UINT (16 BIT)	Last Analysis Cmp. Code (US) [1 - COMP. 11]	READ ONLY
3012	3013	UINT (16 BIT)	Last Analysis Cmp. Code (US) [1 - COMP. 12]	READ ONLY
3013	3014	UINT (16 BIT)	Last Analysis Cmp. Code (US) [1 - COMP. 13]	READ ONLY
3014	3015	UINT (16 BIT)	Last Analysis Cmp. Code (US) [1 - COMP. 14]	READ ONLY
3015	3016	UINT (16 BIT)	Last Analysis Cmp. Code (US) [1 - COMP. 15]	READ ONLY
3016	3017	UINT (16 BIT)	Last Analysis Cmp. Code (US) [1 - COMP. 16]	READ ONLY
3017	3018	UINT (16 BIT)	Last Analysis Cmp. Code (US) [2 - COMP. 1]	READ ONLY
3018	3019	UINT (16 BIT)	Last Analysis Cmp. Code (US) [2 - COMP. 2]	READ ONLY
3019	3020	UINT (16 BIT)	Last Analysis Cmp. Code (US) [2 - COMP. 3]	READ ONLY
3020	3021	UINT (16 BIT)	Last Analysis Cmp. Code (US) [2 - COMP. 4]	READ ONLY
3021	3022	UINT (16 BIT)	Last Analysis Cmp. Code (US) [2 - COMP. 5]	READ ONLY
3022	3023	UINT (16 BIT)	Last Analysis Cmp. Code (US) [2 - COMP. 6]	READ ONLY
3023	3024	UINT (16 BIT)	Last Analysis Cmp. Code (US) [2 - COMP. 7]	READ ONLY
3024	3025	UINT (16 BIT)	Last Analysis Cmp. Code (US) [2 - COMP. 8]	READ ONLY
3025	3026	UINT (16 BIT)	Last Analysis Cmp. Code (US) [2 - COMP. 9]	READ ONLY
3026	3027	UINT (16 BIT)	Last Analysis Cmp. Code (US) [2 - COMP. 10]	READ ONLY
3027	3028	UINT (16 BIT)	Last Analysis Cmp. Code (US) [2 - COMP. 11]	READ ONLY
3028	3029	UINT (16 BIT)	Last Analysis Cmp. Code (US) [2 - COMP. 12]	READ ONLY
3029	3030	UINT (16 BIT)	Last Analysis Cmp. Code (US) [2 - COMP. 13]	READ ONLY

Register Number	Register Offset	Data Type	Variable	Access
3030	3031	UINT (16 BIT)	Last Analysis Cmp. Code (US) [2 - COMP. 14]	READ ONLY
3031	3032	UINT (16 BIT)	Last Analysis Cmp. Code (US) [2 - COMP. 15]	READ ONLY
3032	3033	UINT (16 BIT)	Last Analysis Cmp. Code (US) [2 - COMP. 16]	READ ONLY
3033	3034	UINT (16 BIT)	Run Time (1/30th Sec)	READ ONLY
3034	3035	UINT (16 BIT)	Last Analysis Stream Number	READ ONLY
3035	3036	UINT (16 BIT)	Last Analysis CDT Stream Mask	READ ONLY
3036	3037	UINT (16 BIT)	Current Time - Month (MM)	READ ONLY
3037	3038	UINT (16 BIT)	Current Time - Day (DD)	READ ONLY
3038	3039	UINT (16 BIT)	Current Time - Year (YY)	READ ONLY
3039	3040	UINT (16 BIT)	Current Time - Hour (hh)	READ ONLY
3040	3041	UINT (16 BIT)	Current Time - Minute (mm)	READ ONLY
3041	3042	UINT (16 BIT)	Last Analysis Start Time - Month (MM)	READ ONLY
3042	3043	UINT (16 BIT)	Last Analysis Start Time - Day (DD)	READ ONLY
3043	3044	UINT (16 BIT)	Last Analysis Start Time - Year (YY)	READ ONLY
3044	3045	UINT (16 BIT)	Last Analysis Start Time - Hour (hh)	READ ONLY
3045	3046	UINT (16 BIT)	Last Analysis Start Time - Minute (mm)	READ ONLY
3046	3047	UINT (16 BIT)	UNUSED (PADDING)	READ ONLY
3047	3048	UINT (16 BIT)	UNUSED (PADDING)	READ ONLY
3048	3049	UINT (16 BIT)	UNUSED (PADDING)	READ ONLY
3049	3050	UINT (16 BIT)	UNUSED (PADDING)	READ ONLY
3050	3051	UINT (16 BIT)	UNUSED (PADDING)	READ ONLY
3051	3052	UINT (16 BIT)	UNUSED (PADDING)	READ ONLY
3052	3053	UINT (16 BIT)	UNUSED (PADDING)	READ ONLY
3053	3054	UINT (16 BIT)	UNUSED (PADDING)	READ ONLY
3054	3055	UINT (16 BIT)	UNUSED (PADDING)	READ ONLY
3055	3056	UINT (16 BIT)	UNUSED (PADDING)	READ ONLY
3056	3057	UINT (16 BIT)	UNUSED (PADDING)	READ ONLY
3057	3058	UINT (16 BIT)	UNUSED (PADDING)	READ ONLY
3058	3059	UINT (16 BIT)	New Data Flag	READ/WRITE
3059	3060	UINT (16 BIT)	Analysis / Calibration Flag (0=Calibration, 1=Analysis)	READ ONLY
5001	5002	LONG INT (32 BIT)	Last Analysis Time (1/30 Sec)	READ ONLY
5002	5003	LONG INT (32 BIT)	Last Calibration Time (1/30 Sec)	READ ONLY
7001	7002	FLOAT (32 BIT)	Last Analysis Mole % [Component 1]	READ ONLY
7002	7003	FLOAT (32 BIT)	Last Analysis Mole % [Component 2]	READ ONLY
7003	7004	FLOAT (32 BIT)	Last Analysis Mole % [Component 3]	READ ONLY
7004	7005	FLOAT (32 BIT)	Last Analysis Mole % [Component 4]	READ ONLY

Register Number	Register Offset	Data Type	Variable	Access
7005	7006	FLOAT (32 BIT)	Last Analysis Mole % [Component 5]	READ ONLY
7006	7007	FLOAT (32 BIT)	Last Analysis Mole % [Component 6]	READ ONLY
7007	7008	FLOAT (32 BIT)	Last Analysis Mole % [Component 7]	READ ONLY
7008	7009	FLOAT (32 BIT)	Last Analysis Mole % [Component 8]	READ ONLY
7009	7010	FLOAT (32 BIT)	Last Analysis Mole % [Component 9]	READ ONLY
7010	7011	FLOAT (32 BIT)	Last Analysis Mole % [Component 10]	READ ONLY
7011	7012	FLOAT (32 BIT)	Last Analysis Mole % [Component 11]	READ ONLY
7012	7013	FLOAT (32 BIT)	Last Analysis Mole % [Component 12]	READ ONLY
7013	7014	FLOAT (32 BIT)	Last Analysis Mole % [Component 13]	READ ONLY
7014	7015	FLOAT (32 BIT)	Last Analysis Mole % [Component 14]	READ ONLY
7015	7016	FLOAT (32 BIT)	Last Analysis Mole % [Component 15]	READ ONLY
7016	7017	FLOAT (32 BIT)	Last Analysis Mole % [Component 16]	READ ONLY
7017	7018	FLOAT (32 BIT)	Last Analysis Weight % [Component 1]	READ ONLY
7018	7019	FLOAT (32 BIT)	Last Analysis Weight % [Component 2]	READ ONLY
7019	7020	FLOAT (32 BIT)	Last Analysis Weight % [Component 3]	READ ONLY
7020	7021	FLOAT (32 BIT)	Last Analysis Weight % [Component 4]	READ ONLY
7021	7022	FLOAT (32 BIT)	Last Analysis Weight % [Component 5]	READ ONLY
7022	7023	FLOAT (32 BIT)	Last Analysis Weight % [Component 6]	READ ONLY
7023	7024	FLOAT (32 BIT)	Last Analysis Weight % [Component 7]	READ ONLY
7024	7025	FLOAT (32 BIT)	Last Analysis Weight % [Component 8]	READ ONLY
7025	7026	FLOAT (32 BIT)	Last Analysis Weight % [Component 9]	READ ONLY
7026	7027	FLOAT (32 BIT)	Last Analysis Weight % [Component 10]	READ ONLY
7027	7028	FLOAT (32 BIT)	Last Analysis Weight % [Component 11]	READ ONLY
7028	7029	FLOAT (32 BIT)	Last Analysis Weight % [Component 12]	READ ONLY
7029	7030	FLOAT (32 BIT)	Last Analysis Weight % [Component 13]	READ ONLY
7030	7031	FLOAT (32 BIT)	Last Analysis Weight % [Component 14]	READ ONLY
7031	7032	FLOAT (32 BIT)	Last Analysis Weight % [Component 15]	READ ONLY
7032	7033	FLOAT (32 BIT)	Last Analysis Weight % [Component 16]	READ ONLY
7033	7034	FLOAT (32 BIT)	Last Analysis HV - Gross Dry BTU	READ ONLY
7034	7035	FLOAT (32 BIT)	Last Analysis HV - Gross Sat BTU	READ ONLY
7035	7036	FLOAT (32 BIT)	Last Analysis GPA - Real Relative Gas Density	READ ONLY
7036	7037	FLOAT (32 BIT)	Last Analysis GPA - Z Factor	READ ONLY
7037	7038	FLOAT (32 BIT)	Last Analysis GPA - Wobbe Index	READ ONLY
7038	7039	FLOAT (32 BIT)	Last Analysis - Total Un-normalized Mole %	READ ONLY
7039	7040	FLOAT (32 BIT)	Last Analysis - Gal/1000 SCF C2+	READ ONLY
7040	7041	FLOAT (32 BIT)	UNUSED (PADDING)	READ ONLY
7041	7042	FLOAT (32 BIT)	UNUSED (PADDING)	READ ONLY
7042	7043	FLOAT (32 BIT)	UNUSED (PADDING)	READ ONLY
7043	7044	FLOAT (32 BIT)	UNUSED (PADDING)	READ ONLY

Register Number	Register Offset	Data Type	Variable	Access
7044	7045	FLOAT (32 BIT)	UNUSED (PADDING)	READ ONLY
7045	7046	FLOAT (32 BIT)	UNUSED (PADDING)	READ ONLY
7046	7047	FLOAT (32 BIT)	UNUSED (PADDING)	READ ONLY
7047	7048	FLOAT (32 BIT)	UNUSED (PADDING)	READ ONLY
7048	7049	FLOAT (32 BIT)	UNUSED (PADDING)	READ ONLY
7049	7050	FLOAT (32 BIT)	UNUSED (PADDING)	READ ONLY
7050	7051	FLOAT (32 BIT)	UNUSED (PADDING)	READ ONLY
7051	7052	FLOAT (32 BIT)	UNUSED (PADDING)	READ ONLY
7052	7053	FLOAT (32 BIT)	UNUSED (PADDING)	READ ONLY
7053	7054	FLOAT (32 BIT)	UNUSED (PADDING)	READ ONLY
7054	7055	FLOAT (32 BIT)	Last Analysis HV - Gross Actual BTU	READ ONLY
7055	7056	FLOAT (32 BIT)	Average [1] User Defined	READ ONLY
7056	7057	FLOAT (32 BIT)	Average [2] User Defined	READ ONLY
7057	7058	FLOAT (32 BIT)	Average [3] User Defined	READ ONLY
7058	7059	FLOAT (32 BIT)	Average [4] User Defined	READ ONLY
7059	7060	FLOAT (32 BIT)	Average [5] User Defined	READ ONLY
7060	7061	FLOAT (32 BIT)	Average [6] User Defined	READ ONLY
7061	7062	FLOAT (32 BIT)	Average [7] User Defined	READ ONLY
7062	7063	FLOAT (32 BIT)	Average [8] User Defined	READ ONLY
7063	7064	FLOAT (32 BIT)	Average [9] User Defined	READ ONLY
7064	7065	FLOAT (32 BIT)	Average [10] User Defined	READ ONLY
7065	7066	FLOAT (32 BIT)	Average [11] User Defined	READ ONLY
7066	7067	FLOAT (32 BIT)	Average [12] User Defined	READ ONLY
7067	7068	FLOAT (32 BIT)	Average [13] User Defined	READ ONLY
7068	7069	FLOAT (32 BIT)	Average [14] User Defined	READ ONLY
7069	7070	FLOAT (32 BIT)	Average [15] User Defined	READ ONLY
7070	7071	FLOAT (32 BIT)	Archive Results [1] User Defined	READ ONLY
7071	7072	FLOAT (32 BIT)	Archive Results [2] User Defined	READ ONLY
7072	7073	FLOAT (32 BIT)	Archive Results [3] User Defined	READ ONLY
7073	7074	FLOAT (32 BIT)	Archive Results [4] User Defined	READ ONLY
7074	7075	FLOAT (32 BIT)	Archive Results [5] User Defined	READ ONLY
7075	7076	FLOAT (32 BIT)	Archive Results [6] User Defined	READ ONLY
7076	7077	FLOAT (32 BIT)	Archive Results [7] User Defined	READ ONLY
7077	7078	FLOAT (32 BIT)	Archive Results [8] User Defined	READ ONLY
7078	7079	FLOAT (32 BIT)	Archive Results [9] User Defined	READ ONLY
7079	7080	FLOAT (32 BIT)	Archive Results [10] User Defined	READ ONLY
7080	7081	FLOAT (32 BIT)	Archive Results [11] User Defined	READ ONLY
7081	7082	FLOAT (32 BIT)	Archive Results [12] User Defined	READ ONLY
7082	7083	FLOAT (32 BIT)	Archive Results [13] User Defined	READ ONLY

Register Number	Register Offset	Data Type	Variable	Access
7083	7084	FLOAT (32 BIT)	Archive Results [14] User Defined	READ ONLY
7084	7085	FLOAT (32 BIT)	Archive Results [15] User Defined	READ ONLY
7085	7086	FLOAT (32 BIT)	TCD mV reading – TCD1	READ ONLY
7086	7087	FLOAT (32 BIT)	TCD mV reading – TCD2	READ ONLY
7087	7088	FLOAT (32 BIT)	Last Cal HV - Gross Actual BTU	READ ONLY
7088	7089	FLOAT (32 BIT)	Last Cal HV - Gross Dry BTU	READ ONLY
7089	7090	FLOAT (32 BIT)	Last Cal HV - Gross Sat BTU	READ ONLY
7090	7091	FLOAT (32 BIT)	Last Cal GPA - Wobbe Index	READ ONLY
7091	7092	FLOAT (32 BIT)	Last Cal GPA - Real Relative Gas Density	READ ONLY
7092	7093	FLOAT (32 BIT)	Last Cal GPA - Z Factor	READ ONLY
7093	7094	FLOAT (32 BIT)	Last Cal - Gal/1000 SCF C2+	READ ONLY
7094	7095	FLOAT (32 BIT)	Last Cal - Total Un-normalized Mole %	READ ONLY
9006	9007	UINT (16 BIT)	Current Time - Month (MM)	READ ONLY
9007	9008	UINT (16 BIT)	Current Time - Day (DD)	READ ONLY
9008	9009	UINT (16 BIT)	Current Time - Year (YY)	READ ONLY
9009	9010	UINT (16 BIT)	Current Time - Hour (hh)	READ ONLY
9010	9011	UINT (16 BIT)	Current Time - Minute (mm)	READ ONLY
9011	9012	UINT (16 BIT)	Current Time - Second (ss)	READ ONLY
9012	9013	UINT (16 BIT)	Day of Week - Sun-Sat (0-6)	READ ONLY
9013	9014	UINT (16 BIT)	Plug ID or Modbus Device ID	READ ONLY

Register Usage

3001 – 3032 (Component Codes): These registers are used to indicate which components are responsible for the Mole Percent/Weight Percent readings in registers 7001 – 7032. Registers 3001 – 3016 are the components in CDT 1 (Component Device Table 1), while 3017 – 3032 are the components in CDT 2 (Component Device Table 2).

3033 (Run time in 1/30th of a second): This register holds the current run time of the GC, depicted in 1/30th of seconds. If the current time is 120 seconds, this register will output the value 3600.

3034 (Last Analysis Stream Number): Index number of the last analysis stream which was run. This number may represent either an analysis stream or a calibration stream depending on the configuration.

3035 (Last Analysis CDT Stream Mask): This register requires a bit-wise interpretation. Each bit represents a stream (bit 1 – 16 = Stream 1 – 16). If the stream uses Component Device Table 1 (CDT 1), the bit will be a 1, if the stream uses CDT 2, the bit will be a 0.

3036 – 3040 (Current GC Time): Holds the current GC time, updated at end of analysis (analysis end time).

3041 – 3045 (Last Analysis Start Time): Holds the last analysis start time.

3046 – 3057 (UNUSED): These registers are unused and exist as padding variables to make polling the range as a single list more user friendly. These registers always output 0.

3058 (New Data Flag): This register contains a "1" whenever new data is stored in the Last Analysis Results Registers. This is a read/write register and can be cleared with a "0" by the Modbus Master. When the data becomes fresh again, this flag is set to "1".

3059 (Analysis / Calibration Flag): When this register contains a "1" it indicates that the Last Analysis Results were from an analysis run, when it contains a "0" it indicates that the Last Analysis Results were from a Calibration Run. The Modbus Master can use the data in registers 3058 and 3059 to determine when new analysis results are available from the GC, as well as if those results are from an analysis/calibration run.

5001 (Last Analysis Cycle Time – 1/30th sec): Holds the cycle time for the last analysis run in 1/30th of a second. For example, if the cycle time was 240 seconds, this register will hold 7200.

5002 (Last Calibration Cycle Time – 1/30th sec): Holds the cycle time for the last calibration run in 1/30th of a second. For example, if the cycle time was 240 seconds, this register will hold 7200.

7001 – 7016 (Last Analysis Mole %): These registers hold the Mole % results for the last analysis run. The order of the components is determined by reading registers 3001 – 3016 which contain the US Component Codes.

7017 – 7032 (Last Analysis Weight %): These registers hold the Weight % results for the last analysis run. The order of the components is determined by reading registers 3001 – 3016 which contain the US Component Codes.

7033 – 7039, 7054 (Last Analysis Stream Results): These registers hold the GPA stream results (refer to mapping table).

7040 – 7053 (UNUSED): These registers are unused and exist as padding variables to make polling the range as a single list more user friendly. These registers always output 0.

7055 – 7069 (Averages (User Defined)): These registers hold the averages (periodic samples) as defined by the user/operator. See the Envent GC Software Manual (Section 4.8 Periodic Samples) for a reference on how this is configured. These registers only hold results for the first 15 periodic samples which have been configured.

7070 – 7084 (Archive Results (User Defined)): Stores the first 15 variables which are in the first User Archive in memory. The user archives are user/operator configurable, see the Envent GC Software Manual (Section 4.11 User Archives (Configuration)) for details on how this can be configured.

If the operator wishes for these results to be the archived record of Averages (7055 – 7069), then the User Archive will need to be built to accommodate for this. Contact Envent Engineering for assistance.

7085 – 7086 (TCD mV Reading): These registers hold the live TCD raw mV reading for TCD1 and TCD2 (Analog Input 1 and Analog Input 2).

7087 – 7094 (Last Calibration Stream Results): Contains the results from the last calibration stream which was run (refer to mapping table).

9006 – 9011 (Real Time Clock): These registers hold the real-time clock values, stored as:

9006: MM (Month)
9007: DD (Day)
9008: YY (Year)
9009: hh (Hour, 24-hour clock)
9010: mm (Minute)
9011: ss (Second)

9012 (Day of the Week): This register stores and integer representing the day of the week in a numerical format. 0 – 6 represents the day of the week in order of Sunday to Saturday (Sunday being 0).

9013 (Modbus ID number/Plug ID): This register holds an integer representing the Modbus ID (or Plug ID) that is configured for the Modbus port being monitored. See the Envent GC Software Manual (Section 4.1 Hardware) for details on the Modbus Port configurations.

5.0 MAINTENANCE

The Gas Chromatograph was configured, functionally tested, and calibrated at the factory prior to shipping. All test and calibration data can be found in the Factory Calibration Report.

WARNING:

i. **When performing maintenance on the Gas Chromatograph the operator should carry a personal H_2S monitor, wear a hard hat, hearing protection (if applicable), safety glasses, hand protection, and steel toed boots. Depending on the location, a breathing device may be required. Examples of such devices include SCBAs (Self-contained Breathing Apparatus) and SABAs (Supplied Air Breathing Apparatus).**

ii. **Do not disconnect equipment or open XP enclosures unless the power has been switched off or the area is known to be non-hazardous.**

iii. **Field disassembly of any component of the analyzer or sample conditioning system is not advised. Consult the factory if disassembly is required.**

iv. **Turn off the power before servicing. Ensure that the circuit breakers are off before connecting or disconnecting supply power.**

v. **No modifications or repairs to the flame paths are permitted.**

vi. **Substitution of components may impair flameproof safety and suitability for Class I, Division 1 on model 131S.**

vii. **Substitution of components may impair safety and suitability for Class I, Division 2 on model 132S.**

viii. **XP enclosures must have conduit plugs installed for unused conduit entries.**

ix. **The XP enclosures' covers must remain installed and fully engaged to maintain area classification. They must be secured with the provided 6/32 x ½ set screw. A 1/16 hex key is required for removal.**

x. **All connections must be leak tight to ensure the safety of the user and the operation of the analyzer.**

5.1 Maintenance Procedures

The following maintenance procedures are required to validate proper GC operations and maintain optimal performance:

Step 1. During start up store and maintain all factory calibration reports and operational parameters shipped with the GC for future reference.

Step 2. Check Helium Pressure to ensure minimum pressure of 100 psig is maintained at the regulator attached to the helium bottle(s).

Step 3. Check Calibration Gas to ensure minimum pressure of 10 psig is maintained.

- Also check to ensure Calibration gas is kept warm enough to ensure the heaviest components listed on the certification tab will not condense in the calibration bottle due to cold ambient temperatures.
- As a rule of thumb for Natural Gas Applications, the minimum ambient temperature that needs to be maintained on the calibration gas is -10 °C (8 °F) with C6+ at 300 ppm or less and Pentanes (C5) at 0.2 mole % or less.

Step 4. Check Calibration reports to ensure all RF and RT values do not exceed the deviation limits in the component table.

- Pay particular attention to back flush peaks like C6+

Step 5. Also note which component have the greatest deviations in final calibration reports. Check against original factory reports.

Step 6. Check Raw Data reports to confirm that the component with the largest deviation amounts is a valid peak with peak areas or heights that are close to original factory parameters.

Step 7. Check carrier gas pressure (usually Helium) on the third-stage carrier pressure regulator and pressure gauge and compare it to the factory calibration certificate.

WARNING: Do not make any adjustments to the third-stage carrier pressure regulator(s); consult Envent Engineering Ltd. if the pressure setting is different compared to the factory calibration certificate.

Step 8. Check Chromatograms against original chromatograms from factory calibration using overlay functions.

- Ensure all peaks are eluting at similar retention times and that baseline separation is maintained between peaks relative to original factory chromatograms.
- Note back flush peak relative to factory originals.
- Save " *.chart" files with chromatograms from valid calibrations and with comments at least once per year.

5.2 Monthly Check-Up

CAUTION:

i. **Incorrect configuration of the analyzer may cause errant operation. Injury to the operator and/or damage to the facilities may occur. The analyzer's functionality should be verified if any configuration changes have been made. Consult Envent Engineering Ltd for assistance.**

ii. **When performing maintenance on the Gas Chromatograph the operator should carry a personal H2S monitor, wear a hard hat, hearing protection (if applicable), safety glasses, hand protection, and steel toed boots. Depending on the location, a breathing device may be required. Examples of such devices include SCBAs (Self-contained Breathing Apparatus) and SABAs (Supplied Air Breathing Apparatus).**

iii. **All connections must be leak tight to ensure the safety of the user and the functionality of the analyzer.**

While the Gas Chromatograph requires little in the way of regular maintenance, a monthly check-up is still recommended to ensure that the system is performing to specifications. The recommended steps for a monthly check-up are as follows:

- Check that the analyzer's display is on and displaying the live oven temperature (default configuration) or displaying the values which were requested to be displayed during configuration.
- Check the sample inlet gas flow by inspecting the flow meter(s) and pressure gauge(s).
- Check the filter(s) in the sample conditioning system. Depending on the application and sample gas quality, the inlet filter will last between one and four months.
- It is recommended that a calibration is performed every 3 – 4 months. More frequent calibration may be necessary depending on operating conditions.

5.3 Preventative Maintenance Checklist

This checklist should be printed to ensure smooth operation of the Gas Chromatograph.
Perform at least monthly, or in accordance with the specific requirements of the operations/facility.

Date: ______________________ Technician: ______________________

System Check	Check #1	Check #2	Check #3
Carrier Gas	**Pressure**		
Cylinder 1 (high side) **(replace below 150 PSI)**	___________PSI		
Cylinder 2 (if equipped, high side) **(replace below 150 PSI)**	___________PSI		
Outlet Regulator Reading **(Recommended 150 PSI)**	___________PSI		
Carrier Regulator Setting (on backpan, **do not adjust**)	___________PSI		
2nd Carrier Regulator Setting (if equipped, **do not adjust**)	___________PSI		
Calibration Gas Pressures	**Pressure**		
Cylinder Pressure (high side)	___________PSI		
Regulator Pressure (low side) (**Recommended 15 PSI**)	___________PSI		
Sample Conditioning System	**Pressure**	**Flow (if equipped)**	**Filter State**
Stream 1 (**Rec. PRESS. = 15 PSI, FLOW = 2**)	___________PSI	___________0-6	☐ Dirty ☐ Clean
Stream 2 (**Rec. PRESS. = 15 PSI, FLOW = 2**) (if equipped)	___________PSI	___________0-6	☐ Dirty ☐ Clean
Stream 3 (**Rec. PRESS. = 15 PSI, FLOW = 2**) (if equipped)	___________PSI	___________0-6	☐ Dirty ☐ Clean
Stream 4 (**Rec. PRESS. = 15 PSI, FLOW = 2**) (if equipped)	___________PSI	___________0-6	☐ Dirty ☐ Clean
Analytical			
Sample Outlet 1 (**Recommended Flow = 2**)	__________0-6		
Sample Outlet 2 (**Recommended Flow = 2**) (if equipped)	__________0-6		
TCD1 mV Reading	___________mV		
TCD2 mV Reading (if equipped)	___________mV		

☐ Saved last 3 Calibration Chromatograms (GC Software Manual – Section 6.2)

☐ Saved last 3 Process Chromatograms (3 per stream) (GC Software Manual – Section 6.2)

☐ Saved user archives (records since last maintenance) (GC Software Manual – Section 5.3)

☐ Saved analyzer configuration (File >> Save As…) (GC Software Manual – Section 2.8)

Next Service/Maintenance Date: ______

Envent Engineering (Canada) Service Phone Number: (403) 253-4012 (local) / 1 (877) 936 – 8368 (toll-free)
Envent Technologies (USA) Service Phone Number: 1 (713) 567 – 4421

5.4 Filter Replacement Procedure

Step 1. Ensure that the field site bypass is enabled. No local bypass is available on the analyzer.

Step 2. Halt the analyzer (Navigate to Operations/GC Control/Analysis Sequence and click "halt", or use the top-button on the display)

Step 3. Shut off the sample gas inlet.

Step 4. Ensure there is no pressure in the filter housing by checking the pressure gauge. Open sample sweep needle valve to release any remaining pressure.

CAUTION: Once the pressure has been released, close the sample sweep needle valve to protect the operator from gas releases caused by backpressure from the sample sweep line.

Step 5. Dismantle the ¼'' tube piece by loosening both ¼'' nut fittings using a 9/16'' wrench.

Step 6. Remove the filter housing by using a 3/4'' wrench. Go counterclockwise to loosen filter housing.

Step 7. Rotate the element retainer counterclockwise to gain access to the microfiber coalescing filter element.

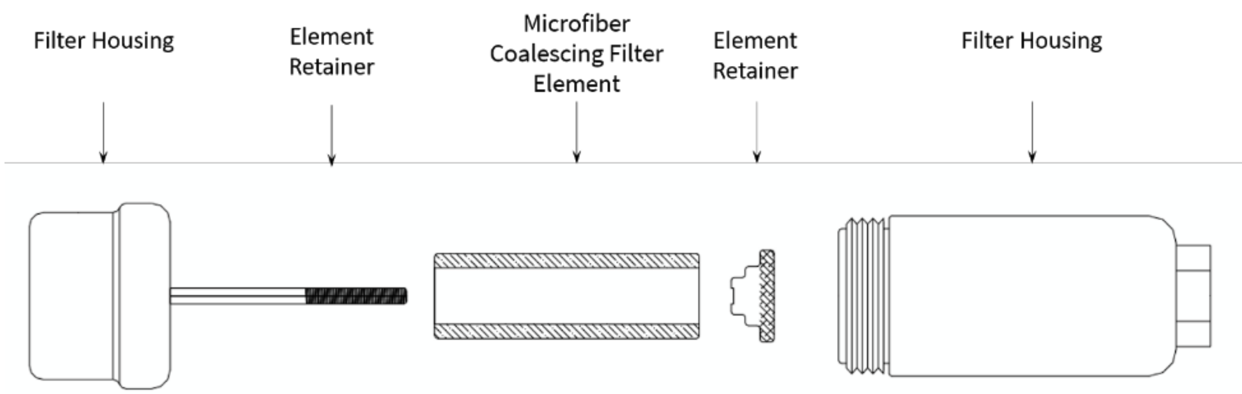


Figure 7: Microfiber Coalescing Filter Element Diagram

Step 8. Discard the microfiber coalescing filter element and replace it with a new one. Refer to Section 5.2 for more information.

Step 9. Tighten the element retainer to between a quarter and a full turn after it first contacts the microfiber coalescing filter element. This will securely seal the filter tube. A mark on the end of the retainer can be used as a guide.

Step 10. Before replacing the filter housing ensure that the mating threads and sealing surfaces are clean and damage free. It is recommended that the threads and sealing faces be lubricated with a small amount of silicone grease before assembly. Stainless steel housings fitting contains a solid PTFE gasket.

Step 11. Install the filter housing back to its top base by using a torque wrench. It should be tightened to a torque of 30 – 40 Nm.

Step 12. Reassemble the ¼'' tube piece using a 9/16'' wrench.

Step 13. Open the sample gas inlet.

Step 14. Open the sample sweep needle valve and adjust based on the desired analyzer response time.

Step 15. Set flows and pressures according to the requirements of the system (typically a label on the back-pan or refer to drawings).

Step 16. Wait 3-4 analysis cycles for the analyzer's readings to stabilize.

Step 17. Disable the field site bypass.

CAUTION: All connections must be leak tight to ensure the safety of the user and the functionality of the analyzer.

5.5 Sample Conditioning System Cleaning Procedure

During start-up or plant upset situations, the analyzer and sample conditioning system may become contaminated with amine or a hydrogen sulfide scavenger solution. This in turn may cause the analyzer to read incorrectly. The scavenger solution is water soluble and therefore is relatively easy to clean. Should it become necessary to clean the sample conditioning system and the CH_4 sensor, follow the steps below.

If the analyzer requires cleaning on a regular basis, the sample point may have to be relocated or additional sample conditioning may be required. Please consult Envent Engineering Ltd.

CAUTION:

i. **Electrostatic Hazard – The aluminum back-pan must be cleaned exclusively with a damp cloth to prevent a static charging hazard.**

ii. **Do not use solvents, brake cleaners, soaps, detergents, or rubbing alcohol to clean the analyzer or the sample conditioning system.**

The materials required to clean the sample conditioning system are:

- A residue free cleaning agent (such as Alconox Laboratory Cleaner)
- Clean fresh water
- 100% isopropyl alcohol
- A rinse bottle

Step 1. Mix the residue cleaning agent and warm water to produce a cleaning solution. The solution should have a concentration of approximately 1% (2.5tbsp/gal).

Step 2. Shut off the sample flow at the sample point prior to the sample system.

The sweep valve on the sample filter should always be left slightly open. This will decrease the likelihood of contamination.

Step 3. Disassemble the sample conditioning system components and tubing.

It is recommended to take pictures before disassembling the components of the sample conditioning system as this will aid in reassembly. Alternatively, refer to the provided customer drawing package

Step 4. Throw away the microfiber coalescing filter element.

Step 5. Place all disassembled components in a bucket and add the cleaning solution prepared in Step 1. The required soaking time required will depend on how contaminated the components are. Ensure that the components and tubing are clean before proceeding to the next step.

Ensure that all valves are completely open when cleaning. 3-way valves should be cleaned with the handle in all positions.

Step 6. Rinse the components with fresh water.

Step 7. Flush the tubing and components with isopropyl alcohol.

Step 8. Dry the tubing and components with clean instrument air.

Step 9. Re-assemble the sample conditioning system and replace the microfiber coalescing filter element according to the drawing package or pictures taken prior to disassembly.

Refer to Section 5.4 for more detailed instructions when installing the new microfiber coalescing filter element into the filter housing.

Step 10. Recalibrate the analyzer. Refer to Section 4.2 for the calibration procedure.

5.6 TCD Bridge Output Adjustment Procedure

It may become necessary to adjust the balance of the TCD Wheatstone Bridge. If the detector millivolt (mV) reading is improperly balanced, it may impact measurement by causing component peaks to be baseline-scooped (triangular-shaped) or detector clipped (flat tops). This can have a negative effect on the component's area and impact the concentration readings.

WARNING:

i. **This procedure will adjust the millivolt (mV) output of the detector(s) TCD bridge, which will have a negative impact on measurement if done improperly.**

ii. **Ensure that the analytical oven temperature is stable (no more variation than +/- 0.02 °C) and keep the analytical oven closed during this adjustment. The sensor will respond to a change in temperature and will make adjustment impossible.**

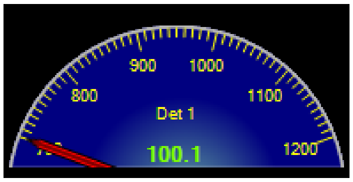
Tools and materials required to perform this procedure:

- A laptop with the Envent ICE Software and a USB Port for communication to the GC
- Small flathead screwdriver (2.5mm head)
- USB Mini cable

Step 1. Set the Gas Chromatograph into halt (idle) mode by use of the top-button on the display panel, or through the software. Allow the GC to finish the measurement cycle and indicate "Idle" (3rd LED on the top of the display panel). Ensure the oven temperature is stable (see note above).

Step 2. Connect to the GC with the Envent ICE Software and navigate to the Operations >> GC Control page, ensure that the "System IO" tab is open (top area of the Dashboard screen above the real time clock display).

Step 3. Observe and record the detector(s) millivolt (mV) value, for a single-detector analyzer this value is displayed in the middle of the left-most speedometer graphic; if the analyzer is a dual-detector analyzer, the two mV values are in the left-most and second-from-left speedometer graphics.

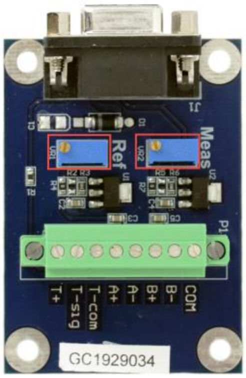


<u>As Found Values:</u>

Detector 1: ______________ mV
Detector 2: ______________ mV (if applicable)

The millivolt (mV) reading should be 100 mV +/- 10 mV. If the reading is below 60 mV or above 1200 mV (typical configuration), the analyzer will output an alarm. If the mV reading is 100 mV +/- 10 mV, no adjustment is necessary.

Step 4. Locate the TCD Sensor Board within the electronics housing, on the TCD Sensor Board, locate the blue-colored variable resistors VR1 and VR2 (circled in red on the photo below); this will be adjusted during this procedure. If the analyzer is a dual-detector variety, there will be two separate TCD Sensor Boards which will have labels "TCD1" and "TCD2". If the sensor board is an older model without variable resistors, then it is not adjustable – contact Envent Engineering.



Step 5. **If the sensor board is new, or minor adjustments are not changing the mV value:**
Reset the position of the two variable resistors (VR1 and VR2) by turning the adjustment screws all the way counter-clockwise (↺) until the resistors are at the end of their range (the variable resistors will make a subtle audible click when they are at the end of their range), then continue onto step 6.

If the sensor board was previously correctly adjusted and only a minor change is required:
Continue to step 6.

Step 6. Locate the Measurement Variable Resistor (VR2, typically on the right-side of the TCD Sensor Board). Adjust this resistor clockwise (↻), slowly, while monitoring the millivolt (mV) reading either on the display or through the Envent ICE Software. Continue to adjust this variable resistor until a millivolt reading of 100 mV +/- 10 mV is achieved. If the variable resistor reaches the end of the range and the reading is unable to reach 100 mV, return the resistor VR2 near to its original setting and continue to step 7.

The response of the millivolt (mV) reading has a slow update time, so make small adjustments (in ¼ or ½ turn increments) and wait a second or two for the reading to update on the display.

Step 7. Locate the Reference Variable Resistor (VR1, typically on the left-side of the TCD Sensor Board). Adjust this resistor clockwise (↻), slowly, while monitoring the millivolt (mV) reading either on the display or through the Envent ICE Software. Continue to adjust this variable resistor until a millivolt reading of 100 mV +/- 10 mV is achieved. If the variable resistor reaches the end of the range and the reading is unable to reach 100 mV, reset the position of both variable resistors, return to step 5.

The response of the millivolt (mV) reading has a slow update time, so make small adjustments (in ¼ or ½ turn increments) and wait a second or two for the reading to update on the display.

6.0 TROUBLESHOOTING

Symptom	Possible Causes	Recommended Solutions
Chromatogram: Components eluting too slowly	Carrier regulator has been improperly adjusted from the factory setting	Check the carrier pressure as compared to the factory calibration certificate. **Carrier pressure should not be adjusted without consulting Envent Engineering Ltd.**
	Blockage or backpressure on the carrier vent(s)	Relieve the source of backpressure or clear the vent lines of debris. Carrier vent(s) must vent to atmosphere.
	Blockage or contamination in the injection valve diaphragm	Replace the diaphragm using diaphragm kit (2000055 or 2000054) and diaphragm tools (2000053).
	Blockage or contamination in the sample loop or columns	Replace the sample loop. Replace the backflush column first (refer to supplied drawings), followed by other columns as necessary. Contact Envent Engineering Ltd. if replacement columns are needed.
	GC Analytical oven temperature too low	Check that the oven temperature is at the setpoint, and that the setpoint is set as indicated on the factory calibration certificate.
		If oven temperature is at room temperature, check the oven output fuse (fuses located just above power input customer connections – refer to Figure 5).
Chromatogram: Components eluting too quickly	GC Analytical oven temperature too high	Allow GC sufficient time to stabilize (typically 4-6 hours after turning on the power).
		Check that the oven temperature is at the setpoint, and that the setpoint is set as indicated on the factory calibration certificate.
	Carrier regulator has been improperly adjusted from the factory setting	Check the carrier pressure as compared to the factory calibration certificate. **Carrier pressure should not be adjusted without consulting Envent Engineering Ltd.**
Chromatogram: nC5 peak missing or neoC6 eluting behind nC5	Improper backflush valve timing	Diagnose the reason for drifting timing (typically leaks or flow blockages). Do not adjust valve timing prior to consulting Envent Engineering Ltd.

Chromatogram: N2 or C2 peaks eluting incorrectly or not showing up	Improper valve timing (Dual Column Valve)	Diagnose the reason for drifting timing (typically leaks or flow blockages). Do not adjust valve timing prior to consulting Envent Engineering Ltd.
Alarm: Oven Hi or Oven Lo	Oven has not yet stabilized, or analyzer has just been turned on	Allow GC sufficient time to stabilize (typically 4-6 hours after turning on the power).
	Oven setpoint or alarm setpoints have been changed	Refer to the factory configuration to ensure that the setpoints are correct. Contact Envent Engineering Ltd. prior to making any changes.
	Blown fuse	If oven temperature is at room temperature, check the oven output fuse (fuses located just above power input customer connections – refer to Figure 5).
Alarm: TCD Hi or TCD Lo	Oven temperature is not stable	Allow GC sufficient time to stabilize (typically 4-6 hours after turning on the power).
	TCD sensor has failed	Sensor requires replacement. Contact Envent Engineering Ltd.
	No carrier pressure or flow	Check carrier cylinder(s) to ensure there is sufficient pressure.
		Check for, and relieve, any backpressure or clear the vent lines of debris. Carrier vent(s) must vent to atmosphere.
	Improperly adjusted sensor bridge	Readjust the sensor bridge. Refer to Section 5.6.
	Faulty sensor bridge	Replace the sensor bridge board (GC Sensor Board). Contact Envent Engineering Ltd.
Alarm: Lo Helium	Carrier inlet pressure too low (<100 PSI)	Check carrier cylinder(s) to ensure there is sufficient pressure. Replace cylinder(s) as necessary.
	Pressure switch has failed	Replace the carrier pressure switch. Contact Envent Engineering Ltd.
	Pressure switch wiring has broken or become disconnected	Check the wiring from the pressure switch to DI1. Refer to Figure 5.
Alarm: Cal Fail	Last calibration (auto/manual) has failed	Check the calibration cylinder pressure and connections. Force calibrate the analyzer. Re-calibrate with a manual calibration.

Alarm: Mole % Hi or Mole % Lo	Component mismatch between calibration standard and process	Ensure the calibration standard closely matches the components found in the process.
	Oven has not yet stabilized, or analyzer has just been turned on	Allow GC sufficient time to stabilize (typically 4-6 hours after turning on the power).
	Different sample pressure when calibrating vs. process sample	GC has ARV: Check ARV vent for backpressure.
		No ARV: Ensure calibration pressure is the same as process sample pressure injected into the GC. Sample shutoff time must be sufficient to bleed sample loop to 0 PSIG.
Un-Normalized Mole % drifting in one direction	Contamination in tubing slowly making its way through the analyzer	Ensure sample sweep has sufficient flow. When changing carrier/calibration cylinder(s), properly purge the tubing to prime the system prior to the analyzer.
Calibration failed (Auto/Manual)	Calibration gas has changed concentrations compared to last gas used	Force calibrate the analyzer with values from the current calibration gas cylinder.
	Calibration gas cylinder empty, closed off, or not properly connected	Check connections to calibration cylinder, ensure the cylinder has sufficient pressure and regulator is set at 15 PSIG.
Lower than expected readings	Leak in Analytical GC Oven	Check for leaks and seal as needed.
	Insufficient sample flow rate	Ensure that the flow rate is appropriate for the analyzer in question.
	Contaminant or liquid carry over in SCS	The sample conditioning system cleaning procedure.
	Blocked sample vent line	Check for blocks and clear as needed.
	Closed sweep valve	Adjust the sweep valve to a level where the analyzer response time increases to the desired rate.
Erratic readings	Injection pressure is random	Check the ARV vent on the ARV (if applicable) to ensure it is venting to atmosphere and clear of debris.
	Changing flow rate due to a faulty regulator	A replacement regulator is required. Contact Envent Engineering Ltd.
Analyzer won't start auto-sequence	Stream lockout is engaged (low carrier pressure or low oven temperature)	See **Alarm: … Oven Lo** or **Alarm: Lo Helium**.

Different from expected readings	Analyzer out of calibration	Re-calibrate analyzer and refer to factory chromatogram. If necessary, perform a gas calibration. Refer to Section 4.2 for the calibration procedure.
	Excessive sample flow rate	Ensure that the flow rate is appropriate for the analyzer in question.
	Calibration and Stream pressure are different	Ensure that the pressure is balanced between calibration and stream runs
Analyzer not turning on	Blown fuse	A replacement Mainboard and/or AC-DC converter is required. Contact Envent Engineering Ltd.
	Inappropriate voltage rating	Refer to the ETL Certification Nameplate on the analyzer or the Factory Calibration Certificate for more information on the analyzer voltage rating
	Mainboard malfunction	A replacement Mainboard is required. Contact Envent Engineering Ltd.
Analog outputs (4-20 mA) not working	Improper wiring	Verify wiring.
	System variable for the AO output has been modified	Analog output 4-20mA is configured based on the specified range.
Pressure gauge not working	Pressure gauge has been over pressurized	A replacement pressure gauge is required. Contact Envent Engineering Ltd.

APPENDIX A – RISK ASSESSMENT

Risk Assessment Matrix

		Severity of Impact and/or Consequences				
		Negligible	Minor	Moderate	Serious	Critical
Likelihood Of Event	Very Likely	Medium	Medium	High	High	High
	Likely	Low	Medium	High	High	High
	Possible	Low	Low	Medium	High	High
	Unlikely	Low	Low	Low	Medium	High
	Very Unlikely	Low	Low	Low	Medium	Medium

Situational Risk Assessment

Hazardous Situation	At Risk Personnel	Safety Hazards	Initial Risk Assessment	Residual Risk Assessment
Changing filter in SCS	Operator(s)	The release of high-pressure gases can cause serious injuries	Possible – Serious (High)	Very Unlikely – Serious (Medium)
The filter is located before the pressure regulator. As such, pressures up to 3600PSI can be present. The operator must isolate the sample system before changing the filter.				
Leakage or rupture due to high pressure	Operator(s)	The release of high-pressure gases can cause serious injuries	Unlikely – Serious (High)	Very Unlikely – Serious (Medium)
Depending on the sample conditioning system, the inlet maximum pressure varies. Please consult document package for the maximum pressure for the sample system. Do not apply more pressure than specified as this can cause damage to the analyzer and create safety risks.				
H_2S Exposure (Atmosphere)	Operator(s)	H_2S exposure is a potentially lethal health/safety risk. Consult Table B4 for more information.	Unlikely – Serious (Medium)	Very Unlikely – Serious (Medium)
For atmospheres where there is H_2S, depending on the levels and company policy, the operator must wear the appropriate equipment before servicing a Gas Chromatograph analyzer				

<table>
<tr><th>Hazardous Situation</th><th>At Risk Personnel</th><th>Safety Hazards</th><th>Initial Risk Assessment</th><th>Residual Risk Assessment</th></tr>
<tr><td>H2S Exposure (Leakage / Overpressure)</td><td>Operator(s)</td><td>H2S exposure is a potentially lethal health/safety risk. Consult Table B4 for more information.</td><td>Unlikely – Critical (High)</td><td>Very Unlikely – Critical (Medium)</td></tr>
<tr><td colspan="5">In case of leakage, follow the company's health and safety policies on how to deal with an H2S leak. Depending on the application and location of the Gas Chromatograph analyzer, the operator might require breathing equipment.</td></tr>
<tr><td>Exposure to other gases</td><td>Operator(s)</td><td>Potentially lethal health/safety risk. Explosion, O_2 deprivation</td><td>Unlikely – Critical (High)</td><td>Very Unlikely – Critical (Medium)</td></tr>
<tr><td colspan="5">In case of a leak, follow the company's health and safety policies on how to deal with gas leak. Depending on the application and location of the Gas Chromatograph analyzer, the operator might require breathing equipment.</td></tr>
<tr><td>Flooding the sample system and analyzer</td><td>Operator(s)</td><td>No immediate health/safety concern</td><td>Possible – Minor (Low)</td><td>Unlikely – Minor (Low)</td></tr>
<tr><td colspan="5">If the analyzer is flooded, the analyzer needs to be immediately isolated, turned off, and cleaned.</td></tr>
<tr><td>Voltage hazards</td><td>Operator(s)</td><td>Immediate health/safety risk.</td><td>Unlikely – Serious (Medium)</td><td>Very Unlikely – Serious (Medium)</td></tr>
<tr><td colspan="5">It is important that the operator is trained on handling the analyzer when it is on. The analyzer does not need to be off when it goes into maintenance. However, it is especially important that the operator is aware of the danger of an electric shock.</td></tr>
<tr><td>Electrostatic hazard - explosion hazard</td><td>Operator(s)</td><td>Immediate health/safety risk.</td><td>Unlikely – Critical (High)</td><td>Very Unlikely – Critical (Medium)</td></tr>
<tr><td colspan="5">The backpan and certification nameplate may be cleaned only with a damp cloth to prevent static charging hazards which could result in an explosion.</td></tr>
<tr><td>Analyzer weight</td><td>Operator(s)</td><td>Body Injury</td><td>Unlikely – Moderate (Low)</td><td>Very Unlikely – Moderate (Low)</td></tr>
<tr><td colspan="5">In some cases, unpacking and transporting the analyzer will require a minimum of two persons.</td></tr>
</table>

Re-configuring the configuration file. Physical configuration of the analyzer and/or sample conditioning system	Operator(s)	Potential safety risk	Unlikely – Serious (Medium)	Unlikely – Serious (Medium)
Do not physically modify the Gas Chromatograph analyzer or sample conditioning system as doing this voids the hazardous location certification.				

Physical Properties of Hydrogen Sulfide (H_2S)

Physical State	- Gaseous above -60°C
Appearance	- Invisible
Odor	- Smell of rotten eggs at 0.5ppb - Olfactory paralysis at ~100ppm
Vapor Density	- Heavier than air (relative density of 1.19 compared to air) - In gas mixtures, it will be present wherever the gas mixture is found - Gas mixtures may be heavier or lighter than air, depending upon their vapor density and temperature compared to the ambient atmosphere (i.e. usually air) - In its pure state, or as a high proportion of a gas mixture, it may flow or settle into low-lying areas, such as pits, trenches, and natural depressions
Flammability	- Flammable at 4.3% – 46% vapor concentration in air, by volume - Burns with a blue flame and creates gaseous sulfur dioxide (SO2). SO2 can irritate the eyes and respiratory system
Solubility	- Soluble in water and oil - Solubility of ~4g/L in water @ 20°C - Solubility is inversely proportional to fluid temperature
Common Locations for H2S	- Piping systems, pipelines, wellheads or wellbores, vessels, production facilities, tanks, pits, and low spots, confined or enclosed spaces, shacks or buildings, berms or diked areas, sour spills.

Health Effects of Hydrogen Sulfide (H_2S) at Varying concentrations

H2S Concentration	Possible Health Effects
<1ppm	- No known health effects - Can be smelled
1ppm – 10ppm	- No known health effects - Up to 10ppm the exposure limit is 8 hours*
10ppm – 15ppm	- Up to 15ppm the exposure limit is 15 minutes between 60-minute breaks*
20ppm – 200ppm	- Eye and respiratory tract irritation and loss of smell - Headache and nausea - loss of smell after 2 - 5 min - Respiratory protection is required beyond this level
200ppm – 500ppm	- Above effects, but sooner and more severe - Loss of breathing and death in 30 min to 1 hour
500ppm – 700ppm	- Affects the central nervous system - Rapid unconsciousness, cessation of breathing, and death
>700ppm	- Immediate loss of consciousness - Permanent brain damage and death in a few minutes even if removed to fresh air at once

***Check local legislations as these values may vary between locations**

APPENDIX B – RECOMMENDED SPARE PARTS LIST

Part Name	Part Number	Description
SCS Filters	2000048*	Box of 10 Filters, 12/19-57-50CSK (For 122 housing)
Filter Membranes	2000047*	Set of 5 membranes for inlet filter
GC Column Set	CONTACT ENVENT	Column sets are application specific and come pre-calibrated with a calibration certificate
10 Port Diaphragm Valve	1300195	10 port diaphragm GC valve
10 Port Diaphragm Replacement Kit	2000055	Diaphragm replacement for 10 port GC valve
6 Port Diaphragm Valve	1300192	6 port diaphragm GC valve
6 Port Diaphragm Replacement Kit	2000054	Diaphragm replacement for 6 port GC valve
Diaphragm Replacement Tool Kit	2000053	Tool kit required to work on, or replace, diaphragms for GC valves

*** NOTE: Contact Envent Engineering Ltd. to confirm that these part numbers are correct for the installed system**

APPENDIX C – CERTIFICATIONS

Go to the Envent website www.enventengineering.com to see the latest certificates for the 131S and 132S.

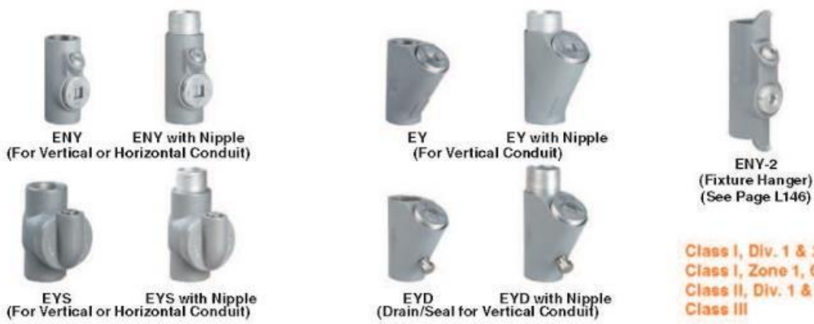
APPENDIX D – SEALING COMPOUND INFORMATION

KILLARK FITTINGS

EY SERIES

KILLARK

SEALING FITTINGS



Class I, Div. 1 & 2, Groups A, B, C, D
Class I, Zone 1, Groups IIC, IIB, IIA
Class II, Div. 1 & 2, Groups E, F, G
Class III

FEATURES-SPECIFICATIONS

Application & Installation
Class I, Divisions 1 and 2

The purpose of seals in a Class I hazardous location is to minimize the passage of gases and vapors and prevent the passage of flames from one electrical installation to another through the conduit system. Seals are required to be installed within 18 inches on any conduit run entering an enclosure which contains devices that may produce arcs, sparks, or high temperature. Where two enclosures are connected by a run of conduit not over 3 ft. long, a single seal located at the center of the run is considered satisfactory. Only explosionproof unions, couplings, elbows, and conduit bodies similar to "L", "T", and "X" type shall be permitted between the sealing fitting and the enclosure.

Seals shall be located within 18 inches of the enclosure or fitting on each conduit run of 2 inch size or larger entering an enclosure or fitting that contains terminals, splices, or taps.

Each run of conduit from a hazardous location to a nonhazardous location should be sealed to minimize the amount of gases and vapors communicated beyond the seal.

Class II, Divisions 1 and 2

Where a raceway provides communication between an enclosure which is required to be dust-ignitionproof and one which is not, suitable means shall be provided to prevent the entrance of dust into the dust-ignitionproof enclosure through the raceway.

Consideration for selection seals:

Select the proper sealing fitting for the hazardous gas/vapor involved; i.e., Class I Groups A, B, C, or D. Zone 1, Groups IIC, IIB, IIC.

Select a sealing fitting for the proper use in respect to mounting position. This is particularly critical when the conduit runs between hazardous and nonhazardous areas. Some seals are designed to be mounted in any position; others are restricted to vertical mounting.

Drains

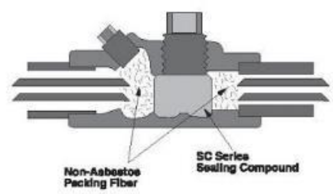
Where there is a probability that liquid or other condensed vapor may be trapped within enclosures for control equipment or at any point in the raceway system, approved means – such as installation of drain seals – shall be provided to prevent moisture accumulation.

For more complete data or special applications, consult the code or your local inspector.

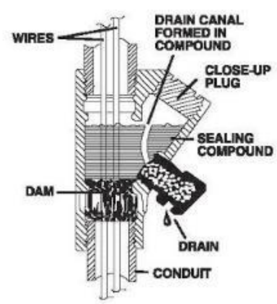
Sealing compounds shall be approved for the purpose and shall not be affected by the surrounding atmosphere or liquids, and shall not have a melting point of less than 93°C. (200°F.).

In the complete seal, the minimum thickness of the sealing compound shall not be less than the trade size of the conduit, and in no case less than 5/8 inch.

NOTE: The amount of Killark sealing compound and packing fiber required for any seal is determined by volume hub size and mounting position of the seal. Refer to installation data table on page F50 for specific amounts required.



Schematic drawings illustrate the application of sealing compound, fiber dams, and installed seal with drain.



Splices and taps shall not be made in fittings intended only for sealing with compound, nor shall other fittings in which splices or taps are made be filled with compound.

Killark sealing fittings are produced with utmost care to insure a substantial margin of safety. Threads are clean, deep, and snug. When properly installed with Killark sealing compound (SC Type) and Killark non-asbestos fiber (PF Type) for the dams, you can be sure your installation will provide more than adequate safety.

F46 KILLARK

WWW.HUBBELL-KILLARK.COM

HUBBELL Harsh & Hazardous

KILLARK FITTINGS

FITTINGS

ENY/EYS SERIES

SEALING FITTINGS

ENY-3 ENY-3-T with Nipple
(For Vertical or Horizontal Conduit)

EYS-3 EYS-3-T with Nipple
(For Vertical or Horizontal Conduit)

ENY-1, 2, 3, 4, 5, 6
Class I, Div. 1 & 2, Groups A, B, C, D
Class I, Zone 1, Groups IIC, IIB, IIA
Class II, Div. 1 & 2, Groups E, F, G
Class III

EYS Series
Class I, Div. 1 & 2, Groups C, D
Class I, Zone 1, Groups IIB, IIA
Class II, Div. 1 & 2, Groups E, F, G
Class III

File No. E10514

Certified File No. LR11716
See files for details or call Killark.

FEATURES-SPECIFICATIONS

Material/Finish

Copper-free Aluminum
(less than 4/10 of 1%)

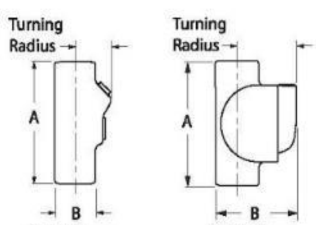
- Electrostatically applied powder coating

Duraloy Iron

- Tri-Coat Finish of electrozinc, chromate sealant, and electrostatically applied powder coating

ENY SEALING FITTINGS						ENY WITH NIPPLE	
HUB SIZE	CATALOG NUMBER		DIMENSIONS		TURNING RADIUS	CATALOG NUMBER	
	KILLARK ALUMINUM	DURALOY IRON	A	B		KILLARK ALUMINUM	DURALOY IRON
1/2"	ENY-1	ENY-1M	4-1/16" (103)	1-9/32" (33)	1-3/32"(30)	ENY-1-T	ENY-1TM
3/4"	ENY-2	ENY-2M	4-3/16" (106)	1-1/2" (38)	1-9/32"(33)	ENY-2-T	ENY-2TM
1"	ENY-3	ENY-3M	5" (127)	1-3/4" (45)	1-13/32"(36)	ENY-3-T	ENY-3TM
1-1/4"	ENY-4	ENY-4M	5-3/8" (137)	2-3/16" (56)	1-25/32"(45)	ENY-4-T	ENY-4TM
1-1/2"	ENY-5	ENY-5M	5-11/16" (144)	2-3/8" (60)	1-29/32"(48)	ENY-5-T	ENY-5TM
2"	ENY-6	ENY-6M	6-3/8" (162)	2-3/8" (60)	2-5/16"(59)	ENY-6-T	ENY-6TM

Dimensions



ENY Series EYS Series

EYS SEALING FITTINGS						EYS WITH NIPPLE	
HUB SIZE	CATALOG NUMBER		DIMENSIONS		TURNING RADIUS	CATALOG NUMBER	
	KILLARK ALUMINUM	DURALOY IRON	A	B		KILLARK ALUMINUM	DURALOY IRON
1/2"	EYS-1	—	2-15/16"(75)	1-13/16"(46)	1-3/16"(30)	EYS-1-T	—
3/4"	EYS-2	—	4-1/16"(103)	2-1/16"(52)	1-9/32"(33)	EYS-2-T	—
1"	EYS-3	—	4-25/32"(121)	2-11/32"(60)	1-13/32"(36)	EYS-3-T	—
1-1/4"	EYS-4	—	5-3/8"(137)	3"(76)	1-25/32"(45)	EYS-4-T	—
1-1/2"	EYS-5	—	5-11/16"(144)	3-1/4"(83)	1-29/32"(48)	EYS-5-T	—
2"	EYS-6	—	6-3/8"(162)	3-15/16"(100)	2-5/16"(59)	EYS-6-T	—
2-1/2"	EYS-7	EYS-7M	7-5/8"(194)	4-1/2"(114)	4-1/8"(105)	EYS-7-T	EYS-7TM
3"	EYS-8	EYS-8M	7-5/8"(194)	4-1/2"(114)	4-3/8"(111)	EYS-8-T	EYS-8TM
3-1/2"	EYS-9	EYS-9M	7-1/8"(181)	5-3/16"(132)	4-3/4"(121)	EYS-9-T	EYS-9TM
4"	EYS-0	EYS-0M	7-1/8"(181)	5-3/16"(132)	4-3/4"(121)	EYS-0-T	EYS-0TM

KILLARK

WWW.HUBBELL-KILLARK.COM

HUBBELL Harsh & Hazardous

F47

FITTINGS

EY SERIES

25% FILL VERTICAL SEALING FITTINGS

EY-75M

EY-75TM

EY Series
Class I, Div. 1 & 2, Groups B, C, D
Class I, Zone 1, Groups IIB, IIA
Class II, Div. 1 & 2, Groups E, F, G
Class III

Certified

FEATURES-SPECIFICATIONS

Applications

To seal conduits in vertical runs. To minimize the passage of gases and vapors and prevent the passage of flames from one portion of the electrical system to another through the conduit.

Features

- Large opening for easy packing of fiber dam and pouring of compound
- Integral bushings in conduit hubs to protect conductor insulation from damage
- Npt tapped hubs to ensure ground continuity
- Design provides minimum turning radius
- 25% conductor fill
- EY-T style supplied with removeable close nipples

Material/Finish

Copper-free Aluminum
(less than 4/10 of 1%)

- Electrostatically applied powder coating

Duraloy Iron

- Tri-Coat Finish of electrozinc, chromate sealant, and electrostatically applied powder coating

EY VERTICAL SEALING FITTINGS

HUB SIZE	CATALOG NUMBER KILLARK ALUMINUM	DIMENSIONS A	DIMENSIONS B	TURNING RADIUS*	SEALING COMPOUND REQUIRED	PER HUB (PF)
1/2"	EY-50	3-5/16" (84)	1-1/8" (29)	1-11/16" (37)	3/4 oz.	1/32 oz.
3/4"	EY-75	3-11/16" (94)	1-5/16" (33)	2" (51)	1-3/4 oz.	1/16 oz.
1"	EY-100	4-3/8" (111)	1-5/8" (41)	2-7/16" (62)	3-3/4 oz.	1/8 oz.

Turning radius with plug removed.

EY VERTICAL SEALING FITTINGS WITH NIPPLE

HUB SIZE	CATALOG NUMBER KILLARK ALUMINUM	DIMENSIONS A	DIMENSIONS B	TURNING RADIUS*	SEALING COMPOUND REQUIRED	PER HUB (PF)
1/2"	EY-50-T	4-3/16" (106)	1-1/8" (29)	1-11/16" (37)	3/4 oz.	1/32 oz.
3/4"	EY-75-T	4-9/16" (116)	1-5/16" (33)	2" (51)	1-3/4 oz.	1/16 oz.
1"	EY-100-T	5-1/2" (140)	1-5/8" (41)	2-7/16" (62)	3-3/4 oz.	1/8 oz.

Turning radius with plug removed.

EY VERTICAL SEALING FITTINGS

HUB SIZE	CATALOG NUMBER KILLARK IRON	DIMENSIONS A	DIMENSIONS B	TURNING RADIUS*	SEALING COMPOUND REQUIRED	PER HUB (PF)
1/2"	EY-50M	3-5/16" (84)	1-1/8" (29)	1-11/16" (37)	3/4 oz.	1/32 oz.
3/4"	EY-75M	3-11/16" (94)	1-5/16" (33)	2" (51)	1-3/4 oz.	1/16 oz.
1"	EY-100M	4-3/8" (111)	1-5/8" (41)	2-7/16" (62)	3-3/4 oz.	1/8 oz.

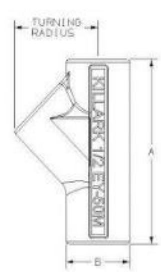
Turning radius with plug removed.

EY VERTICAL SEALING FITTINGS WITH NIPPLE

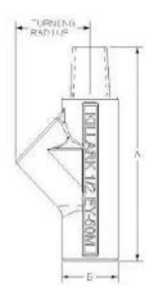
HUB SIZE	CATALOG NUMBER KILLARK IRON	DIMENSIONS A	DIMENSIONS B	TURNING RADIUS*	SEALING COMPOUND REQUIRED	PER HUB (PF)
1/2"	EY-50TM	4-3/16" (106)	1-1/8" (29)	1-11/16" (37)	3/4 oz.	1/32 oz.
3/4"	EY-75TM	4-9/16" (116)	1-5/16" (33)	2" (51)	1-3/4 oz.	1/16 oz.
1"	EY-100TM	5-1/2" (140)	1-5/8" (41)	2-7/16" (62)	3-3/4 oz.	1/8 oz.

Turning radius with plug removed.

EY Female to Female



EY with Nipple Male to Female



FITTINGS

SC/PF SERIES

SEALING MATERIALS

Sealing Compound

Packing Fiber

SC11W

FEATURES-SPECIFICATIONS

Series SC/PF

Sealing Materials

SC Series Sealing compound is a cement used extensively for sealing conduit to prevent the spread of explosive gases. It is non-shrinking and a secure seal is formed. SC Series resists acids, water, oil, etc. It is UL Listed for use with Killark ENY, EY, and EYS Series. Also CSA certified for use with any CSA certified sealing fitting.

Packing Fiber

Killark's Packing Fiber is made from an environmentally safe, non-asbestos material. It is easy to use and forms a positive dam to hold compound (Killark SC Type) in ENY, EY, and EYS Series fittings.

Features of SC with Water

- Exact amount of compound and water are packaged together into a two-compartment plastic pouch.
- The precise amount of compound and water are available for mixing. No mixing or measure implements are required.
- Squeezing the inner water container forces the water into the compartment containing the sealing compound. Complete mixing takes place inside the plastic pouch.
- The mixed sealing compound can be poured directly into the sealing fitting. A tubular straw is provided for those difficult seals to reach.
- The package label indicates the size and quantity of sealing fittings each pouch will properly fill.

OUNCES REQUIRED PER FITTING

SEALING COMPOUND				PACKING FIBER
HUB SIZE	ENY①	EYS①	EY/EYD	
1/2"	1.5 oz.	3.0 oz.	1.0 oz.	1/16 oz.
3/4"	2.0 oz.	3.0 oz.	2.0 oz.	1/8 oz.
1"	3.0 oz.	8.0 oz.	4.5 oz.	1/4 oz.
1-1/4"	6.5 oz.	8.5 oz.	7.5 oz.	1/2 oz.
1 1/2"	8.5 oz.	17.5 oz.	12.0 oz.	1 oz.
2"	15.0 oz.	27.0 oz.	24.0 oz.	2 oz.
2-1/2"	—	42.0 oz.	44.0 oz.	3 oz.
3"	—	47.0 oz.	44.0 oz.	4 oz.
3-1/2"	—	56.0 oz.	75.0 oz.	6 oz.
4"	—	56.0 oz.	75.0 oz.	9 oz.

① ENY/EYS suitable for both horizontal or vertical applications.

SEALING COMPOUND

CATALOG NUMBER	SIZE PACKAGE
SC-4 OZ	4 oz.
SC-8 OZ	8 oz.
SC-1 LB	1 lb.
SC-5 LB	5 lbs.

PACKING FIBER

CATALOG NUMBER	SIZE PACKAGE
PF-2	2 oz.
PF-4	4 oz.
PF-16	1 lb.

SEALING COMPOUND

CATALOG NUMBER	HUB SIZE	WILL FILL THE FOLLOWING SEALS:			CU. IN. FILL PER POUCH	NO. OF POUCHES PER CARTON
		ENY	EYS	EY/EYD		
SC5W②	1/2"	3	1	5	5	5
	3/4"	2	1	2		
	1"	1	—	1		
SC11W②	1/2"	7	3	11	11	5
	3/4"	5	3	5		
	1"	3	1	2		

② Appropriate amount of Packing Fiber is included in carton. Additional Packing Fiber maybe purchased separately.

KILLARK®

WWW.HUBBELL-KILLARK.COM

HUBBELL Harsh & Hazardous

Contact Us

In the event that a situation arises that is not covered by this manual, we encourage you to contact us so that we can help you resolve any issues you may have. Please have this manual readily available when calling for assistance.

For further information on our products or to access our most recently updated manuals and product catalogues, please visit our website at www.enventengineering.com.

Canada (Main)

Toll Free: 1 (877) 936 – 8368
Tel: (403) 253-4012
Fax: (403) 253 -4016
Email: info@enventengineering.com

2721 Hopewell Place NE
Calgary, Alberta, Canada T1Y 7J7

USA

Tel: 1 (713) 567 – 4421

13219 B Stafford Road
Missouri City, Texas, USA 77489

China

Tel: 86 (138) 0119 – 1148
Email: julie.lu@enventengineering.com

Room 305, Bld. No.9, Greenland Qihangguoji
Shunyi District, Beijing, China

International Sales

Tel: (403) 253-4012
Email: international@envent-eng.com

Envent