



# **SGA/TRACES-1000**

## **User Manual** **(Revision C)**

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# Section A - Introduction

## Letter from the corporate

Dear Valued Customer,

During the past several years, we have experienced extraordinary growth and change, due to our continued commitment to teamwork, technology-focused product strategies and to our policy of placing the trust of our customers above all else. We have successfully reached key milestones, expanded research and development initiatives, achieved significant technological advancements, and initiated our position as a premier manufacturer and developer of analytical instrumentation. In the face of challenging economic conditions, we are finding new ways to provide solutions to an evolving industry landscape to ensure we are the brightest light on the marketplace.

The upcoming years will be exciting as we continue to broaden our business efforts and move from promise to product. We have set increasingly ambitious goals but possess the passionate vision and resources to achieve them. We have the knowledge, experience, and expertise to bring specialty products to this niche market, and we know the steps we need to take are simply an extension of what we have been doing successfully since our inception. Simultaneously, we plan to continue responding to market challenges and expand our line of analyzers with products incorporating enhanced features to engage a wider customer base. Consequently, we have set an aggressive timeline for the development of new products to fulfill our commitment.

One of our customers has described our success story as "more a marathon than a sprint." We take pride in this characterization and embrace it as the philosophy for our operations as a successful business is built on sustainable and reliable growth. In recent years, we've grown our business substantially, yet managed to never waver from our promise to deliver the very best products and service to our valued customers. We are building the analyzer tools of tomorrow, hearing the markets' demands and we are ready to meet the challenges.

We credit each of our employees for making these past years such a success. We also like to extend thanks to our customers and our suppliers for their guidance and support.

Thank you for the purchase of this product and please trust in our commitment to your complete satisfaction. Should you have any concerns, please do not hesitate to contact us for support.

## **Mission Statement**

– Founded on fundamental principles and timeless values that perpetually lie at the heart of our business and represent the structural foundation on which it is built.

These principles have helped us to set a higher standard for its products and services, making it a recognized leader for innovative solutions. Our mission is to become a market leader in the development and manufacturing of analytical instrumentation with unsurpassed performance that will fulfill a strategic role in industry to control processes, verify product conformance and help solve a variety of problems for the benefit of society.

## **Creativity**

– To establish and maintain an environment that encourages creativity and promotes innovation to capitalize on collective talents and intellectual resources, to maintain a technologically advanced position and competitive edge within the market.

## **Quality**

– To provide superior quality products in both form and function while continually striving to improve what may already be the best in its class.

## **Integrity**

– Above all, to conduct all aspects of business operations while adhering to the highest level of business ethics and standards.

## **Dependability**

– To proactively address and reliably respond to our customer's needs in a timely fashion.

# Section B - About This Manual

This manual is a multipart user's manual that provides information regarding the proper installation, operation and service of the analyzer. The manual is divided into the following six sections.

- **Section 1** Principle of Operation, Specifications, and Drawings
- **Section 2** Software Operation
- **Section 3** Basic Maintenance Guide
- **Section 4** MODBUS Digital Communications
- **Section 5** Scanner Operation and features
- **Section 6** Postscript

Warranty, compliance, and safety information concerning the analyzer provided immediately following this page.

The benefits, features and configurations of the analyzer are described in Section 1 along with basic theory and operations.

Installation and operation of the analyzer and most optional equipment are illustrated in Sections 2 and 3 of this manual. Future Information may be supplied in other manuals (i.e., options manuals) or addenda to this manual.

Maintenance information includes step-by-step procedures along with a complete set of drawings and schematics.

The information contained herein is furnished without warranty of any kind. Users should consider the data in this manual only as a supplement to other information gathered by them and must make independent determinations of the suitability and completeness of the information.

Some of the terms and labels used in the manual are abbreviated intuitively due to space constraints in tables, photos and illustrations.



## Section C - Conditions for Proper Use

1. Read the manual carefully prior to using the analyzer.
2. Keep the manual near the analyzer for future reference.
3. The improper usage of the analyzer may void the warranty.
4. The general codes for working with chemicals and electrical equipment must be observed while using the analyzer.
5. Use PPE (coveralls, protective gloves, goggles, and hard hat) as required.
6. If faults occur when the analyzer is running and user cannot rectify, then please contact your local partner or our Technical support.
7. Electrical and electronic devices must be disposed according to the local regulations.
8. UV lamp in the analyzer may contain trace amount of chlorine and must disposed according to local regulations.
9. The packaging crate material can be recycled. Please dispose appropriately.
10. Bear in mind the hazards of potentially emanating from the different samples.
11. We do not carry out construction work. The installation of the analyzer and the options are provided by the end user.
12. The analyzer is shipped in a wooden crate. Use of a forklift or a lifting device is strongly recommended to remove the analyzer from the crate. Use of PPE is strongly recommended during this process to prevent any injury.
13. The analyzer doesn't come with power cord and must be provided by the end user. It should meet the power rating of the analyzer, the hazardous location code, and the local electric code.
14. The analyzer is supplied with five  $\frac{3}{4}$ " conduit hub, for the power and communication cable entry. These hubs have  $\frac{3}{4}$ " female NPT threads and are located underneath the main enclosure. The end user will provide the conduit sealing fitting, sealing cement and filler. Conduit sealing fitting, sealing cement and filler must be properly installed and sealed as per the local hazardous location codes and the manufacturer's instruction. If a cable gland is used instead, then it must be installed and sealed as per the local hazardous location codes and the manufacturer's instruction. Cable/conduit glands used for power and communications entry into the unit must be sealed to maintain overpressure in the enclosure. They must have a minimum IP rating of 65.
15. An earth connection point is provided inside and outside the pressurized enclosures. These connections must be used to join the instrument's metalwork to the earth-ground plane. The external earth wire must be protected so that it cannot become accidentally loosened or damaged by twisting. It must be sized in accordance with local rules for electrical installations and must not be smaller in area than 4 square millimeters (7894 circular mils). The purpose of

these connections is to direct any electrical current, internally, or externally generated, into an external ground rod that will eliminate or minimize any damage to personnel and equipment. To achieve the redirection of current, the resistance between the earth-ground connection and the external earth-ground lug must be kept below 0.1 ohms. Use 1/4-20 nut and 1/4" external-tooth lock washer to fasten the earth wire to the analyzer.

16. A manual or automatic power disconnect that removes all power from the analyzer is required to be installed near the unit and should be easily reached. The disconnect must be rated for the hazardous location code. Disconnect must be rated for two times the rated current of the analyzer. It must be labeled as the disconnecting device for the intended analyzer. Wires connecting from the external circuits to the analyzer must be rated for the hazardous location code. Wires and its insulation should be rated for 600V.
17. It is necessary to keep an appropriate distance between the analyzer sides and opposite walls, such that the analyzer doors can be swung open, and maintenance can be done. Note the wall to which the analyzer is to be mounted should have the strength of a concrete wall. For mounting the analyzer use four corrosion resistant, Grade 8 or better, 3/8-16 x 1-1/4" (min) long bolts and flat washers. Make sure the analyzer is oriented horizontally. Use of a forklift or a lifting device is strongly recommended. If the analyzer is mounted on the supplied frame, then anchor the frame to a leveled ground or foundation with four corrosion resistant, Grade 8 or better, 3/8-16 x 1-1/4" (min) long bolts and flat washers.
18. For safety reasons, the purge can only be bypassed by authorized personnel with the key. Those without authorization are not permitted to bypass the purge monitoring device.
19. Utility gases such as Sample, Calibration standards, Oxygen, Argon, zero grade air and instrument air will be provided and connected to the analyzer by the end user. Leak check and connection integrity will be performed by the end user per the Swagelok instruction. If another brand fittings are used, then follow the manufacture's instruction. All external tubing must be instrument grade, debris free, chemically cleaned, and passivated.
20. All the circuit breakers inside the analyzer are switched off before shipping. After connecting the power from mains make sure to switch on the breakers.
21. If the analyzer is not installed upon receipt. Then analyzer must be stored in a dry and frost-free environment at a maximum temperature of 122°F (50°C), preferably in its original packing, and protected against direct sunlight and (rain) water. The storage period should not be more than six months.
22. The analyzer is designed to continuously analyze gaseous samples from a sample handling system and display the amount of sulfur contained in the sample. Operation for any use other than specified may damage the analyzer and/or cause personal injury to the operator. The results obtained from any other use cannot be guaranteed.
23. The standard configuration of the analyzer is not intended for extended use in corrosive environments.
24. The best accuracy and precision are obtained when the analyzer is in a temperature-controlled environment.
25. To ensure safe operation, the purge system should always be engaged during operation of the analyzer except after the area has been determined to be non-hazardous and repairs or tests must be performed that require the purge system to be bypassed.

26. The sample to the analyzer must be filtered through a 2-micron (min) filter and delivered to the analyzer by an approved, leak-free sample handling system to ensure the sample being analyzed is representative of the current process.
27. The sample handling system should eliminate or minimize "dead volumes" and areas in the flow path where new sample can be mixed with old sample.
28. Air and other gas supplied to the analyzer must be filtered and meet specified requirements.
29. All cautions and warnings in this manual, on tags and in other publications pertaining to the installation, operation and maintenance of the analyzer must be read and observed. Failure to consider the warning and caution messages can lead to severe personal injury, equipment damage, void of the warranty and impair the protection provided by the equipment.
30. Instrument should be sheltered from direct sun and rain. If the instrument is to be used for measuring very low concentrations, it should be in a climate-controlled area. Ambient temperature should be between 0°C to +40°C.
31. Before running samples calibrate the instrument.

## Section D - Warnings and Cautions

This manual provides caution and warning messages as listed below. Failure to consider these messages can lead to severe personal injury, instrument damage and/or void of warranty.

- 
- 1. WARNING:** VOLTAGE SPECIFIED ON THE SERIAL NUMBER PLATE OF THE ANALYZER MUST MATCH THAT OF THE END USER POWER SUPPLY. THE SERIAL NUMBER PLATE IS LOCATED ON THE FRONT SIDE OF THE ANALYZER.
- 
- 2. WARNING:** POWER TO ANALYZER MUST BE SUPPLIED FROM AN EXTERNAL POWER BREAKER.
- 
- 3. WARNING:** SEVERE ELECTRIC SHOCK HAZARD MAY EXIST WHEN POWER IS APPLIED WHILE SERVICING INTERNAL COMPONENTS. THE ANALYZER MUST BE SWITCHED OFF FROM THE MAIN BREAKER BEFORE WORKING ON LIVE PARTS.
- 
- 4. WARNING:** SEVERE ELECTRIC SHOCK HAZARD MAY EXIST WHEN CONTACT IS MADE WITH THE AC VOLTAGE COMPONENTS. DO NOT ATTEMPT TO REPAIR OR TEST THE AC VOLTAGE SECTION WITHOUT USING THE APPROPRIATE TEST METER WITH INSULATED PROBES.
- 
- 5. WARNING:** A POOR GROUND CONNECTION MAY PRESENT A SEVERE SHOCK HAZARD. AN EARTH CONNECTION POINT IS PROVIDED IN THE MAIN ENCLOSURE. THIS CONNECTION MUST BE USED TO JOIN THE INSTRUMENT'S METALWORK TO THE EARTH-GROUND PLANE. IT MUST BE SIZED IN ACCORDANCE WITH LOCAL ELECTRIC CODE.
- 
- 6. WARNING:** WHEN IGNITABLE COMBUSTIBLE MATERIALS ARE PRESENT, THE ANALYZER ENCLOSURE MUST NOT BE OPENED UNTIL A COOLDOWN PERIOD OF 3 HOURS IS OBSERVED, OTHERWISE AN EXPLOSION DANGER EXISTS. THE ANALYZER IS EQUIPPED WITH A PURGE/PRESSURIZATION DEVICE THAT AUTOMATICALLY CONNECTS POWER AFTER 15 MINUTES (APPROX.) OF PURGE INTERVAL AND DISCONNECTS POWER UPON LOSS OF PRESSURIZATION.
- 
- 7. WARNING:** HIGH-PRESSURE GASES SHOULD BE HANDLED WITH EXTREME CARE. ENSURE THAT ALL RELEVANT SAFETY PRECAUTIONS ARE CAREFULLY FOLLOWED FOR GAS LINES, REGULATORS, GAS PURIFIERS, ETC.
- 
- 8. WARNING:** AFTER CONNECTING THE TUBINGS AND BEFORE CONTINUING WITH INSTALLATION AND OPERATION. ENSURE THE SAMPLE AND ALL GAS FLOW (INSIDE AND OUTSIDE THE ANALYZER) IS LEAK FREE BY PERFORMING A LEAK TEST WITH HELIUM LEAK DETECTOR (RECOMMENDED) OR LIQUID SOLUTION.

- 
- 9. WARNING: DO NOT LOOK DIRECTLY INTO AN ILLUMINATED UV LIGHT SOURCE, THIS CAN CAUSE EYE DAMAGE.**
- 
- 10. WARNING: SEVERE BURNS CAN RESULT WHEN WORKING AROUND A HOT COMBUSTION TUBE. ALLOW THE COMBUSTION TUBE TO COOL BEFORE PERFORMING MAINTENANCE.**
- 
- 11. WARNING: EYE INJURY CAN RESULT WHEN HANDLING THE GLASS COMBUSTION TUBE. WEAR APPROPRIATE EYE PROTECTION DURING SERVICE, REMOVAL AND REPLACEMENT OF THE COMBUSTION TUBE.**
- 
- 12. WARNING: SEVERE BURNS CAN RESULT WHEN WORKING AROUND A HOT FURNACE. ALLOW THE FURNACE TO COOL BEFORE PERFORMING MAINTENANCE.**
- 
- 13. WARNING: SEVERE BURNS CAN RESULT WHEN REPLACING THE THERMOCOUPLE. ALLOW THE FURNACE TO COOL BEFORE PERFORMING MAINTENANCE.**
- 
- 14. WARNING: SEVERE BURNS CAN RESULT WHEN REPLACING THE BARRELL HEATERS. ALLOW THE HEATERS TO COOL BEFORE PERFORMING MAINTENANCE.**
- 
- 15. WARNING: SEVERE BURNS CAN RESULT WHEN REPLACING THE SAMPLE VALVE AND SSO/ARV VALVE. ALLOW THE ENCLOSURE TO COOL BEFORE PERFORMING MAINTENANCE.**
- 
- 16. WARNING: POTENTIAL ELECTROSTATIC CHARGING HAZARD. WHEN CLEANING THE EXTERIOR PAINTED SURFACE OF THE UNIT IN A HAZARDOUS AREA, USE A DAMP CLOTH TO AVOID POTENTIAL ELECTROSTATIC CHARGING.**
- 
- 17. CAUTION: BECOME FAMILIAR WITH THE LOCATION AND USE OF ALL CONTROLS, INDICATORS, CONNECTIONS AND ACCESSORIES AND CAREFULLY READ ALL INSTRUCTIONS AND WARNING LABELS PRIOR TO OPERATING ANY PORTION OF THE SYSTEM.**
- 
- 18. CAUTION: THE ANALYZER SHOULD BE SHELTERED FROM DIRECT SUNLIGHT AND PRECIPITATION EXPOSURE.**
- 
- 19. CAUTION: FOLLOW INSTALLATION DRAWINGS AND SCHEMATICS IN THIS MANUAL BEFORE STARTING THE ANALYZER.**
- 
- 20. CAUTION: SERIOUS INSTRUMENT DAMAGE CAN OCCUR IF THE OPERATOR IS NOT PROPERLY TRAINED.**
- 
- 21. CAUTION: DO NOT ATTEMPT TO OPERATE THE ANALYZER UNTIL ALL INSTALLATION AND SETUP PROCEDURES OUTLINED IN THE PREVIOUS LISTED SECTIONS OF THIS MANUAL HAVE BEEN SUCCESSFULLY COMPLETED.**

- 
- 22. CAUTION: FITTINGS SHOULD BE TIGHTENED ACCORDING TO THE STANDARD INDUSTRY PRACTICE.**
- 
- 23. CAUTION: DEPRESSURIZE THE SYSTEM BEFORE REMOVING ANY FITTING.**
- 
- 24. CAUTION: THE EXCIMER UV BULB CAN BREAK DURING REMOVAL. WEAR PPE AND CARE SHOULD BE TAKEN WITH THESE BULBS TO AVOID BREAKAGE.**
- 
- 25. CAUTION: THE PHOTO MULTIPLIER TUBE (PMT) IS EXTREMELY LIGHT SENSITIVE. POWER TO THE PMT SHOULD ALWAYS BE TURNED OFF BEFORE EXPOSING THE PMT WINDOW TO ANY AMBIENT LIGHT.**
- 
- 26. CAUTION: ALL FITTINGS ARE COVERED WITH TAPE WHEN SHIPPING. ENSURE ALL TAPES ARE REMOVED AND DISCARDED TO PREVENT TUBE CLOGGING**
- 
- 27. CAUTION: DO NOT EXCEED RECOMMENDED PRESSURES. IF HIGHER PRESSURES ARE USED, SEVERE AND IRREPARABLE DAMAGE MAY BE DONE TO COMPONENTS.**
- 
- 28. CAUTION: THIS UNIT CONTAINS A LITHIUM BACKUP BATTERY, THAT IS USED TO SUPPLY POWER TO THE COMPUTER'S REAL-TIME CLOCK. THE BATTERY CIRCUIT IS INTRINSICALLY SAFE AND REQUIRES NO MAINTENANCE. THE BATTERY IS NOT USER SERVICEABLE.**
- 
- 29. CAUTION: AS WITH ANY TOOL, IF NOT USED PROPERLY HAZARD OF PINCH, PUNCTURE AND SQUEZE CAN OCCUR.**
- 
- 30. CAUTION: ELECTRICAL COMPONENT DAMAGE MAY OCCUR WHEN USING A LIQUID LEAK DETECTOR. CARE SHOULD BE TAKEN NOT TO WET ANY ELECTRICAL OR ELECTRONIC COMPONENTS.**
- 
- 31. CAUTION: MOST LIQUID LEAK DETECTORS CONTAIN SULFUR COMPOUNDS THAT CAN CONTAMINATE THE GAS SUPPLY LINE AND INSTRUMENT FLOW PATH COMPONENTS. CARE SHOULD BE TAKEN NOT TO WET OR CONTAMINATE THE ANALYTICAL FLOW SYSTEM WHEN USING A LIQUID LEAK DETECTOR.**

# Section E - Warnings and Cautions label

Caution and warning labels placed on the analyzer are listed below. Failure to consider these messages can lead to severe personal injury, instrument damage and/or void of warranty.



**HOT SURFACE HAZARD.**



**ELECTRIC SHOCK HAZARD.**



**UV LIGHT HAZARD.**



**CAUTION. REFER MANUAL BEFORE OPERATING.**

# **Section F - Warranty**

## ***Standard Warranty***

We warrant that all products supplied will be of merchantable quality and will comply with the specification agreed for them.

Our warranty is for a period of twelve months from installation of the product or fifteen months from delivery to the customer, whichever is the shorter, all Products and spare parts sold hereunder.

We will repair or replace defective and/or nonconforming parts without charge for material or labor service during the warranty period.

Products that have been repaired or replaced during the warranty period are themselves warranted only for the remaining portion of the original one (1) year.

Repairs, adjustments and service performed after the expiration of the one (1) year warranty period shall be charged to the owner/purchaser at the then current prices for parts, labor, and travel related expenses.

Exceptions to this warranty are:

- Defects, damage, or nonconformity resulting from abuse, misuse, neglect, lack of reasonable care, unauthorized modification, or the attachment of improper devices to the products.
- Installation, operation and maintenance of the products in a manner that does not meet instrument specifications will void this warranty.
- All requests for service or repair under this warranty must be received within the warranty period by us or authorized representative.

The warranties contained in this agreement are in lieu of all other warranties, expressed or implied, including the warranties of merchantability and fitness for a particular purpose.

Statements made by any persons, including our representatives, which are inconsistent or in conflict with the terms of this warranty shall not be binding upon us unless reduced to writing and approved by an officer of the company.

Liability covered under this warranty is limited to the original cost of the instrument supplied. We will not be liable for consequential damages including but not limited to loss of production, throughput or off specification product due to user or equipment error.

This warranty shall be governed by and construed in accordance with the laws of the State of California.



# Section G - Spare Parts List

## Section G.1 - Recommended Consumable Spare Parts List

Part Number	Description	Quantity
60064-00001	Online Combustion Tube, 10.75 L	1
60038-00001	Combustion Furnace	1
60097-10005	Assy, Thermocouple, Single S Type	1
23058-00001	Valve, 6-Port External Sample Injector, High Temp-Air Actuator	1
11228-00001	Dryer, .110" ID, 72" L, Fluorocarbon Fittings	1
60008-10001	Excimer Lamp Envelope	1
10027-00001	Ferrule, Standard 1/4", Graphite, (2/Pk)	6

## Section G.2 - Recommended Replacement Spare Parts List

<b>SAMPLE ENCLOSURE SECTION</b>		
23058-00001	1	VALVE, 6-PORT EXTERNAL SAMPLE INJECTOR, HIGH TEMP-AIR ACTUATOR
23058-00006	1	VALVE, 6-PORT EXTERNAL SAMPLE INJECTOR, HASTELLOY
60062-00003	1	SAMPLE SHUT OFF VALVE TO ARV
60062-00004	1	VALVE, SAMPLE SHUT OFF, W/ ARV, HASTELLOY
60062-00005	1	VALVE, SAMPLE SHUT OFF, W/ ARV, SULFINERT
11258-00001	1	THERMOCOUPLE, TYPE K, 6" LONG
10027-00002	1	FERRULE, STANDARD 1/8", VESPEL
60037-00001	1	ASSY, HEATER, SAMPLE ENCL
<b>COMBUSTION FURNACE SECTION</b>		
60038-00001	1	COMBUSTION FURNACE
60097-10005	1	ASSY, THERMOCOUPLE, SINGLE S
<b><u>COMBUSTION KIT - INCLUDES:</u></b>		
60064-00001	1	COMBUSTION TUBE
10027-00001	1	FERRULE, 1/4", GRAPHITE (2/PK)
23251-00001	1	TUBING, PTFE TEFLON. 1/8" O.D .X 1/16" I.D. (10FT./PK)
23252-00001	1	FERRULE, SET, 1/8" (10/PK)
<b>MAIN ENCLOSURE SECTION</b>		
23248-00001	1	COMPUTER, TOUCH SCREEN, 12IN
60203-10001	1	ASSY, COMPUTER SCREEN PROTECTOR
23135-00001	1	Z-PURGE
23135-00003	1	X-PURGE
60037-00002	1	ASSY, HEATER, ELECTRONICS ENCL
11572-00001	1	VALVE, SOLENOID, 3-WAY

11572-00002	1	VALVE, SOLENOID, 4-WAY
11478-00001	1	CONNECTOR, DIN, MANIFOLD, 24VDC
23242-00001	1	PRESSURE SWITCH ASSY, ADJUSTABLE, 4-125 PSI, 7A, 250V
23245-00001	1	MASS FLOW CONTROLLER, AIR 500 SCCM
11506-00001	1	TEMPERATURE CONTROLLER, SSR OUT, 24V
11280-00001	1	SOLID-STATE RELAY (SSR), 25A, 240 VAC
11233-00001	1	UNIVERSAL SIGNAL CONDITIONER, 24V, 4-20 MA OUT
11224-00001	1	THERMOCOUPLE, 30 AWG TYPE K, PFA
11262-00001	1	THERMOSTAT, 1/2" DIS, AUTO RESET, 15A OPEN@ 48.9C, CLOSE@ 32.2C
11525-00001	1	SOLID-STATE RELAY (SSR), 5VDC, DIN MOUNT
11526-00001	1	RELAY, 24V, DIN MOUNT
23123-00001	1	POWER SUPPLY, 24V, 4.2A, 100W, DIN RAIL
60078-10001	1	SP-2000 SIGNAL PROCESSOR BOARD PCA
60059-10001	1	EXTERNAL INTERFACE BOARD PCA
60079-00004	1	DC/DC CONVERTER, QUAD 24/5V,+15V,-15V,12V
60003-10001	1	DETECTOR WITH PMT
60008-10001	1	EXCIMER LAMP ENVELOPE
60001-10001	1	EXCIMER LAMP ASSY
11228-00001	1	DRYER, .110" ID, 72" L, FLUOROCARBON FITTINGS
23109-00001	1	REGULATOR, AIR, 0-60 PSIG

## Section G.3 - Preventive Maintenance Schedule

### Recommended schedule for parts replacement \*

#### 2 years \*\*

PART NUMBER	DESCRIPTION
60097-10005	ASSY, THERMOCOUPLE, SINGLE TYPE S
60064-00001	COMBUSTION TUBE
10027-00001	FERRULE, 1/4", GRAPHITE (2/PK)
23058-00001	VALVE, 6-PORT SAMPLE INJECTOR, HIGH TEMP

#### 4 years \*\*

PART NUMBER	DESCRIPTION
60038-00001	FURNACE, ON-LINE ANALYZER
60097-10005	ASSY, THERMOCOUPLE, SINGLE TYPE S
60064-00001	COMBUSTION TUBE
10027-00001	FERRULE, 1/4", GRAPHITE (2/PK)
23058-00001	VALVE, 6-PORT SAMPLE INJECTOR, HIGH TEMP

#### 6 years \*\*

PART NUMBER	DESCRIPTION
60008-10001	ENVELOPE, EXCIMER, UV LAMP
60097-10005	ASSY, THERMOCOUPLE, SINGLE TYPE S
60064-00001	COMBUSTION TUBE
10027-00001	FERRULE, 1/4", GRAPHITE (2/PK)
23058-00001	VALVE, 6-PORT SAMPLE INJECTOR, HIGH TEMP

**\* These are the minimum recommended replacement intervals and are based on customer provided data; customers are urged to use their discretion to choose schedule for parts replacement**

**\*\* this only lists typical recommended parts, any other parts if needed, will be additional- please take this into account when planning for budgetary purposes**

# Section 1 – Principle of Operation, Specifications, and Drawings

## Section 1.1 Principle of Operation

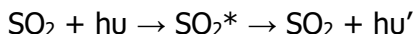
The analyzer has the highest dynamic measurement range of any commercially available analyzer without the need for additional sample valves, calibration gases or system hardware.

The analyzer is an online process analyzer utilizing patented Excimer UV Fluorescence (EUUVF) technology to measure Total Sulfur in a variety of applications such as monitoring of total sulfur in process gas streams.

The UV Fluorescence method (UVF) is one of the most simple and practical low-level sulfur analytical techniques that has been widely used and proven over many years of industrial utilization. The UV Fluorescence method involves injection of a sample into a high-temperature oxidation or combustion furnace, which converts all hydrocarbons into water (H<sub>2</sub>O) and carbon dioxide (CO<sub>2</sub>) byproducts. Total Sulfur content contained in any molecular-bound hydrocarbon species is similarly oxidized at temperatures in excess of 1000°C into sulfur dioxide (SO<sub>2</sub>) by the reaction:



The furnace effluent containing these combustion byproducts is directed into a detection chamber where it is excited by high-energy, short-wavelength emission from a UV excitation source. The UV photons from the excitation source or lamp, transfers energy into the SO<sub>2</sub> molecule and raises its energy level to create an excited singlet state. These excited molecules rapidly decay back to their lower energy ground state releasing the absorbed energy as a secondary emission known as fluorescence.



This low-level fluorescence emission is optically filtered to remove undesired wavelengths of the UV source and background scatter within the detector chamber. Detection of the filtered fluorescence emission is usually accomplished with a Photomultiplier Tube (PMT), Channel-Plate Multiplier (CPM) or other high gain, light-sensitive detector.

## Section 1.2 Specifications

Model	SGA-1000 & TraceS-1000
Service	Sulfur in Flare gas, Natural gas, Stack gas, Polypropylene, Butane, Propane.
Ranges	0 ppm – 100%
Accuracy	± 2% of measuring value
Repeatability	100 ppb SD or 2% RSD (whichever is greater) 50 ppb SD with 5-min. averaging or 2% RSD (whichever is greater) 25 ppb SD with 15-min. averaging or 2% RSD (whichever is greater)
Drift	< 2%/ 2 weeks
Linearity	+/-2% of full scale
Calibration	Manual or automatic
Response time	99% or higher in one cycle of 100 seconds
Output	Two 4-20 mA outputs
	One dry contact for global alarm
	RS-485 or RS-422 or TCP/IP (422/485) or Fiber
HMI	Touch screen monitor
Number of streams	2
Power Input	230 VAC (+/-10%), 50 Hz, 13 A
Power consumption	2310 Watts
Fuses	Cylindrical, 1/4" x 1-1/4"
Instrument grade air for valve actuation and purge	60-70 psig (4.13-4.82 barG), 5.5 SCFM (160 SLPM) (oil free with -40°C dew point), less than 40°C
Zero grade air or Oxygen	UHP, 40-70 psig (2.75-4.82 barG), 500 SCCM (max and application dependent)
Argon	UHP, 40-70 psig (2.75-4.82 barG), 500 SCCM (max and application dependent)
Sample	50-200 cc/min at 5-260 psig (0.3-17.92 barG) (application dependent). 175°C (max)
Mounting	Freestanding Frame and wall mounting
Dimensions	62.25 (HT) x 35.5 (W) x 30.0 (D) inches (158.11 X 90.17 X 76.20 MM)
Weight	Up to 300 lbs (136 KG). Shipping weight 500 lbs (227 KG)
Ambient temperature	0°C to 40 °C
	Climate controlled shelter or three-sided shelter recommended were possible
Altitude	Maximum 2000m above sea level
Humidity	0-80%
Pollution degree	2
Transient overvoltage	Overvoltage Category II

<b>CONNECTION</b>	<b>SERVICE</b>	<b>TUBE SIZE</b>	<b>NOM. PRESSURE (PSIG) (barG)</b>	<b>MAX. PRESSURE (PSIG) (barG)</b>
STREAM1 ACTUATION	PROCESS GAS1	1/8" OD	60 (4.13)	70 (4.82)
STREAM2 ACTUATION	PROCESS GAS2	1/8" OD	60 (4.13)	70 (4.82)
ZERO GAS ACTUATION	LOW CALIBRATION GAS	1/8" OD	60 (4.13)	70 (4.82)
SPAN GAS ACTUATION	HIGH CALIBRATION GAS	1/8" OD	60 (4.13)	70 (4.82)
VALIDATE GAS ACTUATION	VALIDATION CALIBRATION GAS	1/8" OD	60 (4.13)	70 (4.82)
DETECTOR VENT	ATMOSPHERIC REFERENCE VENT	1/4" OD	VENT TO ARV	VENT TO ARV
CARRIER	UHP AIR/OXYGEN/ARGON	1/4" OD	40 (2.75)	70 (4.82)
OXIDIZER	UHP AIR/OXYGEN/ARGON	1/4" OD	40 (2.75)	70 (4.82)
INSTRUMENT AIR	COMPRESSED AIR	1/4" OD	60 (4.13)	70 (4.82)
HEAT TRACE BOOT	SAMPLE & CALIBRATION GAS (IN AND OUT)	1/8" OD	5 (3.45)	260 (17.92)

## Section 1.3 Drawings

# Section 1.3.1 SGA-1000

REVISIONS					
REV.	DESCRIPTION	DATE	APP.	DCR	
1	FIRST ISSUE	09/01/20	HARISH		
2	VARIOUS CHANGES	01/10/22	HARISH		

**NOTES:**

1. PLACE 4X "HOT SURFACE" LABEL APPROXIMATELY AS SHOWN
2. PLACE "ELECTRIC SHOCK" LABEL APPROXIMATELY AS SHOWN.
3. PLACE "CAUTION" LABEL APPROXIMATELY AS SHOWN.
4. EXTERNAL GND STUD.
5. GROSS FREE VOLUME=6.8 FT<sup>3</sup> (193200 CC\*3).
6. HEAT TRACE TUBE: 1.6" (40.64 MM) TO 0.75" (19.05 MM).

The drawings include:

- Front View:** Shows a rectangular unit with a vent on the left side. Dimensions include a total width of [903] (35 9/16") and a vent height of [508] (20.0"). A central panel is labeled [683] (26 7/8").
- Side View:** Shows the unit's profile with a total height of [1274] (50 1/8") and a depth of [762] (30").
- Top View:** Shows the unit from above with a width of [343] (13 1/2") and a depth of [718] (28 1/4").

Callouts 1, 2, 3, and 4 point to specific locations on the unit as defined in the notes.

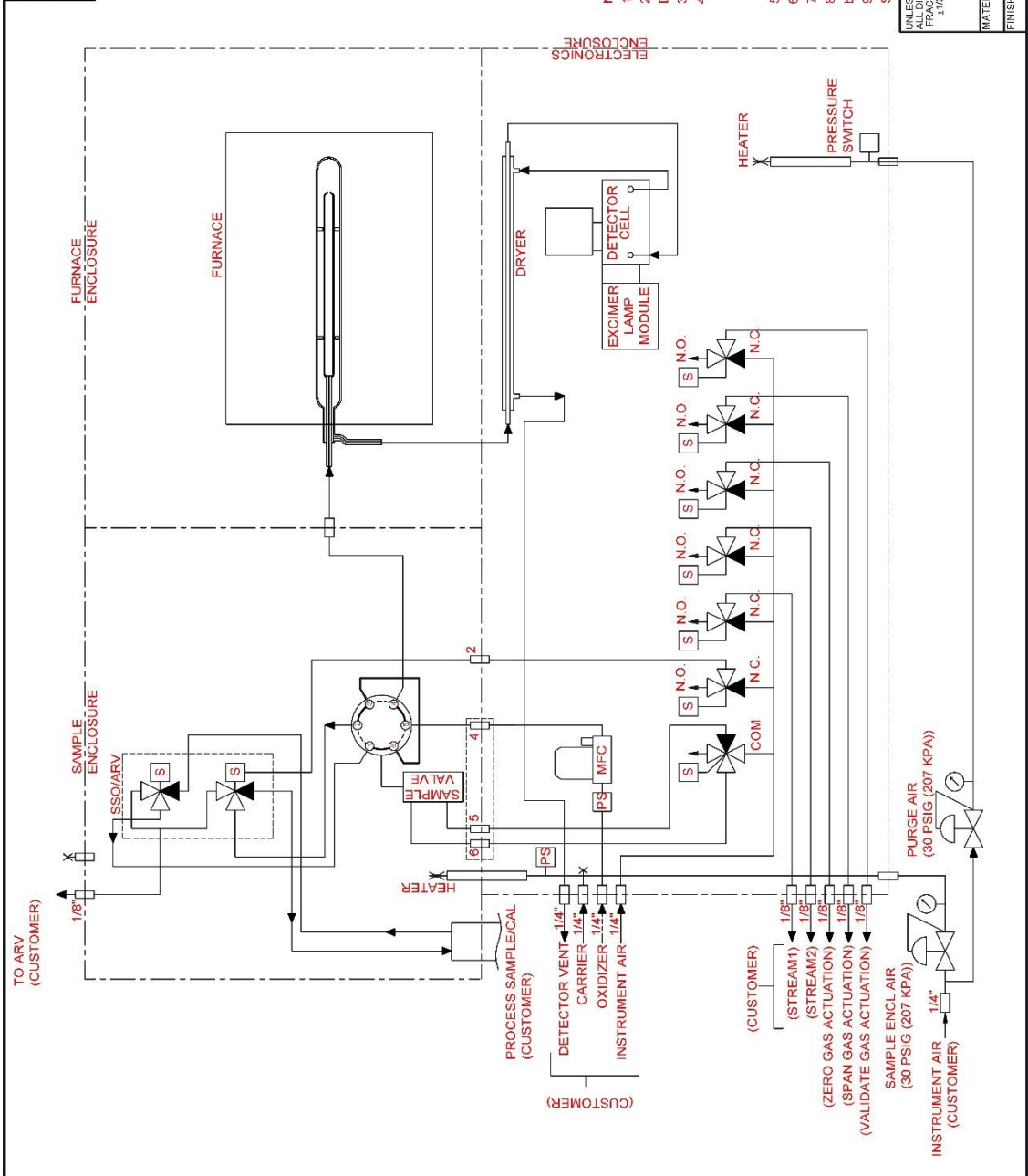
PART	MFG	MFG P/N	NOTES
X PURGE	PURGE SOLUTIONS	PSCS-2	DNV 09 ATEX 48607X
PURGE VENT	PURGE SOLUTIONS	PSO-SBUV-T-DNV 09 ATEX 48607X	

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES FRACTIONS DECIMALS ANGLES 1/162 X .1 31 .XXX .1 005 .XXXX .1 0010	 <b>ATOM</b> HOUSTON, TX, USA <small>MEMBER OF THE ATOM GROUP</small>	TITLE: <b>INSTALLATION DRAWING</b> <b>SGA-1000/TRACES-1000,</b> 230VAC SCALE: DWG NO: <b>60210-30001</b> 1:12 REV: <b>2</b>
MATERIAL: -	DRAWN BY: DATE: SHEET: <b>HARISH B   09/01/20   1 OF 1</b>	

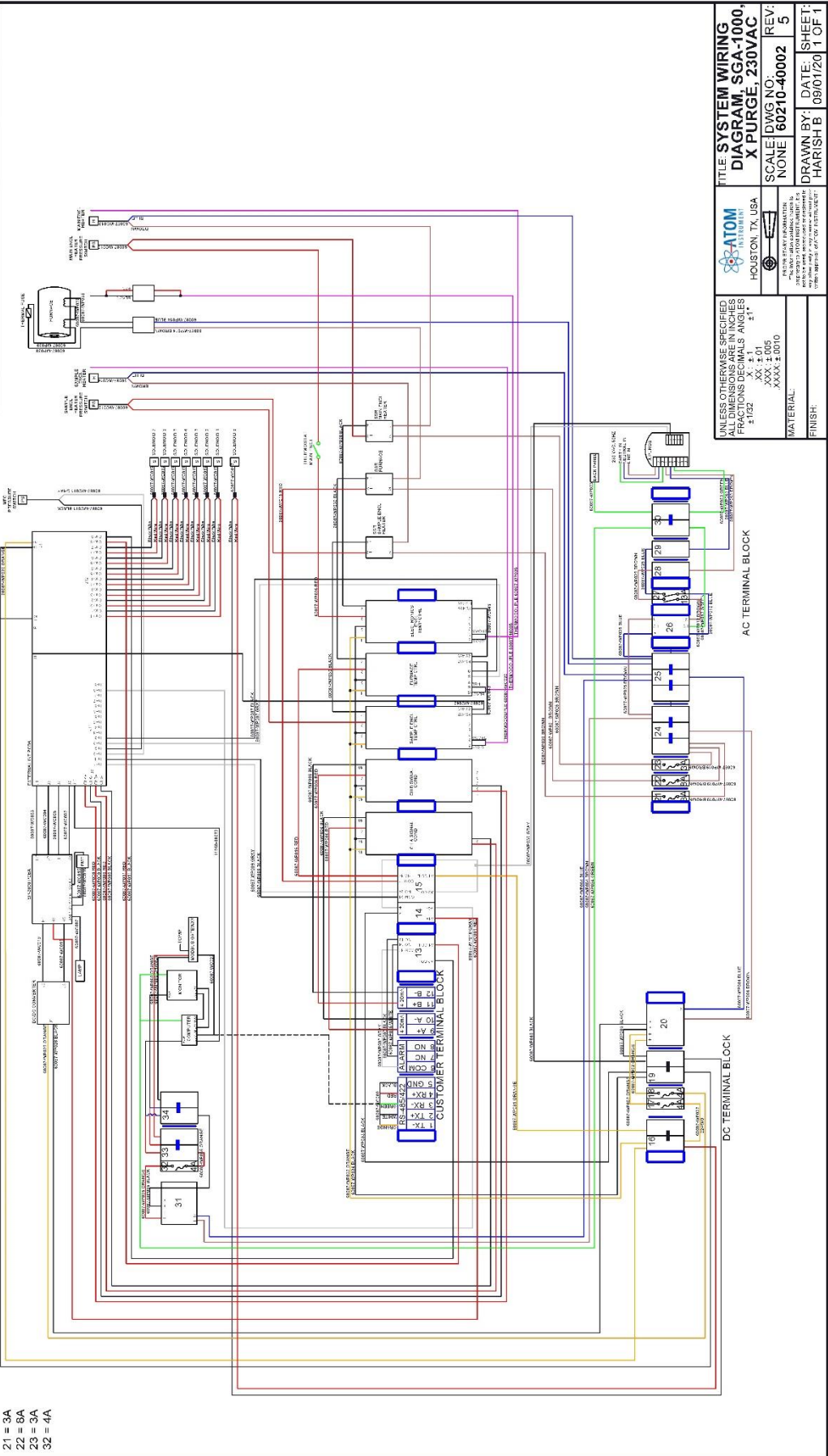


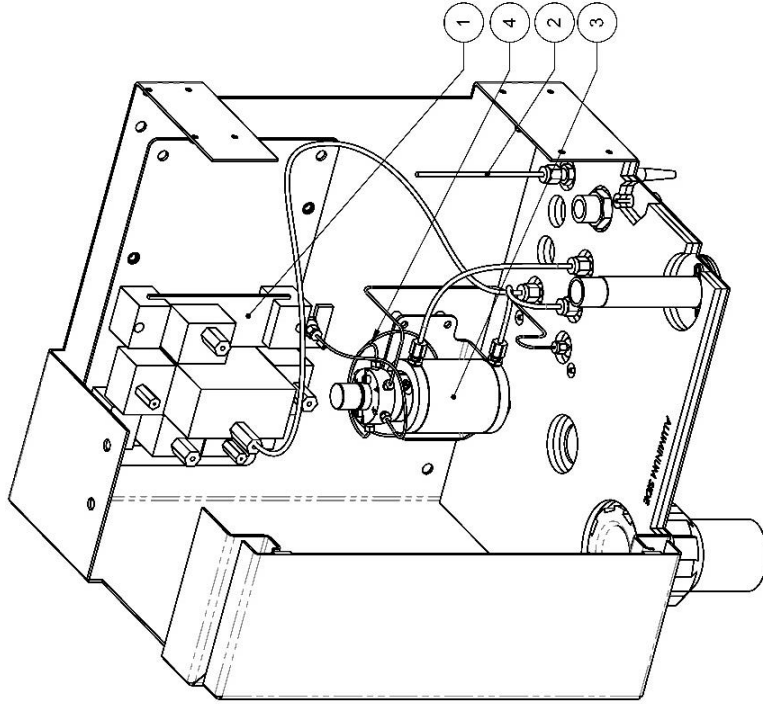
REVISIONS			
REV.	DESCRIPTION	DATE	APP.
4	VARIOUS CHANGES	02/10/22	HARISH



REVISIONS			
REV.	DESCRIPTION	DATE	APP.
5	VARIOUS CHANGES	08/03/22	HARISH


TITLE SYSTEM WIRING DIAGRAM, SGA-1000, X PURGE, 230VAC			
ATOM INSTRUMENT		SCALE	DWG NO.
HOUSTON, TX, USA		NONE	60210-40002
UNLESS OTHERWISE SPECIFIED ALL DIMENSIONS ARE IN INCHES FRACTIONS DECIMALS ANGLES		1"=1'	REV: 5
1/162 XX: ±.01 XXX: ±.005 XXXX: ±.0010			DRAWN BY: HARISH B
MATERIAL:			DATE: 09/01/20
FINISH:			SHEET: 1 OF 1

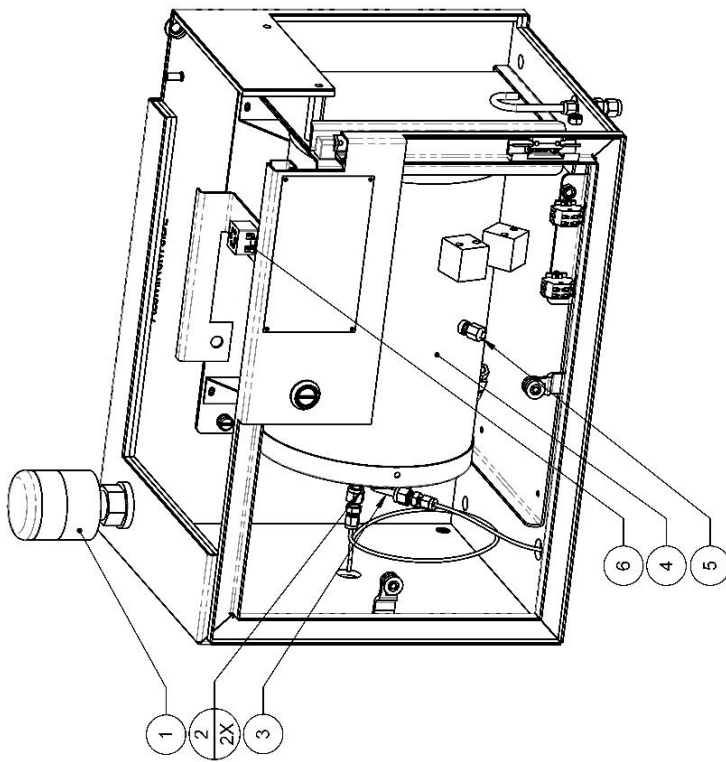




ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	60062-00003	SAMPLE SHUT OFF VALVE TO ARV	1
2	60087-WC020	ASSY, CABLE, THERMOCOUPLE, SAMPLE, ENCL	1
3	23058-00001	SAMPLE VALVE	1
4	60073-00011	SAMPLE LOOP	1

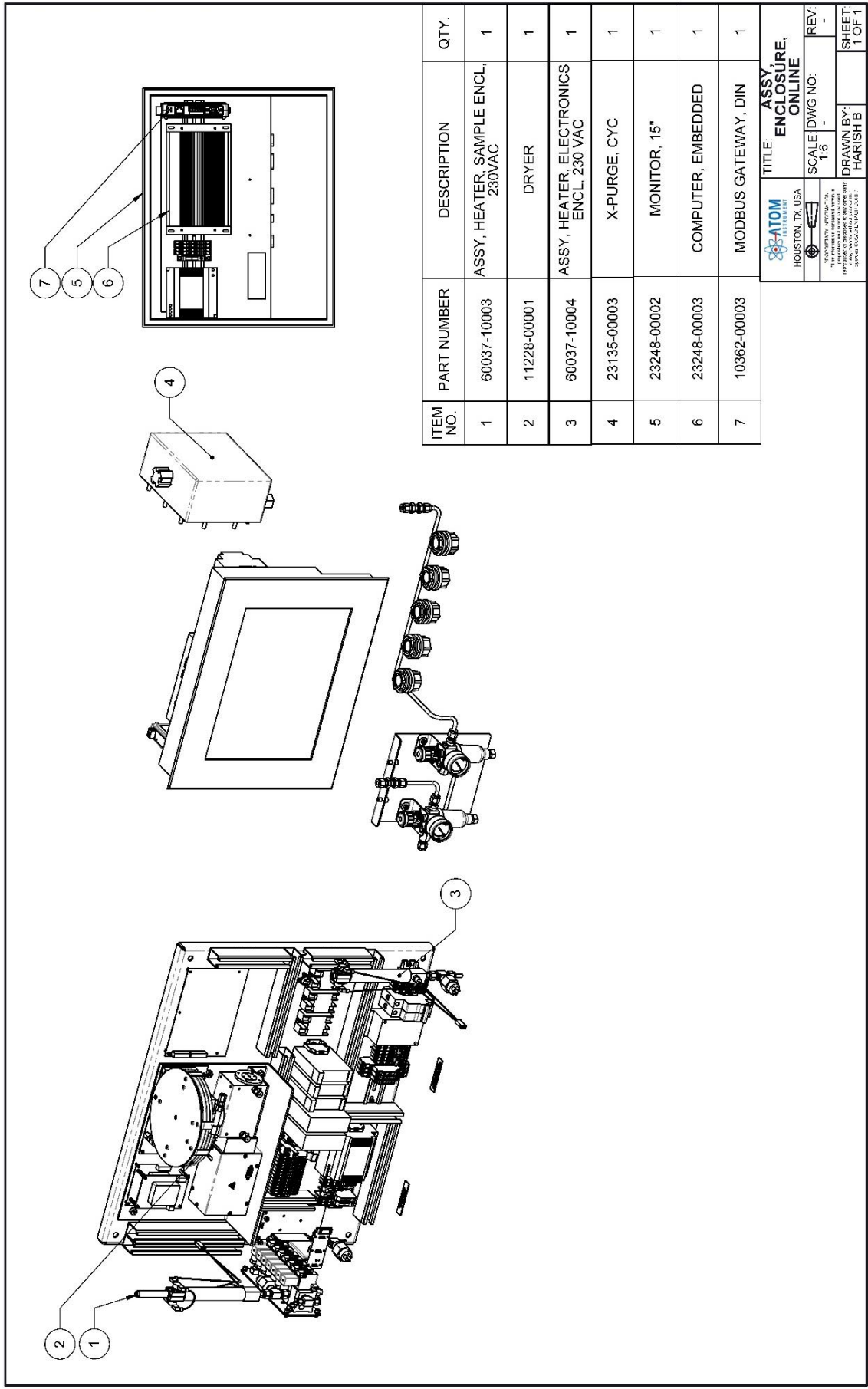
  

 <b>ATOM</b> ANALYTICAL TECHNOLOGIES HOUSTON, TX, USA		TITLE: ASSY ENCLOSURE, SAMPLE, FGA/SGA
SCALE: DWG NO: 1:3	REV: --	DRAWN BY: HARISH B
<small>           *ALL DIMENSIONS ARE IN MILLIMETERS            *DIMENSIONS IN PARENTHESES ARE            APPROXIMATE DIMENSIONS FOR REFERENCE ONLY            *DIMENSIONS OF COMPONENTS ARE NOT TO SCALE         </small>		SHEET: 1 OF 1




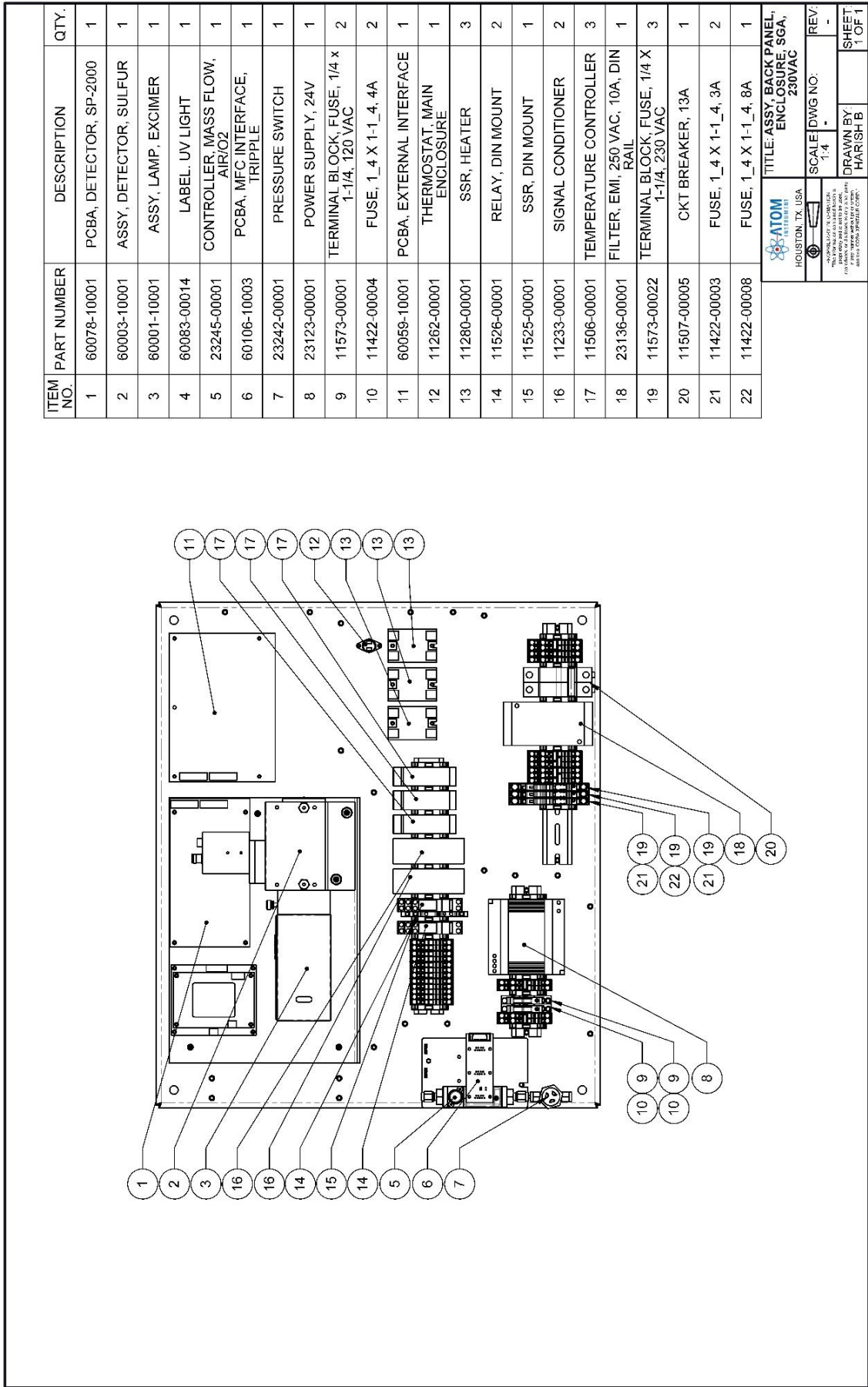
ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	11254-00001	VENT, FURNACE ENCL	1
2	10027-00001	FITTING, FERRULE, 1/4", COMBUSTION TUBE,	2
3	60064-00001	COMBUSTION TUBE, 27MM OD X 10.75L	1
4	60038-00001	FURNACE, 8 IN	1
5	60097-10005	ASSY, THERMOCOUPLE, SINGLE S	1
6	11421-00001	FUSE, THERMAL, SGA	1

<b>ATOM</b> ANALYTICAL THERMAL OVEN HOUSTON, TX, USA		TITLE: <b>ASSY, ENCLOSURE,          FURNACE, FGA/SGA</b>
SCALE: DWG NO: 1:4	REV: -	DRAWN BY: HARISH B
<small>           THE INFORMATION CONTAINED HEREIN IS THE PROPERTY OF ATOM ANALYTICAL THERMAL OVEN, INC. AND IS TO BE USED ONLY FOR THE SPECIFIC PROJECT AND FOR WHICH IT WAS ORIGINALLY INTENDED.         </small>		SHEET: 1 OF 1



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	60037-10003	ASSY, HEATER, SAMPLE ENCL., 230VAC	1
2	11228-00001	DRYER	1
3	60037-10004	ASSY, HEATER, ELECTRONICS ENCL., 230 VAC	1
4	23135-00003	X-PURGE, CYC	1
5	23248-00002	MONITOR, 15"	1
6	23248-00003	COMPUTER, EMBEDDED	1
7	10362-00003	MODBUS GATEWAY, DIN	1


**TITLE: ASSY ENCLASURE, ONLINE**  
 HOUSTON, TX, USA  
 SCALE: DWG NO.:  
 1:6  
 REV: -  
DOCATOM INSTRUMENT, INC. IS AN ISO 9001:2015 CERTIFIED COMPANY.  
 ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SPECIFIED.  
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 DRAWN BY: HARISH B  
 SHEET: 1 OF 1



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	60078-10001	PCBA, DETECTOR, SP-2000	1
2	60003-10001	ASSY, DETECTOR, SULFUR	1
3	60001-10001	ASSY, LAMP, EXCIMER	1
4	60083-00014	LABEL, UV LIGHT	1
5	23245-00001	CONTROLLER, MASS FLOW, AIR/O2	1
6	60106-10003	PCBA, MFC INTERFACE, TRIPPLE	1
7	23242-00001	PRESSURE SWITCH	1
8	23123-00001	POWER SUPPLY, 24V	1
9	11573-00001	TERMINAL BLOCK, FUSE, 1/4 x 1-1/4, 120 VAC	2
10	11422-00004	FUSE, 1_4 X 1-1_4, 4A	2
11	60059-10001	PCBA, EXTERNAL INTERFACE	1
12	11262-00001	THERMOSTAT, MAIN ENCLOSURE	1
13	11280-00001	SSR, HEATER	3
14	11526-00001	RELAY, DIN MOUNT	2
15	11525-00001	SSR, DIN MOUNT	1
16	11233-00001	SIGNAL CONDITIONER	2
17	11506-00001	TEMPERATURE CONTROLLER	3
18	23136-00001	FILTER, EMI, 250 VAC, 10A, DIN RAIL	1
19	11573-00022	TERMINAL BLOCK, FUSE, 1/4 X 1-1/4, 230 VAC	3
20	11507-00005	CKT BREAKER, 13A	1
21	11422-00003	FUSE, 1_4 X 1-1_4, 3A	2
22	11422-00008	FUSE, 1_4 X 1-1_4, 8A	1

**ATOM**  
HOUSTON, TX, USA

TITLE: ASSY, BACK PANEL ENCLOSURE, SGA, 230VAC

SCALE: DWG NO. 1-4

REV: -

DRAWN BY: HARISH B

SHEET: 1 OF 1

# Section 1.3.2 Traces-1000

**NOTES:**

1. PLACE 4X "HOT SURFACE" LABEL APPROXIMATELY AS SHOWN
2. PLACE "ELECTRIC SHOCK" LABEL APPROXIMATELY AS SHOWN.
3. PLACE "CAUTION" LABEL APPROXIMATELY AS SHOWN.
4. EXTERNAL GND STUD.

5. GROSS FREE VOLUME=6.8 FT<sup>3</sup> (193200 CC<sup>3</sup>).

6. HEAT TRACE TUBE: 1.6" (40.64 MM) TO 0.75" (19.05 MM).

REVISIONS			
REV.	DESCRIPTION	DATE	APP. DCR
1	FIRST ISSUE	09/01/20	HARISH
2	VARIOUS CHANGES	01/10/22	HARISH

PART	MFG	MFG P/N	NOTES
X PURGE	PURGE SOLUTIONS	PSCS-2	DNV 09 ATEX 48607X
PURGE VENT	PURGE SOLUTIONS	PSO-SBUV-TDNV 09 ATEX 48607X	

UNLESS OTHERWISE SPECIFIED, ALL DIMENSIONS ARE IN INCHES. FRACTIONS DECIMALS ANGLES 1/64 .XXX ±.005 .XXXX ±.0010

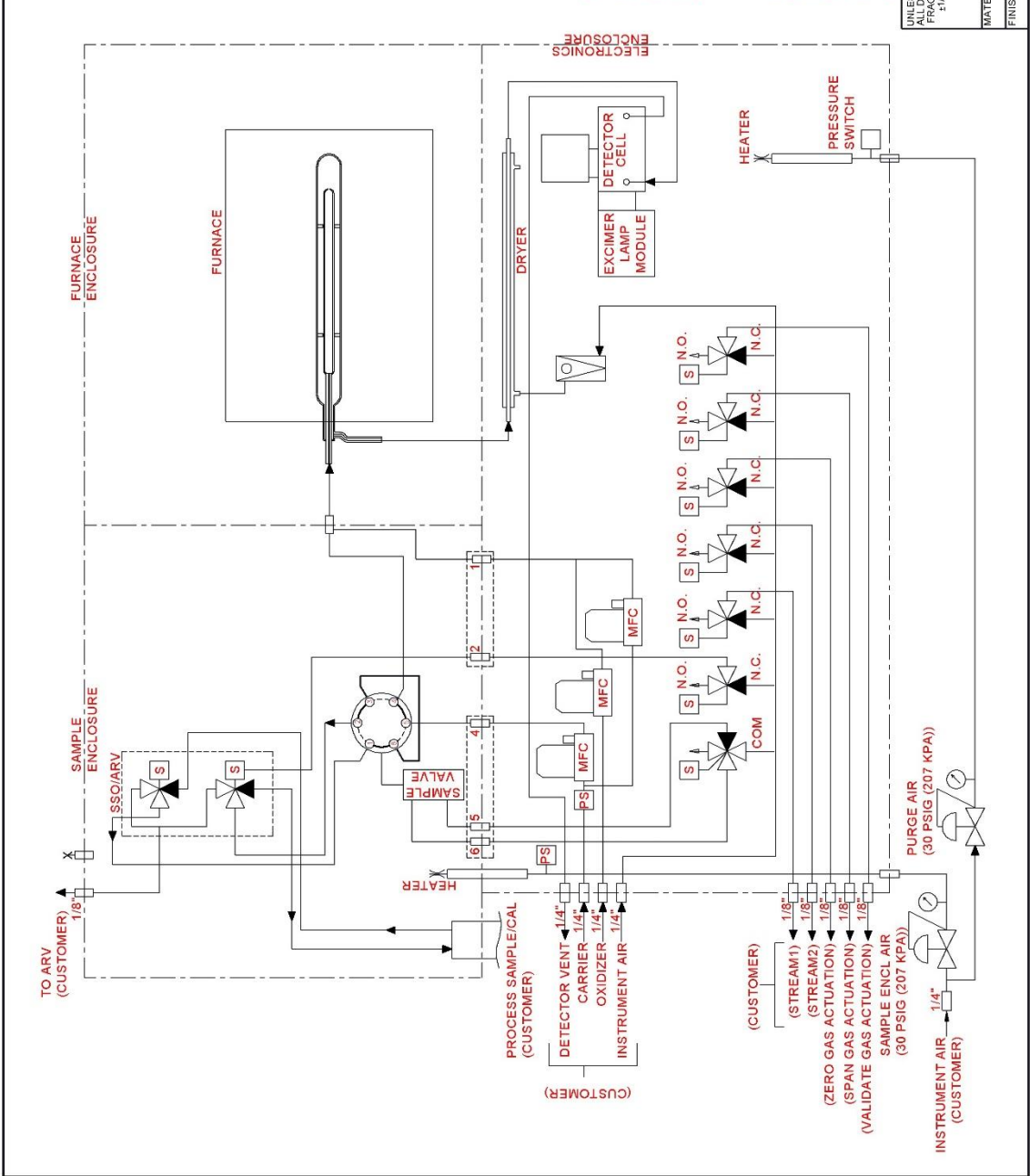
**ATOM** HOUSTON, TX, USA

SCALE: DWG NO: 60210-80001 REV: 2

INSTALLATION DRAWING SGA-1000/TRACES-1000, 230VAC

DRAWN BY: HARISHB DATE: 09/01/20 SHEET: 1 OF 1

REVISIONS			
REV.	DESCRIPTION	DATE	APP.
2	FIRST ISSUE	09/01/20	HARISH



- NOTES:
1. ALL CUSTOMER CONNECTIONS ARE SWAGelok TUBE FITTINGS.
  2. ARV=ATMOSPHERIC REFERENCE VENT. VENT HEIGHT WILL BE DETERMINED ON PLANT SAFETY STANDARD.
  3. INSTRUMENT AIR: USED FOR SOLENOID VALVES AND PURGE.
  4. SAMPLE:
    - PRESSURE: 5-260 PSIG (0.34-17.92 bar(G)).
    - MAX TEMP: 175°C.
    - FLOW: APPLICATION DEPENDENT. GENERALLY 50-200 CC/MIN.
  5. DETECTOR VENT: TO ARV
  6. CARRIER: UHP ARGON, 40-70 PSIG (2.75-4.82 bar(G)).
  7. OXIDIZER: UHP OXYGEN, 40-70 PSIG (2.75-4.82 bar(G)).
  8. INSTRUMENT AIR: INSTRUMENT GRADE AIR, 60-70 PSIG (4.13-4.82 bar(G)).
  9. STREAM1, STREAM2, ZERO SPAN/VALIDATE GAS ACTUATION: AIR SIGNALS TO ACTUATE VALVES IN SGS.

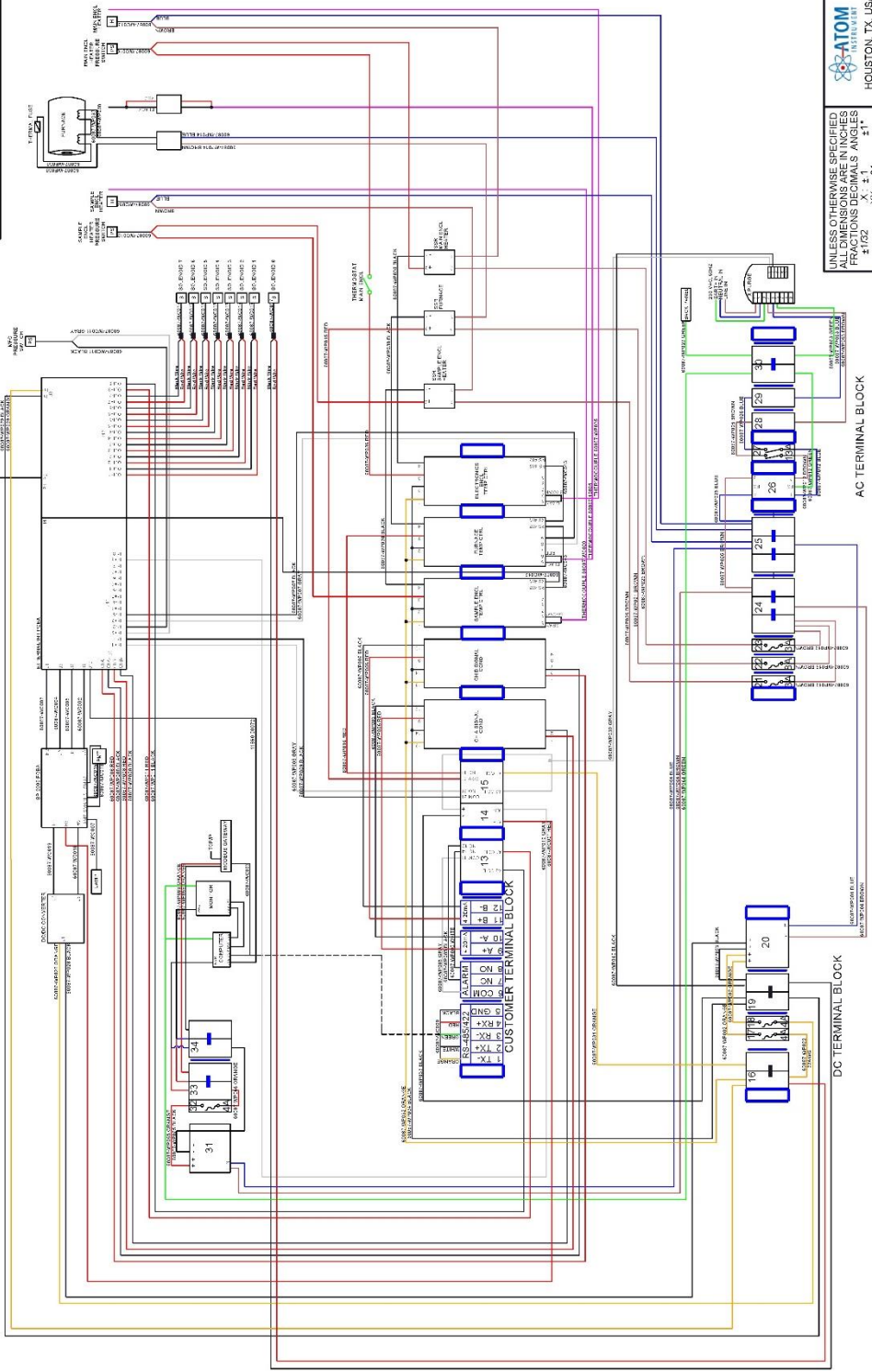
UNLESS OTHERWISE SPECIFIED FRACTIONS DECIMALS ANGLES 1/32 1/16 1/8 1/4 1/2 1"		TITLE SYSTEM PROCESS FLOW DRAWING, TRACES-1000	
HOUSTON, TX, USA		SCALE DWG NO. NONE 60710-70001	REV: 2
MATERIAL: -		DRAWN BY: DATE: HARISH B 05/18/17	
FINISH: -		SHEET: 1 OF 1	



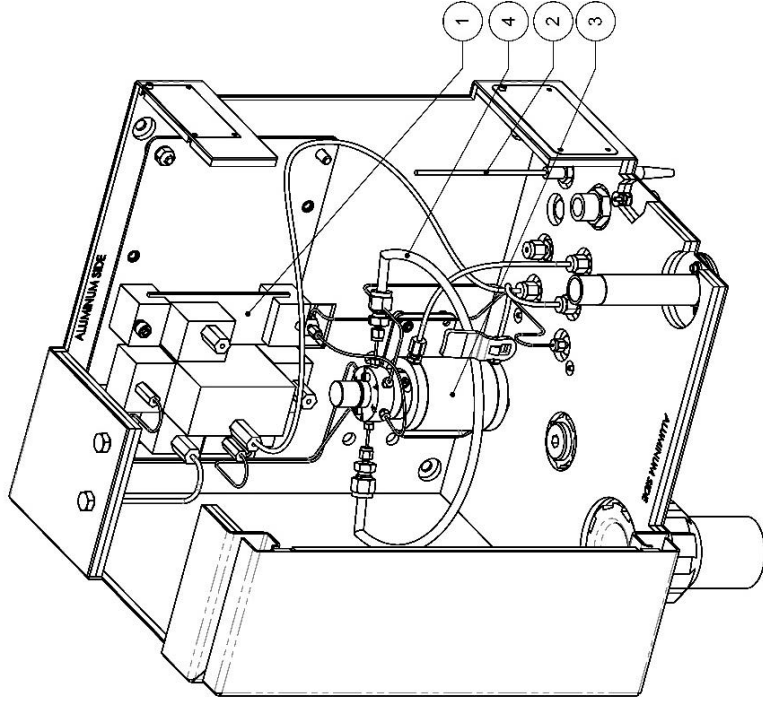
REVISIONS			
REV.	DESCRIPTION	DATE	APP.
2	VARIOUS CHANGES	08/05/22	HARISH
			DCR

NOTES:  
 1. DIGITAL INPUTS TO BE CONNECTED AT IN4 THRU IN7 ON EXTERNAL INT PCB.  
 2. ALL FUSES ARE 1/4" X 1-1/4" CYLINDRICAL.

- 17 = 4A
- 18 = 4A
- 21 = 3A
- 22 = 8A
- 23 = 3A
- 32 = 4A



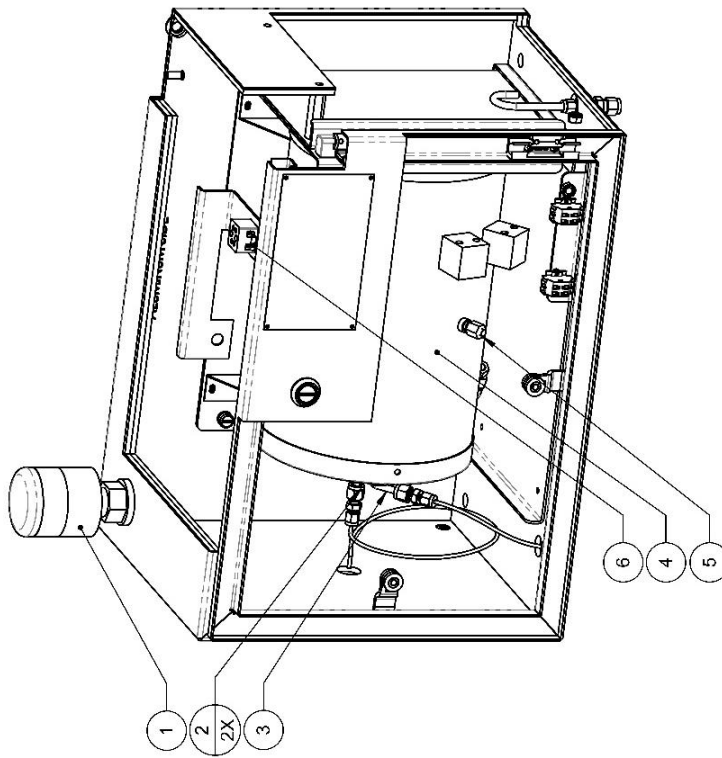
 HOUSTON, TX, USA		<b>TITLE SYSTEM WIRING</b> <b>DIAGRAM, TRACES-1000,</b> <b>X PURGE, 230VAC</b>	<b>REV:</b> NONE
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES DECIMALS ARE IN THOUSANDS XX: ±0.05 XXX: ±0.10 XXXX: ±0.010		<b>SCALE</b> DIMS NO: 1 NONE	<b>REV:</b> 2
<b>MATERIAL:</b> FINISH:		<b>DRAWN BY:</b> HARISH B	<b>DATE:</b> 08/01/20
		<b>REV:</b> 1 OF 1	<b>SHEET:</b> 1 OF 1



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	60062-00005	VALVE, SSO/ARV, SULFINERT	1
2	60087-WC020	ASSY, CABLE, THERMOCOUPLE, SAMPLE, ENCL	1
3	23058-00001	SAMPLE VALVE	1
4	60063-00009	TUBE, 0.21 ID X 1/4 OD, SULF, SAMPLE LOOP, TRACES	1

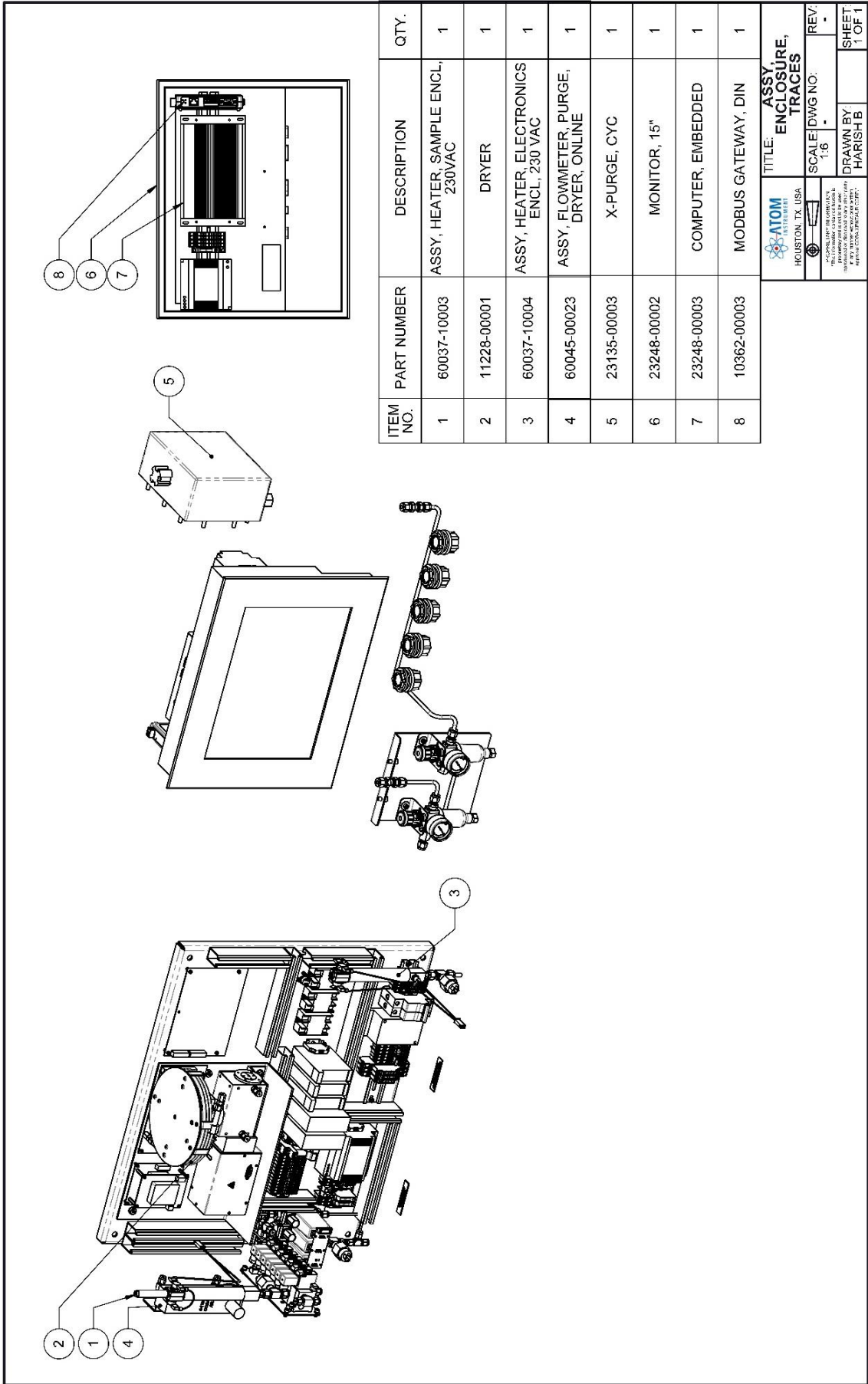
  

<b>ATOM</b> <small>ANALYTICAL SYSTEMS, INC.</small> HOUSTON, TX, USA		TITLE: ASSY ENCLOSURE SAMPLE, TRACES
<small>PRODUCTION DIMENSIONS          THIS DRAWING IS NOT TO BE USED          FOR FABRICATION OF PARTS WITHOUT          THE APPROVAL OF AN ATOM DESIGN          ENGINEER OR QUALITY CONTROL ENGINEER.</small>	SCALE: DWG NO.: 1:3	REV: -
DRAWN BY: HARISH B		SHEET: 1 OF 1



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	11254-00001	VENT, FURNACE ENCL	1
2	10027-00001	FITTING, FERRULE, 1/4, COMBUSTION TUBE	2
3	60064-00001	COMBUSTION TUBE, 27MM OD X 10.75L	1
4	60038-00001	FURNACE, 8 IN	1
5	60097-10005	ASSY, THERMOCOUPLE, SINGLE S	1
6	11421-00001	FUSE, THERMAL, SGA	1

<b>ATOM</b> ANALYTICAL THERMAL OVEN HOUSTON, TX, USA	
TITLE: <b>ASSY, ENCLOSURE,          FURNACE, FGA/SGA</b>	
SCALE: 1:4	DWG NO.: -
REV: -	SHEET: 1 OF 1
DRAWN BY: HARISH B	



ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	60037-10003	ASSY, HEATER, SAMPLE ENCL, 230VAC	1
2	11228-00001	DRYER	1
3	60037-10004	ASSY, HEATER, ELECTRONICS ENCL, 230 VAC	1
4	60045-00023	ASSY, FLOWMETER, PURGE, DRYER, ONLINE	1
5	23135-00003	X-PURGE, CYC	1
6	23248-00002	MONITOR, 15"	1
7	23248-00003	COMPUTER, EMBEDDED	1
8	10362-00003	MODBUS GATEWAY, DIN	1

**ATOM**  
HOUSTON, TX, USA

**TITLE: ASSEMBLY ENCLOSURE, TRACES**

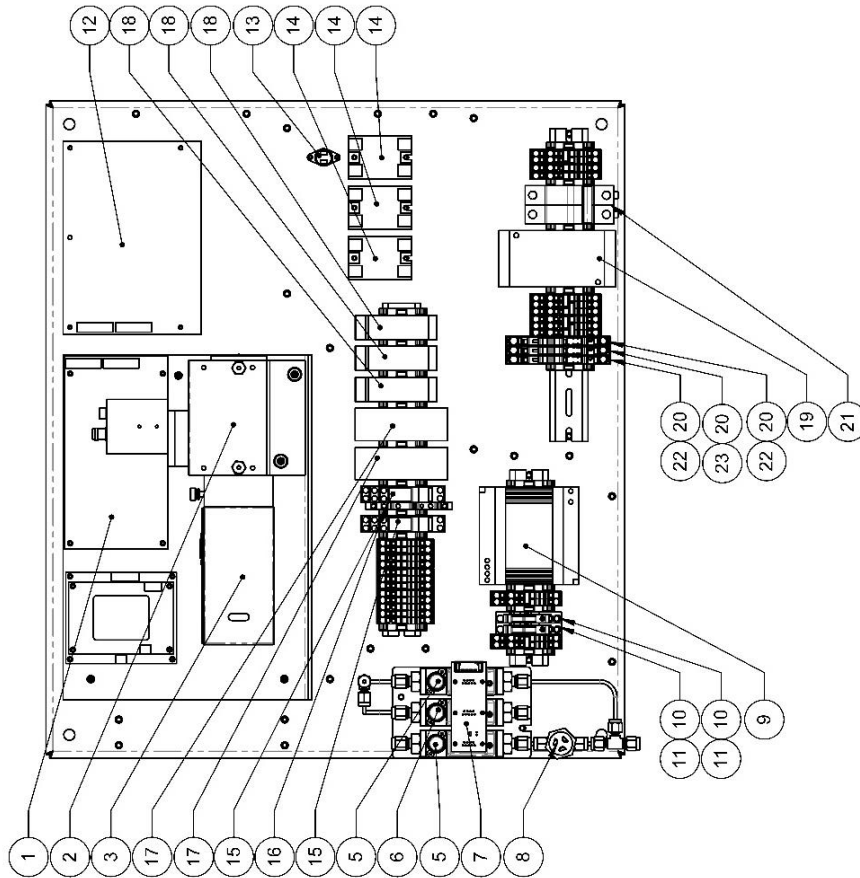
SCALE: DWG NO. 1:6

REV: -

DRAWN BY: HARISHB

SHEET: 1 OF 1

ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	60078-10001	PCBA, DETECTOR, SP-2000	1
2	60003-10001	ASSY, DETECTOR, EXCIMER	1
3	60001-10001	ASSY, LAMP, EXCIMER	1
4	60083-00014	LABEL, UV LIGHT	1
5	23245-00002	CONTROLLER, MASS FLOW, ARGON	2
6	23245-00001	CONTROLLER, MASS FLOW, AIR/O2	1
7	60106-10003	PCBA, MFC INTERFACE, TRIPPLE	1
8	23242-00001	PRESSURE SWITCH	1
9	23123-00001	POWER SUPPLY, 24V	1
10	11573-00001	TERMINAL BLOCK, FUSE, 1/4 X 1-1/4, 120 VAC	2
11	11422-00004	FUSE, 1_4 X 1-1_4, 4A	2
12	60059-10001	PCBA, EXTERNAL INTERFACE	1
13	11262-00001	THERMOSTAT, MAIN ENCLOSURE	1
14	11280-00001	SSR, HEATER	3
15	11526-00001	RELAY, DIN MOUNT	2
16	11525-00001	SSR, DIN MOUNT	1
17	11233-00001	SIGNAL CONDITIONER	2
18	11506-00001	TEMPERATURE CONTROLLER	3
19	23136-00001	FILTER, EMI, 250 VAC, 10A, DIN RAIL	1
20	11573-00022	TERMINAL BLOCK, FUSE, 1/4 X 1-1/4, 230 VAC	3
21	11507-00005	CKT BREAKER, 13A	1
22	11422-00003	FUSE, 1_4 X 1-1_4, 3A	2
23	11422-00008	FUSE, 1_4 X 1-1_4, 8A	1



	
HOUSTON, TX, USA	
TITLE: ASSY, BACKPANEL, ENCLOSURE, TRACES, 230 VAC	
SCALE: DWG NO.:	REV:
1:4	-
DRAWN BY: HARISH B	
SHEET: 1 OF 1	

## Section 2 – Software Operation

This section of the manual is intended to provide a complete overview of the analyzer software providing the user a fundamental understanding of analyzer operation.

There are three programs incorporated into analyzer software that have distinct functions but work together to provide complete control and user interface of the analyzer. The main software program operates in the background and controls all aspects of analyzer operation, which includes protocols for communicating with the detector module. The detector module firmware is a distinctly separate, machine-language program embedded in the onboard microprocessor. The third program is a colorful, high-contrast Graphical User interface or GUI that provides a user-friendly interface comprised of an organized set of intuitive menu screens that are configured for ease of use.

### Start Up

Upon powering up the analyzer, the touchscreen will begin to turn on and Windows 7 will boot. If an administrator password has been set up for Windows 7, the password can be entered using an external keyboard plugged into a USB port to access the software. If no keyboard is connected, the touchscreen keyboard can be displayed by pressing the "Ease of access center" button at the bottom left of the screen and then selecting the "Type without the keyboard (On-Screen Keyboard)" option.

If no Windows administrator password has been implemented, the main GUI menu will open automatically after the analyzer and touchscreen computer are powered on. All sub-menus may then be accessed from this bar found at the top of the desktop screen.



*Figure 2.1 – Main Menu*

To access any of the sub-menus of the GUI, the user must first log into the system. Refer to section 2.1.1 for Login information

## Section 2.1 File Menu



Figure 2.2 – File Drop down Menu

### Section 2.1.1 Login

The **Login** feature allows users to interface with the software on two separate levels. Users without administrative privileges are limited to menu access for viewing purposes only. Those users with administrative privileges have complete access to all menu settings, which can be modified as necessary for customizing or optimizing instrument operation (selectable in User Setup). The **Login** feature is intended to prevent unauthorized changes to instrument operation, allowing it to retain current settings unless an authorized user logs in with valid credentials.

To log in to the analyzer, click **File > Login**. Press the ID line.

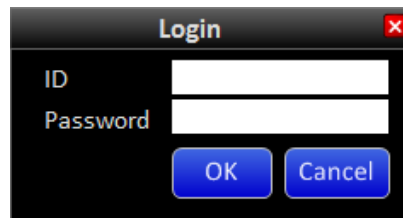


Figure 2.3 – Login Screen

A touchscreen keyboard should automatically pop-up on the screen.



Figure 2.4 – Touchscreen Keyboard

Using the touchscreen keyboard, enter the username ID. Then press the Password line and enter the user assigned password. After proper user credentials have been entered, press the OK button to complete the Login process.

**NOTE:** At any attempt to access a screen that requires administrative privileges, the **Login** screen will automatically pop-up and prompt the user for the required credentials.

**NOTE:** The dropdown menu will read Logout if a valid login has already been entered.

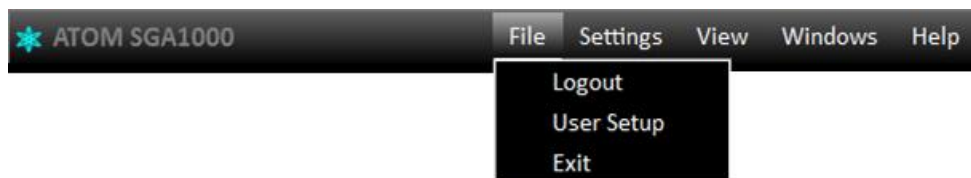


Figure 2.5 – User Already Logged In

There is an auto-logout feature in place to automatically logout any user after 15 minutes of inactivity. After this time, any screen that requires administrative privileges to change or modify settings will automatically cause the Login Screen to reappear and prompt the user to re-enter the required credentials.

## Section 2.1.2 User Setup

The User Setup screen is accessed from **File > User Setup**. Four levels of users are defined in the GUI: Admin, Tech, View and Other (no box selected).

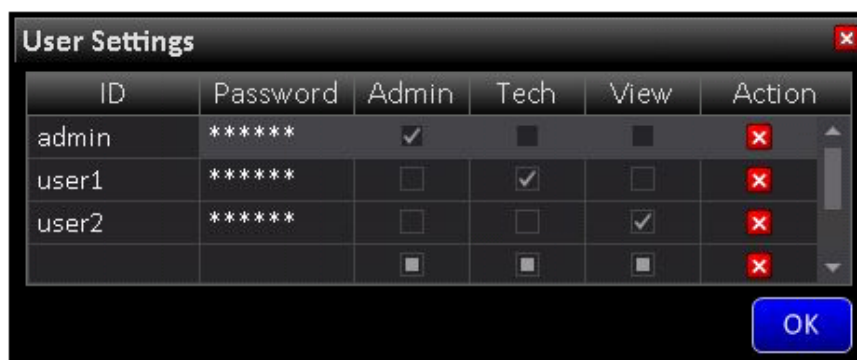



Figure 2.6 – User Settings Screen

Below is a description of each user’s rights:

	Admin	Tech	View
View any GUI screen	X	X	X
Modify analyzer parameters	X	X	
Modify user privileges	X		

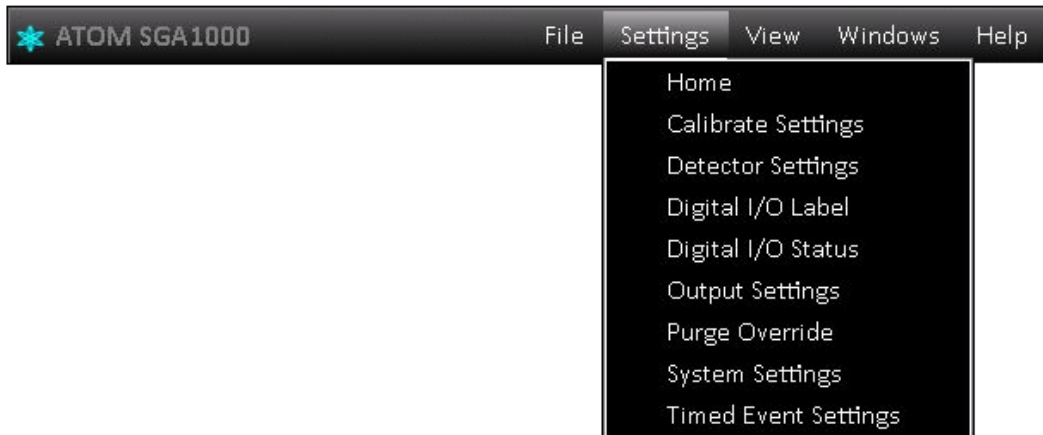
When logged in as a system administrator, pressing the  will delete the corresponding user profile. The factory “admin” cannot be deleted, nor can the name be modified. However, subsequent users with “Admin” privileges can be created or deleted. The administrator can add users and assign/change a user’s privileges. To add a user, click on the last empty ID field and enter the username, a password and then select user level (Admin/Tech/View) to finish user registration.



## Section 2.1.3 Exit

By clicking **File > Exit**, the GUI program will close; however, the analyzer main program will continue to run if there are no operational restrictions, such as loss of purge or other system critical alarm function.

## Section 2.2 Settings



*Figure 2.7 – Settings Dropdown Menu*

## Section 2.2.1 Home

The Home Screen is the top screen in the Settings menu and is the primary user interface for an overview of routine analyzer operation. The Home menu functions are arranged in groups and are discussed separately.



Figure 2.8 – Home Screen Detailed

### Stream Selection and information

#### Start Stream

This setting allows user to select the starting order of stream analysis when the Analyzer begins analyses, either from a reset, or from a "holding" state.

#### Stream Select

In this part of the home screen, the user may select streams to be run by checking the box adjacent to the desired stream(s). At least one of the streams check box must be selected and number of cycles for selected stream entered must be a value greater than zero for analyses to commence.

#### Run

This indicates which stream is currently being analyzed.

#### Cycles

The user can set the number of cycles each stream is sequentially run before switching streams by clicking the Cycles button that will open a text box that allows the user to select between 1 and 9 cycles per stream.



Figure 2.8(a) – Enter Value Screen

When a stream being analyzed, a green radio button is activated next to the stream being analyzed. The Cycles Run counter indicates analysis progression. When all cycles requested by the user are completed, the analyzer switches to the other stream (if both streams are checked).

### **Analyzer “Online”**

This button is tied to Modbus Register R00007 to inform the DCS whether the Analyzer is undergoing maintenance. The DCS can then ignore probable erroneous data while Analyzer is “Offline”.

### **Run Cycle Status**

The Run Cycle Status section of the Home Screen displays information regarding various aspects of the Cycle in process.

#### Start/Stop Button:

The analyzer software is designed so that the Analysis Cycle runs all the time and will automatically restart upon restoring power after a power shutdown. Exceptions to the continuous run feature are:

1. There is an Alarm condition.
2. The Run Cycle is manually stopped.
3. The analyzer is Purging due to an Auto Calibration Check or return to Process.
4. The analyzer is in a “Holding” state as part of the Run Cycle Mode.

When the button is labeled STOP with a green LED, a cycle is either running, or is scheduled to run. Pressing this button will cause the cycle to stop after the current cycle has completed. When stopped, this button will be labeled START with the LED off. Pressing this button again will change the label to STOP and initiate a new cycle run.

#### Event Indicator

Beneath the START/STOP button is an indicator that displays various events related to the Run cycle. Some of the events the Event Indicator will display are, Not Ready, Holding and Purging. Whenever a cycle is currently running, it will display timed events as they occur such as Injecting, Baseline Evaluation and Peak Integration periods.

#### Cycle Time

The Cycle Time in the Run Cycle Status displays the current cycle time in elapsed seconds. A typical cycle time for the Analyzer is 100 seconds. Once the current cycle is completed, it will start a new cycle at time 0.

#### Cycle Number

The Cycle Number displays the total number of completed cycles the analyzer has run since the analyzer was started. This number will increment until the cycle is stopped and will continue to increment once the cycle has restarted. This number will reset whenever the Analyzer is stopped.

## **System Control**

The System Control section of the Home Screen shows the status of the PMT and UV Lamp voltages, the presence of any Zero baseline offset value, and the Alarm/Warning status of the system.

### PMT HV

This button controls high voltage to the Photo-Multiplier Tube and indicates whether it is ON or OFF. The LED will be GREEN if powered ON and is turned OFF by pressing the button to toggle.

### UV Lamp

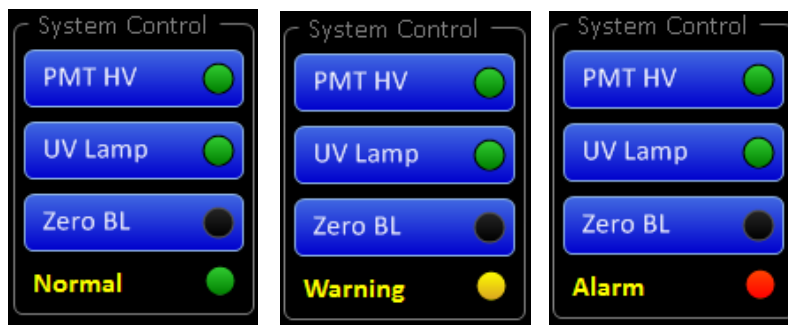
This button controls power to the Excimer Lamp Module and operates like the PMT HV button in its ON/OFF functionality.

### Zero BL

This button allows any baseline level to be zeroed for graphic display purposes, or the analyzer analog output when the detector signal is selected. This function must be enabled in the Detector Settings Screen which will be discussed later in the Software Operation section. Zeroing the baseline level will not affect acquired results or calculations of total sulfur composition.

### Analyzer Alarm Status

This line will display **Normal** with green LED when the analyzer is running properly. This line will display **Warning** with yellow LED indicating a situation that requires user intervention but is not critical enough to affect normal analyzer function. Should a system critical situation arise, this line will display **Alarm** with red LED indicating an alarm condition exists. If this occurs, the Analyzer is designed to immediately abort the current Run Cycle, shut down power to the combustion furnace, and activate the Global Alarm.

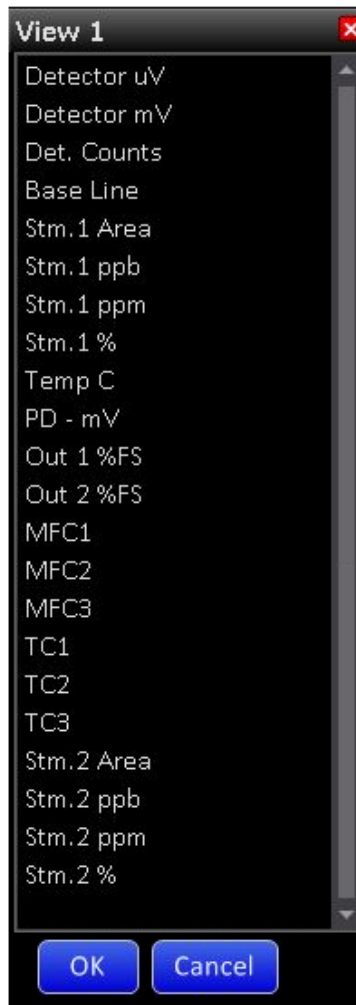


*Figure 2.9 – Normal, Warning, and Alarm Status*

**NOTE:** The status of this indicator will also be prominently flashed on top of the menu bar should the Analyzer go into either WARNING or ALARM mode.

## Variable Display Section

The Variable Display section allows user to monitor up to three selected variables from a view options list. The associated bar graphs can be appropriately ranged to provide a customizable display as per the user preference. Although any combination of variables can be chosen, the graphs are set by default to Detector mV, Stream 1 ppm and Stream 2 ppm. These displays will hold their current value until a new value is calculated, replacing the previous reading with the most recent one. Pressing any of the three buttons above the graphs will open a list of available display variables, which can be selected by highlighting the intended variable and pressing the **OK** button.



*Figure 2.10 – Variable Display Selection Menu for View 2*

Pressing the RANGE button allows the bar graph range to be selected in a likewise fashion. The desired range is chosen by selecting the adjacent radio button.

Alternatively, it is possible to choose a user defined range in the bottom last line of the table.

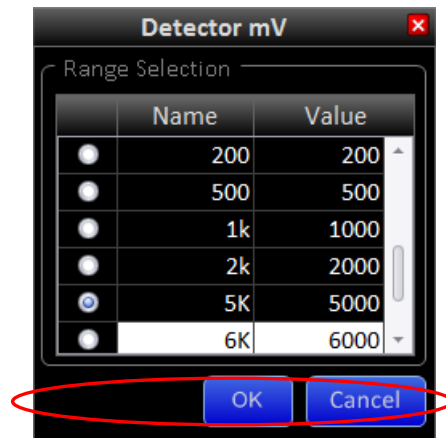


Figure 2.11 – Variable Range Selection Menu

## Section 2.2.2 Calibrate Settings

The Calibrate settings screen is where all information regarding instrument calibration and associated calibration results are displayed.

To access this screen press **Settings > Calibrate Settings**



Figure 2.12 – Calibrate Settings Screen

### Check Cycle Status

The Check Cycle Status allows the user to monitor and review acquired Check Cycle results, as well as the progress of the Check Cycles in progress.

#### View Results

Pressing the **View Results** button opens a separate menu and displays up to ten runs in a Cycle Set, allowing them to be viewed as they occur during Manual or Auto Check Runs. The results displayed are computed with the Response Factor (RF) currently in use.

If a calibration check is in progress, results are updated in real-time as they occur. If the last calibration check is finished, these results will display all acquired values within the last calibration check set. Although "check calibration" results can be viewed at any time, they will be wiped clean and replaced with new data whenever the next Manual or Auto Check calibration is performed. Both Zero and Span sections display Area and Concentration values associated with the calibration check, as computed with the previously accepted Response Factor (RF).

Check Calibration Results				
Run	Zero		Span	
	Area	Conc ppm	Area	Conc ppm
1	477,067	3.1	305,697,594	2,009.9
2	433,441	2.8	304,902,771	2,004.7
3	439,516	2.9	302,925,506	1,991.7
4	477,067	3.1	301,283,435	1,980.9
5	433,441	2.8	302,801,388	1,990.8
6				
7				
8				
9				
10				
Average	452,106	3.0	303,522,138	1,995.6

Figure 2.13 – Check Calibration Results Screen

### Cycles Run

The Cycles Run Line indicates the number of completed runs from the number of cycles selected for the calibration check set.

### Cycle Controls

The Cycle Control section of the menu allows the user to set the number of calibration cycles desired for each Check Calibration Set, as well as the amount of purge time between cycles.

### Cycles/Set

The **Cycles/Set** button allows any number of cycles to be selected between 1 and 10 for the desired set of runs. This number of cycles will be applied to each Zero, Span or Validate samples when selected. By pressing the **Cycles/Set** button a window will pop-up as well as the touchscreen keyboard to enter the desired number of cycles to be run. Press OK to set this value.



**NOTE:** The Enter Value Screen will pop-up throughout the software when required.

Figure 2.14 – Enter Value Screen

### Purge (Sec)

The **Purge (Sec)** button allows the user to select the purge time between sets. This is intended to allow sample concentrations to reach equilibrium prior to starting a calibration check set. The optimal time setting will depend on sample flowrates and dead volume between the selection valves and analyzer.

The purge time will be applied during transition times between running process and a calibration check sample, between each set of calibration checks, and before returning to running the process sample.

If the analyzer is in purge mode, the Home Screen will display **Purging** on the event line and the clock counter will decrement from the chosen setting to "0" seconds.



**\*\* Note:** A loss of purge will cause the analyzer to go into "Alarm", and the analysis is stopped immediately. If this Alarm event occurs right after sample injection, then this sample will still be present in the system even after the alarm condition clears. Once the Alarm is cleared, the analyses resume after purging for the set duration (**Purge (Sec)** set as shown above under Calibration Settings).

If the purge is set for a shorter duration, it may not be enough to sweep the previously injected sample out of the system, before the next sample injection. This increases the probability of system coking. To avoid this, it is **recommended that the sample Purge Time be set to a minimum of 60 seconds.**

## **Calibrate Values**

This section displays all values used or associated with instrument calibration.

### Check Zero and Span

The **Check Zero** and **Check Span** buttons display acquired values from the most recent calibration check. After the calibration checks are finished average calculated areas of Zero and Span will be displayed in these buttons. These values will be used for analyzer recalibration if considered acceptable by the user. Calculated values can be overridden with any User specified value.

### Saved Zero and Span

Values on these lines display previously accepted areas utilized for calibration purposes.

### Zero and Span Concentrations

The **Zero Conc** and **Span Conc** buttons allow the user to enter known concentration of samples, generally utilizing the certified values provided by the calibration gas supplier.

The **Cal Units** button allows the user to select the concentration for both values to be entered in either percent or PPM.

### RF=Count/ppm

The **RF=Count/ppm** button displays the most current response factor. The response factor (RF) is the principal number used to calibrate the instrument representing peak area counts/ppm and is a value proportional differential area between span and zero divided by the differential in respective concentrations.

If the user wishes to modify the calculated RF, or run the instrument with a specified user-defined RF value, the user may press the **RF=Count/ppm** Button and merely enter the desired RF.

## **Manual Check**

The Manual Check section allows the user to manually run a ZERO, SPAN, or VALIDATE set of run cycles. The ZERO and SPAN functions will use the sample bottles that are connected to their respective inputs to calibrate the analyzer. The VALIDATE function will run any concentration of a known sample to ensure the analyzer accurately measures the intended concentration.

## **Auto Check**

The Auto Check section of the Calibration Settings allows the user to set up routine calibration checks.

The **Enable** button enables or disables auto check feature, as indicated by the embedded LED. Any or all of the three possible gas standards can be included in the Auto Check run by selecting the adjacent box to include a checkmark. The user can also specify the desired auto check schedule utilizing the **Freq (Days)** and **Time (24Hr)** buttons. The time of day is always entered in 24-hour format.

### **Demo Mode**

The **Demo Mode** button allows the user to substitute previously recorded data in place of real-time detector data without having to run actual samples. The Demo Mode feature is enabled by pressing the button as indicated by the lit LED.

If the instrument is analyzing process sample when Demo Mode is enabled, normal detector signals will be substituted with pre-recorded data from a 50% concentration sample at the end of the current Run Cycle.

If the instrument is analyzing calibration sample, whether in Manual or Automatic mode, the 50% concentration sample data will be substituted whenever Span is selected.

If Zero gas is selected, a different set of pre-recorded data representing near-zero sample concentration will be utilized. If Validate is selected, pre-recorded data representing 25% total sulfur sample concentration will be utilized.

It is important to note that there are a total of 7 continuous runs recorded for each of the above pre-recorded concentrations. If more than 7 cycles are selected to run in a cycle set, the pre-recorded analysis data will merely repeat every 7 cycles and include any portion thereof necessary to complete the intended set. The detector will return to processing normal real-time signals after DEMO mode is turned OFF.

### **Last Validation**

This section of the menu shows the calculated average concentration and the date and time of the last calibration validation the analyzer performed.

### **Calculate RF**

After Manual or Auto Check is complete, the analyzer will display the new data for zero and span values in the "Check" section. Pressing the "Calculate RF" will automatically calculate the response factor based on the difference between Zero and Span areas from the latest Check Calibration run.

### **Save Calibration**

Whenever any calibration check information has changed, such as completion of a calibration set, manual change to calibration check values, or a response factor that has either been calculated or manually entered, the **Save Calibration** LED will indicate new calibration values that remain to be entered. All changes will not come into effect until the **Save Calibration** button is pressed.

## Section 2.2.3 Detector Settings

The Detector Settings screen contains information about the detector and settings that can be altered.

To access this menu press **Settings > Detector Settings**



*Figure 2.15 – Detector Settings Screen*

### Detector Settings

This part of the menu allows the user to change the PMT HV (Photo-Multiplier Tube High Voltage) and change the filtering constant of the data collected.

The PMT HV button lets the user change the high voltage applied to the PMT to adjust detector sensitivity and associated peak height to the desired level. The PMT HV default value is 800V but is typically modified as necessary at the factory. The maximum voltage setting is 1099 volts.

The Filter (sec) button controls the detector filtering constant, or a rolling “box-car” average of individual 1-sec detector count readings. The optimal setting for the analyzer is 8 seconds for best results, which is a time constant that allows maximum smoothing of detector data without significantly affecting overall peak height.

### Baseline Correction

This section allows the detector baseline to be modified as desired for graphing or output purposes.

The Zero Enable button allows the baseline to be zeroed either manually, or automatically. To turn this function ON press the Zero Enable button and the indicator will turn GREEN. To turn it OFF press the button again and the indicator will be BLACK.

Manual zeroing of the baseline is accomplished by pressing the Zero BL button in the System Control Section of the Home Screen. Automatic zeroing of the baseline is defined in the Timed Events Settings and will occur during the programmed time. Even if the Zero Enable button is enabled, a program time of “0” will prevent automatic zeroing of the baseline.

### Applied $\mu$ V

The Applied  $\mu$ V line displays the voltage applied to the normal detector baseline to shift it to zero. This value is cumulative each time the baseline is zeroed either manually or automatically. When the Zero Enable button is turned off, any cumulative offset value is dropped, and the baseline will return to its normal state.

### Offset $\mu$ V

Whether the Zero Enable button is enabled or not, the Offset  $\mu$ V button allows the user to readjust the baseline to any desired value.

## **Run Cycle Settings**

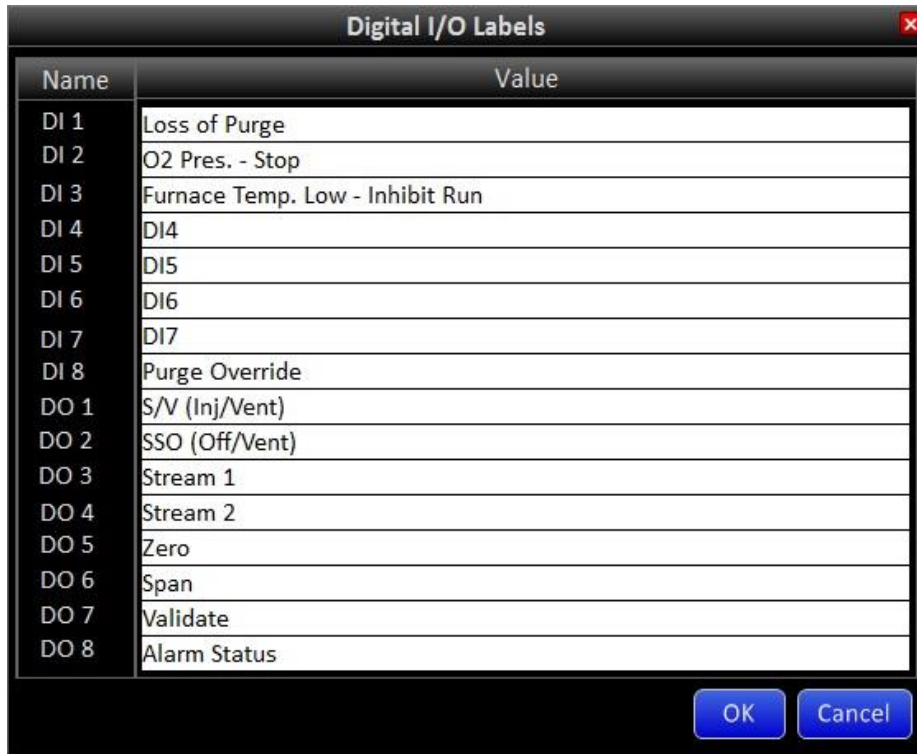
The Run Cycle Settings allow the mode of cycle operation to be selected. The three modes of operation are **Repeat**, **Hold** and **Stop**.

If the selected mode is **Stop**, a running cycle will stop at the end of programmed cycle time. If the selected mode is **Repeat**, a new cycle will immediately restart after the current cycle ends. If the selected mode is **Hold**, a new cycle will start after the Hold time has elapsed. Whether the analyzer is in Repeat or Hold modes, cycles will run continuously until a) the cycle is manually stopped; b) an alarm condition arises; or c) power to the analyzer is turned off.

## Section 2.2.4 Digital I/O Label

The Digital I/O Label screen contains assigned names for all digital inputs and outputs.

To access this menu press **Settings > Digital I/O Labels**



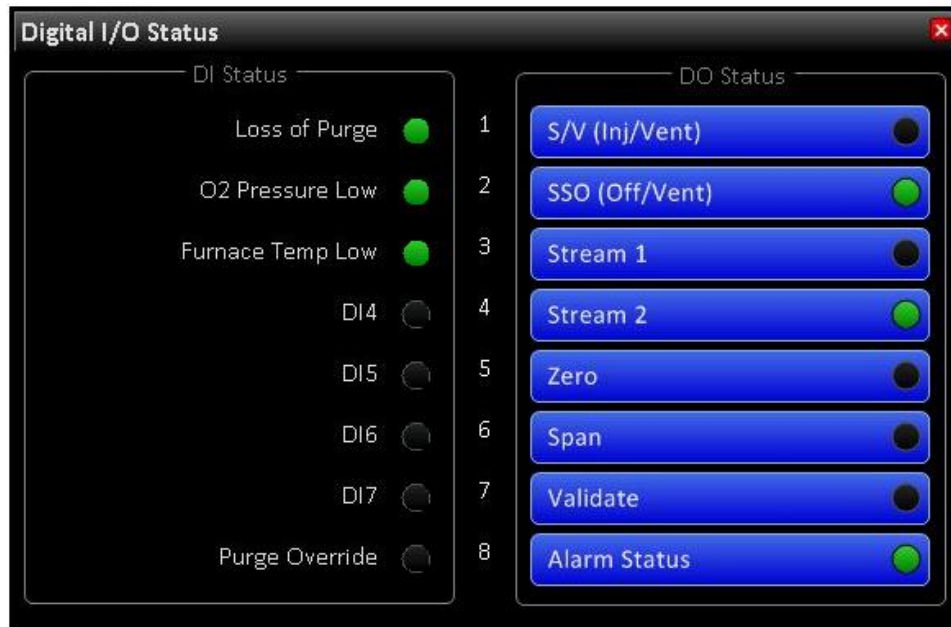
*Figure 2.16 – Digital I/O Labels Screen*

The Digital I/O labels above have been assigned as default names by the factory. To change any of these, the text is selected by pressing the desired line, which will pull up the touchscreen keyboard. The user then enters any alternate name or text desired and presses the **OK** button.

## Section 2.2.5 Digital I/O Status.

The Digital I/O Status screen is consolidated screen to check the status of all the digital inputs and outputs.

To access this menu press **Settings > Digital I/O Status**



*Figure 2.17 – Digital I/O Status Screen*

### **DI (Digital Input) Status**

This section displays the digital inputs in their normal operating state. Digital inputs 1-3 reflect the presence of system critical parameters that are described in the System Setting menu. Digital Inputs DI4 – DI7 are user configurable. All Digital Inputs DI1 – DI7 are “Open Contact” alarms, (i.e., the contacts open to indicate an alarm condition). If an open input occurs on any Digital Input, and the Alarm box is checked, the system will trigger the Global Alarm. In this state, Digital Outputs DO3 – DO7 will be turned off and disabled, putting valve actuators in a cut-off state. The system will stay suspended in this cut-off state until the input generating the alarm is once again closed (alarm condition cleared).

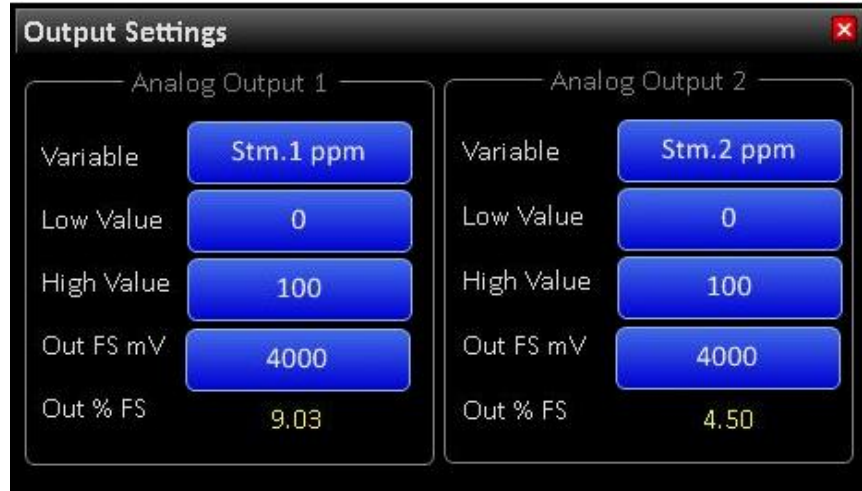
### **DO (Digital Output) Status.**

This section displays the status of all digital outputs as indicated by the associated LED. The digital outputs are configured as 24V DC signals that operate a variety of valves and relays from the External Interface board. When the analyzer is running, these outputs automatically turn on and off as required by timed events and calibration settings. For troubleshooting purpose these outputs can be manually turned on and off, **only** if the analyses have stopped, no Alarm conditions exist, and the Analyzer is in “holding” state.

## Section 2.2.6 Output Settings

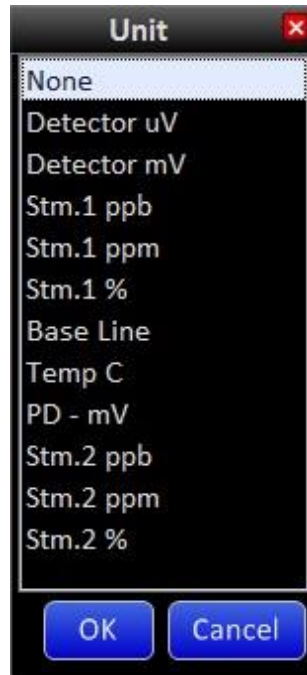
The Output Settings screen allows the user to select the desired variable and scaling for both Analog Output channels available with analyzer.

To access this menu press **Settings > Output Settings**



*Figure 2.18 – Output Settings Screen*

The Output Settings menu is divided into two identical sections for Analog Output 1 and Analog Output 2. Pressing the **Variable** button will open a list of available parameters for the user to choose. The **Low Value** and **High Value** buttons permit the input range to be defined, regardless of the variable selected. Pressing these buttons will open the touchscreen keyboard and enable modification as necessary.



*Figure 2.19 – Output Variables Dropdown Menu*

The **Out FS mV** button allows the output range of the associated DAC to be set. The 18-bit DAC's have a specified output of 0-4000mV. Although lowering this value will allow 100% of range High Value to be achieved at a lower output voltage, the total number of bits representing this value would be correspondingly reduced. In order to capitalize on all available 18-bits of resolution, and to satisfy the Signal Conditioner input requirement of 0-1 VDC, the circuitry incorporates a 4:1 voltage divider built into the SP-2000 signal processing detector board. Therefore, even though the **Out FS mV** is set to 4000mV, the resulting DAC analog voltage output is reduced to 1000mV at this setting.

The Out % FS Line will always indicate the current variable value relative to the variable range in percent full scale.



## Section 2.2.7 Purge Override

If the analyzer is used in hazardous locations, then purge is necessary for maintaining the requirements of the hazardous location code. The analyzer purge is intended to maintain positive pressure in the analyzer enclosures to prevent ingress of potentially hazardous atmospheres. Purge monitoring is accomplished utilizing the purge device.



For safety reasons, the purge can only be bypassed by authorized personnel with the key. Those without authorization are not permitted to bypass the purge monitoring device.

The purge override feature is incorporated into the software to permit analyzer operation without enclosure purge pressure. This enables the enclosure doors to be open for inspection or maintenance of the analyzer when the area is known to be non-hazardous.

Access this mode by pressing **Settings > Purge Override**



Figure 2.20 – Purge Override Menu

The default time for Purge Override is 10 minutes. Pressing the **Start** button initiates the Purge Override function for the designated time. The time at the bottom of the menu reflects time remaining before the Purge Override function is disabled.

Should a different Purge Override time be desired, pressing the **Minutes** button will open an Enter Value window that allows the user to change the Purge Override time up to 1,092 minutes, or just over 18 hours. Should more time than the originally entered time be necessary, the user may enter a new value at any time. Pressing the **Off** button will revert to normal operation, but Purge Override should only be stopped after the enclosure doors have been closed and purge is reestablished to avoid shutdown of furnace and Run Cycles.

The software override can only be performed by setting Purge in bypass with the key.

## Section 2.2.8 System Settings

The System Settings menu allows the user to configure WARNINGS and ALARMS for the analyzer. To access this menu press **Settings > System Settings**

The System parameters are arranged in three groups. The upper group consists of seven digital inputs (DIs) that monitor status of critical and user-selected parameters. DI1 – DI3 are pre- assigned, while DI4 – DI7 are user-programmable. The pre-assigned parameters, DI1 – DI3 are considered system- critical conditions and are configured by default for ALARM. The DI4 – DI7 parameters are unassigned and can be utilized as a customer configurable digital input to either ALARM or WARN.



Figure 2.21 – System Settings Screen

The designated trip points for the system critical parameters are as follows:

Parameter	Trip Condition
(DI1) Loss of Purge	Enclosure Pressure Falls below 0.2" H <sub>2</sub> O pressure
(DI2) O <sub>2</sub> Pressure - Stop	Zero Air Used for Combustion less than 20 PSIG
(DI3) Furnace Temp Low	Combustion Furnace Temperature less than 1025°C

The middle group monitors reported Zero, Span, Stream 1 and Stream 2 values. These parameters allow the user to select both Low Alarm and High Alarm limit settings by entering the desired value in ppm after pressing the associated button. The most recent reported values are displayed between the High/Low limit settings for reference. These parameters are not system critical and can be programmed to WARN only. These are designed to provide indications of process/calibration upsets so that the upset can be tracked, and corrective action taken. This would not be possible if the analyses were stopped in the event of a process upset.

The last group monitors the reported Temperature and Mass Flow controller values. These parameters also allow the user to select both Low Alarm and High Alarm limit settings by entering the desired value. The most recent reported values are displayed between the High/Low limit settings for reference. These parameters can be programmed to either WARN or ALARM.

**NOTE:** The values used for alarm triggers in the Zero, Span and Stream sections are averaged values. To modify the number of runs in the Zero and Span average, please refer to section 2.2.2, for the Stream average, please refer to section 2.3.3.

## Alarm

If the ALARM status is enabled for any parameter, and that parameter falls out of its designated range, the analyzer will trigger an alarm that will be indicated by a red LED in the State column (*Figure 2.21*).



System Settings						
Parameter	State	Alarm	Warn	Low Alarm	Value	High Alarm
MFC 1: cc/min	●	<input checked="" type="checkbox"/>	<input type="checkbox"/>	115	21.0	125

*Figure 2.22 – Loss of Purge Alarm*

Any ALARM state will be reflected by the Analyzer Alarm Status line at the bottom of the System Control section of the Home Screen. The message ALARM! will also be prominently flash on the Main Menu bar in bold red text.



*Figure 2.23 – Main Menu Alarm*

As soon as an ALARM state is triggered (except DI1 – DI3\*), the analyzer is designed to immediately stop analyses. In addition, the GLOBAL ALARM relay will be activated. Run Cycles will automatically resume as soon as all alarm conditions are cleared, and after any programmed Purge time has elapsed. This also means that all alarm conditions must be clear before any Run Cycles can be started.

*\* **NOTE:** DI1 (Loss of Purge), DI2 (O2 Pressure - Stop) and DI3 (Furnace Temperature Low) are system critical parameters and cannot be disabled. In the event of any of these Alarm conditions, the analyses will stop immediately as well as the furnace will be turned OFF. The Analyzer will not begin analyses until ALL three of these alarms are cleared in addition to any other alarm conditions.*

## Warning

If the WARN status is enabled for any parameter and that parameter falls out of its designated range, the analyzer will trigger a warning that will be indicated by a yellow LED in the State column. Similar to ALARM status, the Warning will also be reflected by the Analyzer Warn Status in the System Control section of the Home Screen, as well prominently flash on the Main Menu bar.



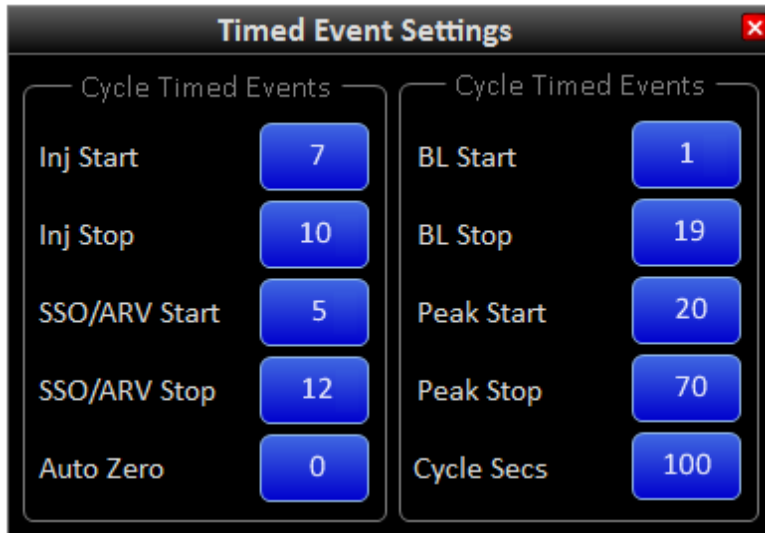
*Figure 2.24 – Main Menu Warning*

Any parameter enabled to generate a WARN status, should it fall outside the designated range, is not considered to be a critical parameter for system operation. It is primarily intended to alert the user to a condition that may require intervention. Run Cycles will not be stopped when a WARN condition exists.

**NOTE:** To disable the alarm or warning monitoring, uncheck the respective box until the parameter is to be monitored again.

## Section 2.2.9 Timed Event Settings

The Timed Event Settings menu allows the user to configure all timing functions associated with the Run Cycle. To access this menu press **Settings > Timed Events**.



*Figure 2.25 – Timed Event Settings Screen*

The Timed Events Settings menu contains 6 separate Cycle Timed Events. These events are defined by 10 programmed timing entries that stipulate Run Cycle control and operation.

Timed Events within this menu include:

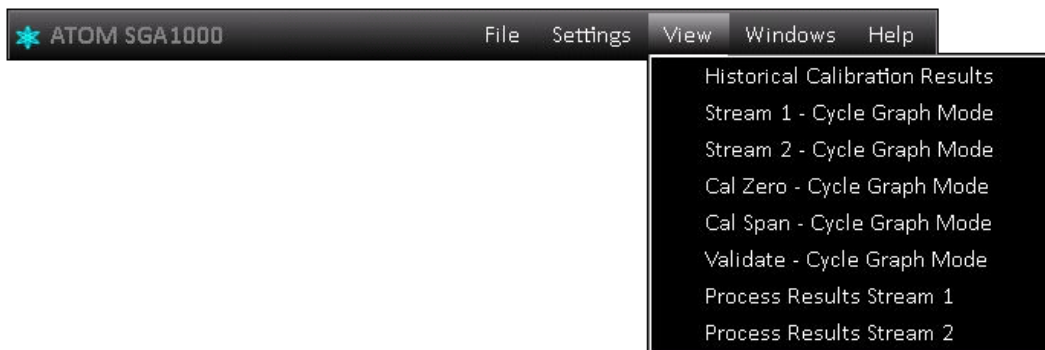
Event Name	Description
Inj Start	Sample Valve is turned ON to Inject Sample in Loop
Inj Stop	Sample Valve is turned OFF to Reload Sample Loop
SSO/ARV Start	Sample Shut Off turned ON relieving Excess Pressure to Atmospheric Reference Vent
SSO/ARV Stop	Sample Shut Off turned OFF returning Normal Sample Flow through Inject Valve
Auto Zero	Sets Time when Auto Zero of Baseline is Performed (Setting of 0 = Off)
BL Start	Initiation of Baseline Evaluation Period; Values Averaged Establishing BL Value.
BL Stop	Completion of Baseline Evaluation; BL Average used to Correct Area Count Readings
Peak Start	Initiation of Peak Integration Period; Begin Summation of BL Corrected Readings
Peak Stop	Completion of Peak Integration Period; Sum All Data to Generate Peak Area Value
Cycle Secs	Sets Cycle duration and Defines completion of the Cycle Time.

To change the timing entry for any of these events, press the associated button that will open an Enter Value screen. The user enters the desired time in seconds and presses the **OK** button. Although the settings provided in the Timed Events menu by the factory have already been optimized for best analyzer performance, the user is at liberty to make changes to these settings. The analyzer performance will be different whenever factory settings have been modified from their original values.

**NOTE:** A value of zero (0) in the Timed Events Settings will turn off the event

## Section 2.3 View

The View menu group contains submenus that provide information regarding instrument performance but does not contain any settings related to instrument operation.



*Figure 2.26 – View Dropdown Menu*

## Section 2.3.1 Historical Calibration Results

The Historical Calibration Results menu allows the user to review previous calibration results that were archived by pressing the **Calibrate and Save** button in the Calibration Settings menu. To access this menu press **View > Historical Calibration Results**.

Historical Calibration Results				
11/19/2018 3:25:23 PM				
Run	Zero		Span	
	Area	Conc ppm	Area	Conc ppm
1	433,441	0.0	302,349,282	9.8
2	457,969	0.0	301,357,942	9.7
3	439,516	0.0	304,075,891	9.8
4	477,067	0.0	305,245,488	9.9
5	433,441	0.0	304,450,665	9.8
6				
7				
8				
9				
10				
<b>Average</b>	<b>448,286</b>	<b>0.0</b>	<b>303,495,853</b>	<b>9.8</b>
Value Used				
	Check Zero		<b>448,286</b>	
	Check Span		<b>303,495,853</b>	
	Calculated & Used RF		<b>30,923,221</b>	

Figure 2.27 – Historical Calibration Results Screen

The menu is like the Check Calibration Results menu, but with supplemental information. The top line shows the date and time the displayed calibration information was saved. Pressing the down arrow located on the far right of the Date/Time Bar opens a list of all previously saved calibration results.

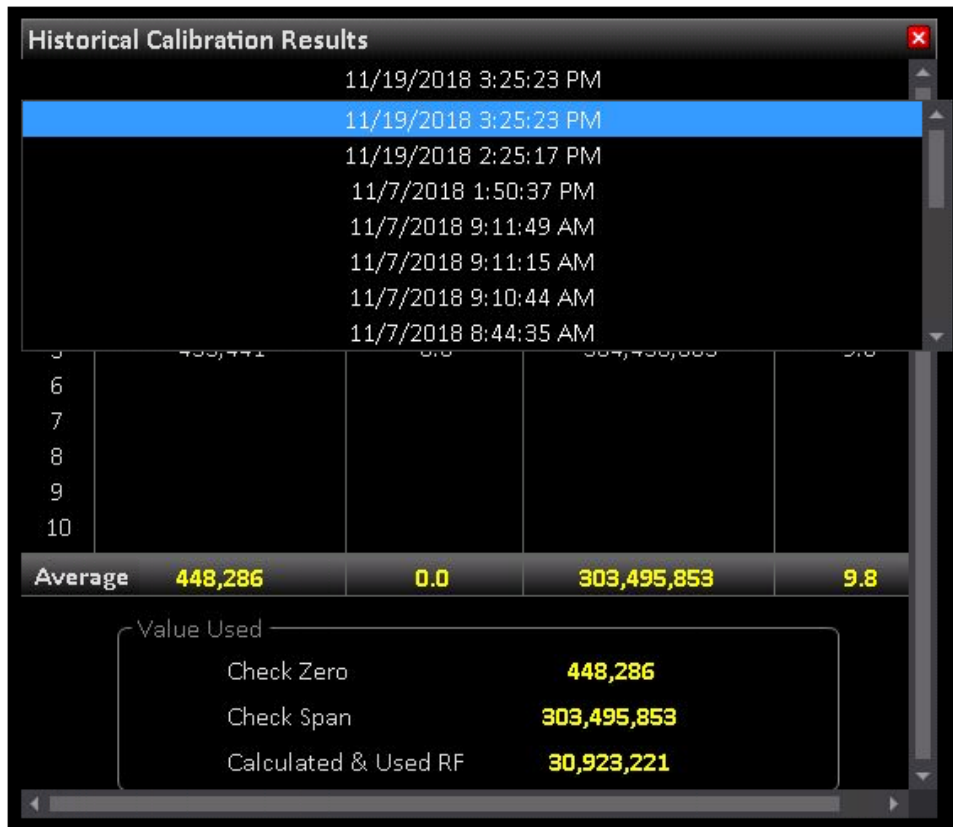


Figure 2.28 – Historical Calibration Results Dropdown Menu

The central section provides individual peak areas and concentrations, as well as the average of all completed cycles run. The Value Used section contains the final values selected for use. In other words, even though the analyzer computes the average area for Check Zero and Check Span concentrations in the Check Calibration process, the user may have used an alternate value for computing the "Calculated and Used" RF. User modification of these values will be evident if there is a difference between Average values and "Value Used".

## Section 2.3.2 Cycle Graph Mode

The Cycle Graph menu is a graphical representation of the detector signal as it occurs in real time during the Run Cycle. This screen allows the user to ascertain general characteristics such as baseline noise, peak profile and peak integration period from one or more sequential analysis.

To access the Cycle Graph Screen press, **View > Cycle Graph Mode** and choose the parameter of interest to display its graph.

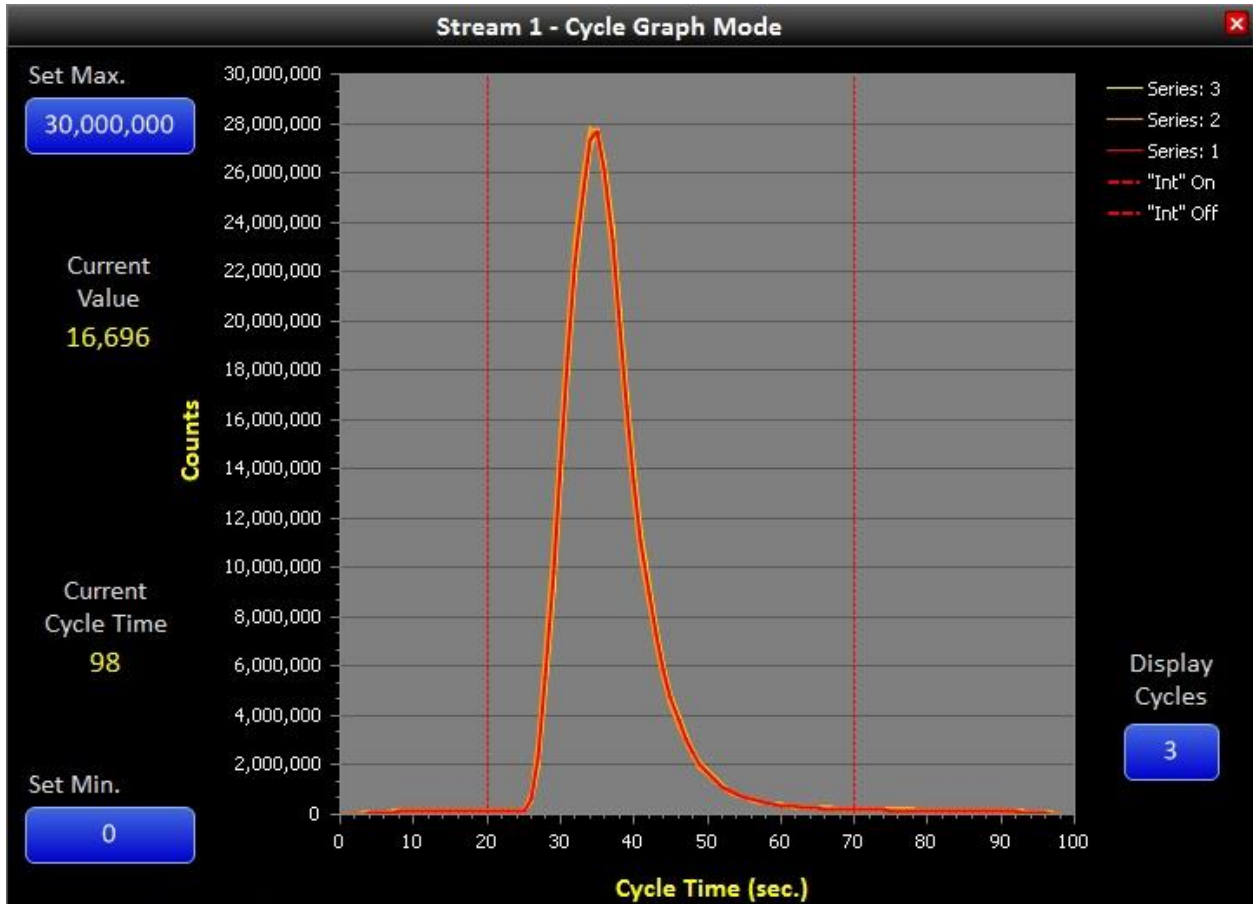


Figure 2.29 – Cycle Graph Mode Screen for Stream 1

### Cycle Graph

The Cycle Graph is a typical X-Y graphical display plotting detector counts versus time in seconds. Individual data points are computed and plotted for each second of the programmed cycle time.

The graph also displays the Start and Stop time of the Peak Integration Window as denoted by the two vertical red lines. The software is designed to sum all baseline corrected areas within this window, or between 20 and 70 seconds in this example.

A feature only available when one series is selected for plotting in Display Cycles is a vertical line cursor with an associated text box. The user may press anywhere within the plot area to activate this cursor, causing an X-Y text box to appear. The user may move the cursor anywhere along the signal to display the time-counts values of the nearest data point. The text box will not appear until there is recorded data within the current Run Cycle.



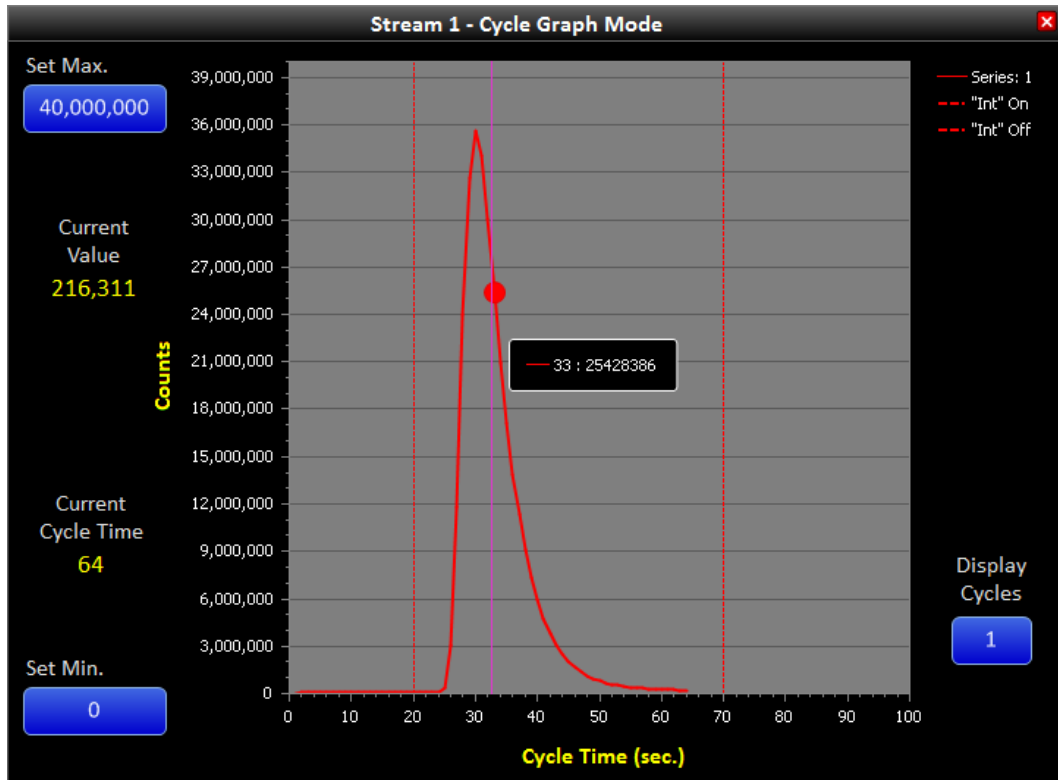


Figure 2.30 – Viewing Specific Data Points on Cycle Graph

### Set Min and Set Max

These buttons allow the user to change the minimum and maximum scaling of the Cycle Graph. The scaling feature enables significant flexibility of the displayed data, depending on user preference.

### Display Cycles

This button allows the number of cycles to be displayed as series, allowing graphical comparison of previous Run Cycles. Any number of sequential analyses may be chosen which are represented as Series 1-7 on the right side of the Cycle Graph.

The Series colors have been selected to convey temporal information related to the Run Cycle in the order in which the analyses occurred. The series colors are as follows:

Series 1	Red	
Series 2	Orange	
Series 3	Yellow	
Series 4	Green	
Series 5	Light Blue	
Series 6	Dark Blue	
Series 7	Purple	

The most recent series will always be red. As additional cycles are run, the color for the displayed series are scrolled such that the data represented by a particular color is always shifted to the next Series color at the beginning of a new cycle.

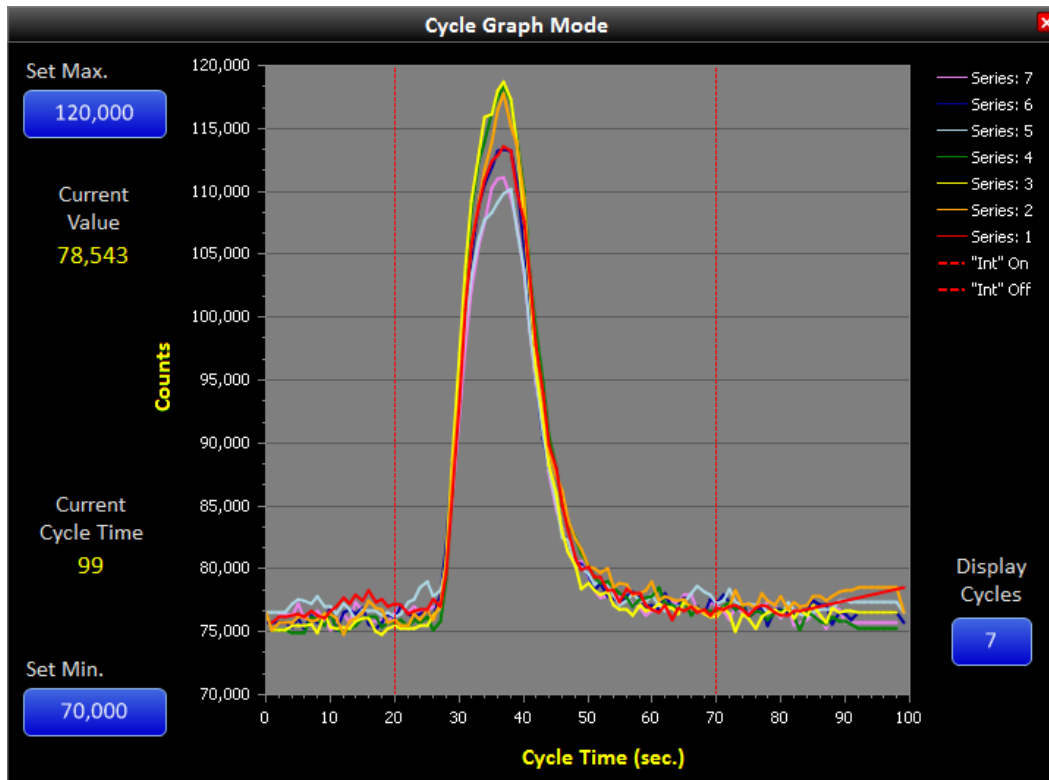


Figure 2.31 – Cycle Graph Displaying Multiple Trace Concentration Peaks

**NOTE:** If there is more than one series selected to be graphed, the previously described vertical cursor displaying the time and detector counts is disabled.

### **Current Value**

This shows the current value as it rises and falls throughout the cycle period.

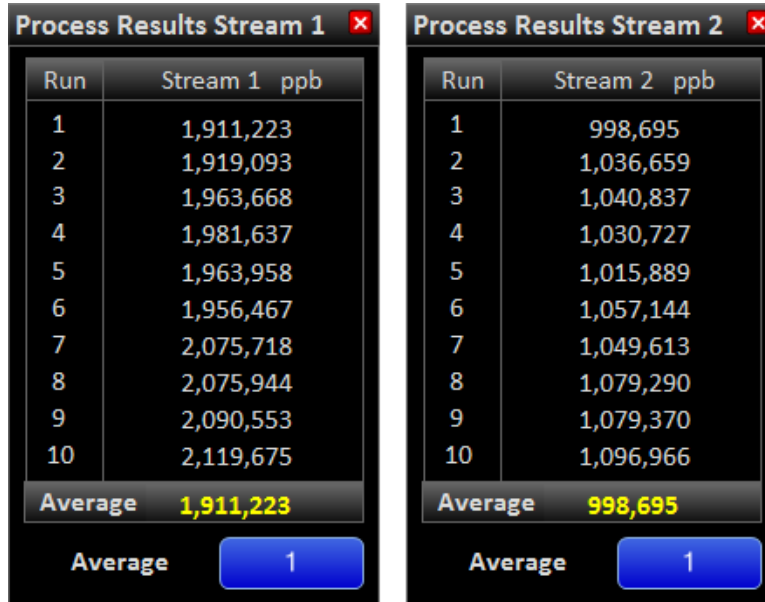
### **Current Cycle Time**

This is the same number that is displayed on the Home Screen and shows the current cycle time for convenience.

## Section 2.3.3 Process Results

The Process Results menu screen allows the user to view analysis results in percent concentration of completed process samples run.

Open this screen by pressing **View > Process Results**.



Run	Stream 1 ppb
1	1,911,223
2	1,919,093
3	1,963,668
4	1,981,637
5	1,963,958
6	1,956,467
7	2,075,718
8	2,075,944
9	2,090,553
10	2,119,675

Average **1,911,223**

Average

Run	Stream 2 ppb
1	998,695
2	1,036,659
3	1,040,837
4	1,030,727
5	1,015,889
6	1,057,144
7	1,049,613
8	1,079,290
9	1,079,370
10	1,096,966

Average **998,695**

Average

Figure 2.32 – Process Results Screen for Stream 1 and Stream 2

The Process Results menu screen displays a list of the last 10 samples run. The most recent sample is listed at the top and results will scroll down as subsequent samples are run.

The average concentration is displayed at the bottom of the table and includes the selected number of most recent runs. To select the number of runs included in the average, press the button adjacent to “Conc. Average” to open a select text box.

**NOTE:** If concentration is chosen as an output of the analyzer, the average concentration calculated above is outputted. To output the concentration for each single run (as displayed on the home screen), select a Conc. Average of 1.

## Section 2.4 Windows

The Windows menu screens allow the user to organize any open menus.

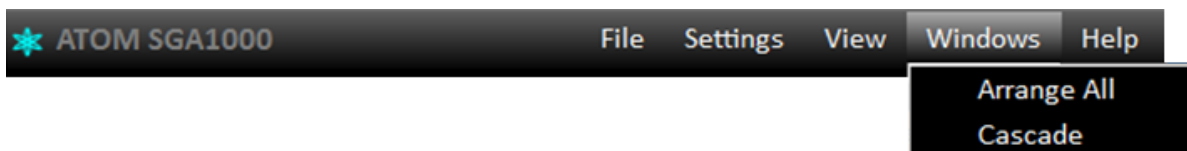


Figure 2.33 – Windows Dropdown Menu

Due to the relatively large size of the available menus in relation to the size of the touchscreen computer display, the only practical arrangement option is to cascade open windows. The **Cascade** function stacks menu screens utilizing the title bar for reference in the order they were opened. Selecting either **Arrange All** or **Cascade** options generates identical arrangement of menu screens, such as in the example below.

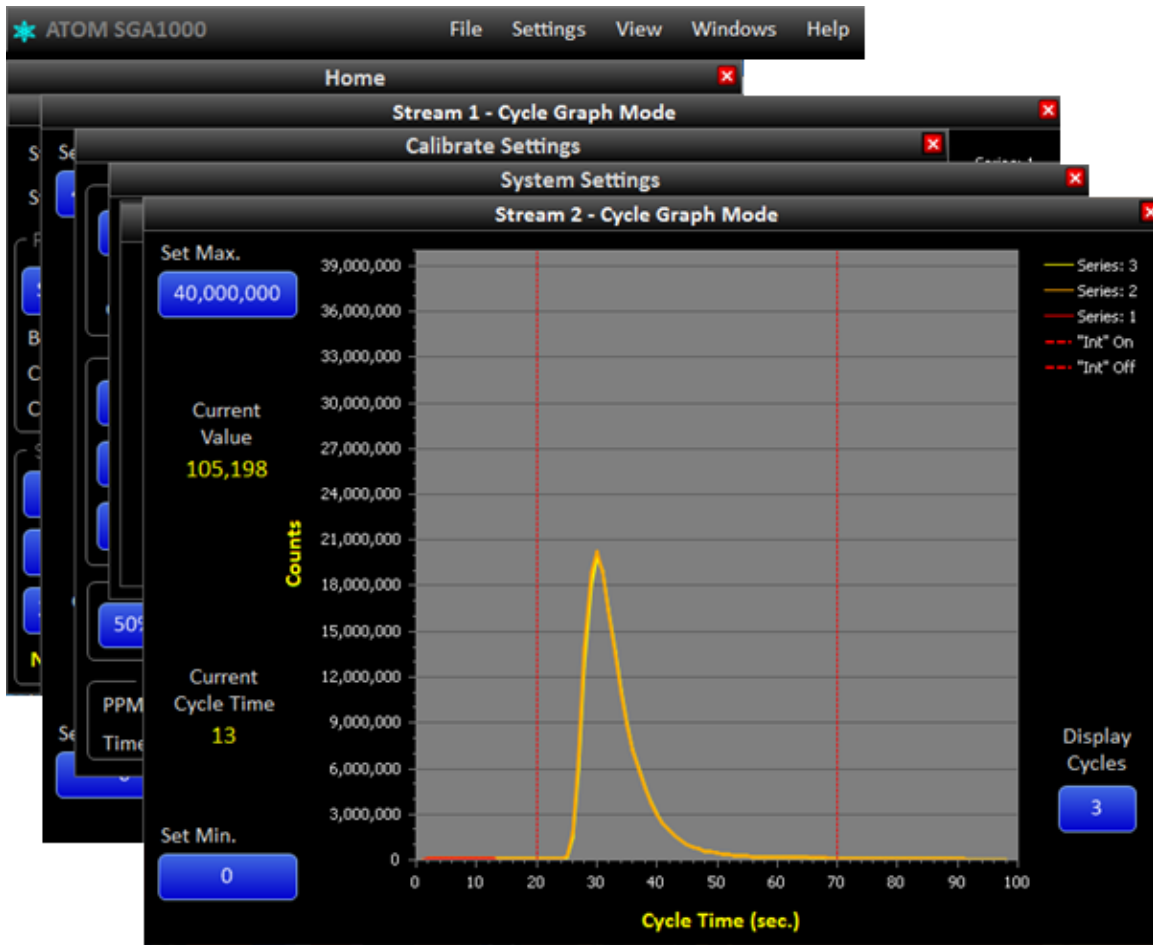


Figure 2.34 – Cascaded Menus

## Section 2.5 Help

The **Help** section contains a single drop-down selection menu.

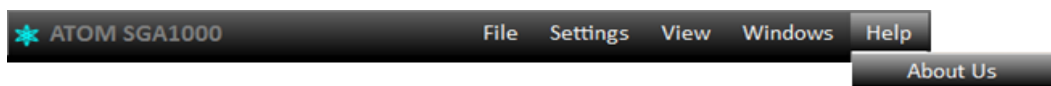
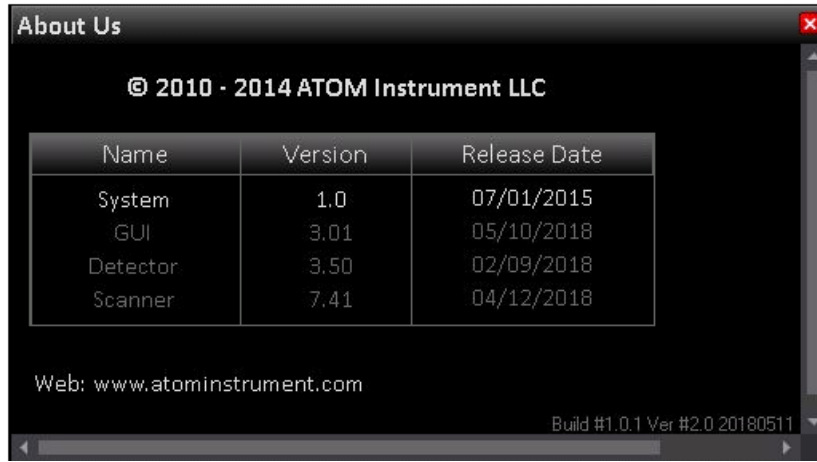


Figure 2.35 – Help Dropdown Menu

To access the **About Us** menu press **Help > About Us**.



*Figure 2.36 – About Us Screen*

The **About Us** Menu Screen displays information regarding the software version and associated release dates of three separate programs. The GUI, Detector and Scanner programs have distinct functions, but work in conjunction with each other to provide comprehensive control of the analyzer and user interface.

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## **Section 3 – Basic Maintenance Guide**

To ensure proper operation of your analyzer, it is recommended that user have regular visual checks using the below guidelines.

Wear PPE before performing any maintenance or inspection and follow the Warning and Caution stated in the manual.

<b>Interval</b>	<b>Visual inspection</b>	<b>Actions</b>
3 months	Leak check	Tighten or replace the fitting with new one
3 months	Dyer	Replace if there is moisture buildup or tube does not look clear
1 month	Plastic tubing	Replace if cracked, pinched, or degraded
1 month	Pressure regulator	Drain if water is collected in the filter bowl
6 months	Sample heater	Replace if not working
6 months	Main enclosure heater	Replace if not working
6 months	Pressure regulator	Replace if gauge is broken
6 months	Sample valve	Replace if it makes croaking sound
12 months	Wire & cables	Replace if cracked, pinched, or degraded
12 months	Purge monitor	Replace if Green/Red light is not working
12 months	Labels outside	Replace if worn out or illegible
12 months	Labels inside	Replace if worn out or illegible
12 months	Ground lugs nut	Tighten if loosened
12 months	Enclosures	If water and dust leakage found, then replace the seals
12 months	Mounting bolts	Tighten if loose and replace if corroded
12 months	Furnace vent	Replace if air flow is restricted

After performing any maintenance make sure following has been done

1. Leak check.
2. Visual inspection of any loose wires that may have not been re-connected or accidentally pulled from the device.
3. Purge the instrument for minimum of 15 minutes.

## Section 3.1 Combustion Tube Replacement

Disconnect power from the mains. Wear heat resistant gloves, coveralls and goggles.



Begin by loosening the two screws indicated above inside the furnace chamber



Gently swing the furnace outward. The furnace incorporates a special roller bearing for support and allows near effortless movement.





Loosen and detach combustion tube inlet and outlet fittings



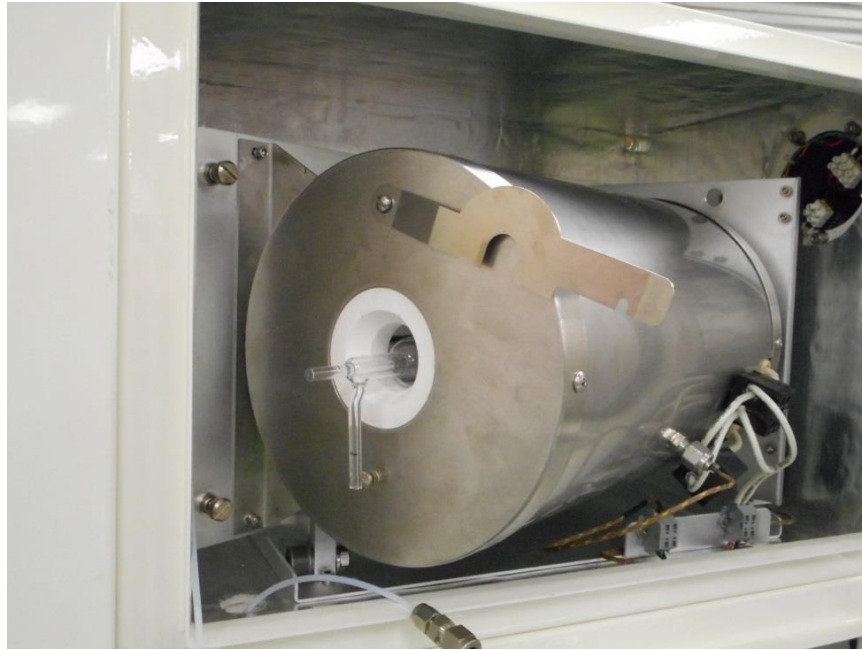
Fittings shown detached from combustion tube



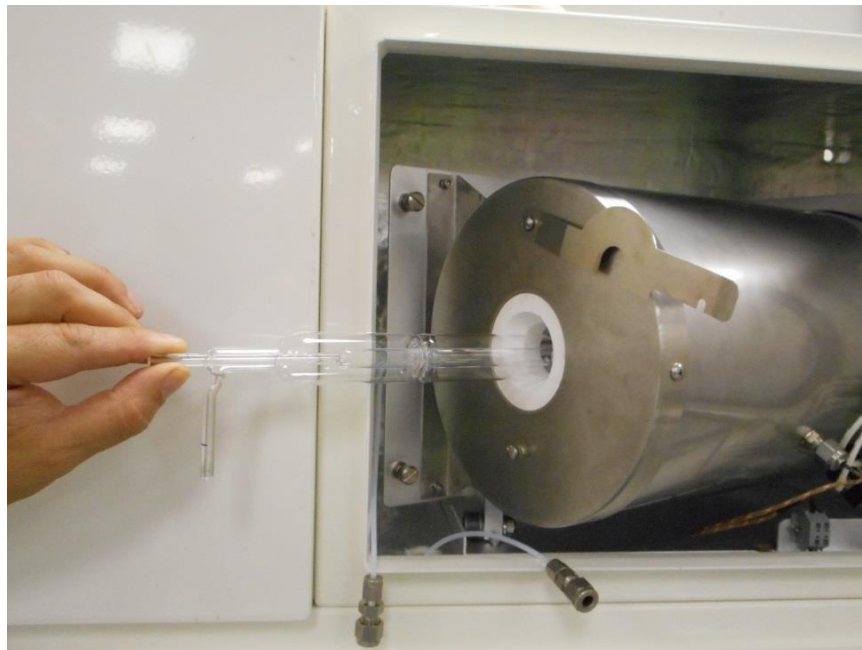
Press and rotate the insulator clamp to allow access to the ceramic insulators



Carefully remove both ceramic insulators



The combustion tube is now ready to be removed



Carefully and slowly remove the combustion tube from the furnace

Insert a new combustion tube, replace ceramic insulators, rotate, and secure insulator clamp.

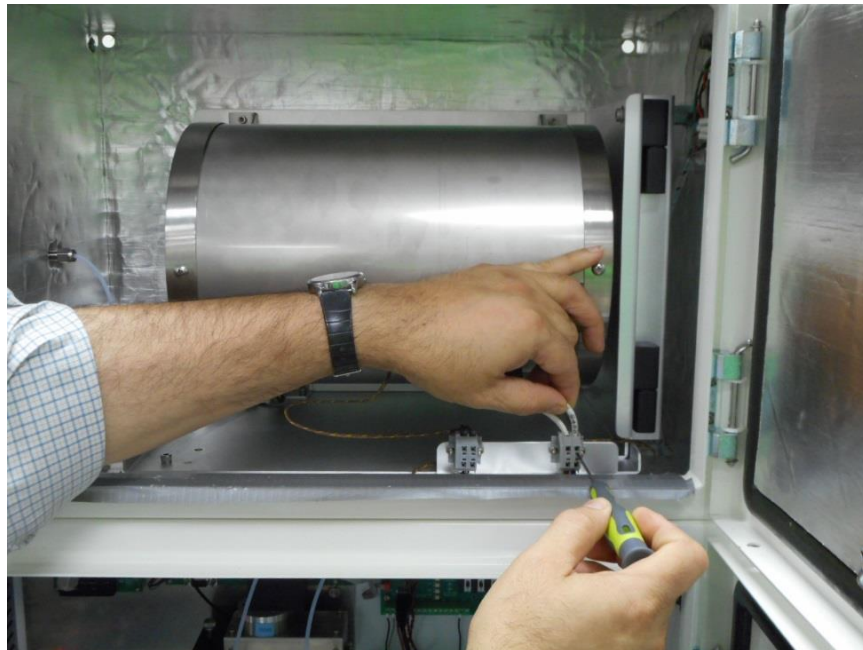
Re-attach combustion tube fittings, carefully roll furnace back in place and retighten screws.

## Section 3.2 Furnace Replacement

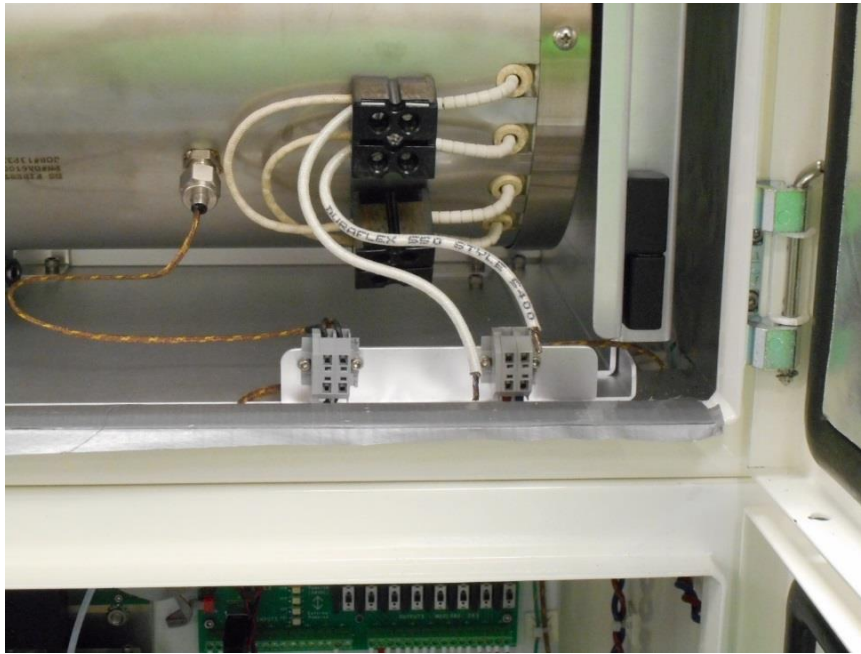
Disconnect power from the mains. Wear heat resistant gloves, coveralls and goggles.



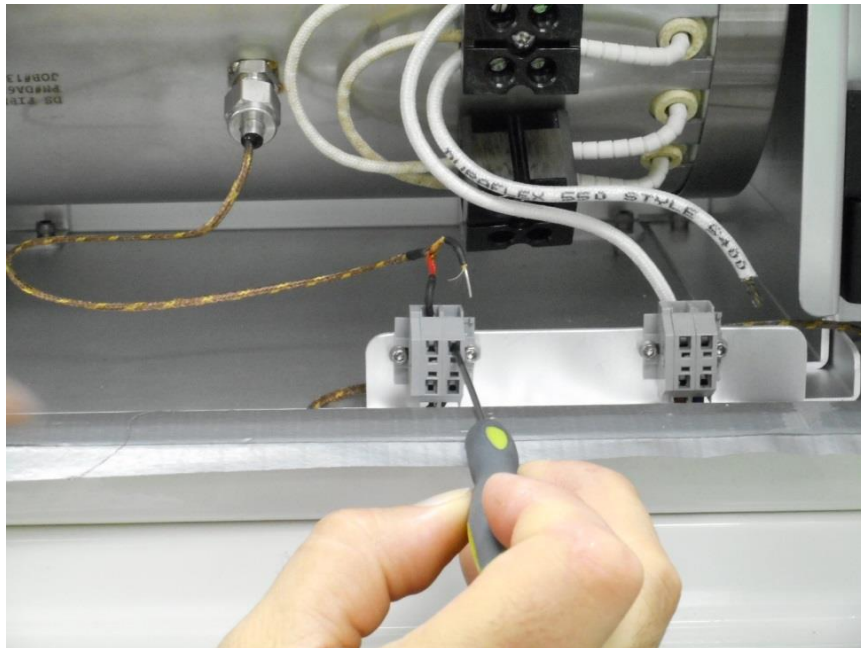
Begin by loosening both screws indicated above



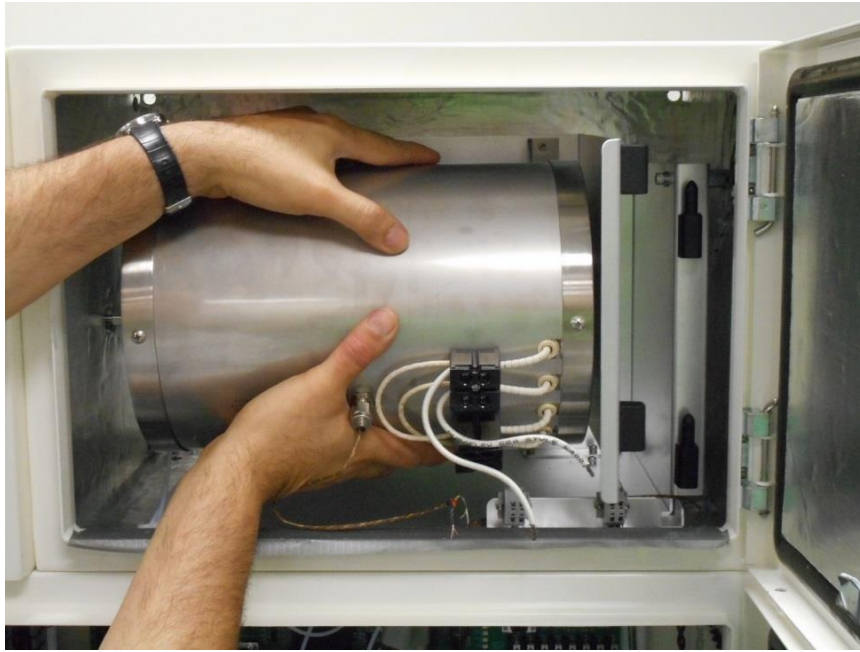
Using a small screwdriver to compress the terminal spring, remove both heater wires



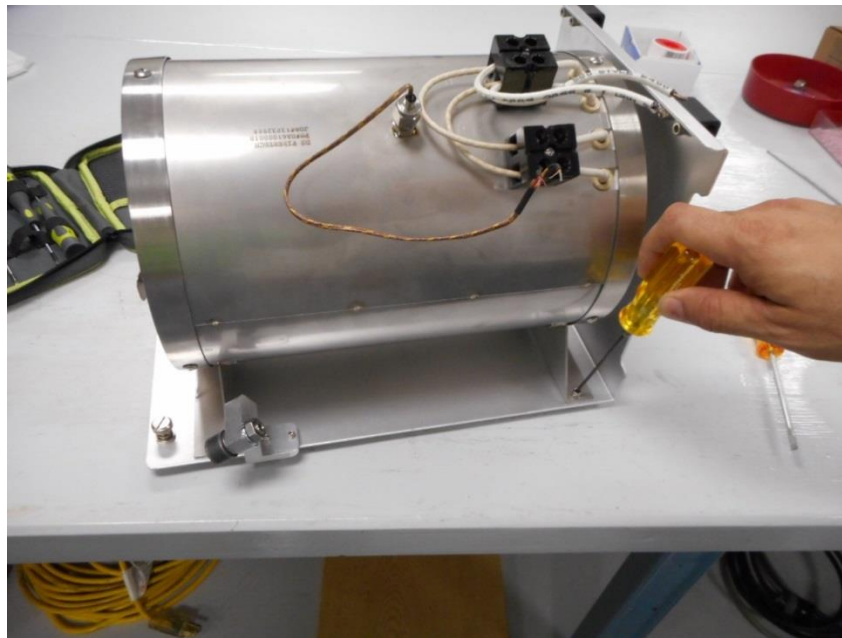
Heater wires removed from terminals



Repeat the above and remove both thermocouple wires from the terminals



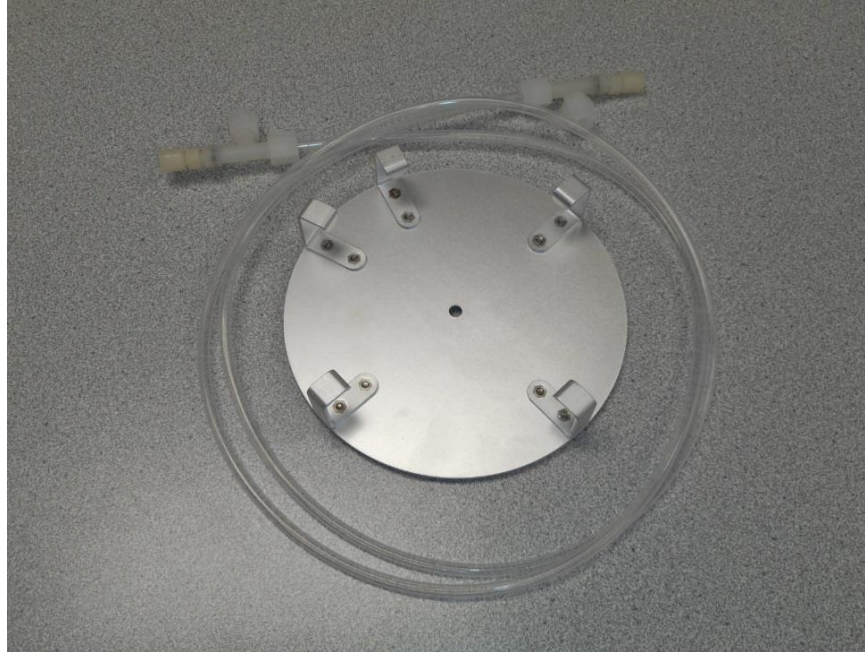
Carefully lift the furnace up off the pin hinges and remove from the furnace chamber



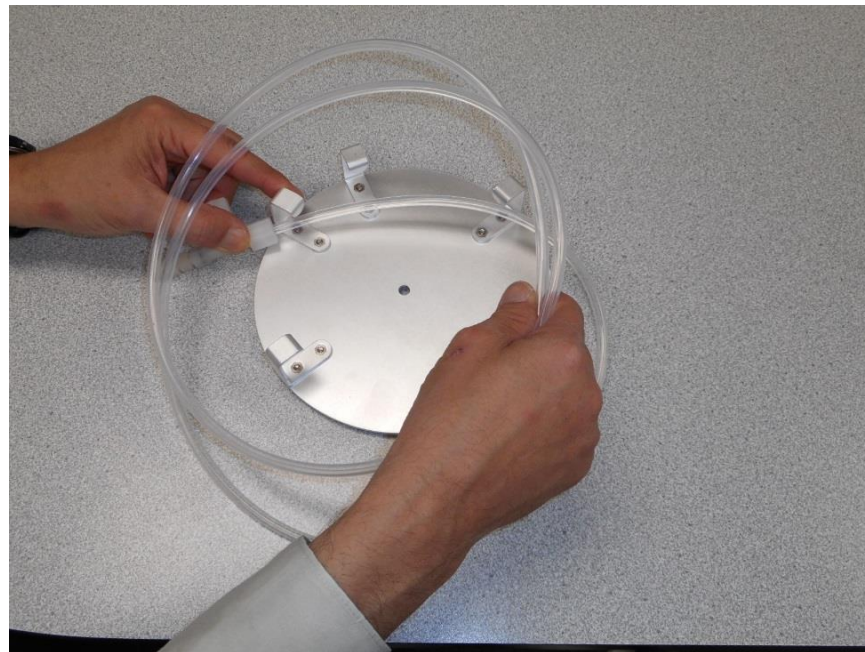
Remove all four furnace mount screws to complete the disassembly process. Follow the process in reverse order to install a new furnace and re-wire it.

## Section 3.3 Membrane Dryer Replacement

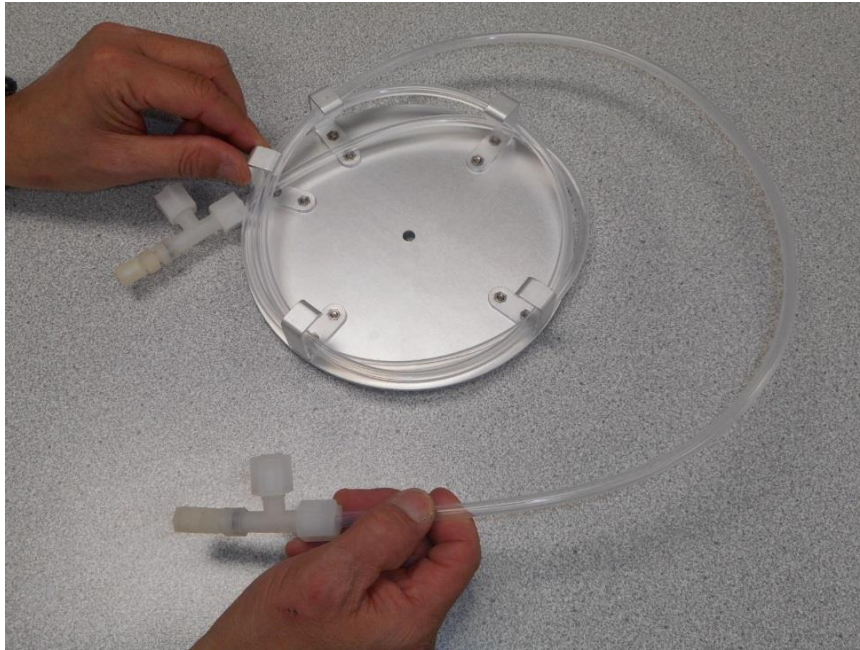
Close all the gas valves and depressurize the system. Wear gloves and goggles.



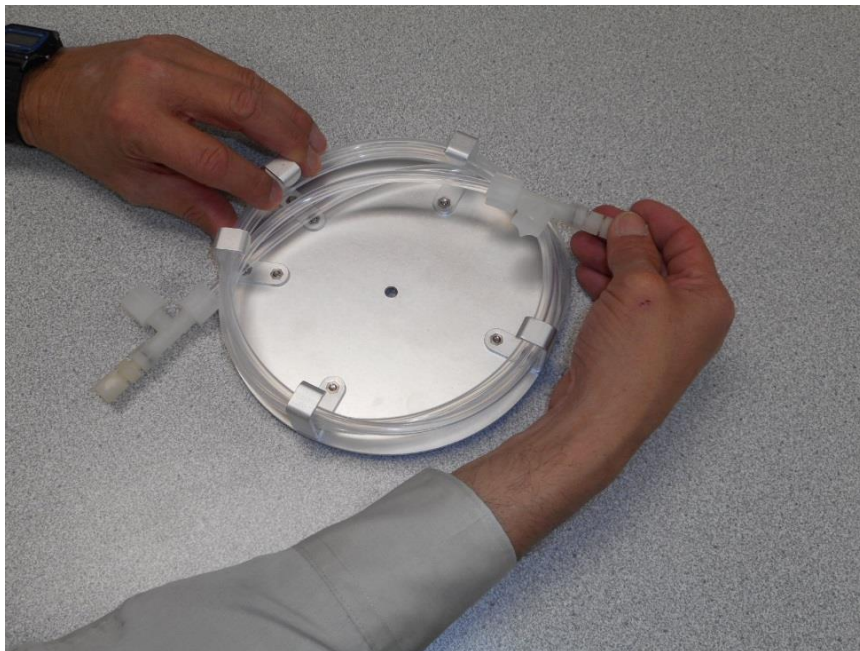
Orient the permeation tube fitting as shown



Begin by placing the tubing inside of the mounting bracket

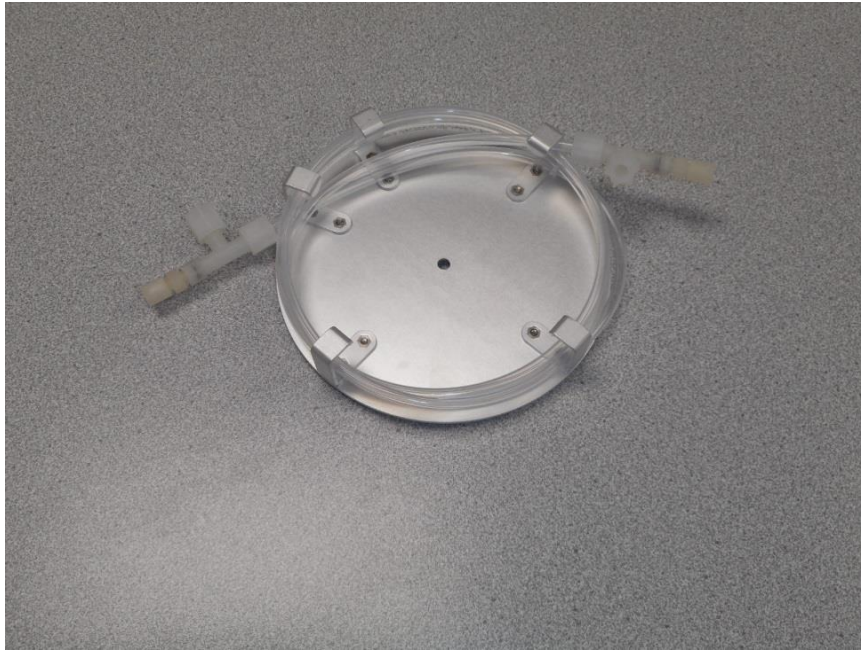


Continue winding, stacking the dryer layer upon layer



Until dryer has been completely wound

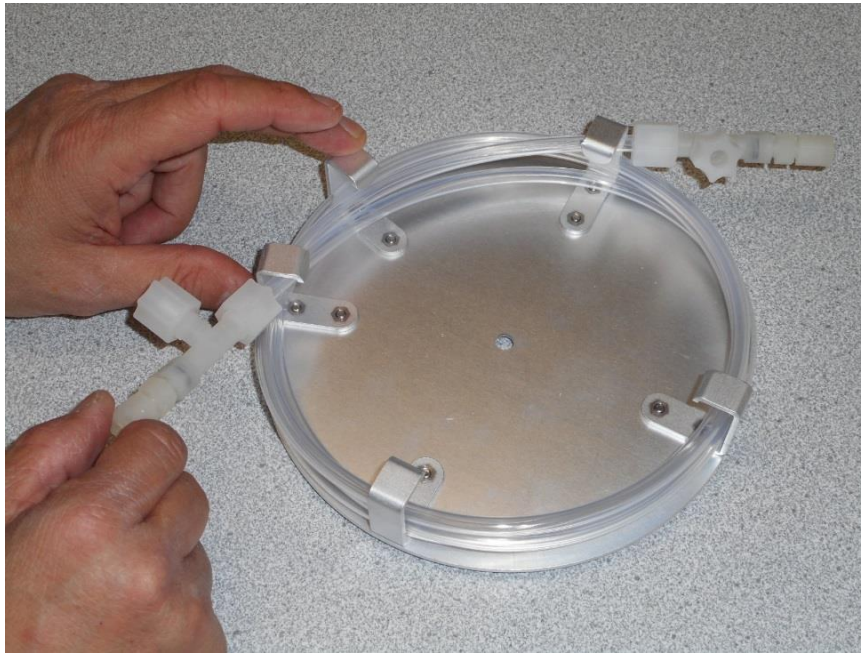




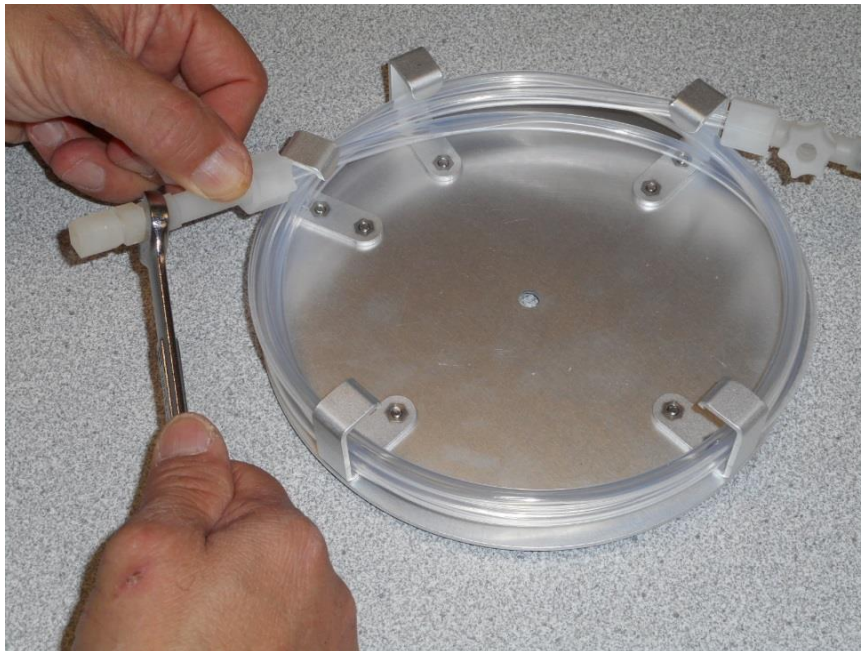
After winding, the Perma Pure Dryer should look like this



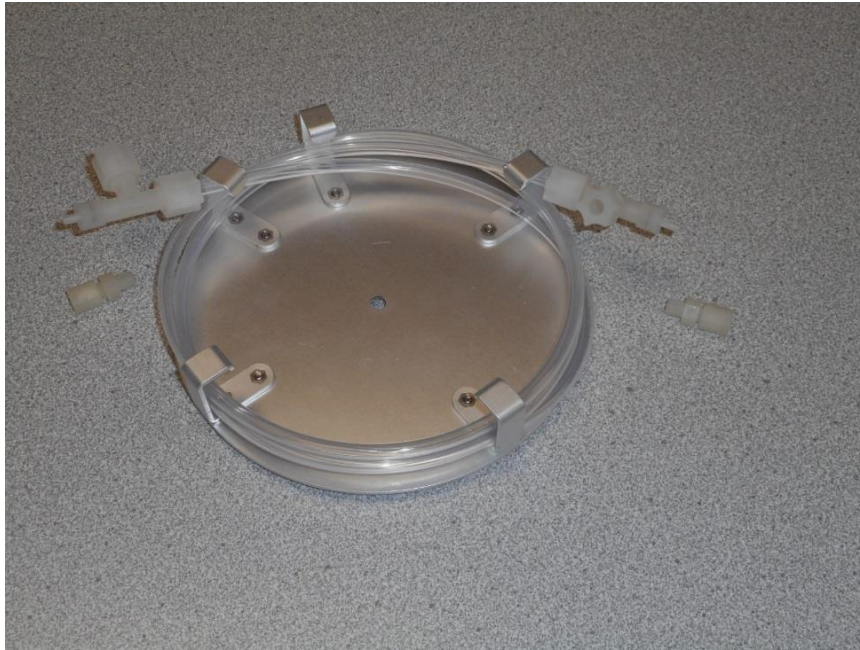
Next, lift tubing to push the first fitting back inside



Then bring to the top against the mounting bracket



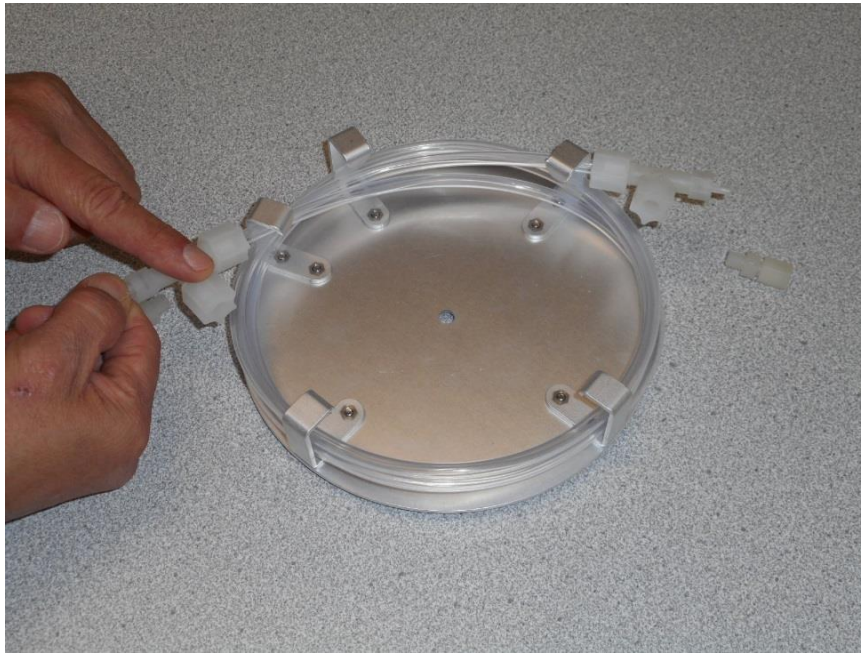
Using a 7/16" wrench, loosen and remove the 1/8" fittings on both ends



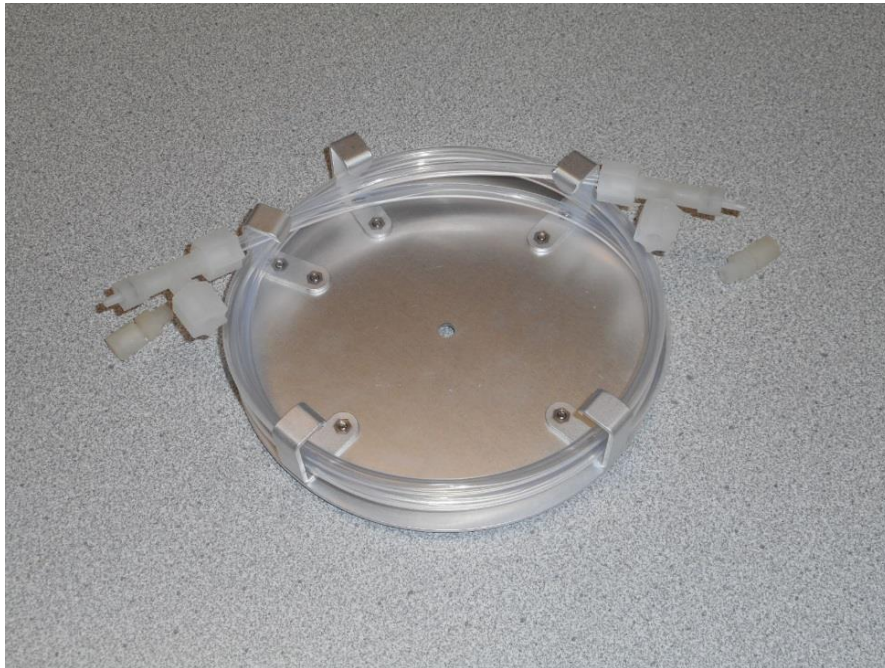
The dryer should look like this after both end fittings are removed



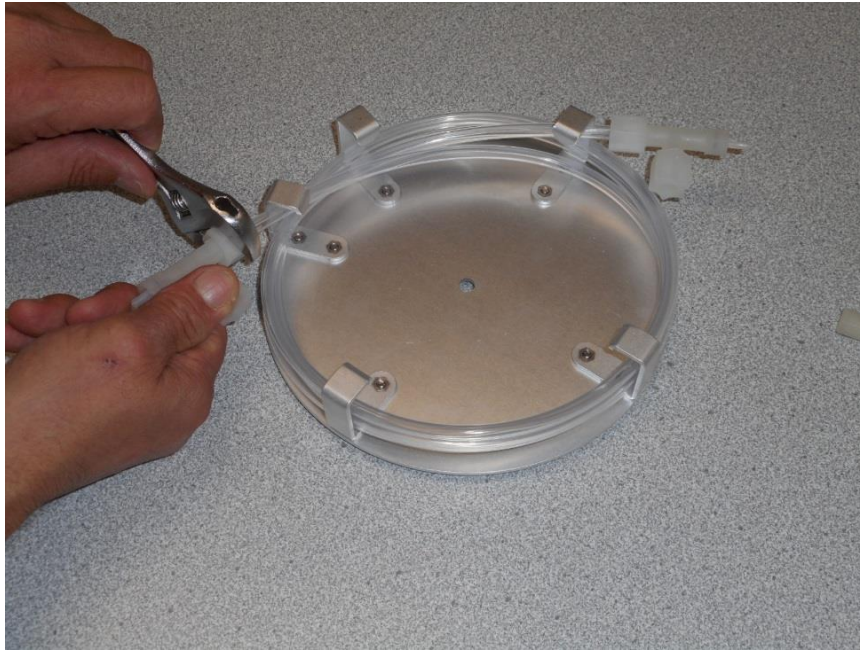
Next, loosen but do not remove the 1/4" inch fitting on both ends



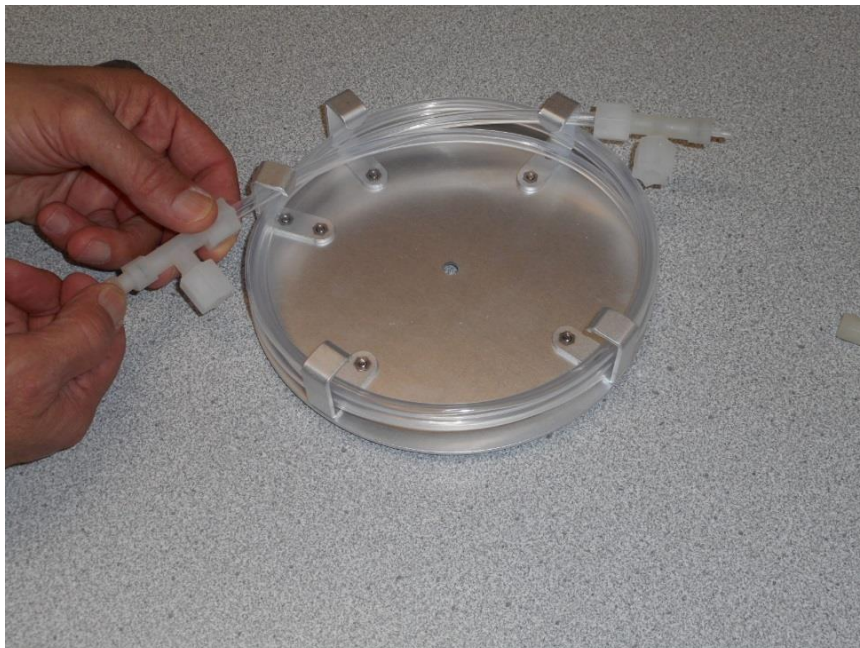
Holding the inner tube, rotate the T-fitting to point toward the inside on both ends



The dryer should then look like this



Re-tighten both 1/4" T-fittings



Lastly, re-attach both 1/8" inch end fittings

The Membrane dryer is now ready to be reinstalled on the analyzer.

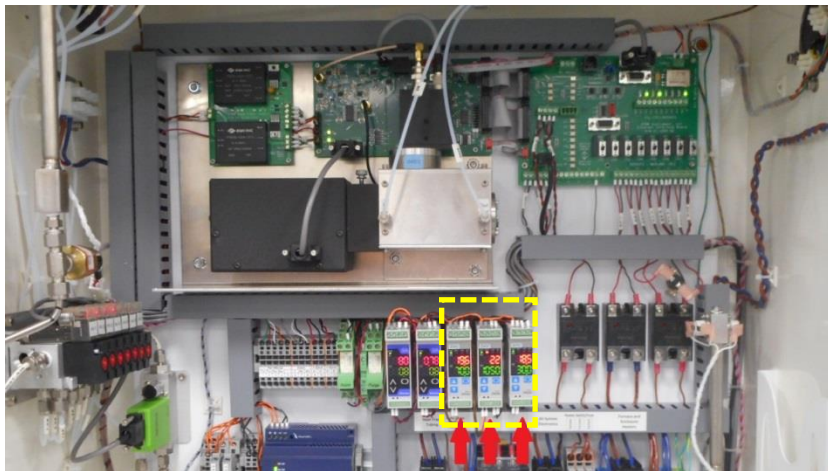
### **Section 3.4 Fuse**

Disconnect power from the mains.

Swing down the fuse holder and then flip the cover open. Replace the fuse with the rated fuse shown on the label. All fuses are cylindrical 1/4" dia x 1-1/4" long.

## Section 3.5 Temperature Controllers

The analyzer has three separate temperature zones controlled by temperature controllers (TCs), which include the Sample Enclosure, Combustion Furnace, and Main Enclosure. These DIN rail mounted controllers are approximately located in the center of the Main Enclosure and are underneath the right-hand side of the detector module.



*Figure 3.1 – Temperature Controllers*

Factory recommended temperature set-points are as follows:

1. Sample Enclosure: 70°C (or sufficient to prevent any condensation of sample)
2. Combustion Furnace: 1050°C (minimum for complete sample combustion and Sulfur conversion)
3. Main Enclosure: 30°C (may be increased to 40°C, if necessary, in colder environments)

The temperature controller settings have been programmed into the instrument installed controllers at the factory and are included in this manual for reference purposes only. The following page contains factory settings for all the three Temperature Controllers for the analyzer.

For complete instructions and menu navigation for the parameters below, refer to the Controller Instruction Manual.




**Note:** Although autotuning is a routine function which is part of analyzer testing at the factory, it is recommended that subsequent autotuning of these controllers is performed in the field for best results.

## Section 3.5.1 Temperature Controller Programmed Settings




Step	7-Segment Display	Parameter Function	Sample Enollosure Heater	Combustion Furnace Heater	Main Enollosure Heater
<b>Main setting mode</b>					
1	4	Desired value	70.0	1050	30.0

Press  to change Desired Value




<b>Sub setting mode</b>					
1	RT	Auto tuning performance	RT	RT	RT
2	P	OUT proportional band	Auto cal	Auto cal	Auto cal
3	I	Integral time	Auto cal	Auto cal	Auto cal
4	D	Derivative time	Auto cal	Auto cal	Auto cal
5	n	Anti-reset windup	Auto cal	Auto cal	Auto cal
6	C	OUT proportional cycle	Auto cal	Auto cal	Auto cal
7	r4EF	Manual reset	Skip	Skip	Skip
8	RI	Alarm value	Skip	25	Skip
9	H□□□	Heater burnout alarm valve	Skip	Skip	Skip
10	LP-L	Loop break alarm time	0	0	0
11	LP-H	Loop break alarm span	0.00	0	0.00

Press the  key while holding down the  key. Press the  key to navigate to the next menu item.

<b>Auxiliary function setting mode 1</b>					
1	Loct	Set value lock	----	----	----
2	4o	Sensor correction	0.0	0.0	0.0
3	cñ4L	Communication protocol	nñdñr	nñdñr	nñdñr
4	cñno	Instrument number	1	2	3
5	cñ4P	Communication speed	192	192	192
6	cñPr	Parity	none	none	none
7	cñ4r	Stop bit	1	1	1

Press the  key for approx. 3 sec while holding down the  key. Press the  key to navigate to the next menu item.

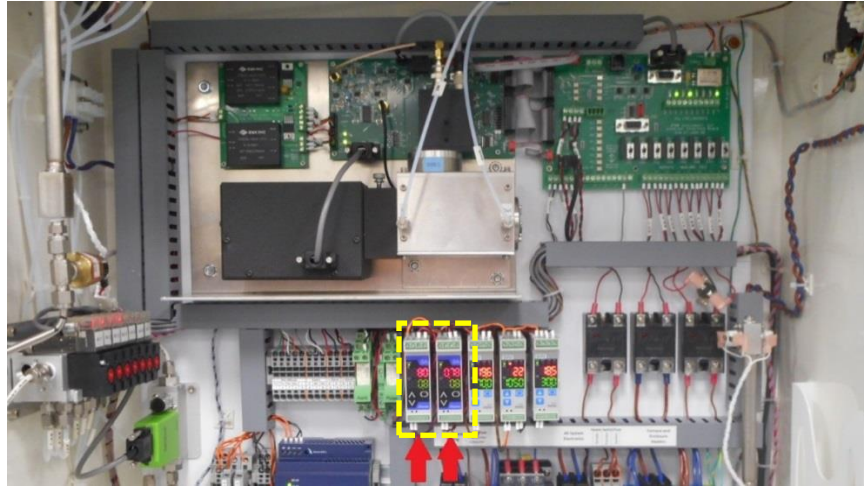
<b>Auxiliary function setting mode 2</b>					
1	4En4	Input type	t L	4 C	t L
2	4FLH	Scaling high limit	80.0	1100	40.0
3	4FLl	scaling low limit	80.0	1000	20.0
4	dP	Decimal point place	Skip	Skip	Skip
5	FILF	PV filter time constant	0.0	0.0	0.0
6	oLH	OUT high limit	100	100	100
7	oLL	OUT low limit	0	0	0
8	H44	OUT ON/OFF hysteresis	Skip	Skip	Skip
9	ALIF	Alarm type	----	HL	----
10	RI Lñ	Alarm action Energized/De-energized	Skip	nññL	Skip
11	RHLd	Alarm HOLD function	Skip	none	Skip
12	RIH4	Alarm hysteresis	Skip	5.0	Skip
13	RI d4	Alarm action delay timer	Skip	0	Skip
14	conf	Direct/Reverse control	HERF	HERF	HERF
15	RT_b	AT bias	20.0	20	20.0
16	4B_b	SVTC bias	0.0	0	0.0
17	FUnc	Output status when input abnormal	Skip	Skip	Skip
18	EoUr	Controller/Converter	Skip	Skip	Skip

Press the  key for approx. 3 sec while holding down the  key. Press the  key to navigate to the next menu item.

## Section 3.6 Signal Conditioners

The analyzer has two analog outputs that utilize din rail mounted Signal Conditioners. These modules have been configured to deliver a 4-20mA output, with a 0-1VDC input signal. These controllers are in the center of the Main Enclosure, to the left of the three temperature controllers.

The intended analyzer variable for the controller input is selected from the Output Settings of the analyzer software utilizing the computer touchscreen. The variable can then be ranged within the same menu as desired, which will deliver the 0-1VDC signal from the SP-2000 Signal Processing Detector board DAC to the Signal Conditioner input.



*Figure 3.2 –Signal Conditioners*




The two Signal Conditioning Modules have been programmed by the factory for the following:




	<b><u>Input</u></b>	<b><u>Output</u></b>	<b><u>Reading</u></b>
<b>Channel A:</b>	0-1VDC	4-20mA	0-999.9 (ppm when Stream 1 Conc. is the variable)
<b>Channel B:</b>	0-1VDC	4-20mA	0-999.9 (ppm when Stream 2 Conc. is the variable)



### Section 3.6.1 Signal Conditioner Programmed Settings

Step	7-Segment Display	Parameter Function	Ch A (4-20 mA)	Ch B (4-20 mA)
<b>Adjustment mode</b>				
1	0Er1	Output zero	0.00	0.00
2	04P1	Output span	0.00	0.00
3	0Er2	Output 2 zero	Skip	Skip
4	04P2	Output 2 span	Skip	Skip
5	1Er	Potentiometer zero input	Skip	Skip
6	14PA	Potentiometer zero output	Skip	Skip
<b>Setup mode</b>				
1	Loct	Set value lock	----	----
2	4En4	Input	dcB	dcB
3	dcB	DC voltage input range	0.18	0.18
4	dP	Decimal point place	0.0	0.0
5	4FL	Output 0% value	0.0	0.0
6	4FLH	Output 100% value	999.9	999.9
7	FiLF	Filter time constant	0.0	0.0
8	4o	Sensor correction	0.0	0.0
9	oUFP	Output	420A	420A
10	oUFL	Output Normal/Reverse	noNL	noNL
11	bUr n	Burnout	Skip	Skip
12	di 4P	Display	dUAL	dUAL
13	Fi nE	Indication time	00.00	00.00

Hold down the  key for approx. 3 sec. Press the  key to navigate to the next menu item. Hold down the  key for approx. 3 sec to exit the menu.

Press the  key for approx. 3 sec while holding down the  (blank) key. Press the  key to navigate to the next menu item.

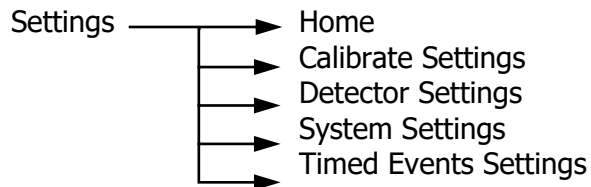
## Section 3.7 Updating Software

The analyzer computer software and detector firmware are easily upgraded as revisions become available from the factory. The GUI and scanner software reside on the solid-state hard drive of the touchscreen computer. The detector firmware can be upgraded utilizing what is known as a bootloader program, which is accessible from the program icon located on the desktop. Future updates may include changes to any, or all embedded programs. Instructions for how to load and update the analyzer software to include the latest released revisions are included below.

### Section 3.7.1 Installing the GUI and Scanner software using the installer program

#### STEP 1: INITIAL SETUP

1. Stop the analysis/cycle (if running)
2. **Settings backup**: On the GUI program take screen-shots (or manually write down information) of the following screens. This can be used to manually re-enter the original settings in the event the data gets erased during software installation.



3. Close the GUI program.



Figure 3.3

4. Close the main program.

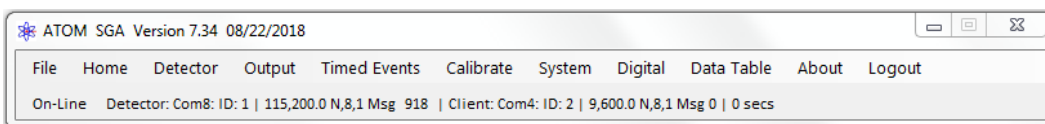
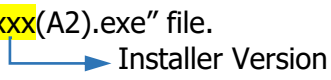
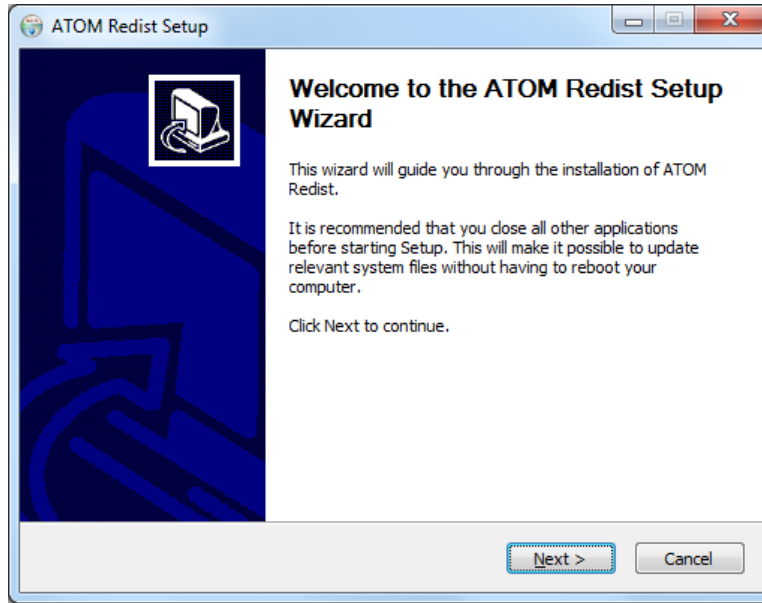


Figure 3.4

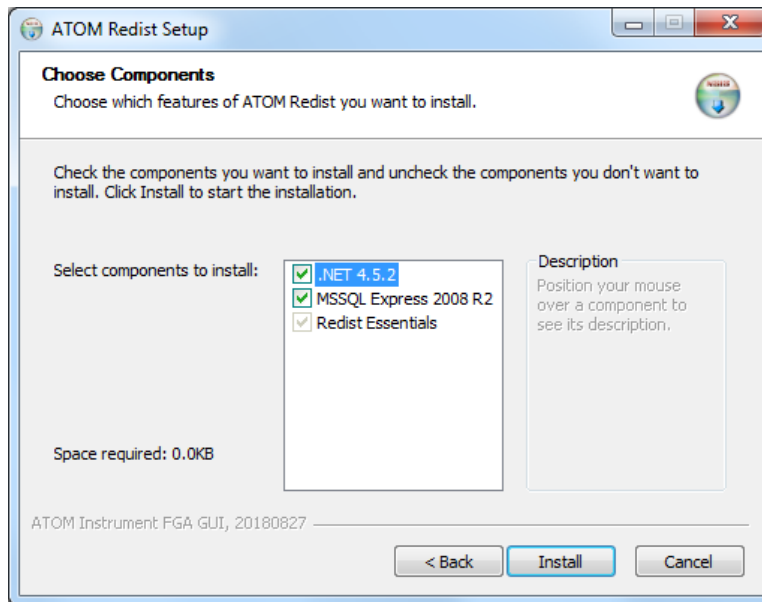
## **STEP 2: INSTALLING THE REDISTRIBUTABLES**

1. Double-click on the "ATOM\_SGA\_Redist\_Vxxx(A2).exe" file.  

2. On the start screen that comes up, click on "Next".



*Figure 3.5*

3. Leave all options "checked" and click **Install**.



*Figure 3.6*

4. The installation process will begin (no user intervention is necessary).

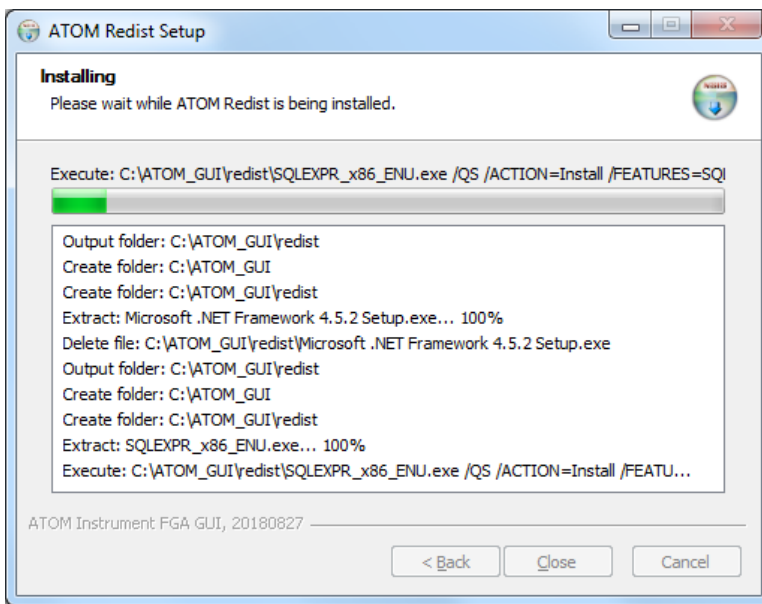


Figure 3.7

5. Once the installation is complete (~ 5 - 10 mins), and when prompted, click "Close".

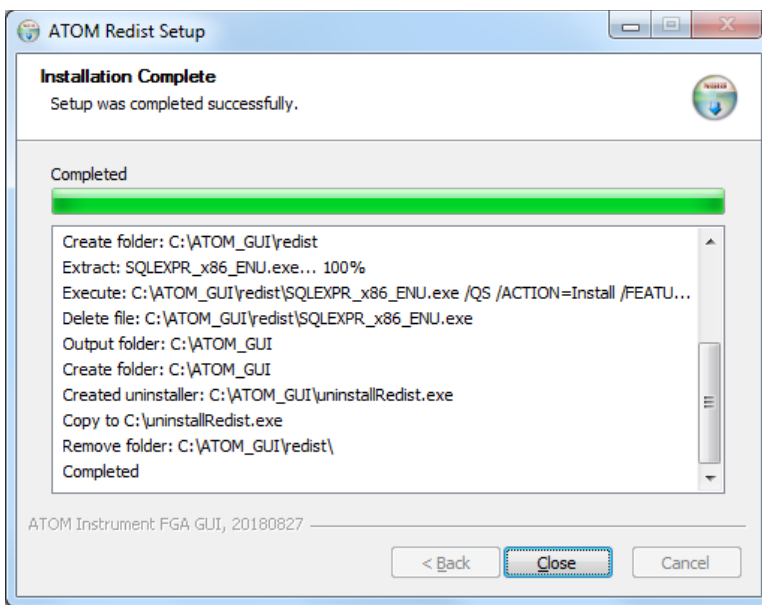



Figure 3.8

This completes the installation of the .NET framework and the SQL Server.

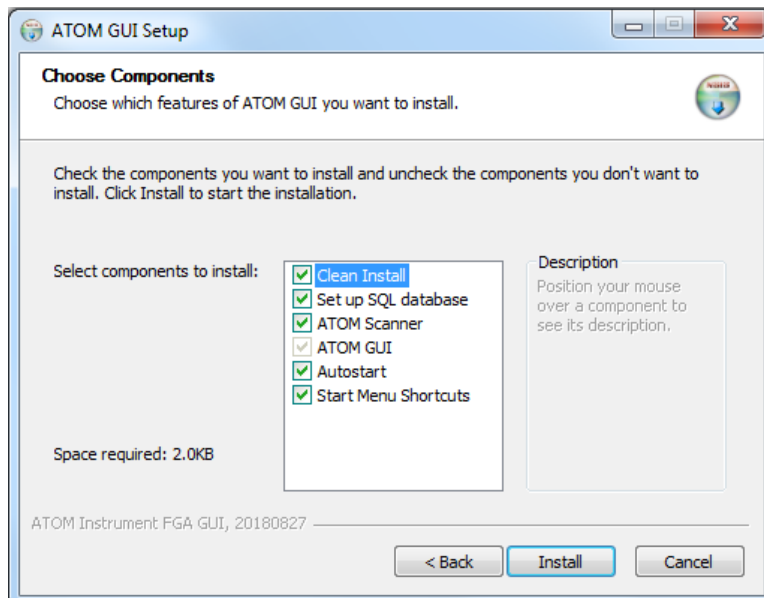
### **STEP 3: INSTALLING THE GUI**

1. Double-click on the "ATOM\_SGA\_GUI\_Vxxx(A2).exe" file.  
 Installer Version
2. On the start screen that comes up, click **Next**.



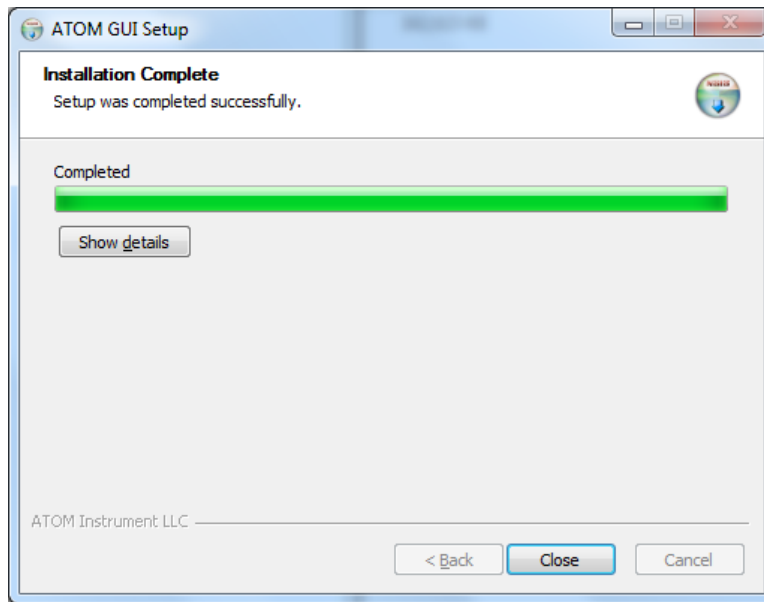
*Figure 3.9*

3. Leave all options "checked" and click **Install**.



*Figure 3.10*

4. Once the installation is complete (~ 1 - 2 mins), click **Close**



*Figure 3.11*

This procedure copies all the updated files into the "C:\ATOM!\\" and "C:\ATOM\_GUI\\" directories. The updated .HEX file, which needs to be loaded onto the Detector board, is also copied into the "C:\ATOM!\\" directory.

### **Section 3.7.2 Bootloader Procedure for Detector Board**

This procedure replaces the embedded HEX file firmware program in the SP-2000 Signal Processing detector board microprocessor. This file must be installed separately as it cannot load automatically without accessing and utilizing the Microchip bootloader program per the following instructions below. Before beginning this procedure, the user will either need the required HEX file to already be on the computer.

1. Open the bootloader software by double-clicking on the "AN1310ui" shortcut on the PC Desktop.



*Figure 3.12*

2. Press the green **Run Mode** button on the bootloader screen. At the bottom right-hand side of the screen the **"Connected"** status will appear as well as the **COM** Port number.

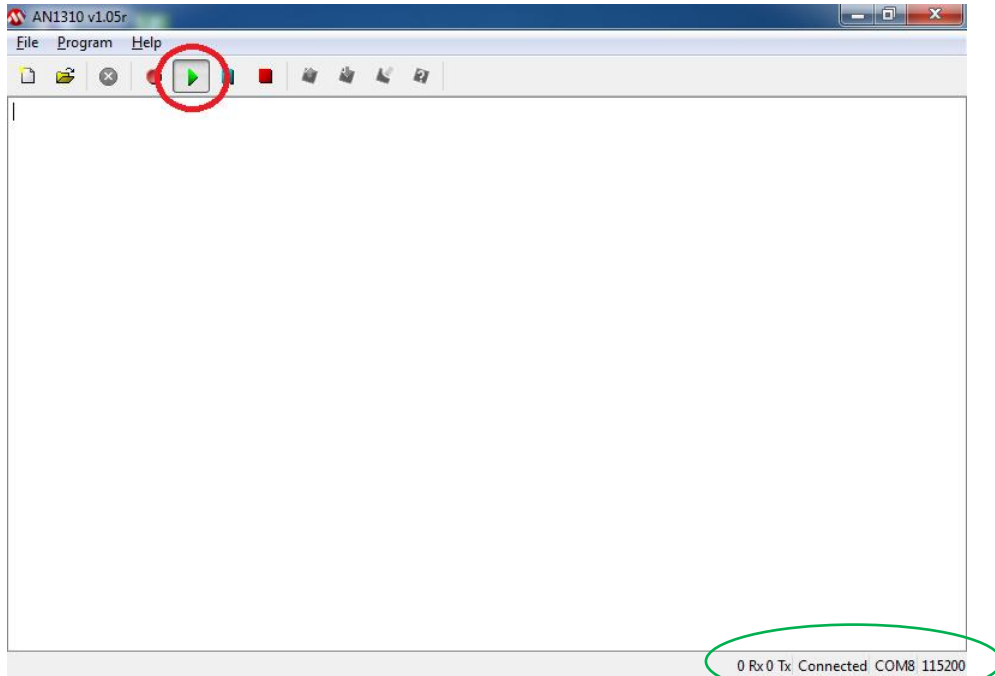


Figure 3.13

3. Press the blue **Break/Reset Mode** button. The bottom status bar will request resetting the SP-2000 board.

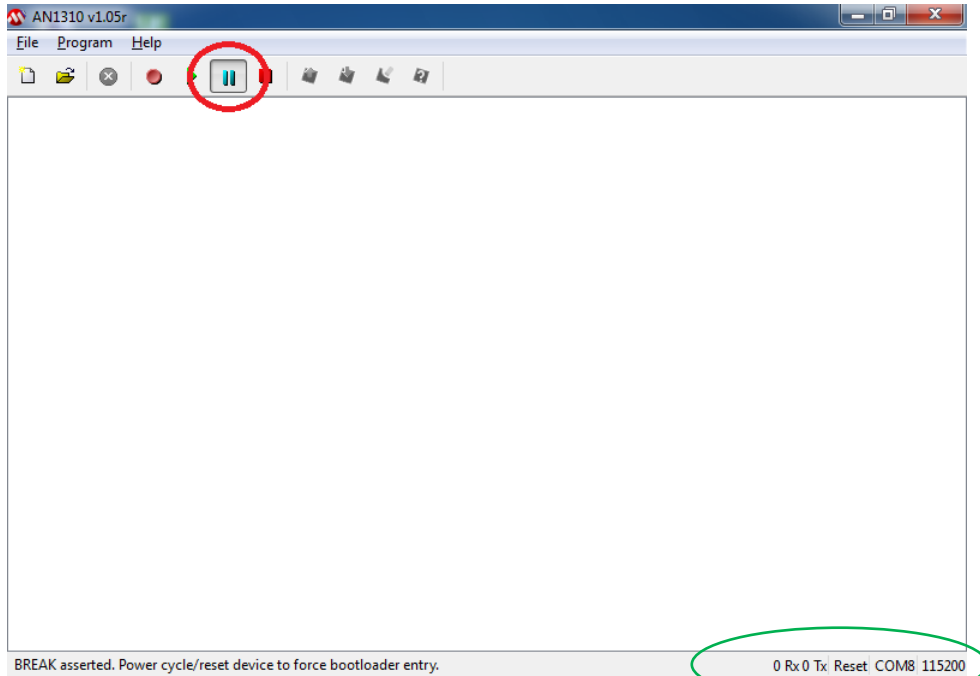


Figure 3.14

4. On the SP-2000 board inside the main analyzer enclosure, press, and hold the **Reset button** for 2 seconds. The SP-2000 board is located immediately behind the Detector assembly.

**⚡ IMPORTANT.....** you only have **30 seconds** to press the "Reset" button before the communication "Times Out". If the connection times out, close the program and re-start from beginning of **Step 1**.

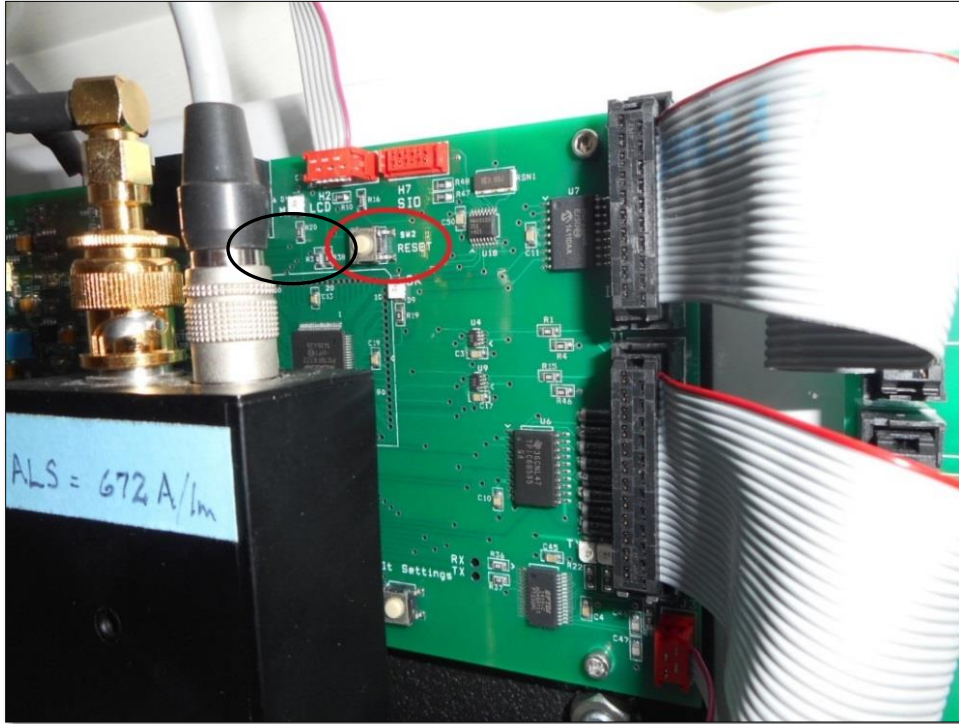


Figure 3.15



5. Press the red **Break Mode** button.

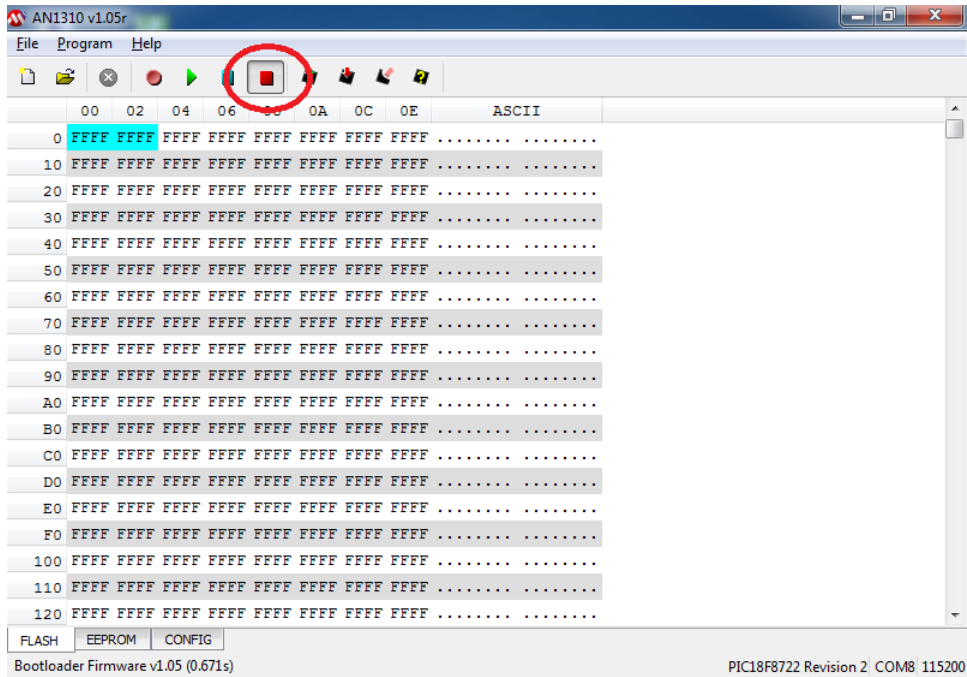


Figure 3.16

6. From the main menu select **File>Open**.

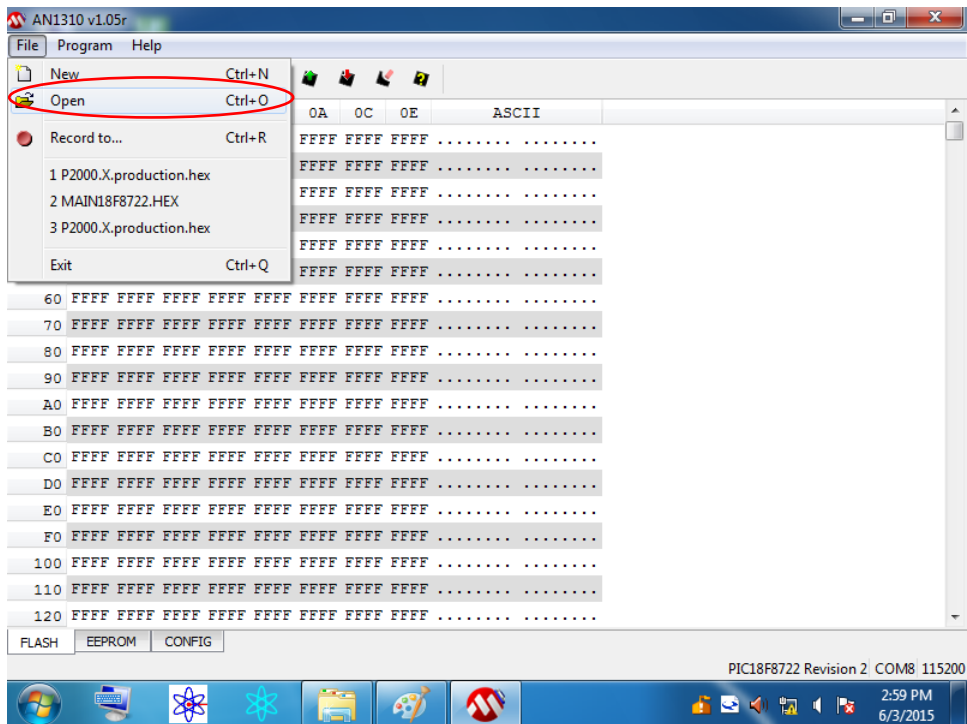


Figure 3.17

7. Select the **SGA-detector.production.hex** file located in **C:\ATOM!** directory and click **Open**. *(The detector HEX file is same for all online analyzer applications)*

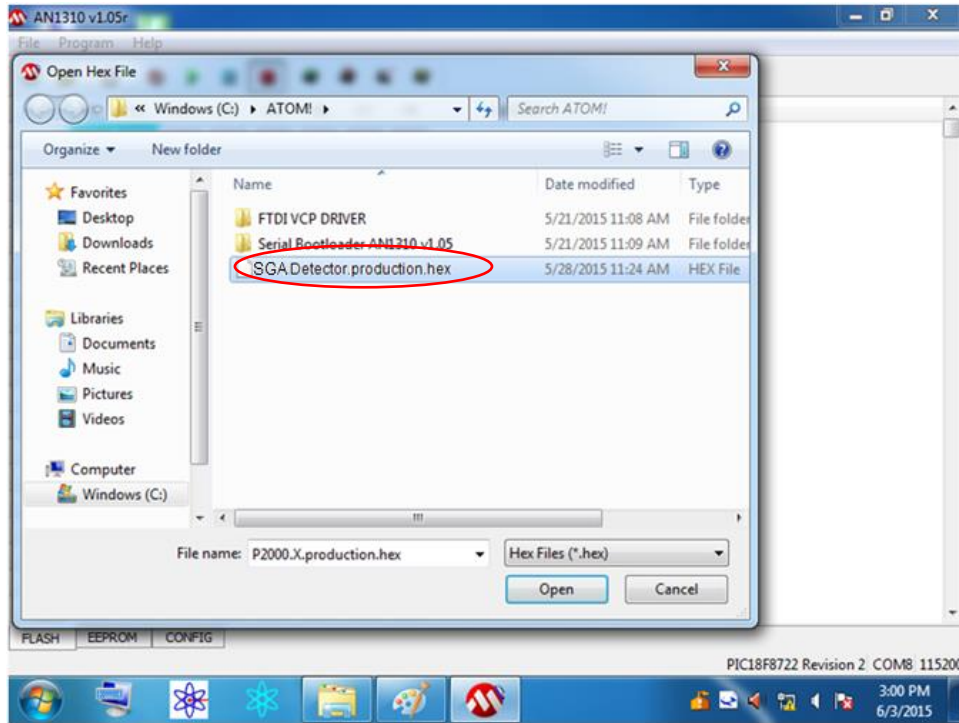


Figure 3.18

8. The bootloader screen will show new hexadecimal values. Click the **Write Device** button.

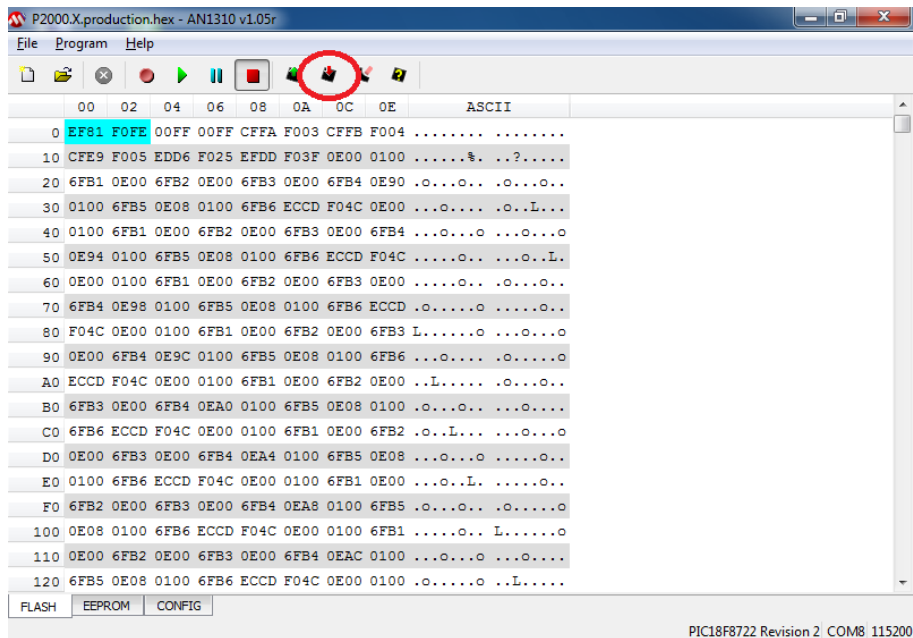


Figure 3.19

- The bootloader software will replace the old firmware in the SP-2000 board with the new one. The bottom status bar will indicate "Write complete" when this step is completed.

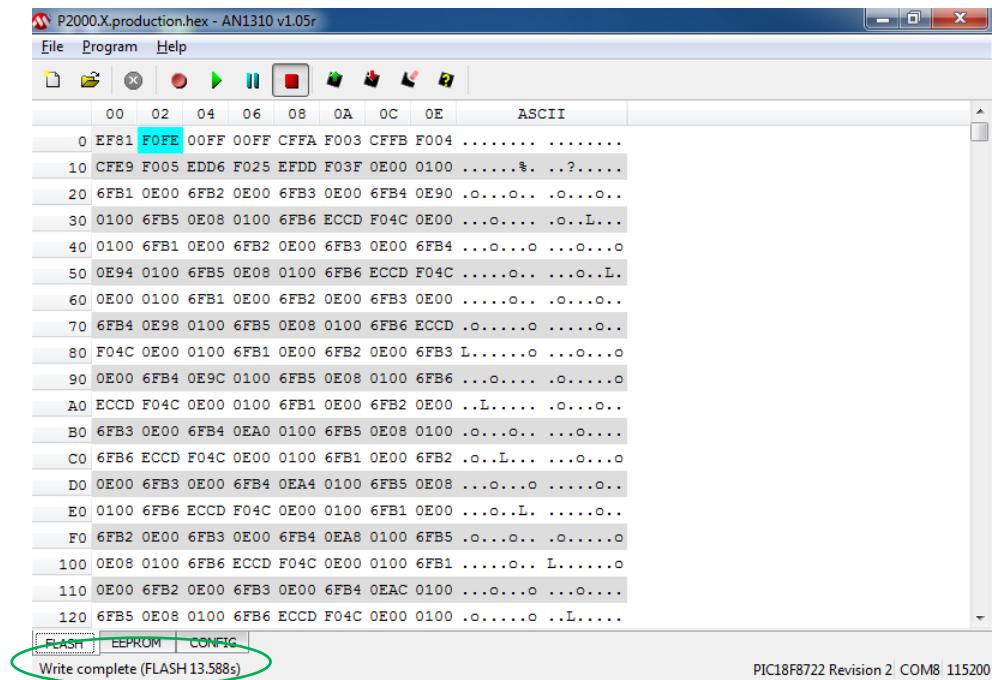


Figure 3.20

- Close the bootloader software.

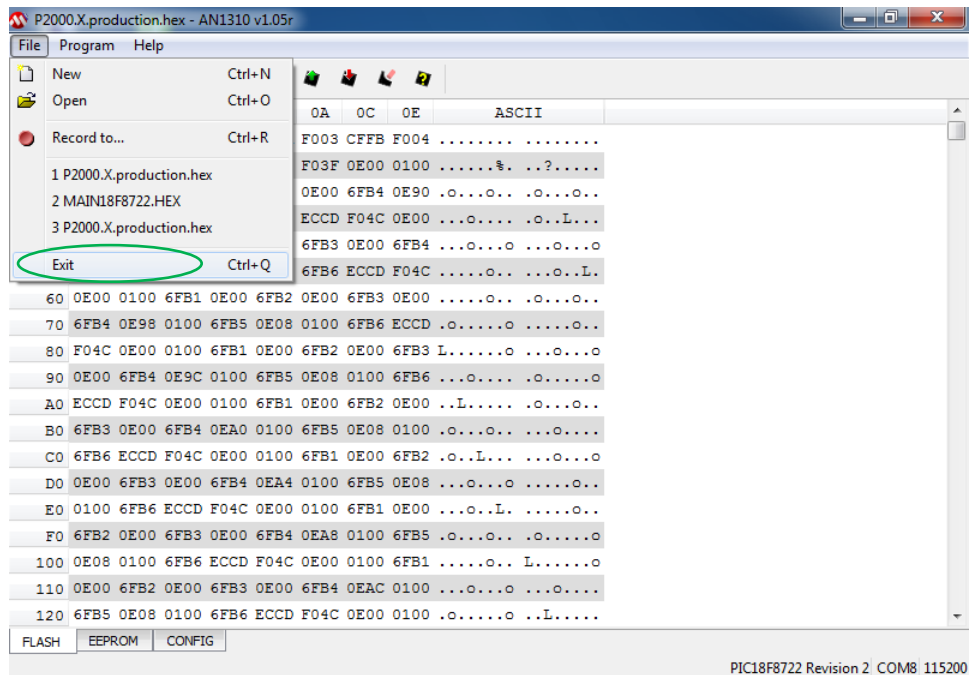


Figure 3.21

- Press and hold the Reset button on the SP-2000 board for 2 seconds to complete this procedure.
- Restart the computer, and both the programs will automatically start up.

Once the GUI is up and running, verify that all the settings on the Calibrate, Detector, System, and Timed Events Settings have been preserved. If not, manually enter these settings before re-starting the analysis.

# Section 4 –MODBUS Digital Communications

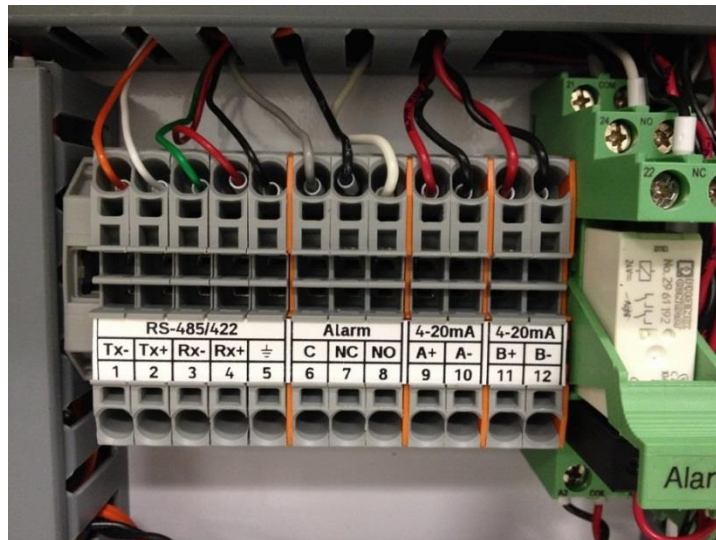
## Section 4.1 Customer Connections

The analyzer supports both RS485 half-duplex and RS422 full-duplex communication for client access to the Database. User communications cable should be connected as specified below, depending upon COM type.

The COM 4 Port on the touchscreen computer which includes a DB-9 connector and associated label with communication signals is assigned to the following Pins:

	RS-485	RS-422
1 TX-	X	X
2 TX+	X	X
3 RX-		X
4 RX+		X
5 GND	X	X

The DB-9 pins are connected to a terminal strip within the Main Electronics Enclosure. Locate the User Connection Terminal Strip within the cabinet

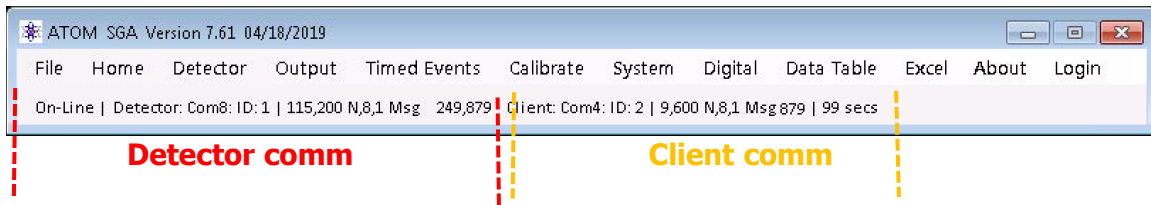


For MODBUS RS-485: Connect to terminals 1,2,5

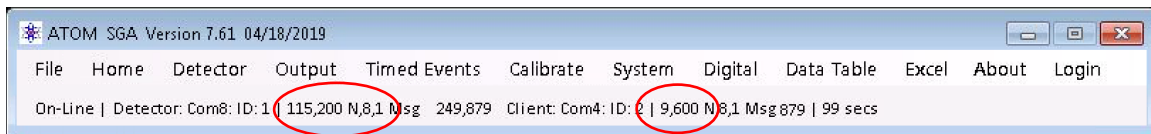
For MODBUS RS-422: Connect to terminals 1,2,3,4,5

## Section 4.2 Communication Settings

There are two sets of communication parameters displayed on the main program, the Detector and Client communications.



The Detector communication settings are intrinsic to communication between the Detector PC board and the main program, and the Client communication settings are intrinsic to communication between the DCS / PLC and the main program. These settings can be modified by editing the *Atom.exe.config* file.



In addition to the communication settings, the "Msg" (message) counters when incrementing give a real-time indication of active communication between the respective modules. If either of the message counter is passive, it is an indication that communication has either been lost or aborted and user intervention may be required to restore it.



**Note:** the above communication settings are crucial for operation and any modifications could lead to Analyzer operation failure. Please contact us if you need more information about modifying these settings. The only recommended setting change is the "Analyzer Slave ID" and is explained in the following section (typically required ONLY if setting up DCS communication with more than one of these analyzers).

## **Setting up Analyzer Slave ID for communication with the DCS/PLC:**

The Analyzer Slave ID setting can be programmed by editing the *Atom2.exe.config* file.

Navigate to the Atom2.exe.config file located in **C:\ATOM!** directory. Right-click on the file and when the selection menu opens, select "Open with.." and choose the Notepad program to edit the config file.

When the file opens in Notepad, locate the <add key="ID\_Slave" value="2"> setting as shown. This value is the unique ID that identifies each analyzer on the network to the DCS. Change the value to a desired number, then click on "File → Save", and then Exit the program.

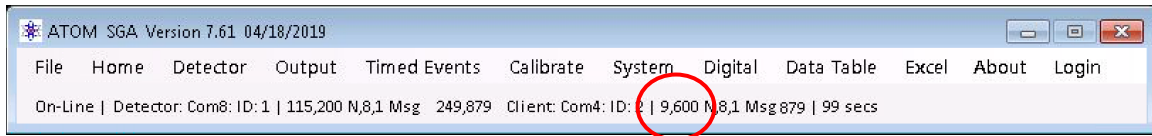
Start the main programs by double-clicking on the "Atom SGA Vxxx(A2)" desktop shortcut – this will automatically start both the main and GUI programs.

```
<?xml version="1.0" encoding="utf-8"?>
<configuration>
  <startup>
    <supportedRuntime version="v4.0" sku=".NETFramework,Version=v4.5" />
  </startup>

  <!--</connectionStrings-->
  <appSettings>
    <add key="ID_SELF" value="1" />
    <add key="COM_D1" value="8" />
    <add key="COM_D2" value="4" />
    <add key="Baud_D1" value="115200" />
    <add key="Baud_D2" value="9600" />
    <add key="ID_Detector" value="1" />
    <add key="ID_Slave" value="2" />
    <add key="Timeout_D1" value="100" />
    <add key="HelperTools" value="0" />
    <add key="UseCorrectedPD" value="0" />
    <add key="ShowTC2" value="0" />
    <add key="Automatic_Restart" value="1" />
    <add key="TC2_Timer1_warn" value="86400" />
    <add key="TC2_Timer2_Shutdown" value="86400" />
    <add key="Version" value="7.41" />
    <add key="NoActivityTime" value="1800" />
    <add key="EnableThermocoupleFailureAlgorithm" value="0" />
    <add key="Enable_TC1_3_Filtering" value="1" />
    <add key="DisableFirstOrderCorrection" value="1" />
    <add key="SQL_Connection_String" value="Data source=.\sqlexpress;
      Initial Catalog=ATOM_ONLINE_DB;Integrated Security=True;
      user id=sa1;password=sa12; MultipleActiveResultsets=True" />
    <add key="Sw_Type" value="SLA" />
    <add key="ClientSettingsProvider.ServiceUri" value="" />
  </appSettings>
  <system.web>
    <membership defaultProvider="ClientAuthenticationMembershipProvider">
      <providers>
        <add name="ClientAuthenticationMembershipProvider" type="System.Web.
          ClientServices.Providers.ClientFormsAuthenticationMembershipProvider,
          System.Web.Extensions, Version=4.0.0.0, Culture=neutral,
          PublicKeyToken=31bf3856ad364e35" serviceUri="" />
      </providers>
    </membership>
    <roleManager defaultProvider="ClientRoleProvider" enabled="true">
      <providers>
        <add name="ClientRoleProvider" type="System.Web.ClientServices.Providers.
          ClientRoleProvider, System.Web.Extensions, Version=4.0.0.0,
          Culture=neutral, PublicKeyToken=31bf3856ad364e35" serviceUri=""
          cacheTimeout="86400" />
      </providers>
    </roleManager>
  </system.web>
</configuration>
```

*Figure 3.1*

If the program successfully establishes communication with the DCS, the message counter on the right hand side of the program (as shown in Figure below) will start incrementing.



*Figure 4.1*

If the main program and the DCS are **not** communicating, the message counter will either read "0", or will not increment.



## Section 4.3 MODBUS Function Code Description

The analyzer is a "MODBUS Slave" while the client (DCS/PLC) is the "MODBUS Master". All commands supported are 8-byte length as described below:

|Address ID| Function code |Start Ho|Start Lo|Data #pts Ho|Data #pts Lo|CRC0|CRC1|

Where:

- Address ID is the address that the station ID main software must find to start a message.
- Function code is a value 1 to 6 declaring what function is to be performed (see below).
- Start HO is the starting register higher order 8-bits. Start LO is the starting register lower order 8-bits. These two bytes are concatenated to create a 16-bit number used in the data base.
- Data #pts Ho and Data #pts Lo are two bytes concatenated to specify the number of registers designated in the MODBUS message.
- CRC0 and CRC1 are two bytes concatenated to specify the CRC of the MODBUS message. Security is maintained by computing the CRC of the message first six bytes and comparing to the last two bytes for a match. A message is not processed if the two CRC's do not match.
  
- Function code 1: Read Relay coils (R1-R32 range).
- Function code 2: Read Input Status Registers (R10001-R10032 range).
- Function code 3: Read discrete 16-bit holding Registers (R40001-R40040 range).
- Function code 3: Read discrete 32-bit holding Registers (R40041-R40120 range) where: R40041-42 is the first pair, R40119-120 is the last pair.
- Function code 4: Read output 32-bit register pairs (R3001-R30082 range) where: R30001-02 is first pair, R30081-R30082 is last pair.
- Function code 4: Read output 16-bit registers (R30083-R30120 range) where: range is 16-bit registers.
- Function code 5: set relay coil register (R1-R40).
- Function code 6: preset single holding register (R40001-R40120).

The double registers specified in function code 3 and 4 must be recognized as 32-bit data to interpret it properly.

## Section 4.5 Reading Algorithm

The MODBUS data is typically a near continuous stream of data packets from the Client. The main software is self-aligning regardless of where it starts listening to packets. This is accomplished by starting with an index of zero. The byte read must equal the Station ID if the index is zero. If not, the alignment procedure begins again without incrementing the index. Alignment is achieved within 8 characters of a packet. When a character read does equal the ID, the index is advanced from 0 to 1. The next character read must equal an allowable function code (1-6). If there is no match the index is reset to 0. Under this scenario, the reception of packets will self-synchronize. If we have a match on the first and second byte, read the next 6 bytes. At this point we have 8 bytes in a receive register. Perform a CRC on the first six characters and compare with the 7<sup>th</sup> and 8<sup>th</sup> characters. There must be a CRC match to process the received packet. If there is no match, the index is again reset to 0 and the process of data capture and qualification repeats. Upon detection of a complete and valid packet the received 8-byte packet is transferred to private processing area. The "Save Packet" function is called which executes a function (1-6) as defined by the function code byte in the 2<sup>nd</sup> byte of the saved packet. The main software creates a reply message for the Client and transmits it back to the client. A message stream resembles the image below showing the command on the left and the response on the right.



Response time is approximately 10ms after the packet is decoded before a reply message is sent.

### Example of reading a single unsigned 32-bit register

In the example below, registers pair R30169 and R30170 are the ppm value. Use function code 4 with an offset of 68 in the MODBUS message to read it.

Example MODBUS query: **02 04 00 44 00 02 31 ED**

Where:

02 = ID

04 = Function Code

00 44 = address offset = 68

00 02 = number of registers requested

31 ED = CRC

Example of MODBUS response, returns 4 bytes from offset 68 : **02 04 04 00 07 B1 84 0D 76**

Where:

02 = ID

04 = Function Code

04 = Byte Count

00 07 B1 84 = 504,196 ppm

0D 76 = CRC

## Section 4.6 MODBUS Map

The MODBUS Data Model presents six database areas where data may be read from or written to. The areas are defined as follows:

MODBUS Database Model			
Database Area	Name	Register Designation	Default Data Type
1	Coils/Boolean	00001 – 00064	Boolean
2	Input Status	10001 – 10080	Boolean
3	Input Register pairs	30001 – 30080	32-bit Integer
4	Input Register	30081 – 30120	16-bit Integer
5	Input Register	30121 – 30342	32-bit Integer
6	Holding Register	40001 – 40080	16-bit Integer
7	Holding Register pairs	40081 – 40240	32-bit Integer

Each discrete data element within the MODBUS database is called a register. Register addressing resolves the database area in which it resides as well as the element offset within the area. For example, the register address of 30083 indicates the integer value stored in register 83 within the Input Registers data base area. MODBUS address 00004 indicates the current Boolean value in register 4 of the Discrete Coil Register area in the data base.

Another aspect of the MODBUS register convention is that some registers are Read-Only from the Host system while other areas are **Read/Write**.

- The Input Status Registers (1xxxx) and the Output Status registers (3xxxx) are Read-Only registers. The Host system is only able to read the values placed into these register areas.
- The Coil Registers (0xxxx) and the Holding Register (4xxxx) are Read/Write registers. The host has read/write access to the registers in these areas. These areas are where Command and Operating Parameter values are written from the Host system. Read only data from the field unit can be placed into these registers as well.

Registers in 3xxxx and 4xxxx range have segments dedicated for 32-bit Integers. These registers require two sequential 16-bit registers. See description in the map.

This data base exists to allow communication from/to the instrument to the main program/GUI program and a RS-485 link for a MODBUS client system.

Controls at the main program allow the administrator to program the COM Port, Baud Rate and MODBUS ID for the Scanner and the RS485 Client link.

Client Access: Although the entire database is available, a client may only have interest in certain data areas. Here is a selection of typical monitor points.

10003	Stream 1 State	1= on Stream 1 (Boolean)
10007	Validate State	1=Validation in Process (Boolean)
10008	Alarm State	Global Alarm Status 0= Alarm, 1=NO Alarm
10019	Purging	1=Purging in Process (Boolean)
10024	Calibrating	1=Calibration in Progress (Boolean)
10025	Running	1=in Run Mode (Boolean)
10026	Holding	1=Status IDLE ("Holding" mode)
10032	Fresh Data	"1" indicates Fresh Data (auto cleared at the end of next peak acquisition while in Process state)
30069-30070	CyclePPM	PPM of current cycle run (stream/process/calibration) (32-bit integer)

**Minimal client monitoring algorithm:**

The client could read 10001-10040 (5-bytes) twice per minute for changes in system status. Registers 30069-30070 could be read when the fresh data flag sets. At least 70 seconds elapses before "Fresh Data" self clears for the next cycle.

## Discrete Coil Registers

Range 00001-00064

R#	Mnemonic	Description (Boolean Commands)
1	New SRN	1=New Sequential Record Number written
2	ARun	Start/Stop a RUN; 0=Stop, 1=Start
3	Calibrate Check Zero	Start/Stop a Calibrate Zero Function, 1=Start
4	Calibrate Check Span	Start/Stop a Calibrate Span Function, 1=Start
5	Calibrate Validate	Start/Stop a Validate Function, 1=Start
6	Manual Zero Set	1=manually zero the baseline (Home Screen)
7	Maintenance	Analyzer 0=Online; 1=Offline
8	Reserved	
9	Calculate RF	1=Calculate the Response Factor (RF)
10	Override	Purge Override 1=ON, 0=OFF
11	Reserved	
12	BL_Enable	1=Base Line Enable for "Zero Baseline" (Detector Settings)
13	Lamp State	Lamp On/Off Control; 0=OFF, 1=ON
14	PMT State	PMT On/Off Control; 0=OFF, 1=ON
15	Auto Cal Enable	1=Automatic Calibrate Enable
16	Reserved	
17	SV State DO	S/V (Sample Valve) 0=OFF, 1=ON (test control of DO)
18	SSO State DO	SSO 0=OFF, 1=ON (test control of DO)
19	Stream 1 State DO	Process Stream 1 (test control of DO)
20	Stream 2 State DO	Process Stream 2 (test control of DO)
21	Zero State DO	Zero (test control of DO)
22	Span State DO	Span (test control of DO)
23	Validate State DO	Validate (test control of DO)
24	Alarm State DO	Alarm Status (test control of DO)
25	Playback	Control of recorded data playback 0=OFF, 1=ON (Demo Mode)
26	Auto Cal Event	Not user programmable – internal use
27	Reserved	
28	Reserved	
29	Cal Parm Change	Is set to "1" if any Cal parameters have been modified – internal use
30	Save RF	Saves the new calculated RF
31	Reserved	
32	Check Sum Request	Set to "1" to request Checksum from main program
33	Stream 1 Enable	1=Stream1 selected (Home Screen Checkbox)

34	Stream 2 Enable	1=Stream2 selected (Home Screen Checkbox)
35	Reserved	
36	Reserved	
37	Thermocouple Warn	Not user programmable – internal use
38	TC1 Set Point Changed	Not user programmable – internal use
39	TC2 Set Point Changed	Not user programmable – internal use
40	TC3 Set Point Changed	Not user programmable – internal use
41	MFC1 Set Point Changed	Not user programmable – internal use
42	MFC2 Set Point Changed	Not user programmable – internal use
43	MFC3 Set Point Changed	Not user programmable – internal use
44	Enable/Disable TC2 algorithm	0=Disable, 1=Enable – internal use
45	Disable/Enable PD Correction algorithm	1=Disable, 0=Enable – internal use
46 - 64	Reserved	

## Discrete Input Status Registers

Range: 10001-10080

R#	Mnemonic	Description (connected to physical outputs)
10001	SV State	Inject/Vent Valve (S/V) Status 1=inject
10002	SSO State	SSO (sample Shut Off) 1=ON, 0=OFF
10003	Stream 1 State (Calibrate State : FGA)	Calibrate / Stream 1 Status
10004	Stream 2 State (Process State : FGA)	Process / Stream 2 Status
10005	Zero State	Zero Calibration Status
10006	Span State	Span Calibration Status
10007	Validate State	Validate Calibration Status
10008	Alarm State	Global Alarm Status 0= Alarm, 1=NO Alarm

R#	Mnemonic	Description (8 bits mapped to physical inputs)
10009	DI1	Digital Input 1 – Loss of Purge
10010	DI2	Digital Input 2 – O2 Pressure Low
10011	DI3	Digital Input 3 – Furnace Temp Low
10012	DI4	Digital Input 4 – user programmable
10013	DI5	Digital Input 5 – user programmable
10014	DI6	Digital Input 6 – user programmable
10015	DI7	Digital Input 7 – user programmable
10016	DI8 (D09)	Read back of Purge Override state

R#	Mnemonic	Description (Boolean Status)
10017	Overriding	1=currently in Purge Override; 0=not in Purge Override
10018	New Cycle Request	Indicates if another cycle is in queue to run – for internal use
10019	Purging	1=Purging in Progress
10020	Check Sum Complete	0=currently performing or not yet performed checksum; 1=has completed a checksum – for internal use
10021	BL Corrected	Data has been offset by baseline corrected value
10022	Logging	Logging to Data Base – for internal use
10023	Reserved	
10024	Calibrating	1=Calibration in Progress (SGA/SLA )
10025	Running	1=In Run Mode
10026	Holding	1=Status IDLE (“Holding” mode)
10027	Stop Pending	Indicates that main program will go into HOLD state at end of current run
10028	Injecting	1=Inject Event (sample being injected)
10029	Fresh Reading	1=new reading posted after computed peak – can be process or calibrate data

10030	Event Base Line	1=Event Base Line acquisition
10031	Event Peak	1=Event Peak acquisition
10032	Fresh Data	1=Fresh Stream/Process only Data available
10033	MFC1 Status	1=value out of range of the set lower or upper limits
10034	MFC2 Status	1=value out of range of the set lower or upper limits
10035	TC1 Status	1=value out of range of the set lower or upper limits
10036	TC2 Status	1=value out of range of the set lower or upper limits
10037	Span Status	1=value out of range of the set lower or upper limits
10038	Zero Status	1=value out of range of the set lower or upper limits
10039	Stream 1 Status	1=value out of range of the set lower or upper limits
10040	TC3 Status	1=value out of range of the set lower or upper limits
10041	Check Sum Valid	1=valid checksum; 0=error – can be used as a debugging tool.
10042	Stream1FreshData	1=fresh Stream1 process data available
10043	Stream2FreshData	1=fresh Stream2 process data available
10044	Stream 1 State	1=currently running; 0=not currently running
10045	Stream 2 State	1=currently running; 0=not currently running
10046	Process State	For internal use
10047	Calibrate State	For internal use
10048	Stream 2 Status	1=value out of range of the set lower or upper limits
10049	Zero Signal	1=selected and in queue
10050	Span Signal	1=selected and in queue
10051	Validate Signal	1=selected and in queue
10052	User Halt Signal	1=selected and in queue
10053	User Start Signal	1=selected and in queue
10054	Reserved For Q	Not available
10055	Reserved For Q	Not available
10056	Reserved For Q	Not available
10057	TC2 failure	1=thermocouple has failed and analyzer has been stopped
10058	MFC3 status	1=value out of range of the set lower or upper limits
10059 - 80	Reserved	



## Discrete Output Registers

Range: 30001-30342

R#	Mnemonic	Description (32-bit RO registers)
30001-30002	Defined	Defined space for s/w use
30003-30004	Uncorrected ppb Stream1	For internal use
30005-30006	Uncorrected ppb Stream2	For internal use
30007-30022	Reserved	
30023-30024	MFC3 Set point Readback	Readback of set point
30025-30026	MFC1 Set point Readback	Readback of set point
30027-30028	MFC2 Set point Readback	Readback of set point
30029-30030	TC1 Set point Readback	Readback of set point
30031-30032	TC2 Set point Readback	Readback of set point
30033-30034	TC3 Set point Readback	Readback of set point
30035-30036	MFC3 value	Mass Flow Controller 3 Value
30037-30038	Applied uV	Applied Baseline offset in microvolts
30039-30040	BL Temp Corrected	For internal use
30041-30042	Which Stream	Defined space for s/w use
30043-30044	MFC1Value	Mass Flow Controller 1 Value
30045-30046	MFC2Value	Mass Flow Controller 2 Value
30047-30048	TC1 Value	Temperature Controller 1 Value
30049-30050	TC2 Value	Temperature Controller 2 Value
30051-30052	TC3 Value	Temperature Controller 3 Value
30053-30054	Reserved	
30055-30056	Reserved	
30057-30058	PMT ave	PMT average (signed 32-bit)
30059-30060	Elapse Seconds	Seconds elapsed since start of current cycle (as seen on Home Screen)
30061-30062	Reserved	
30063-30064	PD average	Photo Diode 1 sec average
30065-30066	Base Line Average	baseline average in detector counts
30067-30068	Area Of Peak Stream 1/Process (FGA)	Stream 1 (SGA/SLA) or Process (FGA) peak area in detector counts
30069-30070	CyclePPM	PPM of current cycle run (stream/process/calibration)
30071-30072	mV_Out	PMT reading in millivolts
30073-30074	uV_Out	PMT reading in microvolts
30075-30076	Area Of Peak Stream 2	Stream 2 peak area in detector counts
30077-30078	DCRFDivisor	Avg Lamp Intensity during baseline of latest cycle - For internal use
30079-30080	Cycle_ppb	PPB of current cycle run (stream/process/calibration)

<b>R#</b>	<b>Mnemonic</b>	<b>Description (16-bit RO registers)</b>
30081	RawTC2value	TC2 value before applying filter - For internal use
30082	RawTC2SP	TC2 set point value before applying filter - For internal use
30083	Reserved	
30084	PCT_FS_DAC1	% of Full Scale for DAC1
30085	TC77_Sensor	On-board Temperature in °C (scaled)
30086	Demo Code	Value between 0-3; selects a preset concentration for playback
30087	CycleNum	Number of current cycle since start of analyses (on Home Page)
30088	Warn States	Bit definitions of WARN checkboxes on System Settings screen
30089	Numbr Cycles	Increments at the end of any cycle. Resets when analysis switches to the next zero, span, validate or process is started.
30090	Alarm Status	Reflected on the Home Screen, 0=no Alarm, 1=Warning, 2=Alarm
30091	Cycleppm (scaled)	For internal use
30092	Version Num	Firmware version ID
30093	PCT_FS_DAC2	% of Full Scale for DAC2
30094	Date Code	Days since 1-1-1900 – 32768 (s/w release)
30095	Reserved	
30096	Override Timer	Secs remaining in cabinet purge override
30097	Numbr Cal Cycles	Current calibration cycle number being run
30098	Alarm States	Bit definitions of ALARM checkboxes on System Settings screen
30099	Stream 1 Progress	Number of current Stream 1 cycle being run out of total requested
30100	Stream 2 Progress	Number of current Stream 2 cycle being run out of total requested
30101	Density Reading S1	Density of Stream 1 - Value used to correct Stream 1 concentration (for SLA only)
30102	Density Reading S2	Density of Stream 2 - Value used to correct Stream 2 concentration (for SLA only)
30103	Alarm Hysteresis	Bit definitions of ALARM checkboxes on System Settings screen
30104	Warn Hysteresis	Bit definitions of WARN checkboxes on System Settings screen
30105	MFC3 Alarm State	Bit definitions of ALARM checkboxes on System Settings screen (extended to incorporate MFC3)

30106	MFC3 Warn State	Bit definitions of WARN checkboxes on System Settings screen (extended to incorporate MFC3)
30107-30120	Reserved	

<b>R#</b>	<b>Mnemonic</b>	<b>Description (32-bit RO registers)</b>
30121-30122	PA1_S2 (Stream 2-1 Area)	Concentration for Stream 2 Peak Area 1 –scrolling array of 10 concentration values in ppm x 100. Oldest data if the array over-written each cycle.
30123-30124	PA1_S2 (Stream 2-2 Area)	Concentration for Stream 2 Peak Area 2
30125-30126	PA1_S2 (Stream 2-3 Area)	Concentration for Stream 2 Peak Area 3
30127-30128	PA1_S2 (Stream 2-4 Area)	Concentration for Stream 2 Peak Area 4
30129-30130	PA1_S2 (Stream 2-5 Area)	Concentration for Stream 2 Peak Area 5
30131-30132	PA1_S2 (Stream 2-6 Area)	Concentration for Stream 2 Peak Area 6
30133-30134	PA1_S2 (Stream 2-7 Area)	Concentration for Stream 2 Peak Area 7
30135-30136	PA1_S2 (Stream 2-8 Area)	Concentration for Stream 2 Peak Area 8
30137-30138	PA1_S2 (Stream 2-9 Area)	Concentration for Stream 2 Peak Area 9
30139-30140	PA1_S2 (Stream 2-10 Area)	Concentration for Stream 2 Peak Area 10
30141-30142	PA1_S1 (Stream 1-1 Area)	Concentration for Stream 1 Peak Area 1 –scrolling array of 10 concentration values in ppm x 100. Oldest data if the array over-written each cycle.
30143-30144	PA1_S1 (Stream 1-2 Area)	Concentration for Stream 1 Peak Area 2
30145-30146	PA1_S1 (Stream 1-3 Area)	Concentration for Stream 1 Peak Area 3
30147-30148	PA1_S1 (Stream 1-4 Area)	Concentration for Stream 1 Peak Area 4
30149-30150	PA1_S1 (Stream 1-5 Area)	Concentration for Stream 1 Peak Area 5
30151-30152	PA1_S1 (Stream 1-6 Area)	Concentration for Stream 1 Peak Area 6
30153-30154	PA1_S1 (Stream 1-7 Area)	Concentration for Stream 1 Peak Area 7
30155-30156	PA1_S1 (Stream 1-8 Area)	Concentration for Stream 1 Peak Area 8
30157-30158	PA1_S1 (Stream 1-9 Area)	Concentration for Stream 1 Peak Area 9
30159-30160	PA1_S1 (Stream 1-10 Area)	Concentration for Stream 1 Peak Area 10
30161-30162	S1_Cycle_ppb	Most recent Stream 1 cycle conc in ppb
30163-30164	S2_Cycle_ppb	Most recent Stream 2 cycle conc in ppb
30165-30166	Ppb Stream 1 1	Scrolling array of 10 values with most recent Stream 1 concentration in ppb in these registers
30167-30168	Ppb Stream 1 2	Concentration for Stream 1 ppb 2
30169-30170	Ppb Stream 1 3	Concentration for Stream 1 ppb 3
30171-30172	Ppb Stream 1 4	Concentration for Stream 1 ppb 4
30173-30174	Ppb Stream 1 5	Concentration for Stream 1 ppb 5
30175-30176	Ppb Stream 1 6	Concentration for Stream 1 ppb 6
30177-30178	Ppb Stream 1 7	Concentration for Stream 1 ppb 7
30179-30180	Ppb Stream 1 8	Concentration for Stream 1 ppb 8
30181-30182	Ppb Stream 1 9	Concentration for Stream 1 ppb 9
30183-30184	Ppb Stream 1 10	Concentration for Stream 1 ppb 10

30185-30186	Ppb Stream 1 ave	Average Concentration in ppb of preset numbers of cycles for Stream 1
30187-30188	Span ppb Cal 1	Scrolling array of 10 values with most recent Span concentration in ppb in these registers
30189-30190	Span ppb Cal 2	Concentration for Span ppb 2
30191-30192	Span ppb Cal 3	Concentration for Span ppb 3
30193-30194	Span ppb Cal 4	Concentration for Span ppb 4
30195-30196	Span ppb Cal 5	Concentration for Span ppb 5
30197-30198	Span ppb Cal 6	Concentration for Span ppb 6
30199-30200	Span ppb Cal 7	Concentration for Span ppb 7
30201-30202	Span ppb Cal 8	Concentration for Span ppb 8
30203-30204	Span ppb Cal 9	Concentration for Span ppb 9
30205-30206	Span ppb Cal 10	Concentration for Span ppb 10
30207-30208	Span ppb Cal ave	Average Concentration in ppb of run cycles for Span
30209-30210	Checksum	Output of detector firmware checksum - For internal use
30211-30212	PPBA1_S2 (Stream 2 ppb)	Scrolling array of 10 values with most recent Stream 2 concentration in ppb in these registers
30213-30214	PPBA2_S2 (Stream 2 ppb)	Concentration for Stream 2 ppb 2
30215-30216	PPBA3_S2 (Stream 2 ppb)	Concentration for Stream 2 ppb 3
30217-30218	PPBA4_S2 (Stream 2 ppb)	Concentration for Stream 2 ppb 4
30219-30220	PPBA5_S2 (Stream 2 ppb)	Concentration for Stream 2 ppb 5
30221-30222	PPBA6_S2 (Stream 2 ppb)	Concentration for Stream 2 ppb 6
30223-30224	PPBA7_S2 (Stream 2 ppb)	Concentration for Stream 2 ppb 7
30225-30226	PPBA8_S2 (Stream 2 ppb)	Concentration for Stream 2 ppb 8
30227-30228	PPBA9_S2 (Stream 2 ppb)	Concentration for Stream 2 ppb 9
30229-30230	PPBA10_S2 (Stream 2 ppb)	Concentration for Stream 2 ppb 10
30231-30232	PPBave_S2 (Stream 2 ppb)	Average Concentration in ppb of preset numbers of cycles for Stream 2
30233-30234	Zero Area 1 Calibrate	Scrolling array of 10 values with most recent Zero Area in these registers
30235-30236	Zero Area 2	Zero Calibration Area 2
30237-30238	Zero Area 3	Zero Calibration Area 3
30239-30240	Zero Area 4	Zero Calibration Area 4
30241-30242	Zero Area 5	Zero Calibration Area 5
30243-30244	Zero Area 6	Zero Calibration Area 6
30245-30246	Zero Area 7	Zero Calibration Area 7
30247-30248	Zero Area 8	Zero Calibration Area 8
30249-30250	Zero Area 9	Zero Calibration Area 9
30251-30252	Zero Area 10	Zero Calibration Area 10
30253-30254	Zero Area Ave Calibrate	Avg Area of run cycles for Zero Calibration
30255-30256	Zero ppb 1 Calibrate	Scrolling array of 10 values with most recent Zero concentration in ppb in these registers
30257-30258	Zero ppb 2 Calibrate	Concentration for Zero ppb 2
30259-30260	Zero ppb 3 Calibrate	Concentration for Zero ppb 3

30261-30262	Zero ppb 4 Calibrate	Concentration for Zero ppb 4
30263-30264	Zero ppb 5 Calibrate	Concentration for Zero ppb 5
30265-30266	Zero ppb 6 Calibrate	Concentration for Zero ppb 6
30267-30268	Zero ppb 7 Calibrate	Concentration for Zero ppb 7
30269-30270	Zero ppb 8 Calibrate	Concentration for Zero ppb 8
30271-30272	Zero ppb 9 Calibrate	Concentration for Zero ppb 9
30273-30274	Zero ppb 10 Calibrate	Concentration for Zero ppb 10
30275-30276	Zero ppb Ave Calibrate	Average Concentration in ppb of preset numbers of cycles for Zero
30277-30278	Span 1 Area Calibrate	Scrolling array of 10 values with most recent Span Area in these registers
30279-30280	Span 2 Area Calibrate	Span Calibration Area 2
30281-30282	Span 3 Area Calibrate	Span Calibration Area 3
30283-30284	Span 4 Area Calibrate	Span Calibration Area 4
30285-30286	Span 5 Area Calibrate	Span Calibration Area 5
30287-30288	Span 6 Area Calibrate	Span Calibration Area 6
30289-30290	Span 7 Area Calibrate	Span Calibration Area 7
30291-30292	Span 8 Area Calibrate	Span Calibration Area 8
30293-30294	Span 9 Area Calibrate	Span Calibration Area 9
30295-30296	Span 10 Area Calibrate	Span Calibration Area 10
30297-30298	Span Area Ave Calibrate	Avg Area of run cycles for Span calibration
30299-30300	Validate 1 ppb	Scrolling array of 10 values with most recent Validate concentration in ppb in these registers
30301-30302	Validate 2 ppb	Concentration for Validate ppb 2
30303-30304	Validate 3 ppb	Concentration for Validate ppb 3
30305-30306	Validate 4 ppb	Concentration for Validate ppb 4
30307-30308	Validate 5 ppb	Concentration for Validate ppb 5
30309-30310	Validate 6 ppb	Concentration for Validate ppb 6
30311-30312	Validate 7 ppb	Concentration for Validate ppb 7
30313-30314	Validate 8 ppb	Concentration for Validate ppb 8
30315-30316	Validate 9 ppb	Concentration for Validate ppb 9
30317-30318	Validate 10 ppb	Concentration for Validate ppb 10
30319-30320	Validate 1 ppb Average	Average Concentration in ppb of preset numbers of cycles for Validate
30321-30322	Validate 1 Area	Scrolling array of 10 values with most recent Validate Area in these registers
30323-30324	Validate 2 Area	Validate Calibration Area 2
30325-30326	Validate 3 Area	Validate Calibration Area 3
30327-30328	Validate 4 Area	Validate Calibration Area 4
30329-30330	Validate 5 Area	Validate Calibration Area 5
30331-30332	Validate 6 Area	Validate Calibration Area 6
30333-30334	Validate 7 Area	Validate Calibration Area 7
30335-30336	Validate 8 Area	Validate Calibration Area 8
30337-30338	Validate 9 Area	Validate Calibration Area 9
30339-30340	Validate 10 Area	Validate Calibration Area 10
30341-30342	Validate Area Average	Avg Area of run cycles for Validate calibration

## Discrete Input Register

Range: 40001-40240

R#	Mnemonic	Description (16-bit RW registers)
40001	Output Average Stream 1 / Process (FGA)	Number of stream 1/process runs concentration to be averaged
40002	Inject Valve Start	Time in seconds from start of cycle to inject valve start
40003	Inject Valve Stop	Time in seconds from start of cycle to inject valve stop
40004	SSOValveStart	Time in seconds from start of cycle to SSO valve start
40005	SSOValveStop	Time in seconds from start of cycle to SSO valve stop
40006	Base Line Start	Cycle Time at which to start baseline acquisition
40007	Base Line Stop	Cycle Time at which to stop baseline acquisition
40008	Auto Zero Time	Time in secs in cycle when baseline is automatically zeroed (display only)
40009	Peak Start Time	Cycle Time at which to start peak acquisition
40010	Peak Stop Time	Cycle Time at which to stop peak acquisition
40011	Run Mode Cycle Sec	Duration in seconds for 1 cycle
40012	Instrument Status	Bit level definition of Analyzer status - For internal use
40013	Compat Last Zero	16-bit converted value of last run zero cycle (FGA)
40014	Compat Last Span	16-bit converted value of last run span cycle (FGA)
40015	State Flag	Bit level definition - last settings saved in EEPROM in case of power failure – For internal use
40016	Purge Seconds	Purge Time in seconds when mode switch occurs
40017	Reserved	
40018	Reserved	
40019	Reserved	
40020	FS_DAC1	Full Scale DAC1 in millivolts
40021	FS_DAC2	Full Scale DAC2 in millivolts
40022	Zero_DAC1	DAC1 lower value (output settings)
40023	Zero_DAC2	DAC2 lower value (output settings)
40024	Auto Cal Freq Days	Auto Calibration frequency in days
40025	Program ID (FGA/SGA/SLA sel)	For internal use
40026	Alarm Mask	Bit mask to enable/disable ALARM checkboxes on System Settings screen
40027	Cal Cycles	Number of calibration cycles set to run

40028	Averages	Smoothing filter setting (number between 1 and 8) – set on Detector Settings screen
40029	DAC1_PV	DAC1 process variable choice
40030	Cycle End	Cycle mode setting : 0=stop, 1=repeat, 2=hold; set on Detector Settings screen
40031	PMT_Volts	PMT Volts (value between 0 and 999)
40032	Compat Last Validate	16-bit converted value of last run validate cycle (FGA)
40033	Number of Cycles	For internal use
40034	Compat Last Process	16-bit converted value of last run process cycle (FGA)
40035	DAC2_PV	DAC2 process variable choice
40036	Cal Units	%, ppm, or ppb
40037	Override Minutes	Cabinet set purge override time in minutes
40038	Secs Until Repeat	Cycle hold time minimum before a new start event (Detector Settings screen)
40039	TOD_Cal	Time of Day for auto calibrate check, if enabled (hh * 60 + min)
40040	Warn Mask	Bit mask to enable/disable WARN checkboxes on System Settings screen
40041	Stream 1 Runs	Total cycles of Stream 1 set to run before switching
40042	Stream 2 Runs	Total cycles of Stream 2 set to run before switching
40043	Stream 1 Density	Density of Stream 1 - Value used to correct Stream 1 concentration for current cycle (for SLA only)
40044	Stream 2 Density	Density of Stream 2 - Value used to correct Stream 2 concentration for current cycle (for SLA only)
40045	Calibration Density	Density of the liquid span calibration standard used to calibrate instrument (for SLA only)
40046	Output Average Stream 2	Number of stream 2 runs concentration to be averaged
40047	MFC1 Initial Address	Currently programmed MFC1 address
40048	MFC1 Desired Address	New address that will be programmed into MFC1
40049	TC Failure Log	For internal use
40050	Alarm Mask2	Bit mask to enable/disable ALARM checkboxes on System Settings screen (extended to incorporate MFC3)
40051	Warn Mask2	Bit mask to enable/disable WARN checkboxes on System Settings screen (extended to incorporate MFC3)
40052	Starting Stream	Sets order of streams at start up – checkbox on Home Screen
40053-	Reserved	

40057		
40058	Count Of Violations	For internal use
40059	Defined	Defined space for s/w use
40060	MFC1 address	For future implementation
40061	MFC2 address	For future implementation
40062	MFC3 address	For future implementation
40063-40080	Reserved	

<b>R#</b>	<b>Mnemonic</b>	<b>Description (32-bit RW registers)</b>
40081-40082	Zero Cal Average Area	Zero cal avg area response value
40083-40084	Span Cal Average Area	Span cal avg area response value
40085-40086	Counts Per ppm	Computed detector counts per ppm = Response Factor
40087-40088	Zero Saved	Last saved zero value
40089-40090	Span_DAC1	High Value for DAC1
40091-40092	Span_DAC2	High Value for DAC2
40093-40094	BOffset_uV	User input baseline offset value in uV
40095-40096	Span Cal ppb	Span cal conc ppb value
40097-40098	Zero Cal ppb	Zero cal conc ppb value
40099-40100	Last Validate ppm	Last value of Validate calibration conc in ppm
40101-40102	Span Saved	Last saved value of Span calibration
40103-40104	DCRF Multiplier	For Internal use
40105-40106	MFC1 Low	MFC1 Low range setting
40107-40108	MFC1 High	MFC1 High range setting
40109-40110	MFC2 Low	MFC2 Low Range setting
40111-40112	MFC2 High	MFC2 High Range setting
40113-40114	TC1 Low	TC1 Low Range setting
40115-40116	TC1 High	TC1 High Range setting
40117-40118	TC2 Low	TC2 Low Range setting
40119-40120	TC2 High	TC2 High Range setting
40121-40122	MFC 1 Set point	MFC 1 Set point setting
40123-40124	MFC2 Set point	MFC 2 Set point setting
40125-40126	TC1 Set point	TC 1 Set point setting
40127-40128	TC2 Set point	TC 2 Set point setting
40129-40130	TC3 Set point	TC 3 Set point setting
40131-40132	TC3 Low	TC 3 Low Range Setting
40133-40134	TC3 High	TC 3 High Range Setting
40135-40136	Zero Low Alarm	Zero Low alarm setting
40137-40138	Zero High Alarm	Zero High alarm setting
40139-40140	Span Low Alarm	Span Low alarm setting
40141-40142	Span High Alarm	Span High alarm setting
40143-40144	Stream 1 Low Alarm	Stream 1 Low alarm setting
40145-40146	Stream 1 High Alarm	Stream 1 High alarm setting
40147-40148	Reserved	
40149-40150	RF Value	User entered RF value (RF value in use)



40151-40152	Reserved	
40153-40154	Zero Value Interference Correct	For Internal use
40155-40156	Timer 1 warn	For Internal use
40157-40158	Timer 2 shutdown	For Internal use
40159-40160	Reserved	
40161-40162	Stream 2 Low Alarm	Stream 2 Low alarm setting
40163-40164	Stream 2 High Alarm	Stream 2 High alarm setting
40165-40166	MFC3 Low Alarm	MFC3 Low alarm setting
40167-40168	MFC3 High Alarm	MFC3 High alarm setting
40169-40170	MFC3 Set point	MFC 3 Set point setting
40171-40240	Reserved	

# Section 5 –Scanner Features and Operation

## Section 5.1 Logs

There are three event log files generated by the main program that provide information about the programs' operation:

- AtomLog.txt
- TrendLog.txt
- DCSlog.txt

When used in conjunction with each other the files provide a powerful debugging tool to isolate causes of operation errors.

The log files are located in the "C:\ATOM!\AtomLog\" folder and provide chronological information about the status of the Analyzer, DCS communication as well as analyses results, and can be viewed/edited using Notepad. Each log entry has a date and time stamp, followed by a line of text describing the event. If any of the log files or the folder are moved or deleted, the program will re-create a replacement folder and/or the files and will continue logging to the new files (in this event any previously logged data will be lost).

### Section 5.1.1 AtomLog.txt

This log provides information about all system alarms and critical events and is basically a snapshot of the "System Settings" screen. An "x" enclosed in brackets indicates a corresponding check box in the GUI that is checked/selected. Empty brackets indicate that the corresponding box is un-checked/deselected. The logic state of a Digital Input is indicated in parenthesis where (\*) indicates the alarm state of a Digital Input. The level of alarm is indicated by the names in parenthesis: (RED) Alarm, (YEL) Warn or (GRN) Normal.

#### Sample AtomLog.txt file

```
-----  
19/04/25 10:47:59 ATOM SGA Event Log Settings SnapShot  
-----  
19/04/25 10:47:59  
19/04/25 10:47:59 Atom Date: 04/18/2019 Version: 7.61  
19/04/25 10:47:59 GUI Date: 09/13/2018 Version: 2.0  
19/04/25 10:47:59 Detector Date: 04/18/2019 Version: 3.10  
19/04/25 10:47:59  
-----  
19/04/25 10:47:59  
19/04/25 10:47:59 Definitions:  
19/04/25 10:47:59 where: (*) State = ON, ( ) State = OFF  
19/04/25 10:47:59 where: (GRN) = NORMAL, (YEL) = Warning, (RED) = Alarm  
19/04/25 10:47:59 ON OFF where: [x] = CheckedBox; [ ] = not CheckedBox  
19/04/25 10:47:59  
19/04/25 10:48:00 ----- Starting Atom -----  
19/04/25 10:48:00
```

*A header is written when a new log file is created detailing the software version, followed by the current status of the System Settings – alarms, status of all check boxes, MFC and TC set points.*

```

19/04/25 10:48:00 [x] Stream1 Select ON
19/04/25 10:48:00 [ ] Stream2 Select OFF
19/04/25 10:48:00      DI-1 Purge Loss OK (GREEN)
19/04/25 10:48:00      DI-2 O2 Pressure OK (GREEN)
19/04/25 10:48:00      DI-3 Furnace Temperature ALARM
19/04/25 10:48:00 [ ] DI-4 Alarm Check OFF
19/04/25 10:48:00 [ ] DI-4 Warn Check OFF
19/04/25 10:48:00 [ ] DI-5 Alarm Check OFF
19/04/25 10:48:00 [ ] DI-5 Warn Check OFF
19/04/25 10:48:00 [ ] DI-6 Alarm Check OFF
19/04/25 10:48:00 [ ] DI-6 Warn Check OFF
19/04/25 10:48:00 [ ] DI-7 Alarm Check OFF
19/04/25 10:48:00 [ ] DI-7 Warn Check OFF
19/04/25 10:48:00 [ ] Zero Alarm Check OFF
19/04/25 10:48:00 [ ] Zero Warn Check OFF
19/04/25 10:48:00 [ ] Span Alarm Check OFF
19/04/25 10:48:00 [ ] Span Warn Check OFF
19/04/25 10:48:00 [ ] Stream1 Alarm Check OFF
19/04/25 10:48:00 [x] Stream1 Warn Check OFF
19/04/25 10:48:00 [ ] Stream2 Alarm Check OFF
19/04/25 10:48:00 [ ] Stream2 Warn Check OFF
19/04/25 10:48:00 [ ] MFC1 Alarm Check OFF
19/04/25 10:48:00 [ ] MFC1 Warn Check OFF
19/04/25 10:48:00 [ ] MFC2 Alarm Check OFF
19/04/25 10:48:00 [ ] MFC2 Warn Check OFF
19/04/25 10:48:00 [ ] TC1 Alarm Check OFF
19/04/25 10:48:00 [ ] TC1 Warn Check OFF
19/04/25 10:48:00 [ ] TC2 Alarm Check OFF
19/04/25 10:48:00 [ ] TC2 Warn Check OFF
19/04/25 10:48:00 [ ] TC3 Alarm Check OFF
19/04/25 10:48:00 [ ] TC3 Warn Check OFF
19/04/25 10:48:00 (GRN) Zero Value    Low = 0 Value = 0 High = 1,000,000 ppb
19/04/25 10:48:00 (GRN) Span Value    Low = 0 Value = 0 High = 550,000,000 ppb
19/04/25 10:48:00 (GRN) Stream1 Value Low = 0 Value = 0 High = 550,000,000 ppb
19/04/25 10:48:00 (GRN) Stream2 Value Low = 0 Value = 0 High = 0 ppb
19/04/25 10:48:00 (GRN) MFC1 Value    L=0 V=0.0 H=0 (cc/min)
19/04/25 10:48:00 (GRN) MFC2 Value    L=0 V=0.0 H=0 (cc/min)
19/04/25 10:48:00 (GRN) MFC3 Value    L=0 V=0.0 H=0 (cc/min)
19/04/25 10:48:00 (GRN) TC1 Value     L=0.0°C V=0.0°C H=80.0°C
19/04/25 10:48:00 (GRN) TC2 Value     L=1040°C V=0°C H=1060°C
19/04/25 10:48:00 (GRN) TC3 Value     L=0°C V=0.0°C H=40°C
19/04/25 10:48:00 ----- End of Startup -----

```

*The digital inputs DI1, DI2 and DI3 are system critical, and the Analyzer will not start analyses unless the status of ALL three DIs is GREEN. In this example, DI3 is RED indicating that the furnace has not reached its set temperature for analysis to begin.*

(RED)

```

19/04/25 10:48:05 ----- On Start Up -----
19/04/25 10:48:05 RF Counts on Calibration dialog is set to 5,076,923
19/04/25 10:48:05 Calibration Units on Calibration dialog is set to ppb
19/04/25 10:48:05 Purge time set to 21 secs
19/04/25 10:48:05 Calibration Cycles on Calibration dialog is set to 3
19/04/25 10:48:05 Check Zero on Calibration dialog is set to 0 counts
19/04/25 10:48:05 Zero Average Concentration: 0 ppb
19/04/25 10:48:05 Check Span on Calibration dialog is set to 0 counts
19/04/25 10:48:05

```

*As an example, the Response Factor (RF) was manually changed to 5,076,923, and the Purge Time was set to 21 seconds.*

19/04/25 10:48:05 Span Average Concentration: 0 ppb  
 19/04/25 10:48:05  
 19/04/25 10:48:05 Zero Conc on Calibration dialog is set to 0 ppb  
 19/04/25 10:48:05 Span Conc on Calibration dialog is set to 6,500 ppb  
 19/04/25 10:48:05 Online Maintenance on Home dialog is ONLINE  
 19/04/25 10:48:05 Frequency for Auto Check on Calibration dialog is set to 1 days.  
 19/04/25 10:48:05  
 19/04/25 10:48:05 Playback Demo on Calibration dialog is OFF  
 19/04/25 10:48:05 PMTVolts on Detector dialog is set to 800 volts  
 19/04/25 10:48:05 Filter on Detector dialog is set to 8 secs  
 19/04/25 10:48:05 Zero Enabled on Detector dialog is set to OFF  
 19/04/25 10:48:05 OFFset uV on Detector dialog is set to 0 uV  
 19/04/25 10:48:05 Hold Time on Detector dialog is set to 0 secs  
 19/04/25 10:48:05 Cycle Mode on Detector dialog is set to REPEAT  
 19/04/25 10:48:05 Injection Start on Timed Event dialog is set to 7 secs  
 19/04/25 10:48:05 Injection Stop on Timed Event dialog is set to 10 secs  
 19/04/25 10:48:05 SSO/ARV Start on Timed Event dialog is set to 5 secs  
 19/04/25 10:48:05 SSO/ARV Stop on Timed Event dialog is set to 12 secs  
 19/04/25 10:48:05 Baseline Start on Timed Event dialog is set to 10 secs  
 19/04/25 10:48:05 Baseline Stop on Timed Event dialog is set to 19 secs  
 19/04/25 10:48:05 Auto Zero Time on Timed Event dialog is set to 0 secs  
 19/04/25 10:48:05 Peak Start on Timed Event dialog is set to 20 secs  
 19/04/25 10:48:05 Peak Stop on Timed Event dialog is set to 70 secs  
 19/04/25 10:48:05 Cycle Time on Timed Event dialog is set to 100 secs  
 19/04/25 10:48:05  
 19/04/25 10:48:05 Stream 2 disabled on Home dialog  
 19/04/25 10:48:05 Stream 1 Cycles on Home dialog set to 5  
 19/04/25 10:48:05 Stream 2 Cycles on Home dialog set to 0  
 19/04/25 10:48:05 Starting Stream on Home dialog is set to 1  
 19/04/25 10:48:05 Run/Stop button on Home page is set to ON  
 19/04/25 10:48:05  
 19/04/25 10:48:05 Purge Override is set to ON for 10 minutes  
 19/04/25 10:48:05  
 19/04/25 10:48:05 Purge Override is set to OFF  
 19/04/25 10:48:05  
 19/04/25 10:48:05 TC1 Low set to 0°C  
 19/04/25 10:48:05  
 19/04/25 10:48:05 TC1 High set to 80°C  
 19/04/25 10:48:05  
 19/04/25 10:48:05 TC1 Set Point set to 70 °C  
 19/04/25 10:48:05  
 19/04/25 10:48:05 TC2 Low set to 1040°C  
 19/04/25 10:48:05  
 19/04/25 10:48:05 TC2 High set to 1060°C  
 19/04/25 10:48:05  
 19/04/25 10:48:05  
 19/04/25 10:48:05 TC2 Set Point set to 1050 °C  
 19/04/25 10:48:05  
 19/04/25 10:48:05 TC2 violations reset to 0  
 19/04/25 10:48:05  
 19/04/25 10:48:05 TC3 Low set to 0°C  
 19/04/25 10:48:05  
 19/04/25 10:48:05 TC3 High set to 40°C

*In addition to the System Settings, the log file records changes made by the user to any of the software menu settings.*

*As seen here, Stream 2 was disabled, and number of Stream 1 cycles to be run was changed to 5.*

19/04/25 10:48:05  
 19/04/25 10:48:05 TC3 Set Point set to 30 °C  
 19/04/25 10:48:05  
 19/04/25 10:48:05 MFC1 Low set to 115 cc/min  
 19/04/25 10:48:05  
 19/04/25 10:48:05 MFC1 High set to 125 cc/min  
 19/04/25 10:48:05  
 19/04/25 10:48:05 MFC1 Set Point set to 120 cc/min  
 19/04/25 10:48:05  
 19/04/25 10:48:05 MFC2 Low set to 0 cc/min  
 19/04/25 10:48:05  
 19/04/25 10:48:05 MFC2 High set to 0 cc/min  
 19/04/25 10:48:05  
 19/04/25 10:48:05 MFC2 Set Point set to 0 cc/min  
 19/04/25 10:48:05  
 19/04/25 10:48:05 MFC3 Low set to 0 cc/min  
 19/04/25 10:48:05  
 19/04/25 10:48:05 MFC3 High set to 0 cc/min  
 19/04/25 10:48:05  
 19/04/25 10:48:05 MFC3 Set Point set to 0 cc/min  
 19/04/25 10:48:05  
 19/04/25 10:48:05 PMT HV on Home dialog is set to ON  
 19/04/25 10:48:05  
 19/04/25 10:48:05 UV Lamp on Home dialog is set to ON  
 19/04/25 10:48:05

*MFC1 low alarm value set to 115 cc/min, the high alarm value set to 125 cc/min, and the Set Point at 120 cc/min.*

**Other events include Check Calibration events as they occur.**

16/07/13 09:58:22 Auto Check Time Set: 00:10:00 (DD:HH:MM)  
 16/07/13 09:59:09 (GRN) Stream 2 Value  
 16/07/13 10:00:00 Auto Check Event Initiated  
 16/07/13 10:00:40 Begin Zero Check cycle  
 16/07/13 10:03:30 End Zero Check Cycle  
 16/07/13 10:03:30 Begin Span Check cycle  
 16/07/13 10:06:19 End Span Check Cycle  
 16/07/13 10:06:19 Begin Validate Check cycle  
 16/07/13 10:09:09 End Validate Check Cycle  
 16/07/13 10:15:25 Calculate RF  
 16/07/13 10:15:28 Save Calibration

*Here, the user has clicked on the "Calculate RF" button and then re-calibrated the Analyzer by clicking on "Save Calibration"*

**Section 5.1.2 Trend Log**

The Trend Log is a comma delimited text file that contains the results of all analyses. It is organized in a format compatible for importing into EXCEL.

**Sample TrendLog.txt file**

When it begins logging, the TrendLog.txt file prints a header which has a date and time stamp, Run Cycle (count of cycles run since analyzer was last started), Stream Cycle (how many of the pre-set stream/calibration cycles have been completed), and Stream and Calibration concentrations.

	YY/MM/DD	HH:MM:SS	Run Cycle	Stream Cycle	Stream1 (ppb)	Stream2 (ppb)	(ppb)	Zero	Span (ppb)	Validate
(ppb)	19/05/01	10:06:34	24	1	112,449					
	19/05/01	10:08:15	25	2	30,208					
	19/05/01	10:09:56	26	1		54,084				
	19/05/01	10:11:37	27	2		47,810				
	19/05/01	10:13:19	28	1	30,074					
	19/05/01	10:15:00	29	2	29,882					
	19/05/01	10:16:41	30	1		41,501				
	19/05/01	10:18:22	31	2		35,204				
	19/05/01	10:20:03	32	1	30,208					
	19/05/01	10:21:44	33	2	30,322					
	19/05/01	10:23:25	34	1		28,913				
	19/05/01	10:25:06	35	2		22,555				
	19/05/01	10:26:48	36	1	29,882					
	19/05/01	10:28:29	37	2	30,048					
	19/05/01	10:30:10	38	1		16,123				
	19/05/01	10:31:51	39	2		16,131				
	19/05/01	13:12:26	39	1			500			
	19/05/01	13:14:07	40	2			481			
	19/05/01	13:15:48	41	3			534			
	19/05/01	13:12:26	42	1				6,500		
	19/05/01	13:14:07	43	2				6,481		
	19/05/01	13:15:48	44	3				6,534		
	19/05/01	13:12:26	45	1					1,500	
	19/05/01	13:14:07	46	2					1,481	
	19/05/01	13:15:48	47	3					1,534	

Following is an example of the above TrendLog.txt file when exported into Excel.

	A	B	C	D	E	F	G	H	I
1	YY/MM/DD	HH:MM:SS	Run	Stream	Stream1	Stream2	Zero	Span	Validate
2			Cycle	Cycle	(ppb)	(ppb)	(ppb)	(ppb)	(ppb)
3	19/05/01	10:06:34	24	1	112,449				
4	19/05/01	10:08:15	25	2	30,208				
5	19/05/01	10:09:56	26	1		54,084			
6	19/05/01	10:11:37	27	2		47,810			
7	19/05/01	10:13:19	28	1	30,074				
8	19/05/01	10:15:00	29	2	29,882				
9	19/05/01	10:16:41	30	1		41,501			
10	19/05/01	10:18:22	31	2		35,204			
11	19/05/01	10:20:03	32	1	30,208				
12	19/05/01	10:21:44	33	2	30,322				
13	19/05/01	10:23:25	34	1		28,913			
14	19/05/01	10:25:06	35	2		22,555			
15	19/05/01	10:26:48	36	1	29,882				
16	19/05/01	10:28:29	37	2	30,048				
17	19/05/01	10:30:10	38	1		16,123			
18	19/05/01	10:31:51	39	2		16,131			
19	19/05/01	13:12:26	39	1			500		
20	19/05/01	13:14:07	40	2			481		
21	19/05/01	13:15:48	41	3			534		
22	19/05/01	13:12:26	42	1				6,500	
23	19/05/01	13:14:07	43	2				6,481	
24	19/05/01	13:15:48	44	3				6,534	
25	19/05/01	13:12:26	45	1					1,500
26	19/05/01	13:14:07	46	2					1,481
27	19/05/01	13:15:48	47	3					1,534

## Section 5.1.3 DCS Log

The DCSLog.TXT file maintains a running log of all "Control" signals received by the program from the DCS / PLC, i.e. the log records the status of Modbus Control Registers in the range between R00001 and R00064.

When used in conjunction with Log, it helps ascertain whether or not a particular change in status of the Analyzer was requested by the DCS / PLC.

### Sample DCSLog.txt file

```

19/03/30 05:48:12 R20 Stream 2 Enable = ON
19/03/30 05:48:17 R2 Run = ON
19/03/30 05:50:32 R2 Run = OFF
19/03/30 05:51:04 R20 Stream 2 Enable = OFF
19/03/30 05:51:14 R21 Zero Enable = ON
19/03/30 05:51:19 R2 Run = ON
19/03/30 05:53:32 R2 Run = OFF
19/03/30 05:54:04 R21 Zero Enable = OFF

```

19/03/30 05:54:14 R19 Stream 1 Enable = ON  
19/03/30 05:54:19 R2 Run = ON  
19/03/30 05:56:32 R2 Run = OFF  
19/03/30 05:57:04 R19 Stream 1 Enable = OFF  
19/03/30 05:57:14 R20 Stream 2 Enable = ON  
19/03/30 05:57:19 R2 Run = ON  
19/03/30 05:59:33 R2 Run = OFF  
19/03/30 06:00:05 R20 Stream 2 Enable = OFF  
19/03/30 06:00:15 R21 Zero Enable = ON  
19/03/30 06:00:20 R2 Run = ON  
19/03/30 06:02:35 R2 Run = OFF  
19/03/30 06:03:05 R21 Zero Enable = OFF  
19/03/30 06:03:15 R19 Stream 1 Enable = ON  
19/03/30 06:03:20 R2 Run = ON  
19/03/30 06:05:33 R2 Run = OFF  
19/03/30 06:06:05 R19 Stream 1 Enable = OFF  
19/03/30 06:06:15 R20 Stream 2 Enable = ON  
19/03/30 06:06:20 R2 Run = ON  
19/03/30 06:08:33 R2 Run = OFF  
19/03/30 06:09:05 R20 Stream 2 Enable = OFF  
19/03/30 06:09:16 R21 Zero Enable = ON  
19/03/30 06:09:20 R2 Run = ON  
19/03/30 06:11:34 R2 Run = OFF  
19/03/30 06:12:06 R21 Zero Enable = OFF  
19/03/30 06:12:16 R19 Stream 1 Enable = ON  
19/03/30 06:12:21 R2 Run = ON


*This sample log is taken from an Analyzer that is totally controlled by a PLC. As seen in this sample log, the PLC stops the analysis at the end of every cycle (R00002 = OFF), actuates one of registers R00019, R00020 or R00021 (selects stream to run), and then re-starts the analysis (R00002 = ON).*



## Section 5.2 Main program Features

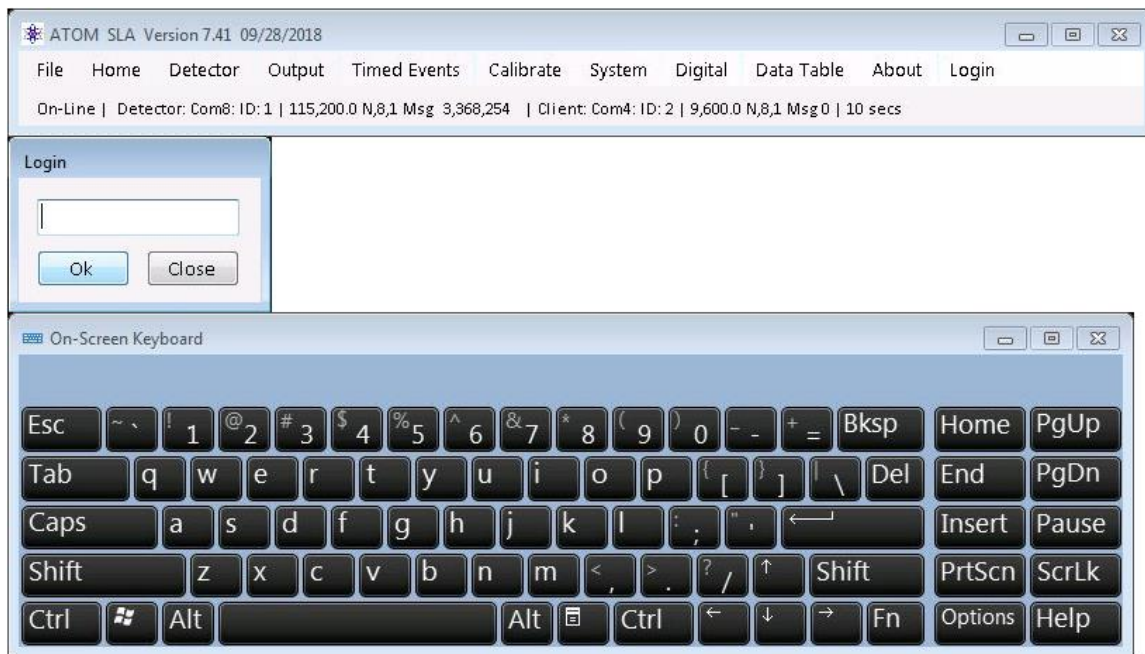
The main program comes with certain features that are not accessible through the GUI. Among the main ones, they provide the user with extended and user-selectable data logging, fully accessible Modbus map to verify DCS data validity, and ability to program MFC addresses.

### Section 5.2.1 Accessing the menus - Login

 **Caution:** Accessing these menus gives user the ability, to change Temperature and Mass Flow Controller settings (among others). Any un-authorized changes to these settings could result in erroneous results and/or damage to the Analyzer.

In order to access all the features, the user will need to login using a password that is independent of the GUI. (Please check with your supervisor for login privileges.)

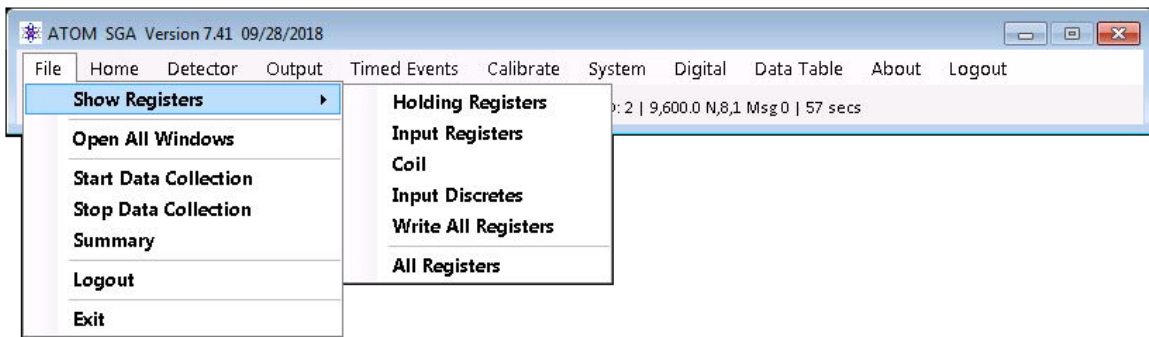
On the program, click on "Login" as shown below in Figure below. Enter the login password using the On-Screen Keyboard and click OK.



Once login is successful user will be able to make changes to Analyzer menus.

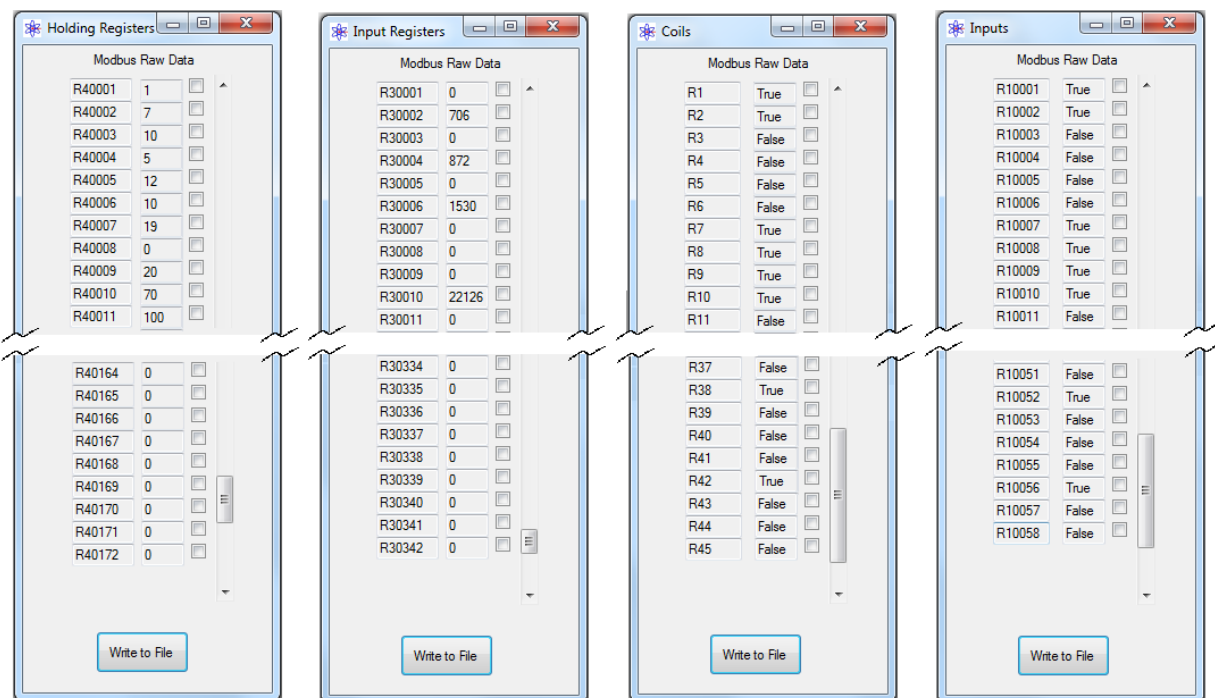
### Section 5.2.2 Accessing the Modbus Map

On the program, click on "File" and "Show Registers" as shown below in Figure below.



By individually selecting the Holding, Input, Coil, or Input Discrete registers will bring up the entire table of the corresponding Modbus registers with the updated current value in unsigned integer format.

Selecting "All Registers" will simultaneously bring up all 4 Modbus tables.



## Interpreting the Modbus Data

The Modbus data for Holding and Input Registers is either stored in a single 16-bit register or in a 16-bit register pair.

The data in the single 16-bit register is read as-is. To interpret the data in the register pair, apply the following math to the two registers:

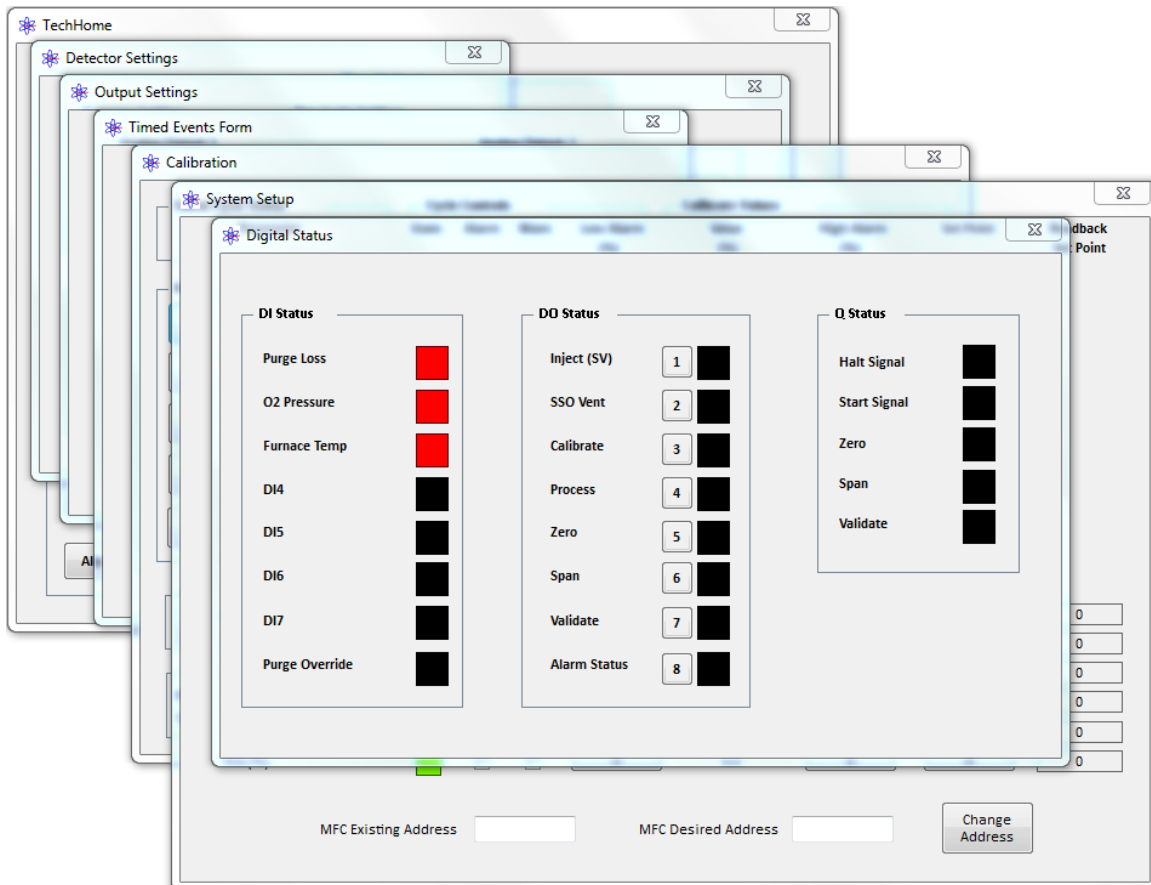
(Higher order 16-bit register X 65536) + (Lower order 16-bit register)

For example, in the register pair R30001-02, R30001 is the higher order 16-bit register, and R30002 is the Lower order 16-bit register.

The Input and Coil registers are single bit registers and can only have one of two states: True=1, False=0.

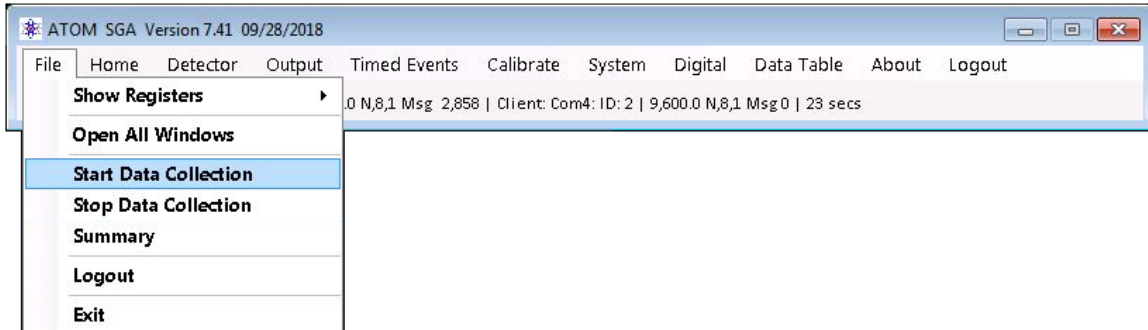
## Section 5.2.3 Open All Windows

Clicking on "File" and "Open All Windows" will pull up and cascade all menus.

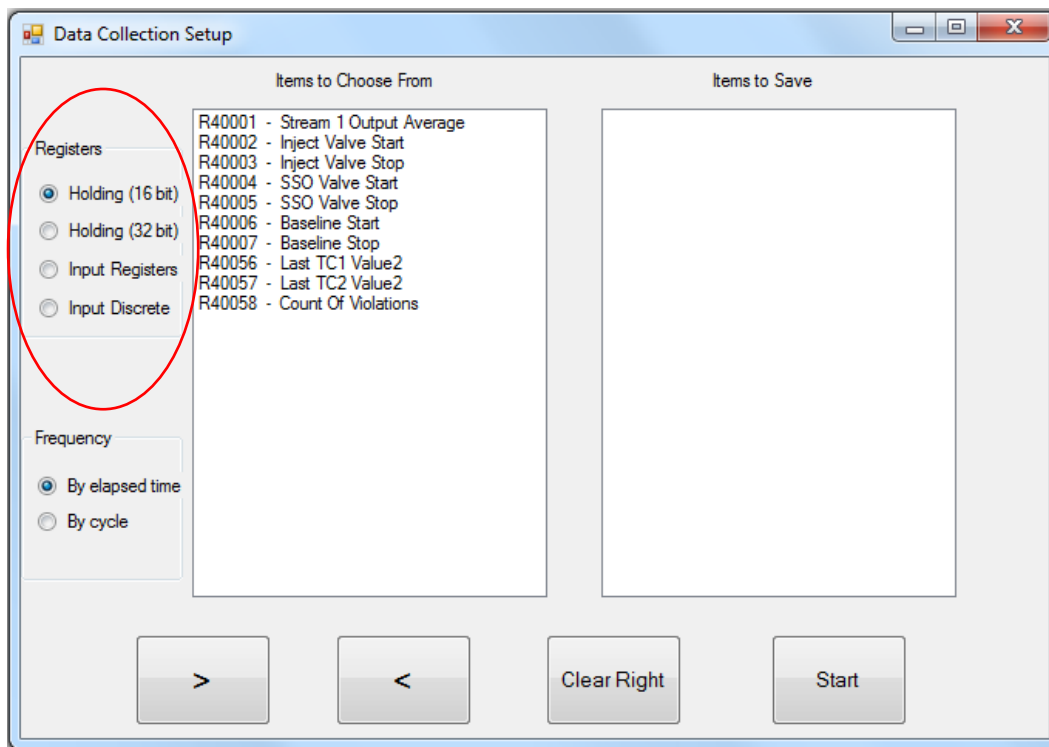


## Section 5.2.4 Extended Data Logging

On the program, clicking on "File", and then "Start Data Collection" opens a dialog window.



This window lets user select parameters to log.



From the list of Registers in the left side pane, select the parameters you wish to log. Then click on the ">" button to transfer the parameter to the "Items to Save" pane on the right. When you are done with the selections, click "Start". This will start data logging to the "DataCollection.txt" file located at C:\ATOM!\ directory. The data can be set to log every second (By elapsed time), or at the end of every cycle (By cycle). This selection applies to ALL selected parameters and cannot be set for individual parameters.

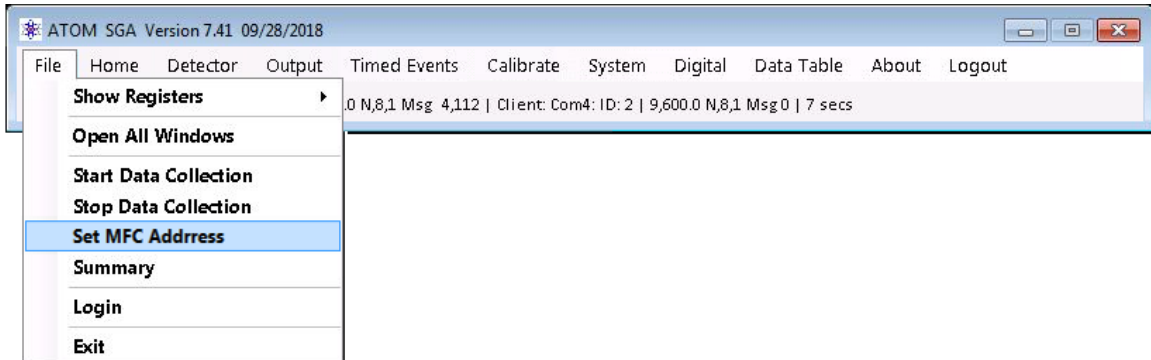
Clicking "Clear Right" will clear all current selections and you can start over.


The data logging can be stopped by clicking on "File" and then "Stop Data Collection" on the program.

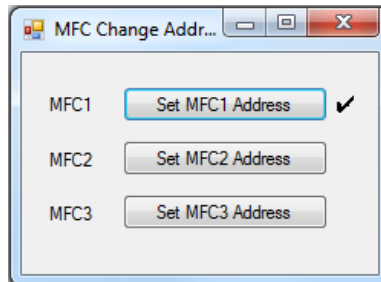
## Section 5.2.5 Replacing a MFC and programming the correct address

Depending upon the application, the online Analyzer may consist of up to 3 MFCs. This option enables users to install a new MFC and program it to the required address with a single click of a button (**Note**: this option will only work if the default MFC address = 0).

Install the new MFC, connect the communication cable to the **single MFC** whose address needs to be programmed. **Disconnect** all other MFCs, if present. On the program, click on "File" and "Set MFC Address" as shown below.



For example, if MFC1 has been replaced, in the dialog box click on "Set MFC1 Address". The program will automatically set the MFC1 address to 11. A "✓" indicates that programming was complete. Click on the  to close the dialog box.



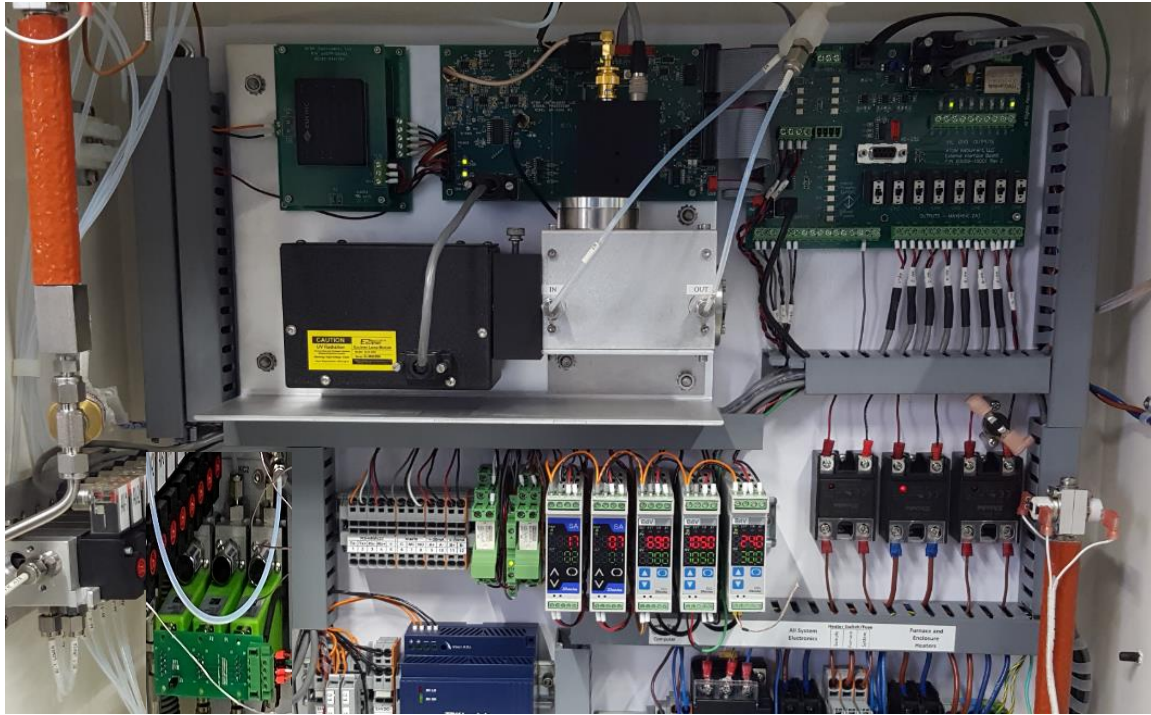
**Note:** For applications that also contain MFC2 and/or MFC3, their respective addresses will be automatically programmed to 12 and 13.

## Section 5.2.6 Changing MFC addresses

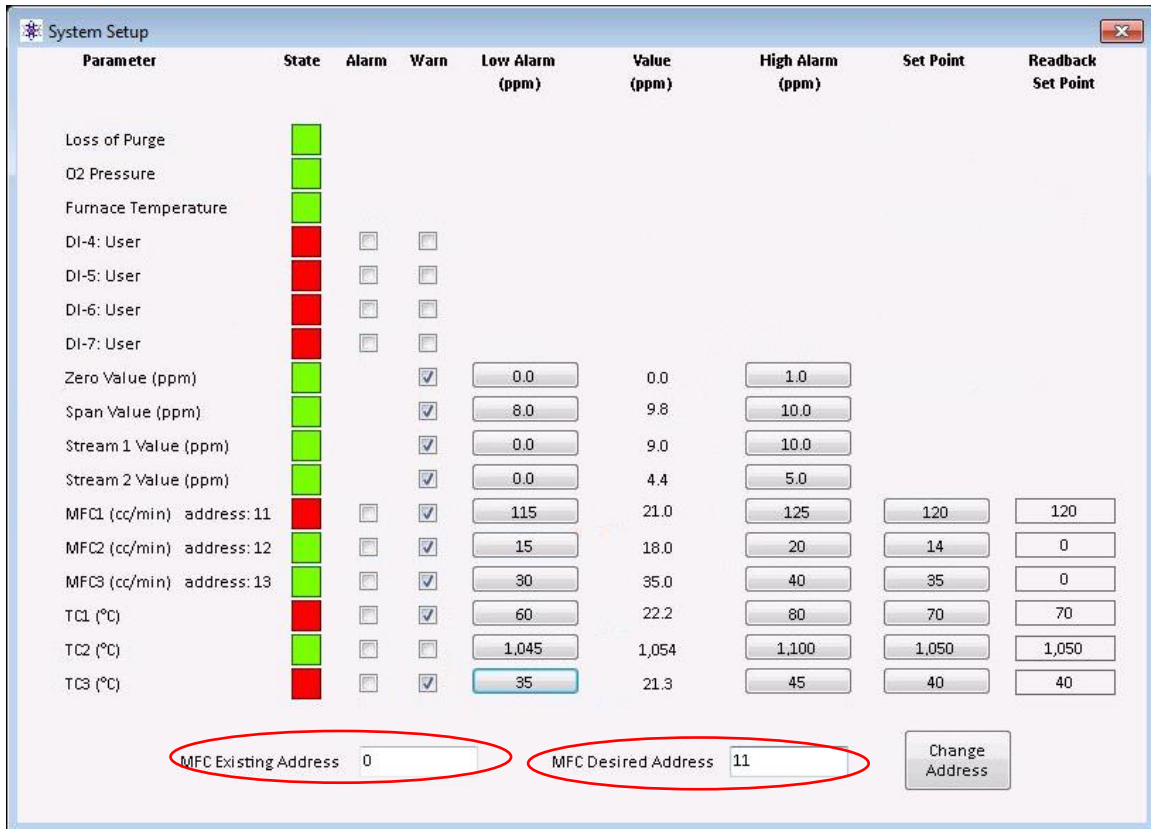
In addition to programming addresses for new MFCs, it is also possible to re-program a MFC address provided that its' current address is known.

This utility can be accessed in the program's System Setup window.

To begin, if multiple MFCs are installed, disconnect all MFC communication cables except to the MFC whose address needs to be changed.



On the program, click on "System", and the System Settings window will open as shown below.



In the "MFC Existing Address" textbox, enter "0" (or the current address of the MFC). In the "MFC Desired Address" textbox enter the desired MFC address – typically 11, 12, or 13. Click on "Change Address". The MFC will now be programmed to the new address. Re-connect all the MFC communication cables to resume normal Analyzer operation.

## Section 5.2.7 Changing the MFC and TC Set Points

On the program, click on "System", and the System Settings window will open as shown below.



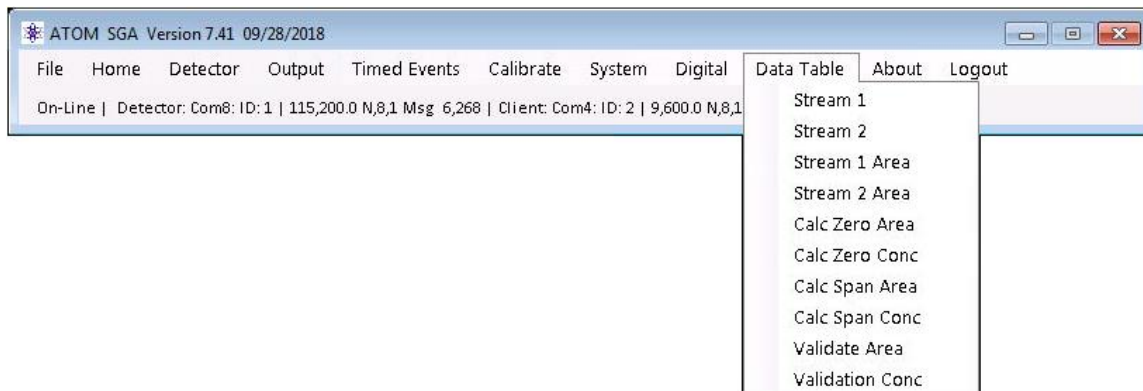
Click on the device's button whose set point you wish to change. In the dialog box that opens enter the new Set point and click OK. Once the new set point is accepted by the device (MFC or TC), the new set point is read back by the program and displayed in the "Readback Set Point" text box.





## Section 5.2.8 Data Display

On the program, click on "Data Table" as shown below.



The drop-down menu to select the process (stream) or calibration results as shown below.

Process Streams data tables:

ATOM <span>Σ</span>		ATOM <span>Σ</span>	
Stream 1 Area		Stream 2 Area	
1	304,454,485	1	163,404,901
2	305,249,308	2	164,445,409
3	304,079,711	3	162,465,552
4	305,249,308	4	160,872,665
5	304,079,711	5	161,707,102
6	301,361,762	6	162,465,552
7	302,353,102	7	160,872,665
8	300,835,149	8	161,707,102
9	301,361,762	9	161,338,539
10	302,353,102	10	161,772,267
Stream 1 Monitor (ppm)		Stream 2 Monitor (ppm)	
1	9.0	1	4.5
2	9.1	2	4.5
3	9.0	3	4.4
4	9.1	4	4.4
5	9.0	5	4.4
6	8.9	6	4.4
7	9.0	7	4.4
8	8.9	8	4.4
9	8.9	9	4.4
10	9.0	10	4.4
Avg 9.0		Avg 4.5	
Avg Value <input type="text" value="1"/>		Avg Value <input type="text" value="1"/>	

Calibration data tables:

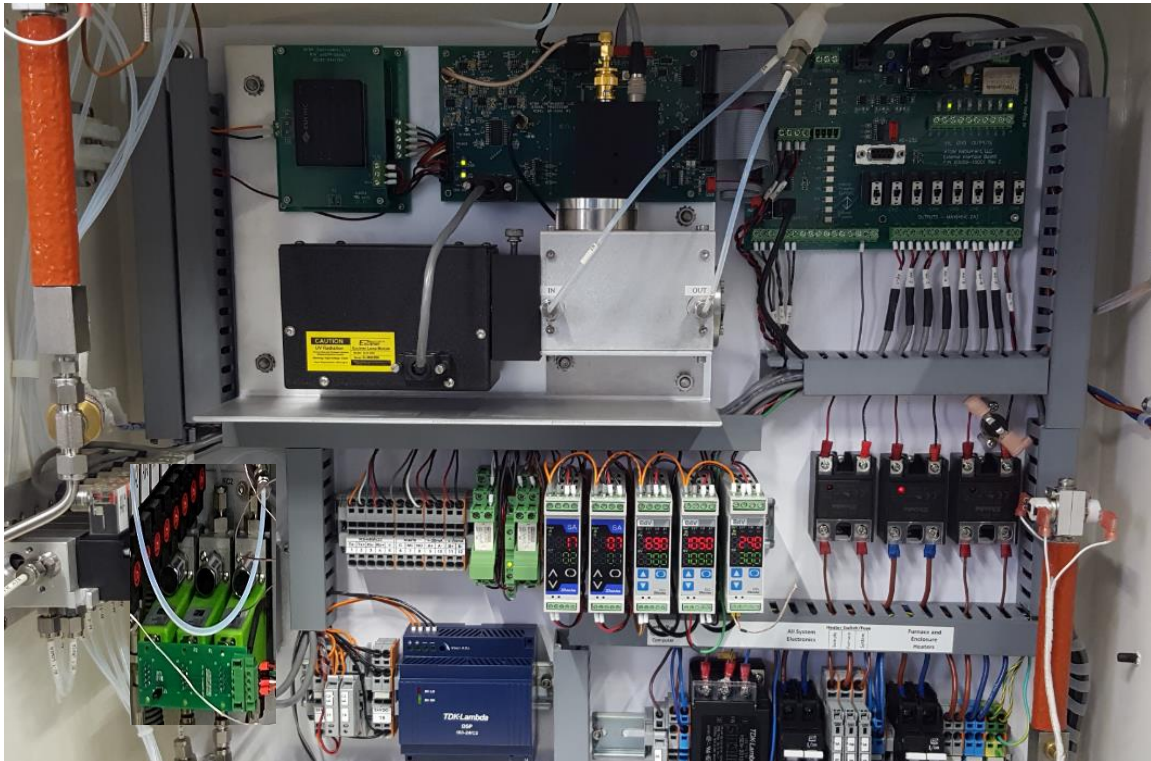
ATOM	ATOM	ATOM
Calculate Zero Area	Calculate Span Area	Validate Area
1 433,441	1 302,349,282	1 0
2 457,969	2 301,357,942	2 0
3 439,516	3 304,075,891	3 0
4 477,067	4 305,245,488	4 0
5 433,441	5 304,450,685	5 0
6 0	6 0	6 0
7 0	7 0	7 0
8 0	8 0	8 0
9 0	9 0	9 0
10 0	10 0	10 0
Avg 448,286	Avg 303,495,853	Avg 0
Calculate Zero Conc (ppm)	Calculate Span Conc (ppm)	Validate Conc (ppm)
1 0.0	1 9.8	1 0.0
2 0.0	2 9.7	2 0.0
3 0.0	3 9.8	3 0.0
4 0.0	4 9.9	4 0.0
5 0.0	5 9.8	5 0.0
6 0.0	6 0.0	6 0.0
7 0.0	7 0.0	7 0.0
8 0.0	8 0.0	8 0.0
9 0.0	9 0.0	9 0.0
10 0.0	10 0.0	10 0.0
Avg 0.0	Avg 9.8	Avg 0.0

## Section 5.2.8 Replacing a MFC and programming the correct address

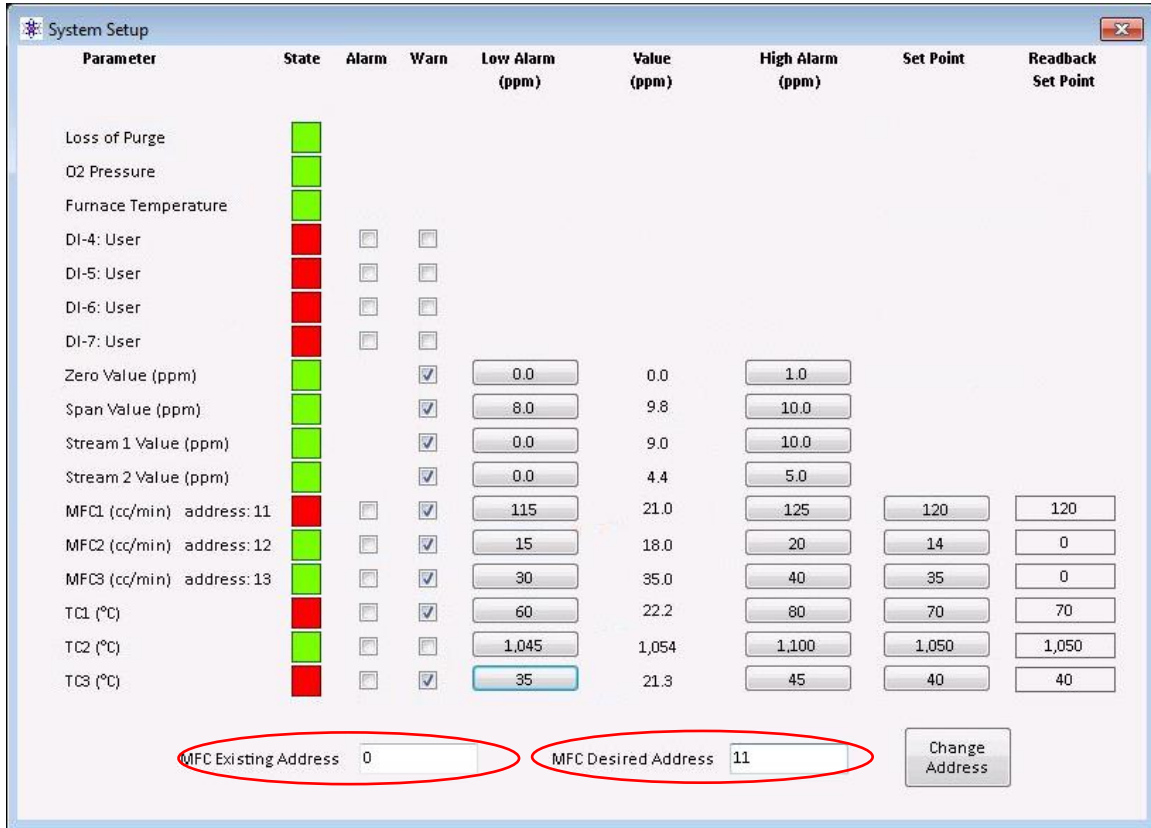
A new MFC is shipped out with a default internal address "0". If a MFC is replaced, then depending upon the application, the MFC address needs to be programmed.

This programming capability can be accessed in the program's System Settings window.

To begin, in the Analyzer's Main/Electronics enclosure replace the desired MFC. If multiple MFCs are installed, disconnect all MFC communication cables except the one to the newly replaced MFC.



On the program, click on "System", and the System Settings window will open as shown below.



In the "MFC Existing Address" textbox, enter "0" (default MFC address when shipped from factory). In the "MFC Desired Address" textbox enter the desired MFC address – typically 11, 12, or 13. Click on "Change Address". The MFC will now be programmed to the new address. Re-connect all the MFC communication cables to resume normal Analyzer operation.

The described procedure can also be used to change the MFC address to a new value if the current MFC address is known.

# Section 6 – Postscript

## Section 6.1 Procedure to Auto-Tune Temperature Controller



Whenever the thermocouple is replaced, the Temperature Controller needs to be “Auto-Tuned” for optimal performance. This is an automatic procedure which sets the PID control parameters that the Temperature Controller uses to maintain the “set” temperature value.

### Before beginning the Auto-Tuning procedure:


- Install the new thermocouple (verify that the **polarity** is correct)
- For proper Auto-Tuning, the furnace temperature must be cooled to less than 90% of the set point value (for a Set Point of 1050°C, less than 940 °C)
- Verify that the Furnace breaker is switched ON
- Verify that the Analyzer is in “**Purge Override**” (otherwise power to the furnace will remain disabled)

### Begin:




Press the  key while holding down the  key and the Temperature Controller reads “AT” and the first line and “----” on the second line.



Press the  key and both the top and bottom line on the Temperature Controller will read “AT”.



Press the  key to start the “Auto-Tune” procedure. The “AT” indicator will begin to flash ON and OFF, and the furnace temperature will begin to increase indicating that the Auto-Tune procedure is in progress.

Once the procedure is complete, the “AT” indicator will automatically turn OFF, and the optimized PID values should maintain the furnace at its set temperature.

**\*\*Note :** During the Auto-tuning procedure it is normal for the furnace temperature to briefly over-shoot the set temperature value.

## Section 6.2 Calibration/Validation Procedure

The Calibrate settings screen is where all information regarding instrument calibration and associated calibration results are displayed.

To access this screen press **Settings > Calibrate Settings**

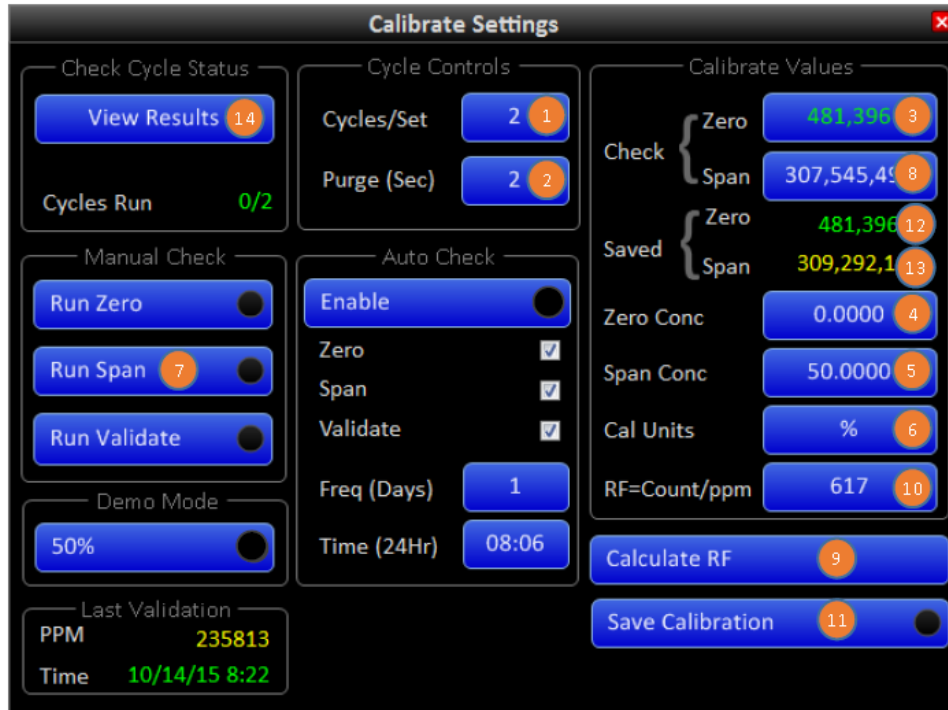


Figure 1.1 – Calibrate Settings Screen

### Manual Calibration:

#### Settings

1. **Cycles/set** ①: Set this to 5.
2. **Purge (Sec)** ②: Set this to 60.
3. **Check Zero** ③: Set this to 0 (zero).
4. **Zero Conc** ④: Set this to 0 (Zero).
5. **Span Conc** ⑤: Set this to SO<sub>2</sub> concentration in the span/cal standard.
6. **Cal Units** ⑥: Select unit based on the format of the value entered in **Span Conc**.

#### Procedure

1. Select **Run Span** ⑦. After 5 cycles of Span is completed, value in **Check Span** ⑧ will get updated.
2. Select **Calculate RF** ⑨. Wait for the value to get updated in **RF=Count/ppm** ⑩.
3. Select **Save Calibration** ⑪ after the indicator on this button turns green.
4. Values in **Saved Zero** ⑫ and **Saved Span** ⑬ will get updated and will be same as ③ & ⑧.

### Manual Validation:

## Settings

1. Keep all the settings same as in Manual calibration.

## Procedure

1. Select **Run Span** ⑦.
2. Select **View Results** ⑭. Screen **Check Calibration Results** will open.



Run	Zero		Span	
	Area	Conc ppm	Area	Conc ppm
1	433,441	0.0	302,349,282	9.8
2	457,969	0.0	301,357,942	9.7
3	439,516	0.0	304,075,891	9.8
4	477,067	0.0	305,245,488	9.9
5	433,441	0.0	304,450,665	9.8
6				
7				
8				
9				
10				
<b>Average</b>	<b>448,286</b>	<b>0.0</b>	<b>303,495,853</b>	<b>9.8</b>

*Figure 1.2 – Check Calibration Results Screen*

3. After 5 cycles are completed the value at ⑮ should be value of SO<sub>2</sub> concentration in span/cal standard.



## Section 6.2 Control circuit for X purge

### Alarm Signal Installation:



**NOTE:** The *CYCLOPS X – Purge Controller, SM Version* provides dry alarm contact(s) for use by the customer. For hook-up and use the alarm contact(s) provided by the purge controller, consult the following Alarm Source Specifications, Alarm Connection table, and Wiring Diagram drawing numbers DO-50007-A, page 75 for 115VAC unit and DO-50008-A, page 76 for 230VAC unit.

<b>Alarm Source Specifications</b>
Alarm Contact is rated for 265Volts AC/DC, 150mA max.
Use up to 20 AWG two conductor copper or tin-plated copper power wire rated for at least 300 V at the required length.

<b>Alarm Connections</b>	
<b>ALARM TERMINAL</b>	<b>TERMINAL NUMBER</b>
Loss of Purge Pressure: Open on Alarm (Standard). Closed on Alarm (Optional). Closed (Standard) Open (Optional) when pressure in enclosure being monitored is at or above 0.50 inch H <sub>2</sub> O (1.25 mbar) Standard, 0.30 inch H <sub>2</sub> O (0.75 mbar) Optional	Terminal Block – 2 Position – 1
Return for position one	Terminal Block – 2 Position – 2
Loss of Exhaust Flow: Open on Alarm (Standard). Closed on Alarm (Optional). Closed (Standard) Open (Optional) when flow of exhaust for enclosure being monitored has fallen below a safe level.	Terminal Block – 2 Position – 3
Return for position three	Terminal Block – 2 Position – 4
Maintenance Alarm and By-Pass Mode: Open on Alarm (Standard). Closed on Alarm (Optional). Open (Standard) Closed (Optional) when maintenance switch or by-pass switch is operated.	Terminal Block – 2 Position – 5
Return for position five	Terminal Block – 2 Position – 6

<b>(Normal Operation Mode) Alarm Matrix</b>			
<b>ALARM</b>	<b>VISUAL INDICATION</b>	<b>REMOTE INDICATION</b>	<b>POWER DISCONNECTED</b>
Purge pressure goes below 0.50 inch H <sub>2</sub> O (1.25 mbar) Standard, 0.30 inch H <sub>2</sub> O (0.75 mbar) Optional	Steady State, Red LED	Yes, when installed	Yes
Exhaust vent flow drops below safe level	Steady State, Red LED	Yes, when installed	Yes
Maintenance Switch turned to Over-Ride	Blinking, Red LED	Yes, when installed	No
During Purge Dilution Cycle Time	Blinking, Green LED	No	Yes
Normal Operation	Steady State, Green LED	No	No

<b>(Power Disconnect By-Pass Switch Mode) Alarm Matrix</b>			
<b>ALARM</b>	<b>VISUAL INDICATION</b>	<b>REMOTE INDICATION</b>	<b>POWER DISCONNECTED</b>
Purge pressure goes below 0.50 inch H <sub>2</sub> O (1.25 mbar) Standard, 0.30 inch H <sub>2</sub> O (0.75 mbar) Optional	Steady State, Red LED	Yes, when installed	No
Exhaust vent flow drops below safe level	Steady State, Red LED	Yes, when installed	No
Maintenance Switch turned to Over-Ride	Blinking, Red LED	Yes, when installed	No
During Purge Dilution Cycle Time	Blinking, Green LED	No	Yes
Normal Operation	Steady State, Green and Blinking Red LED.	Yes, when installed	No