

INSTRUCTION, OPERATING AND MAINTENANCE MANUAL FOR

GC-PRO FID



P/N M82956
DATE 3/28/13



DANGER



Toxic and/or flammable gases or liquids may be present in this monitoring system. Personal protective equipment may be required when servicing this instrument. Hazardous voltages exist on certain components internally which may persist for a time even after the power is turned off and disconnected. Only authorized personnel should conduct maintenance and/or servicing. Before conducting any maintenance or servicing, consult with authorized supervisor/manager.

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This instrument provides measurement readings to its user, and serves as a tool by which valuable data can be gathered. The information provided by the instrument may assist the user in eliminating potential hazards caused by his process; however, it is essential that all personnel involved in the use of the instrument or its interface be properly trained in the process being measured, as well as all instrumentation related to it.

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Safety Messages

Your safety and the safety of others are very important. We have provided many important safety messages in this manual. Please read these messages carefully.

A safety message alerts you to potential hazards that could hurt you or others. Each safety message is associated with a safety alert symbol. These symbols are found in the manual and inside the instrument. The definition of these symbols is described below:



GENERAL WARNING/CAUTION: Refer to the instructions for details on the specific danger. These cautions warn of specific procedures which if not followed could cause bodily Injury and/or damage the instrument.



CAUTION: HOT SURFACE WARNING: This warning is specific to heated components within the instrument. Failure to heed the warning could result in serious burns to skin and underlying tissue.



WARNING: ELECTRICAL SHOCK HAZARD: Dangerous voltages appear within this instrument. This warning is specific to an electrical hazard existing at or nearby the component or procedure under discussion. Failure to heed this warning could result in injury and/or death from electrocution.



Technician Symbol: All operations marked with this symbol are to be performed by qualified maintenance personnel only.

No
Symbol

NOTE: Additional information and comments regarding a specific component or procedure are highlighted in the form of a note.



STAND-BY: This symbol indicates that the instrument is on Stand-by but circuits are active.

CAUTION: THE ANALYZER SHOULD ONLY BE USED FOR THE PURPOSE AND IN THE MANNER DESCRIBED IN THIS MANUAL.



IF YOU USE THE ANALYZER IN A MANNER OTHER THAN THAT FOR WHICH IT WAS INTENDED, UNPREDICTABLE BEHAVIOR COULD RESULT POSSIBLY ACCOMPANIED WITH HAZARDOUS CONSEQUENCES.

This manual provides information designed to guide you through the installation, calibration and operation of your new analyzer. Please read this manual and keep it available.

Occasionally, some instruments are customized for a particular application or features and/or options added per customer requests. Please check the front of this manual for any additional information in the form of an Addendum which discusses specific information, procedures, cautions and warnings that may be specific to your instrument.

Manuals do get misplaced. Additional manuals can be obtained from Teledyne at the address given in the Appendix. Some of our manuals are available in electronic form via the internet. Please visit our website at: www.teledyne-ai.com.

Additional Safety Information



This is a general purpose instrument designed for use in a non-hazardous area. It is the customer's responsibility to ensure safety especially when combustible gases are being analyzed since the potential of gas leaks always exist.

The customer should ensure that the principles of operating of this equipment are well understood by the user. Misuse of this product in any manner, tampering with its components, or unauthorized substitution of any component may adversely affect the safety of this instrument.

Since the use of this instrument is beyond the control of Teledyne, no responsibility by Teledyne, its affiliates, and agents for damage or injury from misuse or neglect of this equipment is implied or assumed.

  **WARNING: HYDROGEN GAS IS USED IN THIS INSTRUMENT AS A FUEL. HYDROGEN IS EXTREMELY FLAMMABLE. EXTREME CARE MUST BE USED WHEN WORKING AROUND GAS MIXTURES CONTAINING FLAMMABLE GASES.**

A successful leak check was performed at TAI on the sample system of this instrument prior to calibration, testing and shipping. Ensure that there are no leaks in the fuel supply lines before applying power to the system.

Always purge the entire system before performing any maintenance and always leak check the system after removing any tubing or fittings on the sample system. See the procedures for purging and leak checking this instrument on the following pages.

If toxic gases or other hazardous materials are introduced into the sample system, the same precautions regarding leak checking and purging apply to the sample lines and sample supply or delivery lines.

WARNING:

ELECTRICAL SHOCK HAZARD.
WITH THE EXCEPTION OF OPENING THE DOOR AND ADJUSTING THE PRESSURE REGULATORS, FLOW CONTROLLER, OR OBSERVING THE PRESSURE GAUGES AND THE FLOWMETER, ONLY AUTHORIZED AND SUITABLY TRAINED PERSONNEL SHOULD PERFORM WORK INSIDE OF THE INSTRUMENT. COMPONENTS WITHIN THE COVER ON THE INSIDE OF THE DOOR, INSIDE THE ISOTHERMAL CHAMBER (SAMPLE SYSTEM), AND ON THE ELECTROMETER-AMPLIFIER PC BOARD CONTAIN DANGEROUSLY HIGH VOLTAGE SUFFICIENT TO CAUSE SERIOUS INJURY OR DEATH.

There are the following three types of inaccessible shock hazards within the Analyzer:

- 1. Line voltages and line related voltages such as 115 VAC which exists within the 230 VAC versions as well. These voltages stop when the Analyzer is turned off and the mains (line) cord is removed from the instrument.*
- 2. The sensor anode supply voltage (approximately 250 VDC). This voltage exists on the Flame Guard, anode power supply, PCB, the motherboard, and the anode/igniter terminals on the sensor. THIS VOLTAGE WILL REMAIN HAZARDOUS FOR MANY MINUTES AFTER THE ANALYZER HAS BEEN TURNED OFF!*

3. *External hazardous voltages which may be connected to the Analyzer alarm relay connections.*

Procedure for Removal of Internal Inaccessible Shock Hazards



CAUTION: **SERVICING OR MAINTENANCE OF THE ANALYZER SHOULD ONLY BE DONE BY SUITABLE TRAINED PERSONNEL. TO AVOID THESE INACCESSIBLE HAZARDOUS VOLTAGES WHEN SERVICING THE GC-PRO FID, PERFORM EACH OF THE FOLLOWING STEPS, IN THE ORDER GIVEN, BEFORE SERVICING BEGINS:**

1. Switch off the power to the Analyzer and remove the main (line) power cord from the Analyzer.
2. Remove all external voltages from the connections to the alarm contacts.
3. Wait one minute.
4. Discharge the anode supply voltage.
 - a. Connect one end of an insulated (to 1000 VDC or more) clip lead to Analyzer chassis ground (the standoff for the upper right corner of the mother PCB).
 - b. Put one end of a 500V rated 1000 ohm resistor in the other end of the clip lead.
 - c. Check the voltage between chassis ground (the standoff for the upper right corner of the mother PCB) and the top side of R2 at PCB number B74671. It should be between -5VDC and +5VDC. If is in that range, the inaccessible hazardous voltage removal procedure is completed, if not repeat steps 4.a and 4.b.

If it is absolutely necessary to work inside the instrument with power on, use the ONE HAND RULE:

Work with one hand only.

Keep the other hand free without contacting any other object. This reduces the possibility of a ground path through the body in case of accidental contact with hazardous voltages.

WARNING:

THIS INSTRUMENT IS DESIGNED TO BE OPERATED IN A NONHAZARDOUS AREA. THE ANALYZER USES HYDROGEN GAS AND/OR OTHER COMBUSTIBLE GASES IN ITS OPERATION. THIS EQUIPMENT, IF NOT USED AND MAINTAINED PROPERLY CAN BE AN EXPLOSION HAZARD. THE ANALYZER, DEPENDING ON THE APPLICATION, MAY ALSO USE TOXIC GASES. IT IS THEREFORE, THE CUSTOMER'S RESPONSIBILITY TO ENSURE THAT PROPER TRAINING AND UNDERSTANDING OF THE PRINCIPLES OF OPERATION OF THIS EQUIPMENT ARE UNDERSTOOD BY THE USER. SINCE THE USE OF THIS INSTRUMENT IS BEYOND THE CONTROL OF TELEDYNE, NO RESPONSIBILITY BY TELEDYNE, ITS AFFILIATES AND AGENTS FOR DAMAGE OR INJURY RESULTING FROM MISUSE OR NEGLIGENCE OF THIS INSTRUMENT IS IMPLIED OR ASSUMED. MISUSE OF THIS PRODUCT IN ANY MANNER, TAMPERING WITH ITS COMPONENTS OR UNAUTHORIZED SUBSTITUTION OF ANY COMPONENT MAY ADVERSELY AFFECT THE SAFETY OF THIS INSTRUMENT.

CAUTION:

WHEN OPERATING THIS INSTRUMENT, THE DOORS MUST BE CLOSED AND ALL COVERS SECURELY FASTENED. THE GAUGES MUST BE IN PROPER WORKING ORDER. DO NOT OVERPRESSURIZE THE SYSTEM.

READ THIS MANUAL BEFORE OPERATING THE INSTRUMENT AND ADHERE TO ALL WARNINGS INCLUDED IN THIS MANUAL.

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Introduction

The GC-Pro FID Analyzer is a microprocessor controlled digital instrument incorporating a Flame Ionization Detector (FID) coupled with a gas separation column and switching valve designed to measure the quantity of aromatic hydrocarbons present in a positive pressure sample gas. Up to 8 channels of output are present for measuring specific analytes in a sample stream. Unlike other benzene or hydrocarbon analyzers, the GC-Pro FID Analyzer expands its diagnostic capabilities to look for other aromatics, like toluene, ethyl benzene, xylenes and other separable species. The GC-Pro FID Analyzer has multiple channels for measurement with enhanced versatility and capabilities. Due to its flexibility, it is vitally important that you refer to Appendix C for the specific factory setup for your application.

The GC-Pro FID features a modern user interface with a touch screen front panel facilitating operation, calibration, data collection and display. With the Ethernet connectivity feature, this new interface allows the instrument to be operated remotely with a VNC software application from another digital device whereby the analyzer can be accessed, controlled, data displayed etc. as if the analyzer were physically present.

Although the analyzer arrives already setup for your specific application, a gas chromatograph mode allows the user to program the instrument for measuring different species present in the sample.

1.1 Main Features of the Analyzer

The GC-Pro FID Analyzer is sophisticated yet simple to use. A touch screen display on the front panel provides access all phases of setup, calibration, operation, and troubleshooting on the GC-Pro FID.

The main features of the analyzer include:

- Data acquisition and control functions supporting:
 - Pressure measurements, 5-Channels
 - Flow (MFC) measurements, 3-Channels
 - Oxygen measurements, 6-Channels



- Temperature measurements and control, 4-Channels
- 6-Channel Dew point Hygrometer measurements, 6-Channel
- Relay, (10) and solenoid outputs, (4)
- Alarm, (3) and over range indication outputs, (4)
- 4-20mA current loop outputs, 10 channels
- HMI through Maple touch sensitive display
- The system operates at single phase AC, 110 or 220V 50/60 Hz.
- High resolution, accurate readings of concentration.
- Versatile analysis with three user-definable analysis ranges.
- Microprocessor based electronics: 8-bit CMOS microprocessor with 32 kB RAM and 128 kB ROM.
- Auto ranging allows analyzer to automatically select the proper preset range for a given measurement. Manual override allows the user to lock onto a specific range of interest.
- Two adjustable concentration alarms and a system failure alarm.
- Extensive self-diagnostic testing at startup and on demand with continuous power supply monitoring.
- RS-232 serial digital port for use with a computer or other digital communication device.
- 8-Analog outputs for concentration and range identification (0-1 VDC standard and isolated 4-20 mA dc).
- Superior Accuracy

1.2 Principle of Operation

The analyzer uses a gas separation column to separate the component of interest, for instance, benzene, from the other hydrocarbons in the sample gas. Using a carrier gas and a microprocessor actuated switching valve, the eluted gas is analyzed in



Flame Ionization Detector (FID) and the column is back flushed to accept the fresh sample for the next cycle. More information is provided in Section 2.1 *Introduction*, under *Operational Theory*. The electrical output of the electrometer-amplifier is directly proportional to the concentrations of the ionizable hydrocarbons present over the ranges of interest.

1.3 Analyzer Description

The standard analyzer is a rack mountable instrument designed to fit into a standard 19" instrument rack. The front interface screen is mounted on the left side of the panel. The right side of the panel includes the gas controls, pressure gauges and flowmeter. The front panel is shown in Figure 1-1.

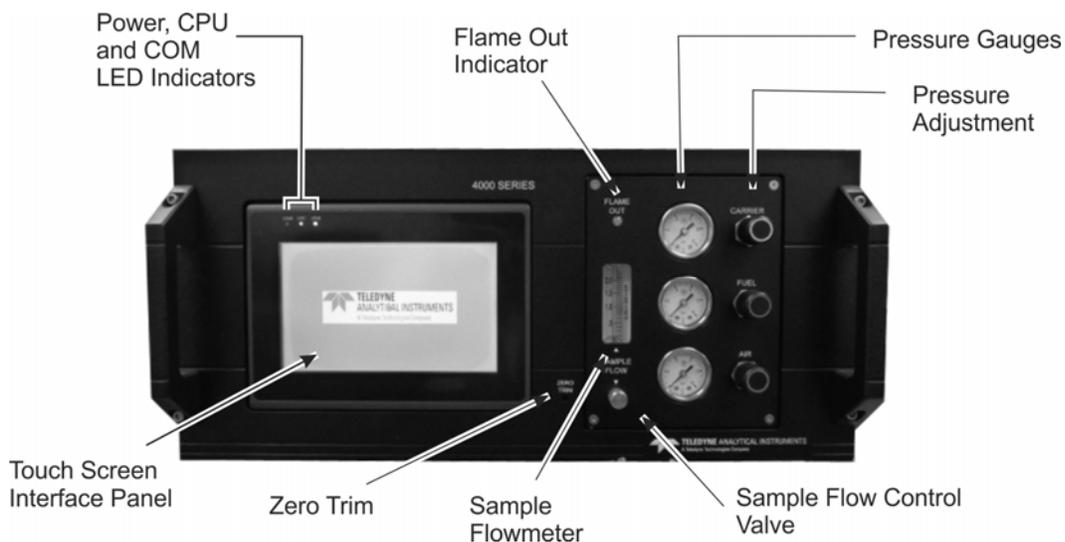


Figure 1-1: GP-Pro Front Panel

Gas pressure gauges and controls are mounted on the front panel adjacent to the touch screen (human/machine interface abbreviated as HMI) display as shown in Figure 1-1.

At the rear of the instrument are ports for the introduction of air, fuel, zero, span, and sample gas as well as vent port connections. Three 50-pin user-interface cable connectors route input/output and alarm signals to external devices. RS232 and a network port are also available

at the rear panel for connection to a remote computer or other digital communication device. Internally, there are two USB user connections which are used for updating firmware to the PCBs. Figure 1-2 shows the rear panel including the user connections for the standard instrument without the auto calibration manifold.

The analyzer is set up for either 120 VAC 60 Hz or 230 50/60 Hz operation depending on the customer's requirements. The appropriate power cord for your unit is included with the analyzer.

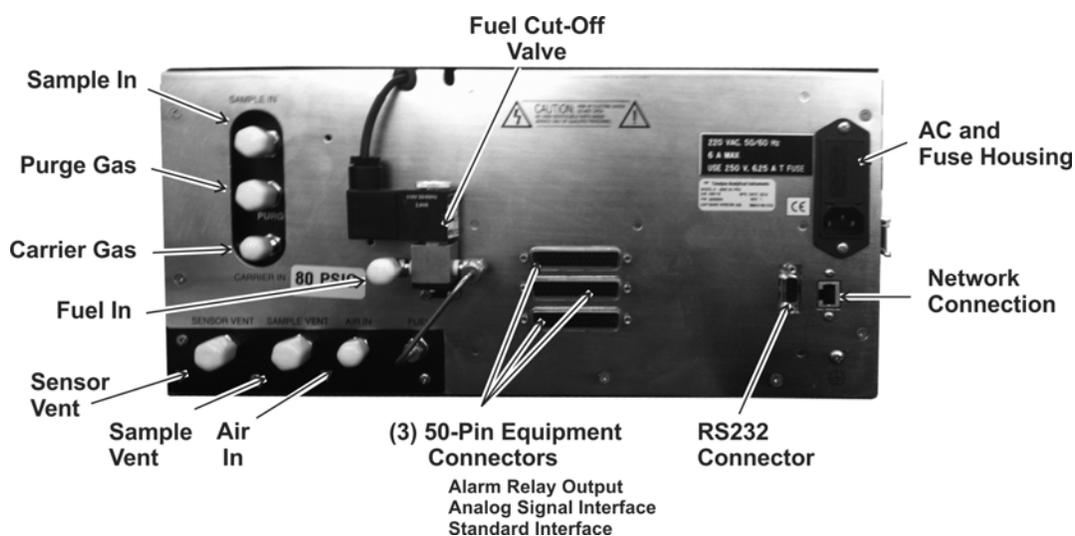


Figure 1-2: GC-Pro FID Rear Panel

Internally, there are three isothermal chambers each separately controlled for precise control and separation of analyzed species. In the electronics section, internal PC boards are stacked in an assembly in an order based on inter connectivity needs between the PCBs as well as their association with other sub assemblies distributed within the system. See Figure 1-3.

Following is the card stack-up from top to bottom planned inside the system

- Heater card
- 9261 controller card

- Analog data acquisition card
- Analog signal conditioning card
- 89C5131 controller card

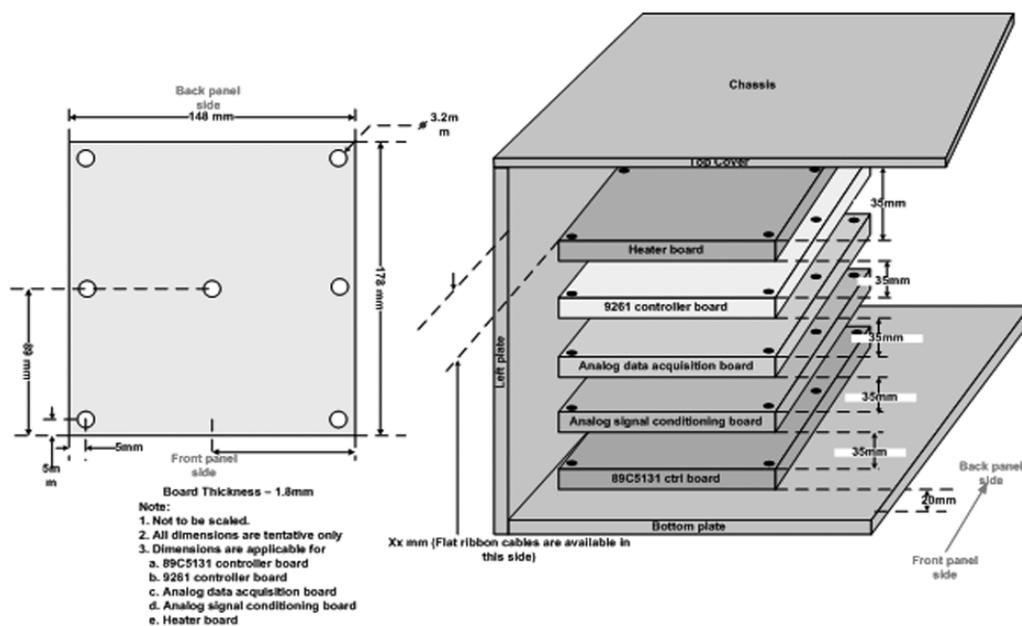


Figure 1-3: Internal PCB Arrangement

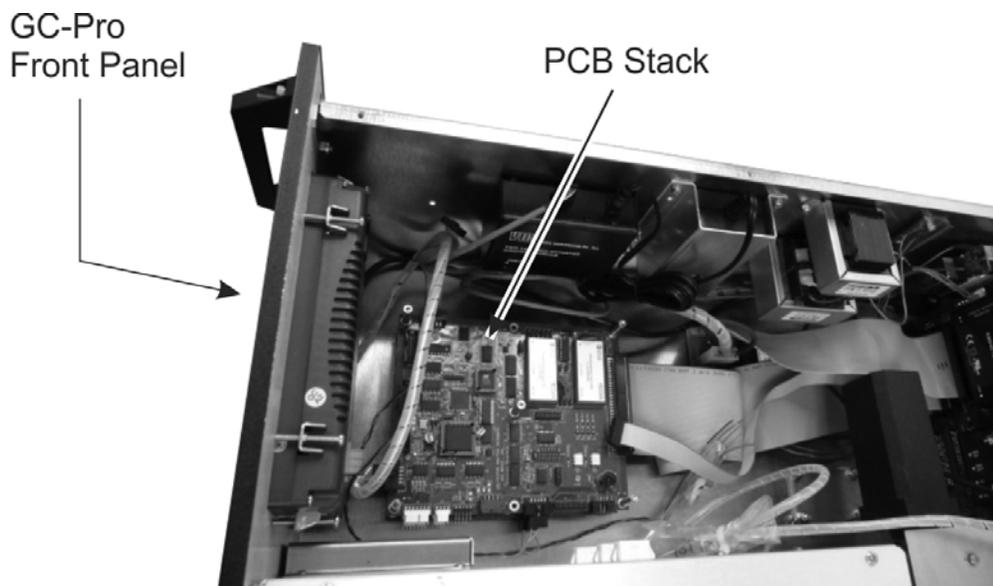


Figure 1-4: GC-Pro FID Internal View

1.4 Applications

- Monitoring the benzene concentration of carbon dioxide gas for use in the beverage industry.
- Monitoring aromatic contamination in air liquefaction and other gas production processes.
- Gas purity certification.
- Detecting trace benzene in ambient air.
- Detecting atmospheric pollutants.

Operational Theory

2.1 Introduction

The GC-Pro FID Analyzer uses a Flame Ionization Detector (FID) and a Gas Chromatograph (GC) Column to separate and analyze different fractions of a volatile hydrocarbon sample. Using a carrier gas and a microprocessor actuated switching valve, a fixed volume of sample is pushed into the Column maintained at a constant temperature. The eluted gas is analyzed for benzene or other specific analyte configured for your specific application in a FID detector and the column is back flushed to accept the fresh sample for the next cycle. Actual separating and detecting sequence may vary depending on compounds of interest in the application for which the analyzer is configured.

The Flame Ionization Detector was selected for use in the GC-Pro FID Analyzer based on the positive performance and extensive experience in the use of this detector in other Teledyne analyzers. The FID has proven itself to be a rugged, stable, long life sensor giving years of trouble free operation in various applications. Also considering the fact that the required sensitivity of 100 ppb full scale was achieved, FID was considered a better choice over the limited life and less reliable Photo Ionization Detector.

A stainless steel packed column containing Chromosorb Diatomite is used at a constant temperature of 70°C. Using nitrogen as a carrier gas and a 5 ml sample loop, benzene elutes from the column within a few minutes. Additionally, a clear separation is observed from other aromatic hydrocarbons, namely toluene, ethyl benzene, and xylenes. The actual temperature setpoint and compound separation for your instrument may be different depending on the application. It is listed in the *Addendum and Testing Results* section of Appendix C.

2.2 Modes of Operation

The analyzer has 2 modes of operation depending on the position of the GC Sampling Valve (See Piping Diagram in Figure 2-2). They are: Sample Mode (position A) and Analysis Mode (position B).

1. Valve Position A—**Sampling Mode**

In this mode the analyzer configures the operational valve to back flush the column and charge the sample loop. The Sample Mode is programmed to continue for a 7 minute period by factory default; however, it is usually modified to match the needs of a particular process. The specific timing interval for your system is listed in the *Addendum and Testing Results* section of Appendix C. It is possible to set the Sample Mode duration up to 25 minutes.

2. Valve Position B—**Analysis Mode**

In this mode the analyzer configures the sampling valve to feed the gas in the sample loop through the column and to the detector. The eluted sample from the column is fed to the FID for the analysis of the compound of interest in the hydrocarbon stream. If configured to do so, the analyzer may read the detector for a programmed 5 second period at some point within this mode cycle to obtain a baseline reading for further calculation. This mode is usually programmed to continue until the compound of interest is fully eluted from the column. It is possible to set it up to 25 minutes.

During the Analysis Mode, a 'Peak Detect' period is programmed at which time the analyzer reads the detector output. The analyzer integrates the peak area during this time in conjunction with the baseline settings to calculate the concentration of the compound of interest. The calculation is performed at the end of the 'Peak Detector' period and the result is displayed at the end of Analysis Mode.

2.3 Analyzer Subsystems

The Model Analyzer is composed of three subsystems:

1. Sample System
2. Detector Cell
3. Electronic Signal Processing, Display and Control



2.3.1 Sample System

All components used to control the sample and supporting gases, as well as the combustion portion of the detector cell, are located inside the analyzer chassis. They are accessible by opening the front door of the analyzer.

Adjustments are made using the appropriate control on the front panel.

The analyzer contains three separate isothermal chambers 'SAMPLE', 'FID', and 'COLUMN' that are controlled by internal temperature control PCBs. The temperature can be monitored and controlled using the touch screen main menu item 'Temperature'. See Figure 2-1 and Section 4.7.7.

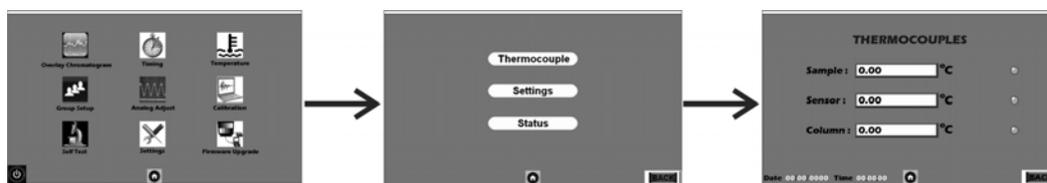


Figure 2-1: Internal Temperature Controller Screens

The sample chamber contains the 10-port GC switching valve and 2 sample loops. The 'FID' chamber contains the flame, pressure regulators, pressure gauges and flow restrictors used by the FID detector. The 'COLUMN' is housed in a separate 'COLUMN' enclosure and maintained at a temperature of 70° C by its PID temperature controller. The actual temperature setpoint for your instrument may be different depending on the application. It is listed in the *Addendum and Testing Results* section of Appendix C.

2.3.2 Gas Flow Control System

The analyzer is equipped with ports for the introduction of air, fuel, carrier gas, span, and sample gas. It is imperative that these gases are supplied at constant pressures using two stage stainless steel diaphragm gas regulators. The recommended pressure range is 30 to 80 psig; however, the span gas should be supplied at a pressure of 20 psig to the restrictor fitting either on the optional auto calibration module or the span inlet on the rear panel.

The Piping Diagram for the standard instrument is shown in Figure 2-2. A 10-port 2-position GC sampling valve is used to control and direct gas flows including sampling, back flush, and carrier gas. The fixed volume sample loop ensures the same volume of sample injection in the column every cycle.

If your instrument is fitted with the optional auto calibration module, a separate compartment containing of a pair of solenoid valves is installed for controlling the introduction of sample or span gas to the detector. Calibration can be performed automatically on a programmed schedule or manually using the front panel interface.

2.3.3 Fuel and Blanket Air Systems

Stable flow is achieved by maintaining a constant pressure across restrictors upstream from the cell. Each system incorporates an adjustable pressure regulator, pressure gauge, and restrictor. A flame out light is included to indicate when the flame fails. A fuel shut-off solenoid valve, mounted on the line that supplies fuel, stops the fuel flow in case of flame failure. This valve is located in line with the fuel port.

2.3.4 Flame Ionization Detection Cell

The carrier gas containing sample and fuel are combined within a tee fitting located in the isothermal chamber. The mixed gas is emitted from a burner within the sensor assembly. Blanket air is introduced into the sensor (or cell) by means of a separate fitting that is located in the base section of the assembly. The upper half of the assembly houses the anode-igniter, collector, and flame guard thermistor.

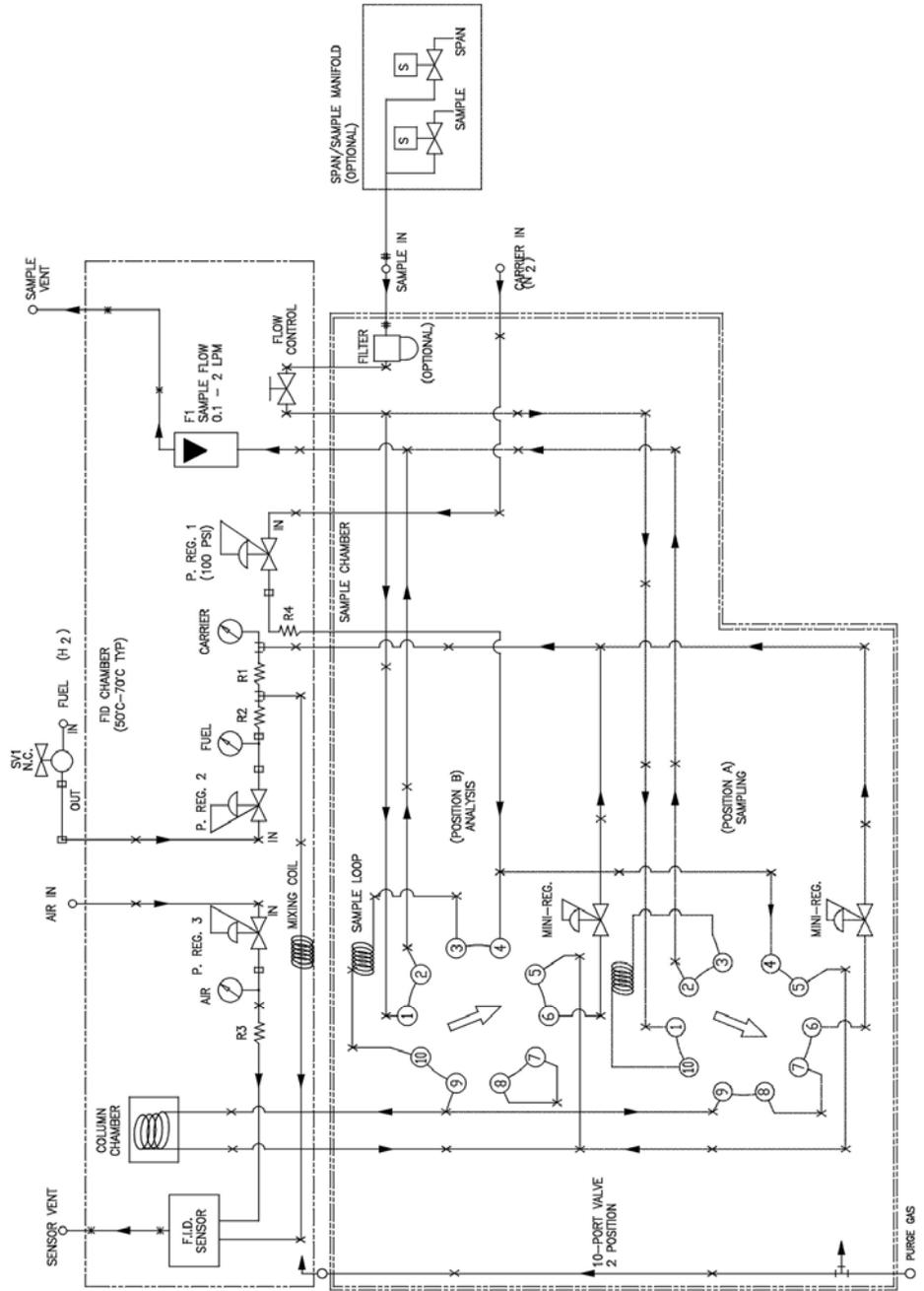


Figure 2-2: Typical Piping Diagram for the GC-Pro FID Analyzer

2.4 Detection Cell

The upper section of the stainless steel flame ionization cell houses the cylindrical collector electrode, the high voltage (+260 VDC) anode-igniter coil, and the sensing thermistor of the flame guard circuit (see cell cross-section in Figure 2-3).



WARNING: ***DANGEROUS HIGH VOLTAGE EXISTS AT THE ANODE IGNITER COIL (+260 VDC). DO NOT ATTEMPT TO DISCONNECT THE IGNITER COIL CABLE OR DISASSEMBLE ANY OF THE FLAME IONIZATION CELL COMPONENTS WITHOUT TURNING OFF THE POWER AND DISCONNECTING THE POWER CORD.***

The collector is interconnected with the electrometer-amplifier PC board by a coaxial cable. Although the cable and fittings are intended for coaxial service, the cable is actually being used as a shielded single-conductor connection.

The anode-igniter, as its name implies, serves two functions. When relay K2 at PCB part number B74671 is energized, the coil becomes an electrical heating element that glows red-hot and ignites the hydrogen fuel. When relay K2 at B74671 is de-energized, the coil is connected to the +260 volt DC terminal of the anode-flame guard power supply PC board. In this configuration, the necessary potential difference is established between the coil (anode) and collector to promote ionization of the burned hydrocarbons. The coil functions as the high voltage anode in all three-range positions of the selector switch.

The thermistor acts as the sensor in the flame guard circuit. Its ambient temperature resistance is in the 100 K ohms region. When the flame is ignited, its resistance is reduced by a factor of 100. The thermistor is coupled to a semiconductor control circuit on the anode-flame guard power supply PC board, which will be described in a following section.

The cell electrodes of both the anode-igniter and flame guard thermistor are connected to the electronics chassis by means of a plug-in cable.

The electrode section of the cell may be removed for inspection by turning off the power, disconnecting the electrode lead plug, and removing the screws, which retain the electrode assembly in the sensor body.

2.4.1 Electrometer-Amplifier

The collector cable is coupled directly to a coaxial fitting located on the electrometer-amplifier PC board. The PC board is located on the side panel next to but outside of the isothermal chamber. It consists of an electrometer amplifier and an operational amplifier. This circuit is a very high-gain, current-to-voltage converter circuit, having an input impedance measuring in the billions of ohms. It is static sensitive and highly susceptible to contamination. Special care must be taken in handling this PC board.

Refer to Section 5.5.3: *Electrometer-Amplifier PC Board* for more information concerning the electrometer-amplifier and the other printed circuits that follow.

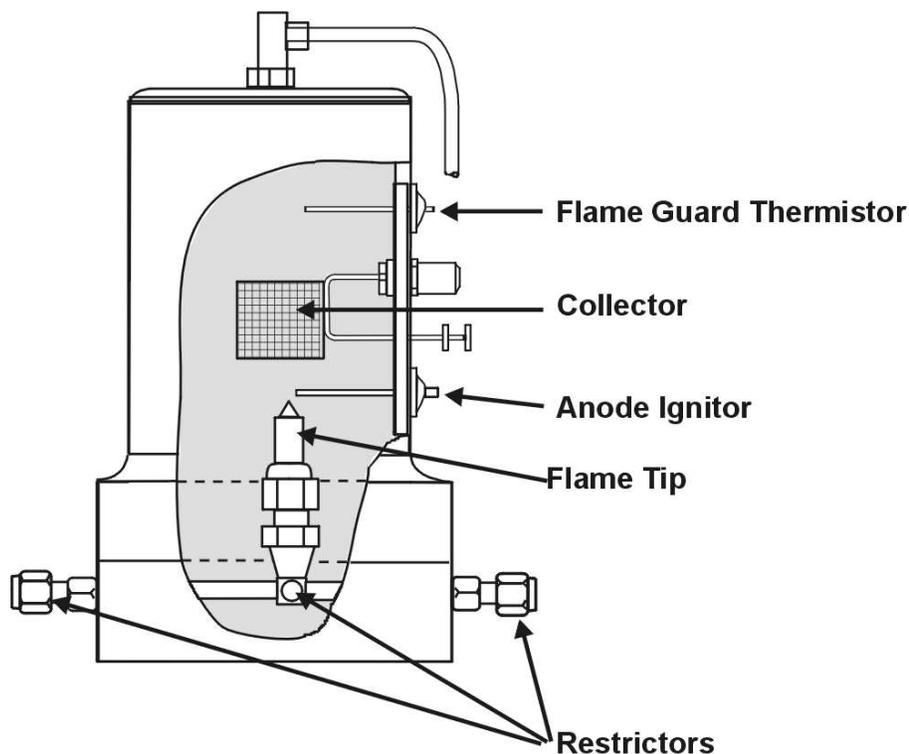


Figure 2-3: Flame Ionization Cell

2.4.2 Anode Power Supply

The high voltage anode power supply components are mounted on the anode power supply printed circuit board. High voltage regulation is achieved through the use of series-connected zener diodes. The simplicity of this circuit's design can be attributed to the extremely low current demand of the anode circuit. The positive output voltage is nominally 125 volts. Output tolerance is ± 10 volts from the specified 125 volts.

2.4.3 Flame Guard Circuit

A thermistor-controlled, transistorized switching circuit is employed to operate a relay in the event of a flame-out condition. A panel indicator light and fuel shut-off solenoid valve are operated by the relay to alarm personnel that a flame-out condition has occurred. The fuel shut-off solenoid valve stops the hydrogen flow.

2.4.4 Flame Ignition Circuit

The flame ignition circuit includes the anode-igniter electrode (in the detector cell), a transformer, and processor controlled relay. The circuit is automatically energized when the FID cools due to lack of flame.

If automatic ignition fails five times, there will be a message that reports this, and the flame can be re-ignited by pressing the re-ignite icon from the touch screen. See Figure 2-4 and Section 4.6.



Figure 2-4: Onscreen Re-Ignition Button

Installation

Installation of the GC-Pro FID Analyzer includes:

1. Unpacking
2. Mounting
3. Gas connections
4. Electrical connections
5. Testing the system.

3.1 Unpacking the Analyzer

Although the analyzer is shipped with all the materials you need to install and prepare the system for operation. Carefully unpack the Analyzer and inspect it for damage. Immediately report any damage or shortages to the shipping agent.

3.2 Mounting the Analyzer

The GC-Pro FID is a general-purpose analyzer and is designed with (non-sealed) enclosures. It must be installed in an area where the ambient temperature is not permitted to drop below 32°F or rise above 100°F. In areas outside these temperatures, auxiliary heating/cooling must be supplied. The GC-Pro FID enclosure is oil and dust resistant and although it is designed to resist moisture, it should NOT be considered completely watertight. Mounting to walls or racks must be made securely. Avoid locations that are subject to extreme vibration and sway.

Sufficient space must be provided around and above the analyzer to accommodate the necessary electrical conduit and plumbing connections and top cover removal. The top cover must be allowed to be lifted off for possible service access to all components within the enclosure. Refer to the system/analyzer outline drawings for dimensions.

Regardless of configuration, the analyzer/system must be installed on a level surface with sufficient space allocated on either side for

personnel and test equipment access. Subject to the foregoing, the Analyzer/system should be placed as close to the sample point as is possible.

All pertinent dimensions, connecting points, and piping details can be found in the drawings section as part of the outline, input-output, and piping diagrams. These drawings are specific to the instrument or system to which the manual applies.

3.3 User Connections

All user connections are made on the rear panel. Consult the input-output and outline diagrams in the drawing section of the manual. Not all the features displayed may be present in your system. Refer to any Addenda for additional information that may apply to your instrument.

3.3.1 Electrical Power Connections

The standard analyzer requires a supply of 100-125VAC, single-phase power. Power connections are made at the rear panel of the unit. Refer to the input-output diagram for more information. The electrical power service must include a high-quality ground wire. A high-quality ground wire is a wire that has zero potential difference when measured to the power line neutral. If you have the 220 VAC option, you will require 220 or 240 VAC, 50/60 Hz power. Check the analyzer input-output diagram, power schematic, outline, and wiring diagrams for incoming power specifications and connecting points.

CAUTION: PRIMARY POWER TO THE SYSTEM SHOULD NOT BE SUPPLIED UNTIL ALL CUSTOMERS WIRING IS INSPECTED PROPERLY BY START-UP PERSONNEL.



3.3.2 Electronic Connections

Figure 3-1 shows the GC-Pro FID rear panel. There are connections for power, digital communications, and both digital and analog concentration output.

For safe connections, no uninsulated wiring should be able to come in contact with fingers, tools or clothing during normal operation.

CAUTION: USE SHIELDED CABLES. ALSO, USE PLUGS THAT PROVIDE EXCELLENT EMI/RFI PROTECTION. THE PLUG CASE MUST BE CONNECTED TO THE CABLE



SHIELD, AND IT MUST BE TIGHTLY FASTENED TO THE ANALYZER WITH ITS FASTENING SCREWS. ULTIMATELY, IT IS THE INSTALLER WHO ENSURES THAT THE CONNECTIONS PROVIDE ADEQUATE EMI/RFI SHIELDING.

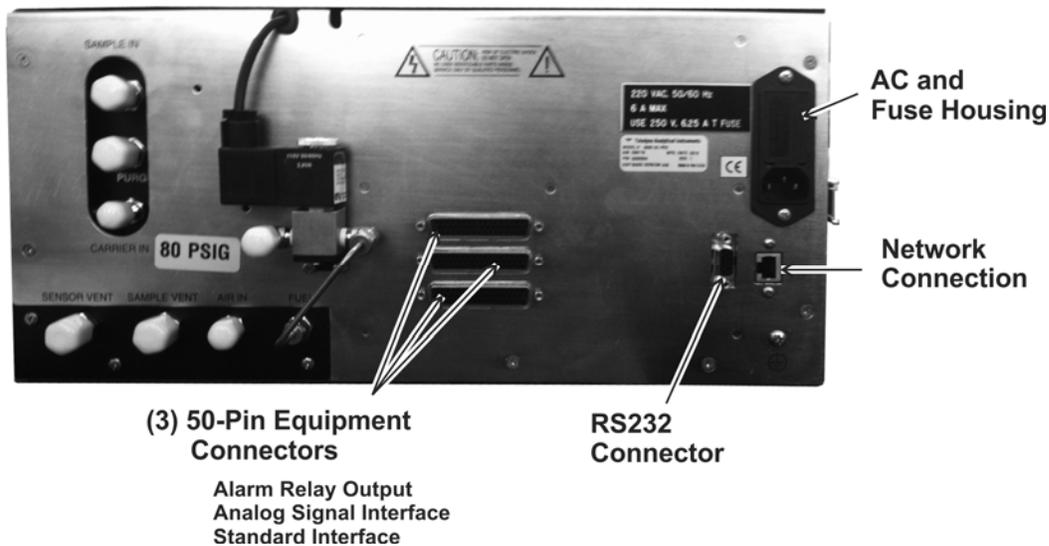


Figure 3-1: GC-Pro FID Electronic Connections

3.3.2.1 PRIMARY INPUT POWER

The power cord receptacle and fuse block are located in the same assembly. Insert the power cord into the power cord receptacle.

CAUTION: POWER IS APPLIED TO THE INSTRUMENT'S CIRCUITRY AS LONG AS THE INSTRUMENT IS CONNECTED TO THE POWER SOURCE.



The standard power supply requires 110 VAC, 50/60 Hz or 220 VAC, 50/60 Hz (optional) power.

3.3.2.2 FUSE INSTALLATION

The fuse block, at the right of the power cord receptacle, accepts US or European size fuses. A jumper replaces the fuse in whichever fuse receptacle is not used.

3.3.2.3 50-PIN EQUIPMENT INTERFACE CONNECTOR

There are three 50-pin Equipment Interface Connectors installed on the rear panel of the GC-Pro FID. Figure 3-2 shows the pin layout of the Equipment Interface connectors. The arrangement is shown as seen when the viewer faces the rear panel of the analyzer. The pin numbers for each input/output function are given where each function is described in the paragraphs below.

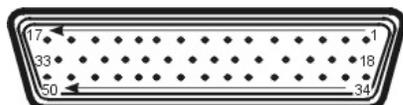


Figure 3-2: Equipment Interface Connector Pin Arrangement

From top to bottom the signals handled by the individual connectors are as follows:

- Top connector: Alarm relay connections
- Middle connector: Analog output signals
- Bottom connector: Standard connector for all additional signals

See Section 3.3.2.9 for Pin-Out connections for each connector.

3.3.2.4 ANALOG OUTPUT

There are four DC output signal pins—two pins per output. These are found on the middle connector. For polarity, see Table 3-1. The outputs are:

- | | |
|---------------------|--|
| 0–1 VDC % of Range: | Voltage rises linearly with increasing concentration, from 0 V at 0 concentration to 1 V at full scale. (Full scale = 100% of programmable range.) |
| 0–1 VDC Range ID: | 0.20 V = Low Range
0.5 V = Medium Range |

0.80 V = High Range

4–20 mA DC % Range: Current increases linearly with concentration, from 4 mA at 0 concentration to 20 mA at full scale. (Full scale = 100% of programmable range.)

4–20 mA dc Range ID: 6.8 mA = Range 1
12.0 mA = Range 2
16.8 mA = Range 3

Table 3-1: Analog Output Connections — Middle Connector

Pin	Function
3	Channel 2, + 4-20 mA, floating
4	Channel 2, – 4-20 mA, floating
5	Channel 1, + 4-20 mA, floating
6	Channel 1, – 4-20 mA, floating
8	Channel 2, 0-1 VDC
23	Channel 2, 0-1 VDC, negative ground
24	Channel 1, 0-1 VDC
7	Channel 1, negative ground

Examples:

The analog output signal has a voltage which depends on gas concentration relative to the full scale of the range. To relate the signal output to the actual concentration, it is necessary to know what range the instrument is currently on, especially when the analyzer is in the auto ranging mode.

The signal output for concentration is linear over the currently selected analysis range. For example, if the analyzer is set on a range that was defined as 0-100 ppb benzene, then the output would be as shown in Table 3-2.

Table 3-2: Analog Concentration Output—Example

Ppb Benzene	Voltage Signal Output (VDC)	Current Signal Output (mA DC)
0	0.0	4.0
10	0.1	5.6
20	0.2	7.2
30	0.3	8.8
40	0.4	10.4
50	0.5	12.0
60	0.6	13.6
70	0.7	15.2
80	0.8	16.8
90	0.9	18.4
100	1.0	20.0

3.3.2.5 ALARM RELAYS

The nine alarm-circuit connector pins connect to the internal alarm relay contacts. The pins for the alarm relays are available from the top interface connector. Each set of three pins provides one set of Form C relay contacts. Each relay has both normally open and normally closed contact connections. The contact connections are shown in Table 3-4. They are capable of switching up to 3 amperes at 250 VAC into a resistive load. The connectors are:

Threshold Alarm 1:

- Can be configured as high (actuates when concentration is above threshold), or low (actuates when concentration is below threshold).
- Can be configured as failsafe or non-failsafe
- Can be configured as non-latching
- Can be configured out (defeated).

Threshold Alarm 2:

- Can be configured as high (actuates when concentration is above threshold), or low (actuates when concentration is below threshold).
- Can be configured as failsafe or non-failsafe
- Can be configured as non-latching
- Can be configured out (defeated).

System Alarm:

- Actuates when DC power supplied to circuits is unacceptable in one or more parameters. Permanently configured as failsafe and latching. Cannot be defeated.

Note: Reset by pressing the STANDBY button to remove power. Then press STANDBY again and any other button except SYSTEM to resume. Further detail can be found in Chapter 4, Section 4.7.4.

Table 3-4: Alarm Relay Contact Pins — Top Connector

Pin	Contact
45	Threshold Alarm 1, normally closed contact
28	Threshold Alarm 1, moving contact
46	Threshold Alarm 1, normally open contact
42	Threshold Alarm 2, normally closed contact
44	Threshold Alarm 2, moving contact
43	Threshold Alarm 2, normally open contact
36	System Alarm, normally closed contact
20	System Alarm, moving contact
37	System Alarm, normally open contact

3.3.2.6 DIGITAL REMOTE CAL INPUTS

The digital remote calibration signals are available on the bottom connector. They input accepts 0 V (off) or 24 VDC (on) for remote control of calibration. (See *Remote Calibration Protocol* below.) See Table 3-5 for pin connections.

Span: Floating input. A 5–24 V input across the + and – pins puts the analyzer into the *Span* mode. If cycle mode is ‘Continuous’. Either side may be grounded at the source of the signal. A 0–1 volt across the terminals allows *Span* mode to terminate when done. A synchronous signal must open and close external span valve appropriately.

Cal Contact: This relay contact is closed while analyzer is spanning. (See *Remote Calibration Protocol* below.)

Table 3-5: *Remote Calibration Connections — Bottom Connector*

Pin	Function
10	+ Remote Span
12	– Remote Span
40	Cal Contact
41	Cal Contact

Remote Calibration Protocol: To properly time the Digital Remote Cal Inputs to the GC-Pro FID Analyzer, the customer's controller must monitor the Cal Relay Contact.

When the contact is OPEN, the analyzer is analyzing, the Remote Cal Inputs are being polled, and a span command can be sent.

When the contact is CLOSED, the analyzer is already calibrating. It will ignore your request to calibrate, and it will not remember that request.

Once a span command is sent, and acknowledged (contact closes), release it. If the command is continued until after the span is complete, the calibration will repeat and the Cal Relay Contact (CRC) will close again.

For example:



1. Test the CRC. When the CRC is open, send a span command until the CRC closes (The CRC will quickly close.)
2. When the CRC closes, remove the span command.

When CRC opens again, the span calibration is done, and the sample is being analyzed.

3.3.2.7 'MEASURE ONCE' (OR ONE SHOT MEASUREMENT) CONTACTS

There are three dedicated relay contacts and these are available from the bottom Equipment Interface Connector. They are assigned to indicate status of 'measure once' (or one shot measurement). Contacts are normally open, and they close when GC-Pro TCD switches to that particular range.

Table 3-6: 'Measure Once' Relay Connections

Pin	Function
9	+ Start Measurement Digital Input
11	- Start Measurement Digital Input
21	IDLE Contact 1
38	IDLE Contact 2
22	IN MEASUREMENT Contact 1
39	IN MEASUREMENT Contact 2
19	MEASUREMENT DONE Contact 1
18	MEASUREMENT DONE Contact 2

MEASUREMENT DONE contact only closes for 5 seconds at end of measurement cycle. After that IDLE contact closes. However reading is display and analog output stays till new measurement is requested.

Digital input range is 5 to 24 vdc to start measurement.

3.3.2.9 PIN OUT TABLE

The following table summarizes all the outputs/inputs available on the three 50 pin D-Sub connectors on the back panel of the analyzer.

Table 3-7: Pin out of Alarm Relay O/P (Top) 50 pin D-Sub Connector

pin #	Description	pin #	Description
1	Alarm Relay # 9, NC contact	26	Alarm Relay # 17, C contact
2	Alarm Relay # 9, C contact	27	Alarm Relay # 17, NO contact
3	Alarm Relay # 9, NO contact	28	Alarm Relay # 18, NC contact
4	Alarm Relay # 10, NC contact	29	Alarm Relay # 18, C contact
5	Alarm Relay # 10, C contact	30	Alarm Relay # 18, NO contact
6	Alarm Relay # 10, NO contact	31	+15 VDC
7	Alarm Relay # 11, NC contact	32	Analog Ground
8	Alarm Relay # 11, C contact	33	+15 VDC
9	Alarm Relay # 11, NO contact	34	Analog Ground
10	Alarm Relay # 12, NC contact	35	+15 VDC
11	Alarm Relay # 12, C contact	36	Ch. # 1, 4-20 madc input, HOT
12	Alarm Relay # 12, NO contact	37	Analog Ground
13	Alarm Relay # 13, NC contact	38	+15 VDC
14	Alarm Relay # 13, C contact	39	Ch. # 2, 4-20 madc input, HOT
15	Alarm Relay # 13, NO contact	40	Analog Ground
16	Alarm Relay # 14, NC contact	41	+15 VDC
17	Alarm Relay # 14, C contact	42	Ch. # 3, 4-20 madc input, HOT
18	Alarm Relay # 14, NO contact	43	Analog Ground
19	Alarm Relay # 15, NC contact	44	+15 VDC
20	Alarm Relay # 15, C contact	45	Ch. # 4, 4-20 madc input, HOT
21	Alarm Relay # 15, NO contact	46	Analog Ground
22	Alarm Relay # 16, NC contact	47	Ch. # 5, 4-20 madc input, HOT
23	Alarm Relay # 16, C contact	48	Ch. # 6, 4-20 madc input, HOT
24	Alarm Relay # 16, NO contact	49	+15 VDC
25	Alarm Relay # 17, NC contact	50	Spare Analog Input

Table 3-8: Pin out of Analog Signal (Middle) 50 pin D-Sub Connector

pin #	Description	pin #	Description
1	4-20 ma Out, Ch. # 3- HOT	26	0-1 vdc Out, Ch. # 8 - HOT
2	4-20 ma Out, Ch. # 3- RET	27	Analog Ground
3	4-20 ma Out, Ch. # 4- HOT	28	0-1 vdc Out, Ch. # 9 - HOT
4	4-20 ma Out, Ch. # 4- RET	29	0-1 vdc Out, Ch. # 10 - HOT
5	4-20 ma Out, Ch. # 5- HOT	30	Analog Ground
6	4-20 ma Out, Ch. # 5- RET	31	O2 sensor Hot Input #2 (NI)
7	4-20 ma Out, Ch. # 6- HOT	32	O2 sensor Return Input #2 (NI)
8	4-20 ma Out, Ch. # 6- RET	33	Thermistor for O2 sensor #2 ((NI)
9	4-20 ma Out, Ch. # 7- HOT	34	Thermistor for O2 sensor #2 (NI)

pin #	Description	pin #	Description
10	4-20 ma Out, Ch. # 7- RET	35	O2 sensor Hot Input #3 (NI)
11	4-20 ma Out, Ch. # 8- HOT	36	O2 sensor Return Input #3(NI)
12	4-20 ma Out, Ch. # 8- RET	37	Thermistor for O2 sensor #3 (NI)
13	4-20 ma Out, Ch. # 9- HOT	38	Thermistor for O2 sensor #3 (NI)
14	4-20 ma Out, Ch. # 9- RET	39	O2 sensor Hot Input #4 (NI)
15	4-20 ma Out, Ch. # 10- HOT	40	O2 sensor Return Input #4 (NI)
16	4-20 ma Out, Ch. # 10- RET	41	Thermistor for O2 sensor #4 (NI)
17	Analog Ground	42	Thermistor for O2 sensor #4 (NI)
18	Analog Ground	43	O2 sensor Hot Input #5 (NI)
19	0-1 vdc Out, Ch. # 3 - HOT	44	O2 sensor Return Input #5 (NI)
20	0-1 vdc Out, Ch. # 4 - HOT	45	Thermistor for O2 sensor #5 (NI)
21	Analog Ground	46	Thermistor for O2 sensor #5 (NI)
22	0-1 vdc Out, Ch. # 5 - HOT	47	O2 sensor Hot Input #6 (NI)
23	0-1 vdc Out, Ch. # 6 - HOT	48	O2 sensor Return Input #6 (NI)
24	Analog Ground	49	Thermistor for O2 sensor #6 (NI)
25	0-1 vdc Out, Ch. # 7 - HOT	50	Thermistor for O2 sensor #6 (NI)

(NI) = Not Implemented

Table 3-9: Pin out of Standard (Bottom) 50 pin D-Sub Connectors

pin #	Description	pin #	Description
1		26	
2		27	
3	+ Output 4-20 ma - Channel 2	28	Alarm 1 C Contact
4	- Output 4-20 ma - Channel 2	29	
5	+ Output 4-20 ma – Channel 1	30	
6	- Output 4-20 ma – Channel 1	31	
7	- Output 0-1 v (Channel 1)	32	Exhaust Solenoid Hot
8	+ Output 0-1 v (Channel 2)	33	Sample Solenoid Hot
9		34	Range 4 Contact/ not used
10	Remote Span +	35	Range 4 Contact/not used
11		36	Alarm 3 NC Contact
12	Remote Span -	37	Alarm 3 NO Contact
13		38	Range 1 Contact
14		39	Range 2 Contact
15		40	Calibration Contact
16	Span Solenoid Return	41	Calibration Contact
17	Span Solenoid Hot	42	Alarm 2 NC Contact
18	Range 3 Contact	43	Alarm 2 NO Contact
19	Range 3 Contact	44	Alarm 2 C Contact
20	Alarm 3 C Contact	45	Alarm 1 NC Contact

pin #	Description	pin #	Description
21	Range 1 Contact	46	Alarm 1 NO Contact
22	Range 2 Contact	47	
23	- Output 0-1 v (Channel 2)	48	Exhaust Solenoid Return
24	+ Output 0-1 v (Channel 1)	49	
25		50	Sample Solenoid Return

3.3.2.10 RS-232 PORT

The digital signal output is a standard RS-232 serial communications port used to connect the analyzer to a computer, terminal, or other digital device. It requires a standard 9-pin D connector.

Input: The input functions using RS-232 that have been implemented to date are described in Table 3-8.

Table 3-10: Commands via RS-232 Input

Command	Description
AS <enter>	Auto Span immediately (continuous mode)
SV <enter>	Switch to Span Valve
ZV <enter>	Switch to Zero Valve
AV <enter>	Switch to Analyze Valve
C1 <enter>	If in 1Shot mode, start a cycle
C2 <enter>	If in 1Shotm modde, start a span cycle
PMA <enter>	Switch to standard message
PMB <enter>	Switch to FID output mode
PMC <enter>	Switch to Query Mode (used for interface with OPC server)

Implementation: The RS-232 protocol allows some flexibility in its implementation. Table 3-9 lists certain RS-232 values that are required by the Standard Mode GC-Pro FID implementation.

Table 3-11: Required RS-232 Options

Parameter	Setting
Baud	9600
Byte	8 bits

Parity	none
Stop Bits	1
Message Interval	Sent at the end of each cycle.

3.3.3 Gas Connections

The analyzer gas connection diagram identifies the various gas connection points as to function and location. Figure 3-1 shows the gas connection points for the standard instrument without the optional auto calibration module. If the optional auto calibration manifold is present, sample and span gas connections would be made to labeled fittings on the manifold.

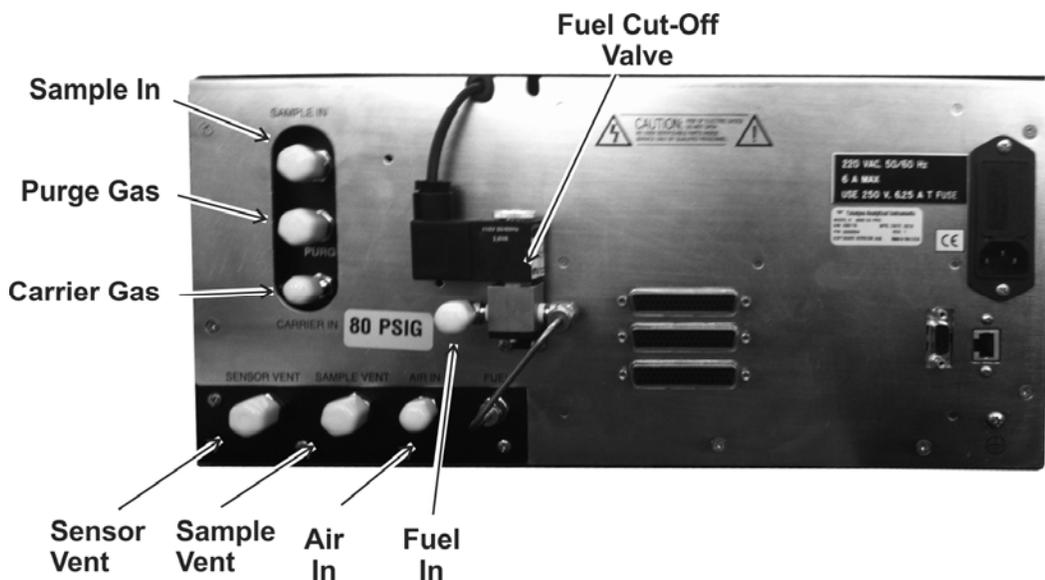


Figure 3-3: Gas Connections

Note: For instruments without the auto calibration option, the customer must provide means of switching sample and span gas to the analyzer. It is recommended that you use a tee with appropriate valves as opposed to disconnecting the sample gas connection when span gas is required.

Gas connections to the instrument are made at the 1/8" or 1/4" stainless steel tube fittings provided on the rear panel. Note that the

optional purge (not shown) and sensor vent fittings are 1/4" while all other gas connections are 1/8".

It is recommended that all gas tubing leading to the connections on the back of the analyzer be of the coiled type. This will facilitate sliding the unit out of the case without disconnecting the gas supply to the analyzer.

Before tubing is connected to the system, it must be decontaminated to eliminate any hydrocarbon deposits. Using a small torch, heat each length of tubing while passing nitrogen through it until it glows red. Begin at the nitrogen source end and proceed down the length of the tube, "chasing" the red glow (and hydrocarbon deposits) down to the open end of the tube. Cap the tubing while not in use with suitable non-contaminating caps.

All sample, calibration, and supporting gas lines, which deliver gas to the analyzer, must be decontaminated before connection; vent lines do not.

When connecting the various gas lines to the system, be absolutely certain that no "dead ends" are left; that is, no unused branch lines should be left capped off, where pockets might form of material that is not representative of the current contents of the line, or which might keep contaminants from being purged out of the system.

CAUTION: THE GASES USED MUST BE OF THE HIGHEST QUALITY, ULTRA ZERO GRADES, AS SHOWN BELOW. FAILURE TO DO SO WILL RESULT IN CONTAMINATION AND FAILURE TO DETECT AT THE REQUIRED ACCURACY.



AIR: USE WATER PUMPED AIR WITH THC LESS THAN 0.1 PPM. DO NOT USE OIL PUMPED AIR UNDER ANY CIRCUMSTANCES.

FUEL: HYDROGEN GAS, 100%, ZERO QUALITY WITH THC LESS THAN 0.5 PPM.

CARRIER GAS: NITROGEN GAS, ULTRA ZERO GRADE WITH THC LESS THAN 0.05 PPM.

Normally, four supporting gases of different composition (see Section 4.1: *Equipment*) will be required to operate the analyzer. The recommended composition is specified Appendix C: Addendum and Testing Results. The gases should be supplied from cylinders that are

equipped with the type of regulator specified in the aforementioned sections.

CAUTION: **UNDER NO CIRCUMSTANCES SHOULD YOU EMPLOY A REGULATOR THAT IS NOT EQUIPPED WITH A METALLIC DIAPHRAGM ANYWHERE IN THE SYSTEM.**



The regulators should be inspected prior to installation to be sure that they are oil-free. Failure to comply with these directives will result in a constant drift in analyzer output, as organic compounds will outgas into the plumbing system at a rate that is related to the ambient temperature. Use 316 stainless steel, dual-stage stainless steel diaphragm regulators only in fuel, sample, and blanket air lines; shutoff valves should be used downstream from each regulator.

Place the supply cylinders as close to the analyzer as possible, and connect to the analyzer with new tubing. Be sure that all plumbing connections are free of leaks.

Note: Use only stainless steel tubing throughout the system. Consult the assembly, piping, outline drawings, and any Addenda included with this manual to determine if special conditions apply.

3.3.3.1 EFFLUENT

All the gases introduced into the detection cell vent from one fitting at the rear of the analyzer. TAI recommends that the cell be permitted to vent directly to the atmosphere wherever possible.

If a vent line is required, the installation must include a drop-out pot to collect the water that is formed by the burning of the hydrogen fuel. The vent line must be constructed so that water and dirt cannot collect in it.

3.3.3.2 SAMPLE BYPASS VENT

The sample bypassed by the back-pressure regulation system vents from a separate port at the rear of the analyzer. If a vent line is required, it must be installed so that water and dirt cannot accumulate in it.

3.3.3.3 FUEL AND AIR CONNECTIONS

The fuel used to provide combustion should be hydrogen gas, zero quality with certified THC of less than 0.5 ppm and supplied at a pressure of 40 psig. The compressed air, ultra zero gas quality with THC less than 0.1 ppm should be used and supplied at a pressure of 40 psig. Connect the fuel and air sources to the instrument according to the gas connection diagram included at the back of this manual.

3.3.3.4 SAMPLE AND SPAN GAS CONNECTIONS

The sample and span gas connections are made at the rear panel. If the optional auto calibration module is installed, the sample and span gas will connect to this module. If no auto calibration module is present, these gases connect to the labeled fittings on the rear panel.

Set the supply pressure for sample and span gas to 20 psig.

3.4 Placing the System in Operation

See Section 4 for information on starting the analyzer for the first time. Make sure that all electrical connections have been made correctly and all connectors are fully seated. Make sure all gas connections are correct and leak-free.

Operation

This section of the manual describes how to setup and operate the GC-Pro FID Analyzer. It includes preliminary steps and equipment needed for operation, initial startup, and then the actual operation of the analyzer using the touch screen interface is described. You should read this chapter in its entirety and become familiar with the operating characteristics of this system before starting the analyzer for the first time. The *Addendum and Testing Results* section of Appendix C lists the software revision and default settings for your specific analyzer.

The GC-Pro FID Analyzer incorporates a HMI interface that uses a touch-sensitive LCD display with menus logically grouped for easy, intuitive access to all functions. The features supported by the newly designed system HMI interface include:

1. Sensor data acquisition, data logging and system health monitoring performed through the touch-screen display.
2. Firmware up-grades of the 89C5131 PCB can be carried out through an internal USB 2.0 interface
3. Firmware up-grade for the 9261 controller board can be carried out through the USB 2.0 interface using the SAMBA tool.
4. Stand alone testing of the 89C5131 PCB can be performed through the debug hyper terminal (9600Kbps) connection on the rear panel.

Operation of the analyzer including setup functions are performed from the touch screen. The HOME screen is the main display screen and the MENU screen allows the user to enter any phase of operation, calibration, and setup simply by touching the specific on-screen button. See Section 4.7.

4.1 Equipment

The following supporting gases and hardware will be required to operate the (standard) analyzer:

1. **Fuel:** A cylinder containing a hydrogen gas, zero gas quality composition will be required to supply the fuel for the flame ionization burner. The cylinder is to be equipped with an oil-free metallic diaphragm regulator (dual stage).
2. **Blanket Air:** A cylinder of compressed air, zero gas quality will be required to maintain the proper atmosphere within the cell. The cylinder is to be equipped with an oil-free, dual stage, metallic diaphragm regulator.
3. **Carrier Gas:** A cylinder of nitrogen gas, zero gas quality, equipped with dual stage metallic diaphragm regulator is required.
4. **Span Gas:** A cylinder or a permeation device system, capable of generating known concentration of benzene and/or other aromatic hydrocarbons of interest, will be required to standardize the analyzer.
5. **Sample Pressure Regulation:** An oil-free, metallic diaphragm regulator must be installed at the sample point when possible; see Section 3.3.3 *Gas Connections*.

CAUTION:  **THE GASES USED MUST BE OF THE HIGHEST QUALITY, ULTRA ZERO GRADES, AS SHOWN BELOW. FAILURE TO DO SO WILL RESULT IN CONTAMINATION AND FAILURE TO DETECT AT THE REQUIRED ACCURACY.**

AIR: USE WATER PUMPED AIR WITH THC LESS THAN 0.1 PPM. DO NOT USE OIL PUMPED AIR UNDER ANY CIRCUMSTANCES.

FUEL: HYDROGEN GAS, 100%, ZERO QUALITY WITH THC LESS THAN 0.5 PPM.

CARRIER GAS: NITROGEN GAS, ULTRA ZERO GRADE WITH THC LESS THAN 0.05 PPM.

4.2 Preliminary Power-Off Check List

Make the following checks of the installation before proceeding further into the start-up procedure:

1. Check to see that the sample and supporting gas installation is in accordance with the specifications called for in the installation and application sections of the manual (Chapter 3). Be sure that the supporting gases are of the proper composition and are connected to the correct fittings at the rear of the analyzer.
2. Check to see that the electrical installation conforms to the instructions contained in the installation section (Chapter 3) and on the input-output diagram.
3. Remove the top cover and check to see that the printed circuit boards and cables are firmly seated in their respective sockets.
4. Confirm that recorder and alarm connections are properly made.

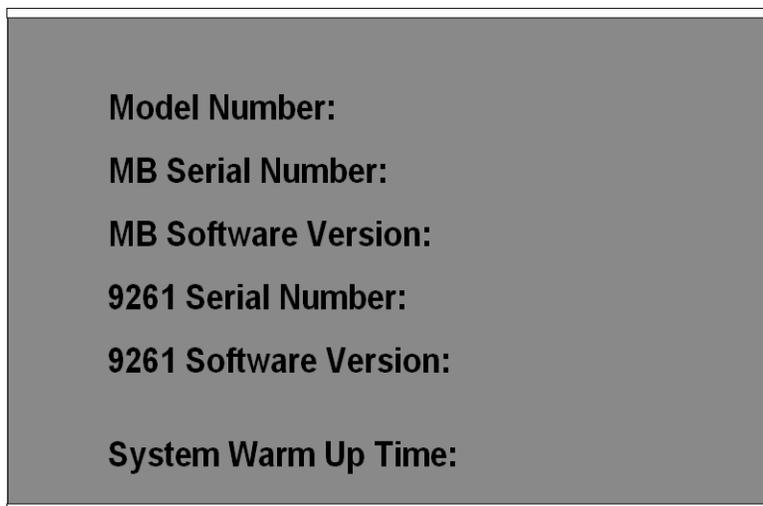
4.3 Powering Up the Unit

Before applying power to the analyzer for the first time perform the following checks:

1. Make sure that the proper power 120/220 VAC 50/60 Hz is available.
2. Connect the AC power cord to the rear panel and then plug the other end into the mains supply. As soon as power is established, the unit will turn on.
3. Check that the Power, CPU, and COM LEDs illuminate and the Teledyne Logo screen appears on the display.



4. Momentarily, the Teledyne screen will be replaced with a second start-up screen that lists the Model, Serial Number, Software Version and other parameters specific to your instrument.



5. A one hour warm up time is required for the internal heaters to come up to the required temperature and stabilize. The screen will indicate a countdown as the warm up period progresses.
6. During the warm up period activate the support gases as described in Section 4.4.

7. Following the warm up, the system will initiate a self-diagnostic routine and display the results as either “OK” or “Failed”

RUNNING DIAGNOSTICS	
TESTS	RESULTS
5V Test	
15V Test	
DAC A Test	
DAC B Test	

8. After the self diagnostic test has completed the instrument will attempt to ignite the flame. See Section 4.6.

4.4 Activating the Support Gases

The instrument gas controls are located on the front panel adjacent to the touch screen display as shown in Figure 1-1. Make sure that the following support gases are available at the analyzer:

- Air: (HC-free) for combustion
- Carrier gas: (usually nitrogen but refer to Appendix C for your specific application.
- Fuel: 100% hydrogen
- Span gas: Typically 70-90% of measured component on the range of interest in a clean background gas. Refer to Appendix C for the specific span gas composition for your application.

4.4.1 Air

1. Set the air source regulator to 40 psig.
2. Adjust the analyzer air regulator until the air pressure gauge reads the recommended air pressure of 7.0 psig.

After the air is flowing through the sensor and warm-up time has been completed, activate the following gases:

4.4.2 Carrier Gas

Set the carrier gas source regulator to 80 psig and adjust the analyzer sample regulator until the sample pressure gauge reads the recommended sample pressure of 7.0 psig.

4.4.3 Span Gas

1. Feed span gas to the analyzer (see Section 4.4.3). Gas switching can be performed manually or handled through the auto calibration valves (if the option is added). See Section 4.7.10.3.
2. Observe that the analyzer sample flow meter reads from 0.3 to 1.0 SCFH.

4.4.4 Fuel

1. Open the main valve on the fuel source and set the fuel pressure regulator to 40 psig.
2. Adjust the fuel regulator until its pressure gauge reads the recommended pressure of 4.0 psig.

Note: Adjust fuel settings only when the red LED (flame failure light) is off.

4.5 Sample Pump

A built-in sample pump is provided to draw sample gas from ambient air. The gas flow rate should be maintained at about 1000 to 1200 cc/minute using the Front Panel flow control valve (clockwise increases flow). See Figure 1-1.

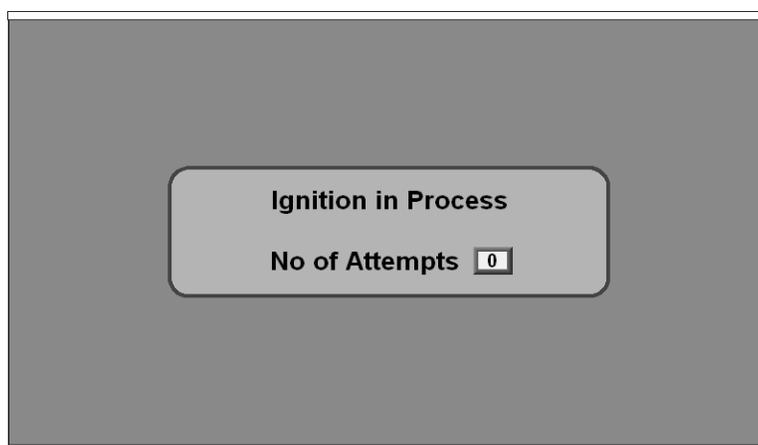
4.6 Flame Ignition

After the warm up countdown on the display reaches zero, open the gas control door and observe that the amber heater lamp is blinking (indicating that the temperature controller is maintaining the temperature setpoint) and the red Flame Out lamp on the front panel is on. See Figure 1-1.



The GC-Pro FID will automatically attempt a flame ignition sequence following the warm up period which has been preset at the factory.

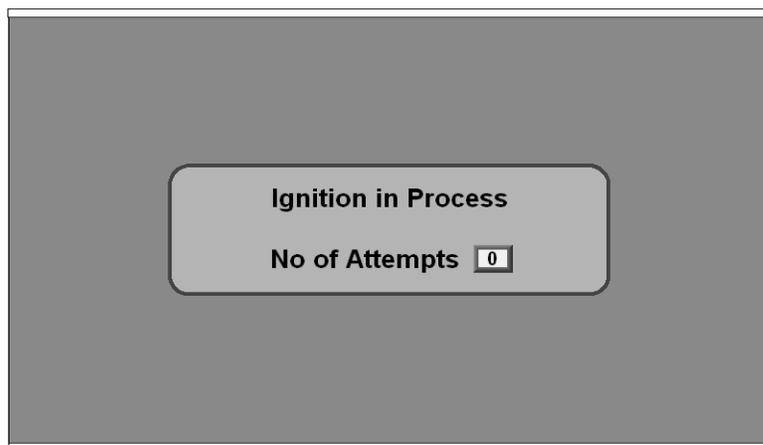
If the ignition process fails, the instrument will attempt to ignite the flame 4 more times. If it continues to fail after the fifth attempt, a flame failure message will appear on the display. If this occurs refer to Section 5.



Attempting to reignite the flame by touching the “RE-IGNITE” button will display a confirmation window as shown below.



Again the ignition process will start if user selects the “OK” button. The number of attempts will be updated on the screen below.



The above process will repeat until the flame ignites successfully. The status will be updated as shown in the next screen.



Once the ignition process is successful the HOME screen will appear on the display.

4.6.1 Verification of the Flame Guard Circuit

Prior to using the analyzer for the first time, the operation of the flame guard circuit should be checked. This circuit has been checked at the factory, but should be re-verified during start-up. Use the following procedure after ignition of the flame has been achieved:

1. Turn off the fuel at the supply cylinder.
2. Observe the fuel pressure gauge on the analyzer control panel. The gauge indication will decay as the fuel in the line is exhausted. When the gauge reading reaches near zero, the flame will extinguish as the fuel solenoid shuts off the fuel supply. The display will indicate an ignition failure followed by a request to re-ignite.



3. The analyzer will automatically try to re-ignite. After 5 attempts, it will display: flame failure, check air, fuel and the flame failure LED will be on.
4. Open the cylinder supply valve and re-ignite the flame by pressing the 'OK' button on the Re-ignite screen.

4.6.2 Ignition and/or Flame Guard Circuit Failure

If the flame ignition or guard circuits do not operate as described in the above two sections, set the instrument fuel regulator to the recommended pressure. If still fails to ignite, proceed as directed in Chapter 5: *Maintenance & Troubleshooting*.

4.7 Analyzer Operation

Although the GC-Pro FID has been programmed for your application at the factory, it can be further configured at the operator level. Depending on the specifics of the application, this might include all or a set of the following procedures:

1. Setting system parameters
 - Establish a security password, if desired, requiring operator to log in.
 - Establish and start an automatic calibration cycle (if equipped with the optional auto calibration module).
2. Routine operation.
 - Calibrate the instrument.
 - Choose auto ranging or select a fixed range of analysis.
 - Set alarm setpoints and modes of alarm operation.
3. Special functions setup.
 - Calibrate analog output, select analog output source.

Procedures for accessing and/or changing parameters as well as analyzer operation are detailed in the sections to follow. All functions can be accessed from the MENU screen which is accessible via the center button on the HOME screen.

The default screen is the HOME screen (see Section 4.7.2). This is the analysis display and shows details regarding the current sample being analyzed. However, the user can go directly to any function supported by the analyzer by pressing the MENU button. The only exception to this is when the instrument is powered up. It will go through a warm-up period, followed by a diagnostic self-test routine as explained in Section 4.3.



4.7.1 Default Parameters

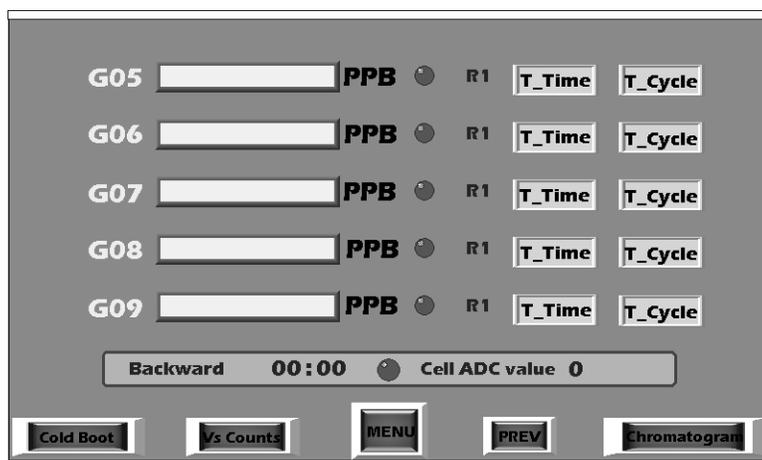
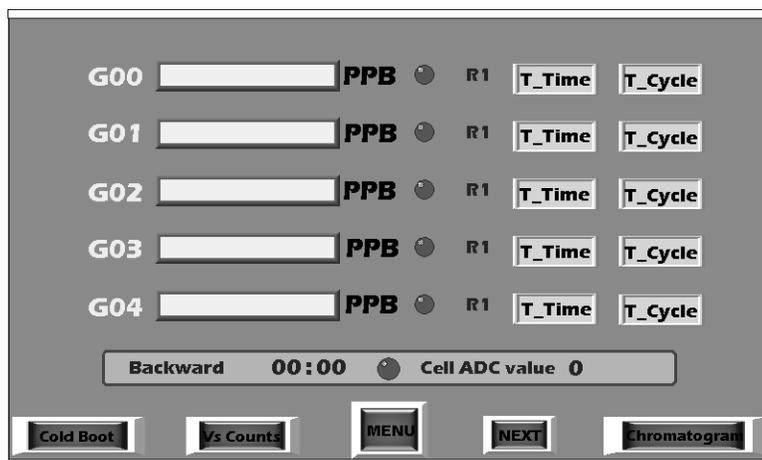
The versatility of this analyzer usually results in significant changes being made to parameters over the course of time to better suit a particular application. Occasionally processes change requiring alteration to alarms, filter settings etc. At some time, it may be beneficial to reset the analyzer to the default conditions as it was when shipped from the factory. Below is a listing of the default parameters used in configuring the typical GC-Pro FID instrument. Your specific application may require different settings. Refer to the *Addendum and Testing Results* section of Appendix C for any specific changes or recommendations that apply to your application.

Range/Application:	Refer to the <i>Addendum and Testing Results</i> section of Appendix C
Range:	Manual
Alarms:	Defeated, 20ppb, 50ppb, HI, NON-FAILSAFE, NON-LATCHING
Auto Span Timing:	Defeated, every 7 days, at 12 hours
Span:	80 ppb
Password:	11111

4.7.2 The HOME Screen

The HOME screen is the default display and represents the *Analysis Mode* of the instrument. It is a set of two screens that present information regarding the current measurement state. The HOME screen is where the maximum information about the instrument is displayed.

The Group name/tag is listed on the left most column and the concentration for groups are displayed in PPB, PPM or % depending on the range and value. The Enabled group is represented by the glowing LED. Each group has three user settable ranges R1, R2, and R3 and the current range index is displayed in the Group row. It is possible to view the VS (Volt-second) count by touching the “Vs Count” button.



The phase cycle (forward or reverse) and corresponding phase timer along with the cell ADC value are displayed in the lower box. The green LED within the rectangle starts blinking whenever a peak is detected for active time frames (groups) running in the respective cycle.

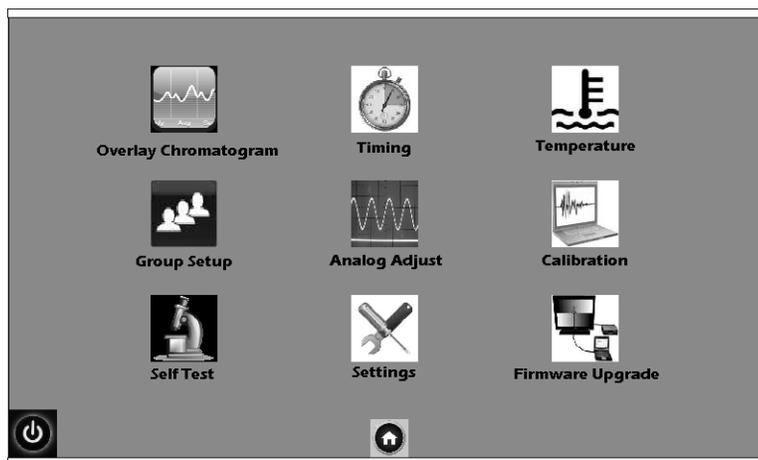
The ten groups are split into two screens showing five on each screen. Either screen can be displayed by selecting “NEXT” and “PREV” on the HOME screen.

A “Cold Boot” button is located on the bottom left corner of the HOME screen that when pressed will allow the user to revert back to factory settings or retain the current instrument settings. See Section 4.7.13.5 for additional details regarding a cold boot.

Each group has buttons associated with it (T_Time and T-Cycle) that will bring up a graph displaying the analysis trend in the group with respect to time or cycle. With these buttons, the user can evaluate the instantaneous analysis as opposed to waiting for a complete cycle to terminate. See Section 4.7.13 for more details.

4.7.3 The MENU Screen

Instrument parameters can be accessed and set by pressing the “MENU” button on the HOME screen. This brings up the following MENU screen:



Any function can be entered by touching the respective icon. The functions are:

- Standby (lower left corner on display)
- Home (home icon at bottom center)
- Overlay Chromatogram
- Timing
- Temperature
- Group Setup
- Analog Adjust
- Calibration
- Self Test

- Settings
- Firmware Upgrade

These functions are described in the sections that follow.

4.7.4 Standby

This function allows you to place the instrument in STANDBY mode.

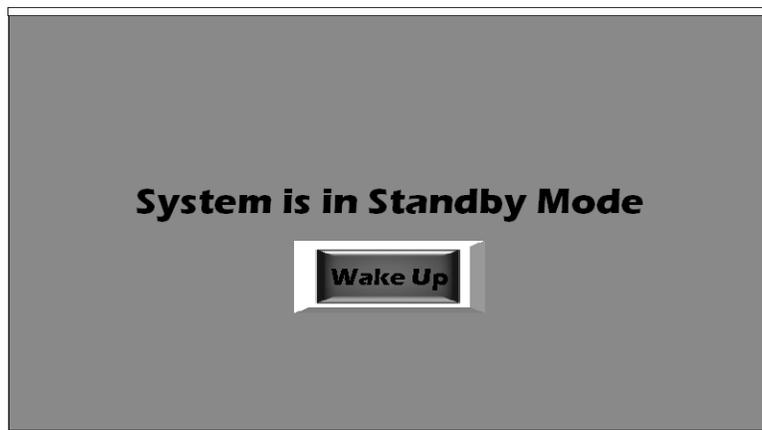
CAUTION: STANDBY SHUTS DOWN POWER TO THE DISPLAYS ONLY. INTERNAL CIRCUITS ARE STILL ENERGIZED AND ELECTRICAL SHOCK HAZARD STILL EXISTS.



To place the instrument in STANDBY status press the “Standby” button at the lower left corner of the display. The following Confirmation screen will pop up.



Selecting ‘OK’ puts the system goes into a sleep mode and following window will be displayed on the screen.



To come out of standby mode, touch the “WAKE UP” button. An informational pop up screen will appear for approximately one minute displaying a message “Please wait.....”.



4.7.5 Overlay Chromatogram

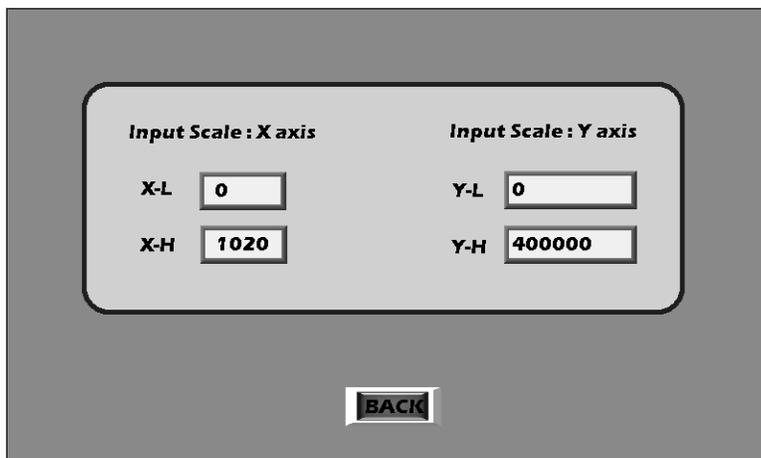
Selecting “Overlay Chromatogram” brings up the following screen:



The above screen displays the overlay chromatogram with the ADC values on y axis plotted against the sample number on the x axis. To display the graph onscreen, touch the “PLOT” button. To clear the screen touch “REFRESH”.

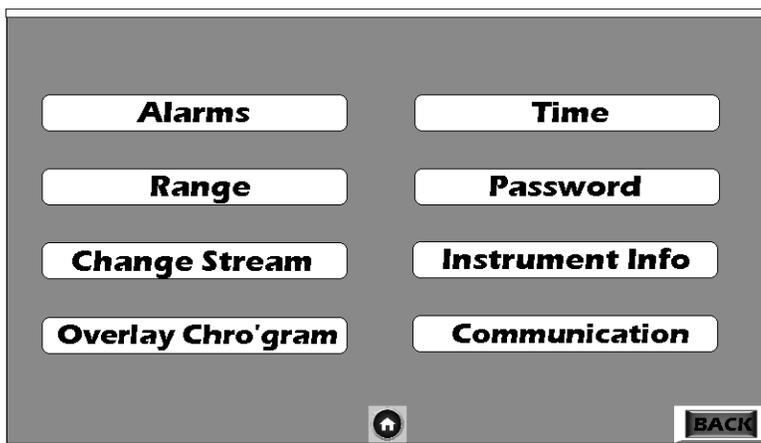
Use the “Scale” button to change the X axis or Y axis scaling.

Note: The chromatogram will be displayed for a maximum of 1020 samples. The chromatogram will not display if the total sum of the forward phase duration & backward phase duration is more than 1020 seconds.



In this screen, low and high limits on the X and Y axes can be input. The maximum limit for X-High is 1020 i.e., 1020 seconds. So the maximum cycle time (forward + backward) time should not exceed 1020 seconds (17 min) for the overlay chromatogram.

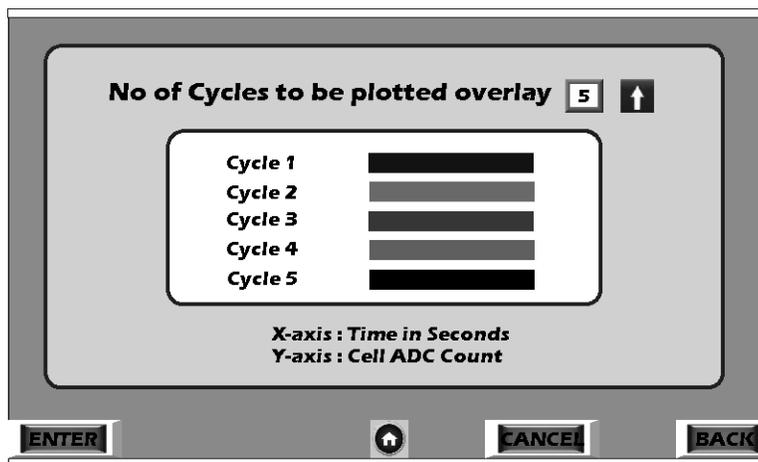
The user can also select the number of channels to be plotted on the overlay chromatogram screen by selecting the “Setting” icon from the MAIN menu. Doing so will display the Setting submenu screen as shown below.



From this menu, touch the “Overlay Chro’gram” button. This will bring up the CHANNEL SELECTION window as shown below.

Use the UP ARROW to select the number of channels then touch ENTER to confirm the selection or CANCEL to abort the selection and return the previous selection. This screen also provides the color

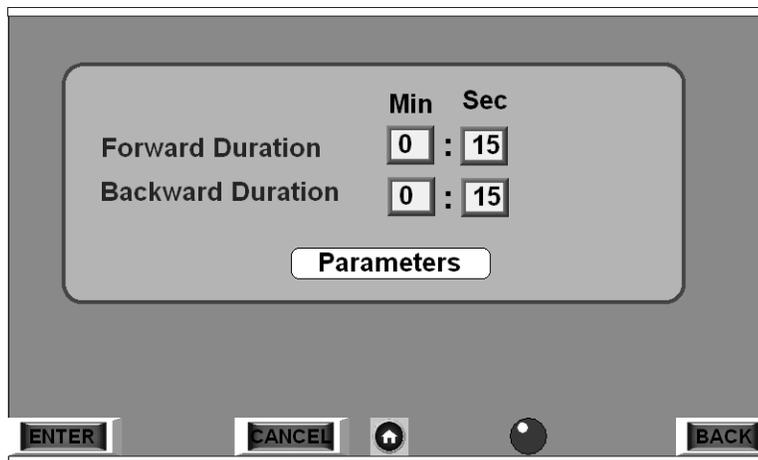
indicators for the plot on the various channels. These colors are fixed and cannot be changed.



4.7.6 Timing

Timing controls the parameters of the valve and data acquisition. It is specific to the setup of the instrument and must be determined at the factory or TAI trained personnel. Refer to the *Addendum and Testing Results* section of Appendix C for the specific timing settings used for your system and application. Do not change these values unless directed by Customer Service at TAI. For further information please contact TAI Customer Service.

In the event the timing must be changed or viewed, touch the “Timing” icon on the MENU screen. The following screen is displayed.



The window screen is used to set the forward and backward duration in MM:SS format. After setting the required duration, select the ENTER button to save the values.

If the onscreen LED is red, all available buttons will be disabled and timing cannot be adjusted. Wait until the LED turns green again before resuming any button presses.

Note: The chromatogram will be displayed up to a maximum of 1320 samples i.e. if the sum of the forward plus backward phase duration is more than 1320 seconds. Beyond that value, that the chromatogram will not be displayed.

With the LED green, the “Parameters” icon can be selected to view and edit several parameters for each time frame, as shown in the screen below.

Sum	Active	Phase	Begin Time	End Time	Edit
S00	<input type="radio"/>	Backward	0 : 3	0 : 10	Edit
S01	<input checked="" type="radio"/>	Backward	0 : 0	0 : 0	Edit
S02	<input checked="" type="radio"/>	Backward	0 : 0	0 : 0	Edit
S03	<input type="radio"/>	Forward	0 : 4	0 : 14	Edit
S04	<input checked="" type="radio"/>	Backward	0 : 0	0 : 0	Edit
S05	<input checked="" type="radio"/>	Backward	0 : 0	0 : 0	Edit
S06	<input type="radio"/>	Forward	0 : 5	0 : 10	Edit
S07	<input checked="" type="radio"/>	Backward	0 : 0	0 : 0	Edit
S08	<input checked="" type="radio"/>	Backward	0 : 0	0 : 0	Edit
S09	<input type="radio"/>	Backward	0 : 6	0 : 8	Edit

The above screen displays the Phase, Begin Time and End Time along with the active ON/OFF field. The screen also contains an EDIT button that can be used to view or modify all the parameters for the selected timeframe, as shown below.

S00

Active	↑ No	Begin	0 55	Edit Time
Phase	↑ BCK	End	1 50	
Lead Base	↑ No	Adjust Vs Offset	0	
Trail Base	↑ No	Adjust Vs Factor	0.00	
Base Res	↑ Off	Loc Min Mode	↑ None	
Gain	↑ Low	Loc Min Window	↑ 0	

ENTER CANCEL Home Power BACK

The parameters can be modified by either touching the UP arrows or by entering the values in input fields.

In order to input the Begin/End Time, touch on the Green “EDIT TIME” button. This causes an input window to appear as shown below.

S00

Begin 0 : 55

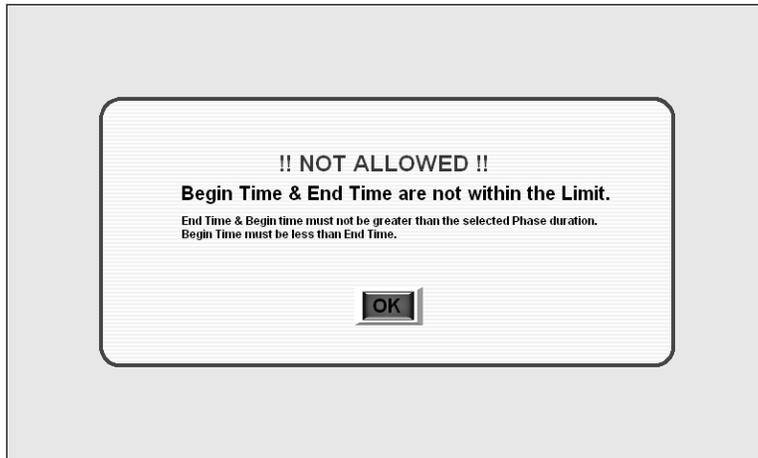
End 1 : 50

OK

FWD Duration 6 0 BCK Duration 6 0

In this screen, the Begin/End Time can be changed (minutes and seconds) by touching the requisite box. A pop up numerical keypad appears onscreen that allows the direct input of numerical values.

If an inappropriate value is input, for example a Begin time greater than the End time or an End time which exceeds the selected (FWD+BCK) phase duration, an onscreen warning will appear as shown below.



Once a valid input has been entered as shown in the example screen above, the display will return to the Parameter window, which will now reflect the modified values.



After modifying the above parameters touch the ENTER button to save the new inputs. A confirmation window will pop up before actually saving the inputs. Select OK to save, otherwise touch CANCEL to reject the new inputs.



4.7.7 Temperature

Temperature control is a critical factor in GC analysis. The GC-Pro FID Analyzer incorporates three dedicated temperature controllers.

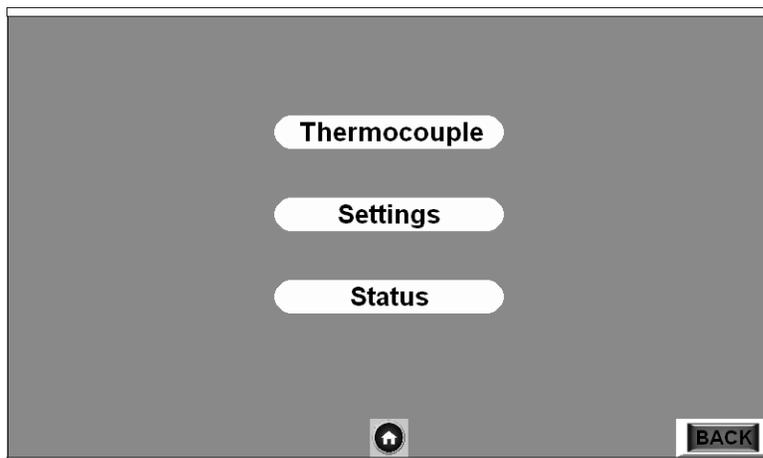
- FID Temperature (Sensor)
- GC Column Temperature (Column)
- Sample Chamber (Sample)

Refer to the *Addendum and Testing Results* section of Appendix C for the specific temperature setpoints used for your system and application. Do not change these values unless directed by Customer Service at TAI. For further information please contact TAI Customer Service.

Caution: *The temperature settings have been carefully determined and set at the factory for your application. Temperature is a key factor in determining the accuracy of the resultant analysis. It is recommended that the user consult TAI before making any changes to the temperature setpoints as listed in Appendix C of this manual.*

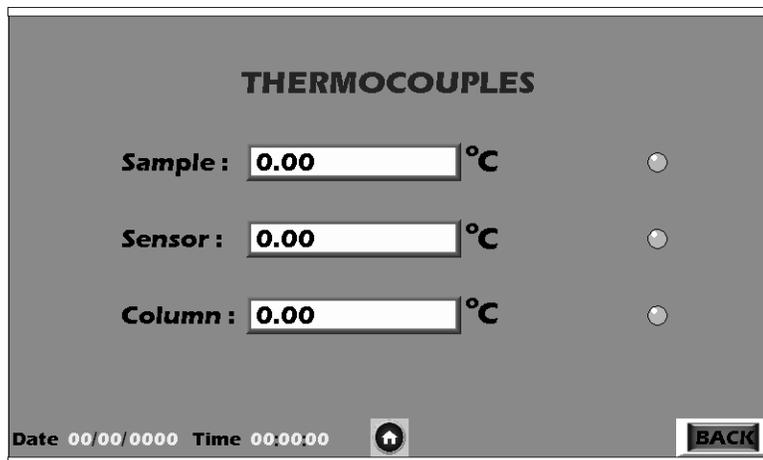


To monitor the temperatures, check the status of a thermocouple or change a temperature controller setpoint select “Temperature” from the MAIN screen. The following screen will display.



4.7.7.1 THERMOCOUPLE

Selecting “Thermocouple” from the Temperature menu shows the actual temperature reading (°C) of the three sections: Sample, Sensor, and Column.

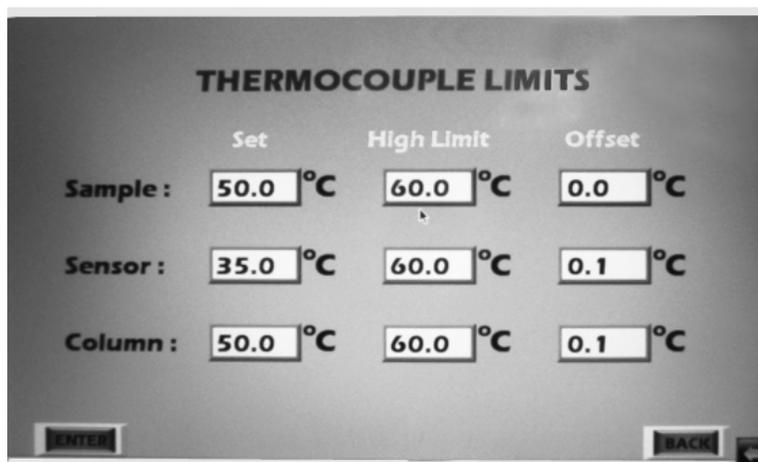


The temperature sensor value will be displayed in degrees Centigrade. If the values are within the limits the green LED will be illuminated. The LED will be red if the values are above or below the

setpoint limits. The screen also displays the date and time of the thermocouple data acquisition. The values are updated every five seconds.

4.7.7.2 SETTINGS

To redefine the limits and offset for the thermocouple values, press “Settings” from the Temperature screen. The following screen will appear.



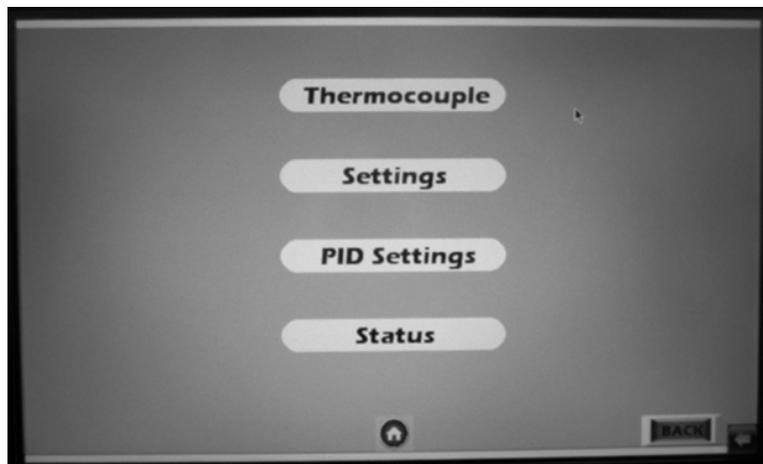
Pressing any data box will bring up an onscreen numerical keyboard that allows data input. When finished making setpoint, limit and offset changes, press ENTER to return to the Temperature screen.

4.7.7.3 PID SETTINGS

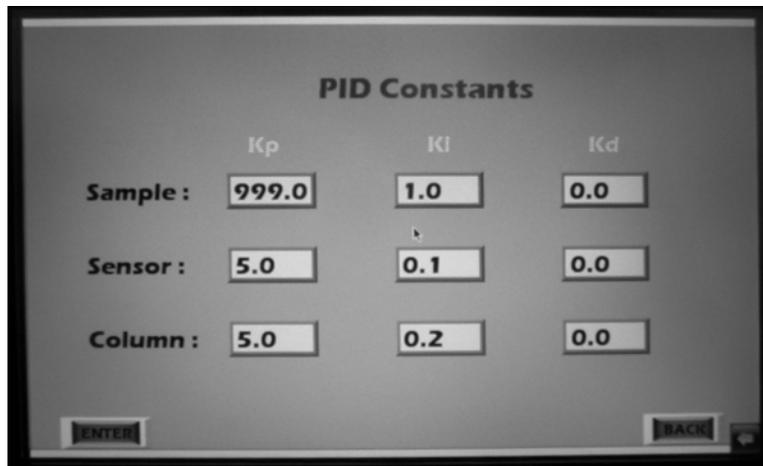
The temperature controllers used in the GC-Pro are three-term controllers with proportional (Kp), Integral (KI), and derivative (Kd) settings. Together, these parameters determine the overall control and response of the instrument.

Optimum values for Kp, KI, and Kd have been determined at the factory and set for your instrument. The PID Settings menu from the Temperature main menu will display the current values for each of the three heaters and allow the user to modify the setting.

To access the parameters, press PID Settings from the Temperature screen.



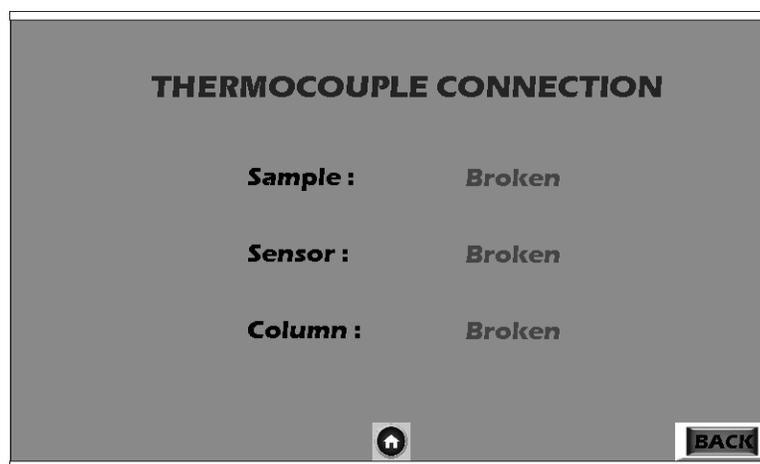
Pressing PID Settings will bring up the following screen that displays the current settings for each of the three temperature controllers.



You can adjust any of the three PID constants by touching the data box and entering a new value into the numerical entry box that pops up. Once the value has been entered, press ENTER on the entry box to accept the value and dismiss the numerical entry box. After all parameters have been set, save the values by pressing ENTER on the lower left corner of the screen. This will return you to the Temperature main screen.

4.7.7.4 STATUS

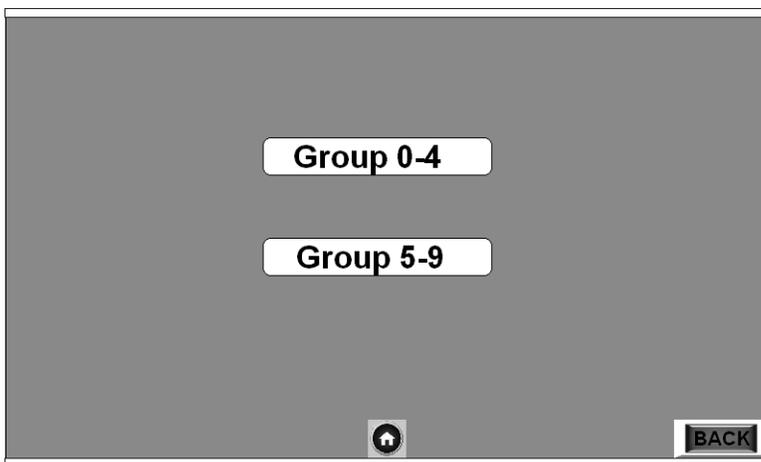
The STATUS screen displays the status for the three thermocouple sensors. If a thermocouple is open or damaged, this condition will be indicated by the message “Broken” in the corresponding sensor column. Otherwise, if a thermocouple is operating properly “Normal” will be displayed in the sensor column.



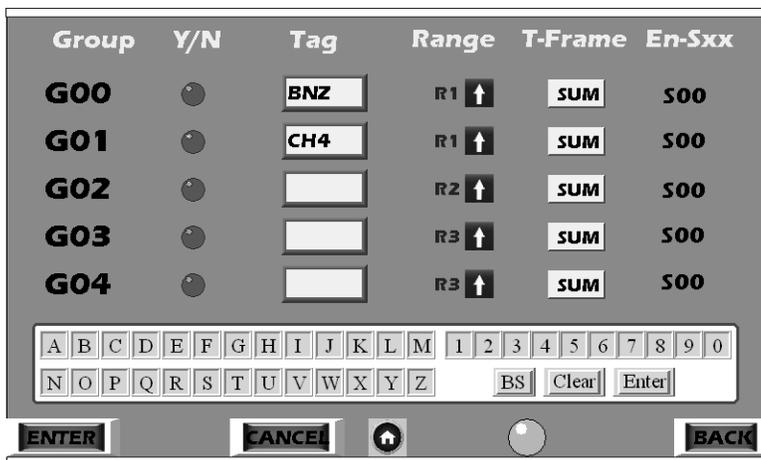
4.7.8 Group Setup

Group Setup assigns to each compound a name, a range given in Range settings and an associated peak window that is determined in Timing settings. These values should not be modified unless directed by TAI customer Service.

When the Group Setup icon on Main Menu is selected, the following screen is displayed.



The Group Setup is function split into two screens covering Groups 0-4 and 5-9 on individual setup screens. The Group Setup screen gives the option to display either half of the Groups by touching the relevant icon. When user touches the “Group 0-4” icon, a new window appears as shown below.



From these screens (0-4 and 5-9) a specific group or groups can be selected, names (tag) assigned, a range assigned as well as concentration peaks (Sxx) added or subtracted.

A group is selected by touching the adjacent LED. When selected the LED icon should turn green.

A tag is limited to three characters (letters or numbers 0-9). A tag can be assigned by touching any three keys provided in the on-screen keypad after selecting the tag field for the relevant group. You must press ENTER on the **keypad** to assign the tag before moving to another setting or group, otherwise the tag will NOT be assigned.

To assign a range, touch the UP arrow button adjacent to the range of the selected group.

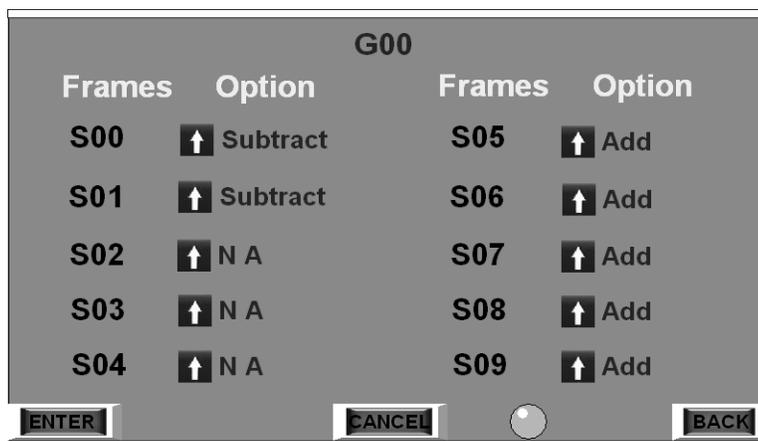
Once all the required inputs have been made, select ENTER to save. A confirmation window pops up to confirm the inputs or cancel.



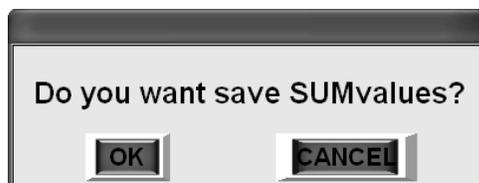
*Note: You can view the first of the Enabled Sxx on the Group Setup screen for the respective Groups. If none of the Sxx are enabled S** will be displayed. Details for enabling the Sxx are given below.*

It is possible to add or subtract concentration peaks to groups using the SUM function available from the Group Select screen.

Selecting SUM from a selected group brings up an additional screen.



This screen has three inputs for ten peaks S00 through S09. The possible inputs are Subtract, Add, and NA (Not Applicable). The user can assign these inputs by touching the UP arrow button available. After touching the ENTER button to save the inputs, a confirmation window pops up.



Note: After selecting the ENTER button there will be a delay of few seconds to update the inputs. All other buttons (i.e. home, cancel, back etc) available on the screen will be disabled during the delay period.

As an example, assume Groups G00 and G01 have been setup to monitor two different hydrocarbons with peaks associated as follows:

Group	Assigned Peak
G00	S00
G01	S01

Then, it is possible to setup a group to monitor total hydrocarbon as G03 which would have both hydrocarbon peaks assigned to it by using the SUM function:

Group	Assigned Peak
G00	S00
G01	S01
G02	S01 + S02

Similarly, group setup inputs can be provided for the other five groups by selecting Group 5-9 icon on the first Group Setup screen.

4.7.9 Analog Adjust

The GC-Pro FID Analyzer has ten 4-20 mA DC output channels that can be assigned to the various groups. Any group can be assigned to any output channel and it is also possible to assign groups to multiple channels.

Channel 0 and channel 2 are unique channels. For these channels the user can assign gain and offset values to the output. Channel 0 has an additional feature called “WAVE” which when selected will assign the ADC counts to the 4-20 mA output for the group assigned to channel 0.

Note: The WAVE function will not be accessible until a group has been assigned to channel 0.

WAVE is only visible on channel 0 but it may be changed back to GROUP by pressing the WAVE button again. The WAVE button toggles between WAVE and GROUP.

Selecting Analog Adjust from the MAIN screen brings up the following screen.

Channel	Group	Gain	Offset	
0	G00 ↑	-200	10	GROUP
1	G01 ↑	NA	NA	
2	G02 ↑	150	-5	
3	G03 ↑	NA	NA	
4	G04 ↑	NA	NA	
5	— ↑	NA	NA	
6	— ↑	NA	NA	
7	— ↑	NA	NA	
8	— ↑	NA	NA	
9	— ↑	NA	NA	

ENTER HOME CANCEL BACK

Pressing GROUP and assigning a specific group to Channel 0, the screen changes to:

Channel	Group	Gain	Offset	
0	— ↑	-200	10	WAVE
1	G01 ↑	NA	NA	
2	G02 ↑	150	-5	
3	G03 ↑	NA	NA	
4	G04 ↑	NA	NA	
5	— ↑	NA	NA	
6	— ↑	NA	NA	
7	— ↑	NA	NA	
8	— ↑	NA	NA	
9	— ↑	NA	NA	

ENTER ↑ CANCEL BACK

where WAVE function is now available.

Any group that is available (see Section 4.7.8 *Group Setup*) can be assigned to any output channel.

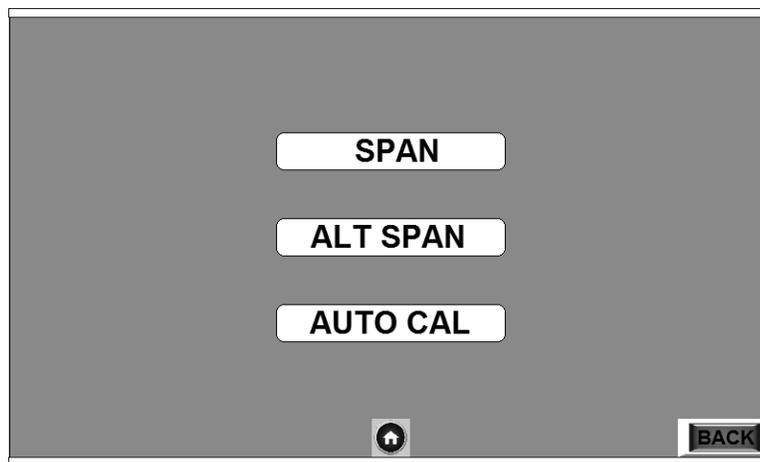
To assign a group to a channel: Press the UP Arrow button under group and it will start with G00, pressing UP again increments it to G01, and so on. After G09, it will return to G00.

4.7.10 Calibration

The SPAN function is used to calibrate the analyzer. Span can be performed either manually or automatically with the auto calibration function if equipped. Typically, each group will require a separate calibration.

The analyzer is calibrated using span gas as described in Section 4.1. See also *Appendix C Addendum and Testing Results* for any specific requirements regarding span gas for your application. This section assumes that this gas has been properly connected and the line checked for leaks.

To initiate a span calibration, touch the Calibration icon on the MAIN screen. The following screen is displayed.



4.7.10.1 SPAN

When user touches SPAN the following screen is displayed.



This screen allows the user to select which group or groups to calibrate. There are two separate screens, one for groups 0 through 4 and another for groups 5 through 10. Both screens function identically and allow the user to input the concentration of the known span gas for each group, set the concentration unit as parts per billion (ppb), parts per million (ppm) or percent (%) and span calibrate the group or groups.

Selecting “GROUP 0-4” brings up the following screen:

Group	Y/N	PPB	PPM	%
	<input checked="" type="radio"/>	<input type="text" value="0"/>	<input type="text" value="0.00"/>	<input checked="" type="radio"/> 78.14
	<input type="radio"/>	<input type="text" value="0"/>	<input type="text" value="0.00"/>	<input type="radio"/> 55.66
	<input type="radio"/>	<input type="text" value="0"/>	<input type="text" value="0.00"/>	<input type="radio"/> 60.78
	<input type="radio"/>	<input type="text" value="0"/>	<input type="text" value="0.00"/>	<input type="radio"/> 88.55
	<input checked="" type="radio"/>	<input type="text" value="0"/>	<input type="text" value="0.00"/>	<input type="radio"/> 90.23

A similar screen displays if Group 5-9 is selected.

Group	Y/N	PPB	PPM	%
	<input type="radio"/>	<input type="text" value="781400000"/>	<input type="text" value="781400.00"/>	<input checked="" type="radio"/> 78.14
	<input type="radio"/>	<input type="text" value="556600000"/>	<input type="text" value="556600.00"/>	<input type="radio"/> 55.66
	<input type="radio"/>	<input type="text" value="607800000"/>	<input type="text" value="607800.00"/>	<input type="radio"/> 60.78
	<input type="radio"/>	<input type="text" value="885500032"/>	<input type="text" value="885500.00"/>	<input type="radio"/> 88.55
	<input checked="" type="radio"/>	<input type="text" value="902300032"/>	<input type="text" value="902300.06"/>	<input type="radio"/> 90.23

A lit green LED next to a group indicates the group is enabled (selected) for calibration. An unlit green LED means the group has not been selected and will not be calibrated. Touching on the group’s LED will toggle the LED between lit (enabled) and unlit (deselected).

The SPAN value inputs for each selected group in any of the three units PPB, PPM or Percent can be entered by touching the respective yellow LED next to the correct unit input box. A numerical keyboard will pop up allowing the user to input the known composition of the

span gas. After inputting the value, press ENTER on the pop up keyboard to input the value into the box.

Only inputs with the glowing yellow LED will be affected. When user touches the ENTER button the inputs with the glowing yellow LED will be saved following confirmation on the pop up screen.



To initiate the calibration, touch the “SPAN BEGIN” button and then “OK” on the next pop up screen to calibrate the analyzer for the selected groups.

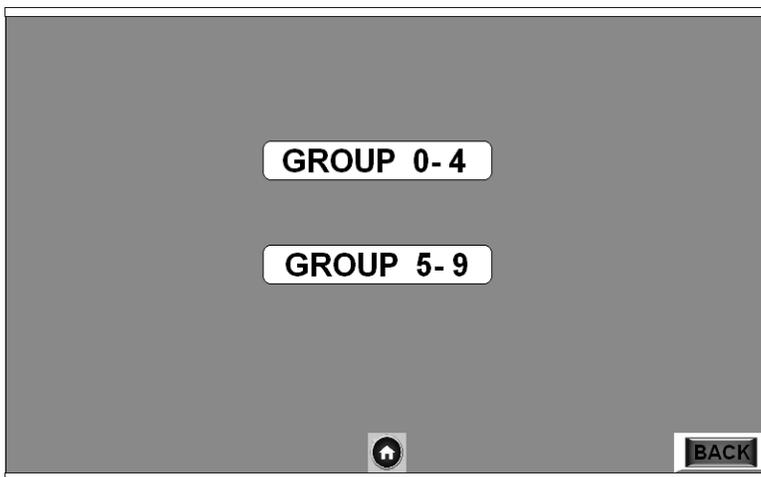


Once calibration is complete, the display will revert to the HOME screen. The same procedure can be followed for calibrating groups 5-9.

4.7.10.2 ALT SPAN

If a particular compound of interest is not available or not contained in the span gas, another compound existing in the span gas can be used for the alternate calibration. This requires assigning a factor that results in a best fit approximation to the calibration standard normally required for that group. These factors must be determined by the factory since entering an incorrect value will seriously affect the measurement capability of the instrument for that group. For this reason, TAI recommends contacting customer service before using the Alt Span function.

Touch the ALT SPAN listing on the Calibration screen to enter the Alt Span function. The following screen is displayed:



The function is split into two screens addressing to Groups 0-4 and 5-9. The screen below shows the display addressing Groups 0-4 (Group 5-9 screen is similar).

Group	Include	Factor
G00	<input type="radio"/>	↑04.2 ↑
G01	<input type="radio"/>	↑07.1 ↑
G02	<input type="radio"/>	↑04.3 ↑
G03	<input type="radio"/>	↑05.6 ↑
G05	<input type="radio"/>	↑10.0 ↑

At the bottom of the screen are buttons: ENTER, Perform AltSpan, a home button icon, CANCEL, and BACK.

In this screen a dark green color on the LED in the “Include” column adjacent to a group indicates that Alt Span is currently disabled for that group. A bright green LED indicates that Alt Span is enabled for the corresponding group. The Alt Factor value can be entered into the box in two phases i.e., an integer part using the UP arrow on the left and a fractional part using the UP arrow on the right.

Once the appropriate values have been entered select ENTER to save the factor. A confirmation screen will arise asking the user to confirm the changes before saving.



After confirmation, a display screen will appear where the user can be the currently saved factor. If you "Cancelled" the entry on the last screen, the previous Alt Span factor will be used.



To initiate an Alt Span calibration, touch "OK" to bring up the next screen to select which group to span on or "CANCEL" to exit the Alt Span function.

After pressing "OK" the next screen appears.



Use the "UP/DOWN" arrows to enter the group to span on and then press "ENTER" to begin the calibration or "CANCEL" to exit the function.

Once the calibration has completed the HOME screen will appear on the display.

Use the same procedure for performing an Alt Span on any member or members in Groups 5-9.

4.7.10.3 AUTO CAL

The GC-Pro FID Analyzer can be fitted with an external auto calibration module as an option. This feature provides automatic switching of sample and calibration gases and allows the operator to program calibration events to occur automatically

Note: If your instrument is not fitted with an auto calibration module, the auto calibration screens will still appear on the display but will be non-functional.

Note: Before setting up an AUTO CALIBRATION, be sure you understand the Span function as described in Section 4.7.10.1 and follow the procedures given there for inputting the calibration gas compositions for each group etc. Auto Span performs a span calibration using the target span value set that has been set in the Span feature menu.

To setup an auto calibration cycle for a span events to occur in a certain number of days/hours select the “Auto Cal” button from the Calibration screen. The Auto Cal screen is displayed.



A dark green color of the LED button adjacent to the Auto Span indicates that Auto Span is disabled while a bright green color means that the Auto Cal feature is enabled.

Touching the text box adjacent to either Days or Hours brings up a numeric keypad for entering the time between calibration events (up to 255 day and/ or 24 hours). On numeric display user can see max and min numeric value he can enter. After entering the value, press ENTER to place the value into the onscreen box (days or hours). When the correct values have been loaded into the Days and the Hours boxes, touch the Green LED adjacent to Auto Cal to toggle it to the lit (bright green) state. This enables the Auto Span feature. Or toggle it to the unlit (dark green) state to disable auto calibration.

After pressing ENTER, a confirmation window pops up. Selecting “OK” all inputs will be registered and the auto cal status as determined by the state of the green LED will become active.

Touching the CANCEL button will abort the present inputs and revert back to the last saved values and state.

Auto Cal countdown (if enabled) will begin as soon as the display returns to the HOME screen by pressing the HOME icon.

4.7.11 Self Test

The GC-Pro FID has a built-in self-diagnostic testing routine which automatically runs whenever the instrument is powered up. The self-testing routine can also be run by the operator at any time by pressing the Self-Test icon on the MAIN screen.

In the self-test routine, preprogrammed signals are sent through the power supply, output board, preamp board and sensor circuit. The return signal is analyzed, and at the end of the test the status of each function is displayed on the screen as either “GOOD” or “BAD”. If any of the functions fail, the System Alarm is tripped.

Note: The self diagnostics will interrupt analysis temporarily.

To initiate a self-test from the MAIN screen press the Self Test icon and then select either “Main Board” or “9261 Board”

Selecting “Main Board” displays the following screen:

RUNNING DIAGNOSTICS	
TESTS	RESULTS
5V Test	
15V Test	
DAC A Test	
DAC B Test	

After about one minute the results of the self test is displayed as “GOOD” or “BAD” for the various tests. Once the diagnostic test has begun, it cannot be stopped. After performing the self test the display will revert back to the Self Test screen where you can continue the diagnostics by selecting “9261 Board”.

RUNNING DIAGNOSTICS	
TESTS	RESULTS
5V Test	
15V Test	
DAC A Test	
DAC B Test	
T1 Test	
T2 Test	
T3 Test	
T4 Test	

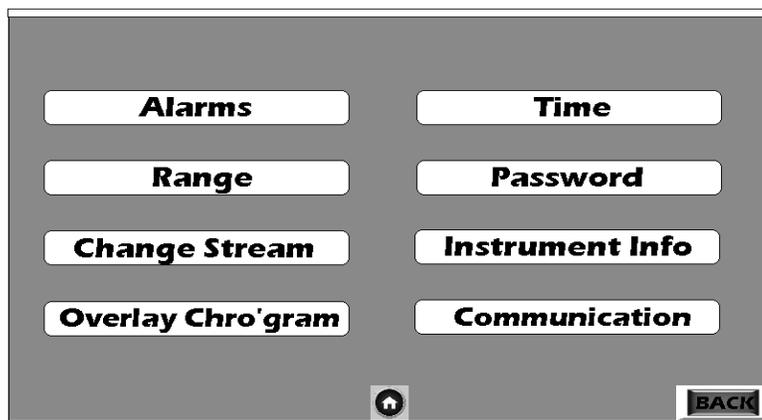
After about one minute the results of the self tests are displayed as “GOOD” or “BAD”. The T1 to T4 tests analyze the 4 thermocouples for continuity. Once the user enters into this screen there is no option for stopping the self test in the middle. After performing the self test the screen automatically reverts back to the self test screen.

4.7.12 Settings

Touching the Settings icon brings up a screen with eight functions that are used to customize the analyzer to your specific needs. The functions available are:

- ALARMS: Used to set the alarm setpoints and determine whether each alarm will be active or defeated, HI or LO acting, and failsafe or not.
- RANGE: Used to set up three analysis ranges that can be switched manually.
- CHANGE STREAM: Used to manually switch between sample and calibration gas.
- PASSWORD: Used to establish password protection or change the existing password.
- OVERLAY CHROMATOGRAM:
- TIME: Used to set the current date and time on the instrument.
- INSTRUMENT INFORMATION: Displays Manufacturer, Model, and Software version of the instrument.
- COMMUNICATION: Selects between four different RS232 protocols.

Pressing the “Settings” icon displays the following screen:

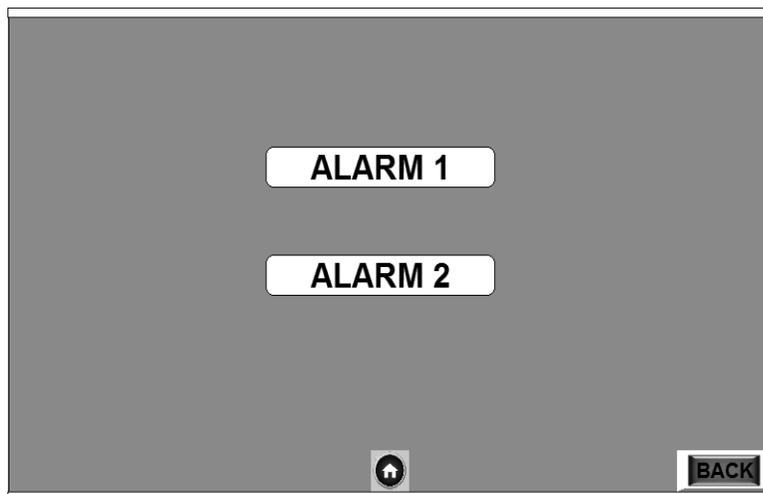


4.7.12.1 ALARMS

The GC-Pro FID provides two concentration alarms with relays. When an alarm condition exists, the relay or relays will change state. The relays are available from the 50-pin Equipment Connector as described in Section 3.3.2.5 and 3.3.2.9. The alarms screens are used to configure how the concentration alarms operate.

There are two identical screens within the ALARMS function, one for setting the parameters on ALARM 1 and the other for ALARM 2.

Pressing the ALARMS button brings up a screen where you can change or view the alarm parameters for either Alarm 1 or Alarm 2.



Selecting ALARM 1 displays the following screen:

The screenshot shows a configuration screen for ALARM 1. The title 'ALARM 1' is centered at the top. Below it are four rows of settings, each with a radio button to its right: 'Active / Defeated', 'High / Low', 'Failsafe / Non-Failsafe', and 'Latching / Non-Latching'. Below these is a 'Trigger Value' field with a text box containing '0.00'. The 'Source' field contains '0' and has up and down arrow buttons next to it. At the bottom of the screen are four buttons: 'ENTER', a home icon, 'CANCEL', and 'BACK'.

From this screen you can make Alarm 1 active or defeated, configure it as a high or low alarm, failsafe or non-failsafe and whether the alarm will be latching or non-latching by touching the respective LED's.

The user can enter the trigger value (alarm setpoint) by touching in the Trigger Value box. This causes a numeric keypad to display for entering the value. Hit ENTER to close down the keypad and enter the value into the Trigger Value box.

The user can also select the group to which the Alarm will be associated by using the UP/DOWN arrows adjacent to the Source box.

The configurable items are as follows:

DEFEATED: If an alarm is defeated, its relay is de-energized, regardless of failsafe condition. A defeated alarm does not react to a transition over its trip point in either direction.

HIGH: If an alarm is set as HIGH, it will not create a new alarm condition (see latching) if the analysis concentration is below the trip point, if the analysis concentration is above the trip point, then an alarm condition will be created or maintained.

FAILSAFE: A non-defeated alarm that is in FAILSAFE mode *energizes* an alarm relay in a non-alarm condition and *de-energizes* an alarm relay in an alarm condition.

Note: Failsafe condition of an alarm is a software property. This

is not related to relays that have both normally-open and normally-closed terminals.

LATCHING: The latching property configures the alarm such that the user must manually relieve the alarm condition even though the concentration no longer violates the trip point of the alarm. So, if an alarm is NON-LATCHING, and the analysis concentration temporarily drifts above the trip point of a HIGH alarm, the alarm condition occurs only during the time the concentration is above the trip point. If that alarm were LATCHING, the alarm condition would persist (even though the concentration is no longer above the trip point), until the user released it.

RELEASING A LATCHED ALARM: When alarm conditions are present, the relay associated with that alarm changes state. To reset from an alarm condition, enter the Alarm 1 or Alarm 2 screen and disable the alarm. Then re-enable the alarm. If the alarm condition still exists, the alarm will again trigger.

TRIGGER POINT: This is the threshold at which an active alarm can enter into alarm condition. If an alarm is HIGH, ACTIVE, and set at 20.00 ppb, then when the analysis concentration is at or above 20.00 ppb an alarm condition is initiated or maintained.

CAUTION:



IT IS NOT GOOD PRACTICE TO SILENCE AN EXISTING ALARM BY SETTING THE ALARM ATTRIBUTE TO 'DEFEAT'. THE ALARM WILL NOT AUTOMATICALLY RETURN TO "ACTIVE" STATUS. IT MUST BE RESET BY THE OPERATOR. IF IT IS NOT RESET, YOUR PROCESS WILL BE RUNNING WITHOUT THE SAFEGUARDS THIS INSTRUMENT IS DESIGNED TO PROVIDE.

When finished configuring the alarms, touch the ENTER button at the bottom right corner of the screen. A confirmation window will pop up and by selecting "OK" the new alarm configuration will be the active settings. Then, by touching the HOME icon, all alarm 1 inputs will be saved permanently. Touching the CANCEL button will abort the inputs and return the previously saved values.

The ALARM 2 screen is an identical screen for configuring ALARM 2.

Note: An alarm in 'alarm condition' is signaling that action must be taken such as correcting the alarm or the analysis concentration. If an active (not defeated) alarm has been set to HIGH at 20.0 ppb, and the analysis concentration is above that level, then the 'alarm condition' is occurring.

4.7.12.2 RANGE

There are three settable analysis ranges on the GC-Pro FID Analyzer. Both upper and lower bounds may be set. The value of each limit on the currently selected range affects the corresponding upper and lower value of the voltage and current of the analog outputs of the analyzer as well as contact closures (if present) indicating which range is current. The analog outputs from the 50-pin Equipment connector (see Section 3.3.2.3 and Table 3-1) represent the proportion of the analysis concentration to the currently selected range limit.

RANGE LIMITS: Ranges may be set for ppb, ppm, or percent analysis however, range 3 can only be set at a value greater than range 2 and range 2 can only be set at a value greater than range 1. In addition, the lower bound on each range must always be less than the upper bound.

To set the ranges select “Range” from the SETTINGS screen. The following screen will appear:

Range		PPB	PPM	%
Range 3	HIGH	100000000	1000000.00	100.00
	LOW	950000000	950000.00	95.00
Range 2	HIGH	100	0.10	0.00
	LOW	0	0.00	0.00
Range 1	HIGH	10	0.01	0.00
	LOW	0	0.00	0.00

ENTER HOME CANCEL BACK

Once the input range has been decided, press the corresponding LED icon to turn it on. Touch the input box and a numerical keypad will display from which you can enter the upper range limit (the lower limit on each range is always zero). Once the value is entered, press ENTER to dismiss the keypad and enter the value into the range box selected.

When finished, touch the ENTER button and the inputs with the glowing yellow LED will be converted in other available units and a confirmation pop up window will appear. Press “OK” button to proceed further.



Repeat the procedure for the other two ranges.

If the range values entered by the user does not follow the order $R3 > R2 > R1$ then a warning will display.



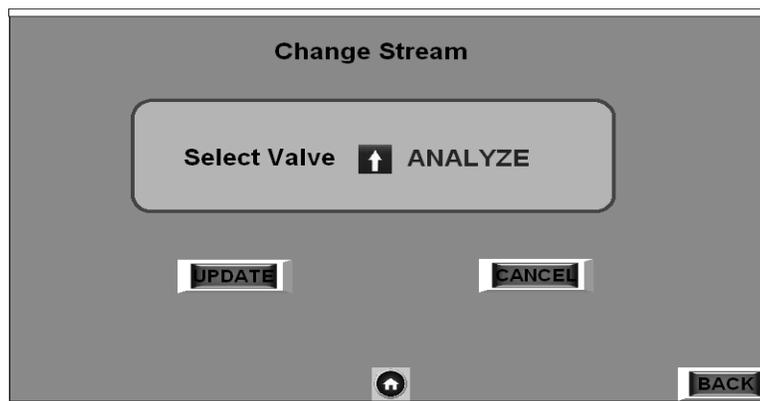
Touching the “OK” button allows the user to input the values again. If the input values follow the order $R3 > R2 > R1$; a final confirmation window pops up on the screen. Select OK to save or CANCEL ignore the entered inputs.

4.7.12.3 CHANGE STREAM

The Change Stream function is used to manually select between sample and calibration (span and zero) gases.

Note: If the analyzer is equipped with the Auto Calibration feature, input from this screen will override the Auto Calibration status.

To manually change the gas stream sent to the analyzer, press Change Stream from the SETTINGS screen. The following screen will appear:



Touch the UP arrow to toggle the display between ANALYZE/SPAN /ZERO. Pressing UPDATE will select the displayed stream and open the corresponding valve. Use CANCEL to abort the selection.

The user can return to the analyze mode by pressing the HOME icon or go back to the SETTINGS screen by touching the BACK button.

4.7.12.4 TIME

The date and time are set from the Time screen. Select Time from the SETTINGS screen.

Touching any of the Date and Time value boxes will bring up a numerical keypad that allows the date and time to be input. The time settings entered in this screen sets the RTC which is interfaced to 9261 board on the I2C interface.

After selecting Time, the following below screen displays:

DATE

Date Month Year

TIME

Hour Minute Second

After entering each value press the “Enter” button on the keypad to input the number and move to the next field. When all inputs have been made, press the ENTER button on the display screen and then respond to the confirmation display that appears.

Do you want set time?

Pressing “OK” saves the new date and time settings.

4.7.12.5 PASSWORD

There are two functions in the GC-Pro FID that if misused can result in significant changes to the instrument. These are: Default Settings from a Cold Boot (Section 4.7.13.5) and Firmware Upgrade. These functions are therefore password protected functions.

The password is assignable by the user or the default password “11111” can be used. The password can be any number between 1 and 99999.

To assign a new password, press “Password” from the SETTINGS screen. The following screen will appear:



Touching the password box will display a numeric keypad allowing the new password to be entered. Press ENTER on the keypad to dismiss the keypad and insert the new password into the box.

Pressing the HOME icon installs the password and places the analyzer back into the analyze mode. Pressing BACK also installs the new password but returns the display to the SETTINGS screen.

4.7.12.6 COMMUNICATION

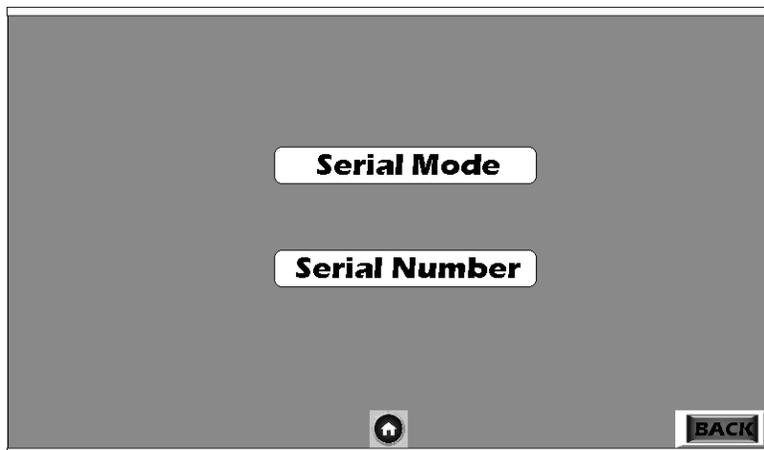
There are four different serial communications modes available to the user and these are accessible from the Communications screen.

The available modes are:

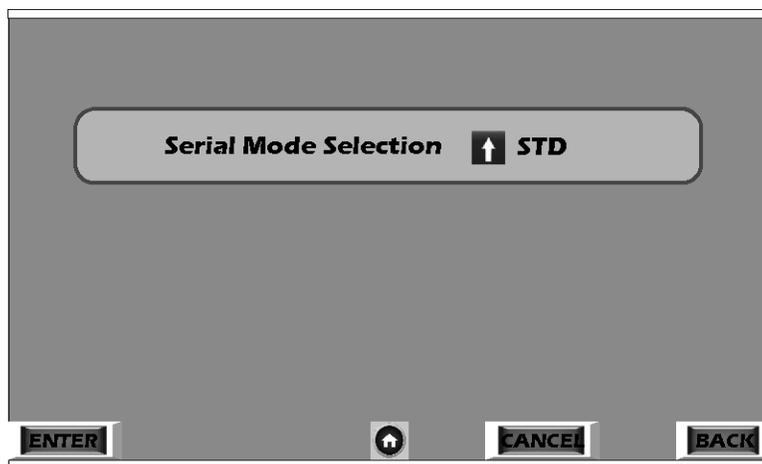
- **Detect Mode:** Used with a laptop computer running custom TAI software and is designed to interact with the chromatogram screen. (Contact TAI for software upgrade).
- **Query Mode:** A specialized communication protocol that enables interaction with the analyzer via an OPC server.
- **Profi Mode:** This mode is compatible with a Teledyne Valve Box (VB1-VB5) used in switching gas streams to an analyzer.
- **STD Mode:** The standard mode outputs a text string every two seconds that includes concentration, range, and alarm status. If there are multiple

components (groups) being analyzed, the output will cycle through each component in sequence.

Press the Communications icon on the SETTINGS screen to enter the communications function.



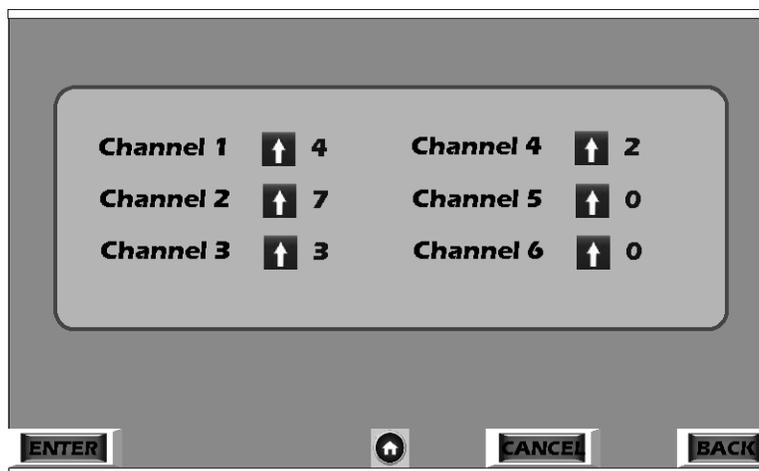
The user can shift between different serial modes by selecting the "Serial Mode" from the above screen and then on the next screen using the UP arrow button, cycle through the modes until the desired mode is



presented. Select the mode using the ENTER button.

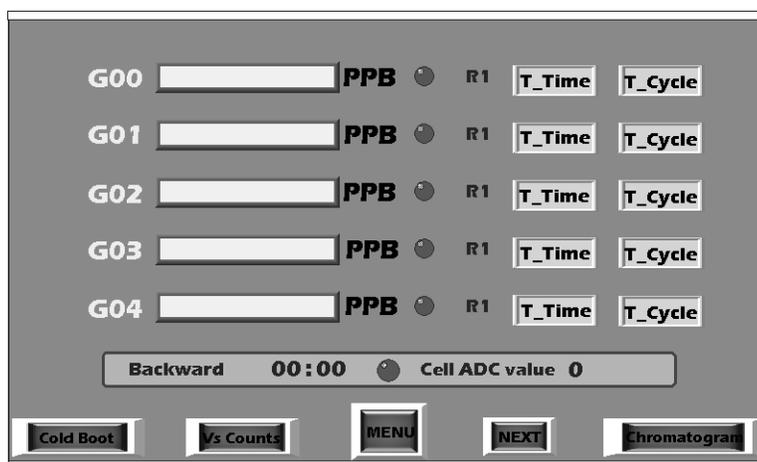
Selecting Serial Number from the Communications Screen produces another screen which allows the user to input the serial number for the

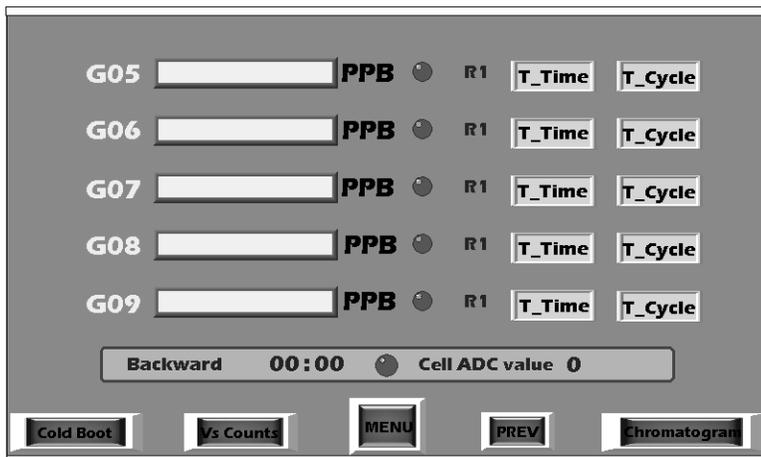
analyzer which is used by the RS232 when in Profi mode to identify the analyzer. Use the UP Arrow and then select the ENTER button next to each channel. The following example screen has the analyzer serial number set to 473200. The default serial is 100000.



4.7.13 Analysis Mode

Analysis mode is the default mode of the instrument where measurements are updated after each cycle (forward + reverse) and displayed on the HOME screen.



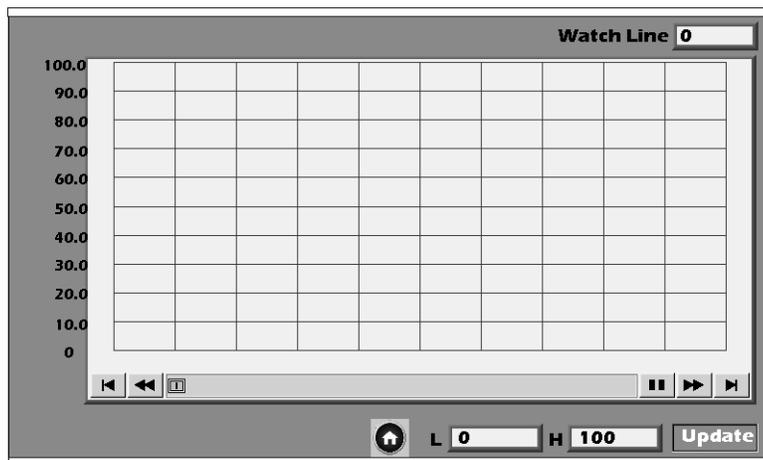


The GC-Pro FID is analyzing in both the forward and reverse cycles and measurement value integrated over the last complete cycle is shown in the display box adjacent to the group identifier (G00-G09, Bnz, etc.) for any group that has been activated (LED lit). See Group Setup for activating a group. The cycle direction and time into the cycle are shown in the lower box as is the current ADC output value. The current analysis range is indicated next to the Group LED.

4.7.13.1 T-TIME

Each group has “T_Time” and “T-Cycle” selectable buttons associated with it that will bring up a graph displaying the analysis trend in the group with respect to time or cycle. With these buttons, the user can evaluate the instantaneous analysis as opposed to waiting for a complete cycle to terminate.

The T_Trend screen shows the analysis trend with respect to time.



This screen displays the concentration behavior or trend for the group on y axis against the time into the cycle on the x axis.

Low and High values can be set for the y axis using the “L” and “H” boxes below the graph. Touching the “Update” button will reformat the y axis index with the new input.

It is possible to view the instantaneous value by touching the trend graph at the location of interest and the corresponding value will be displayed in “Watch Line” box at the top right corner.

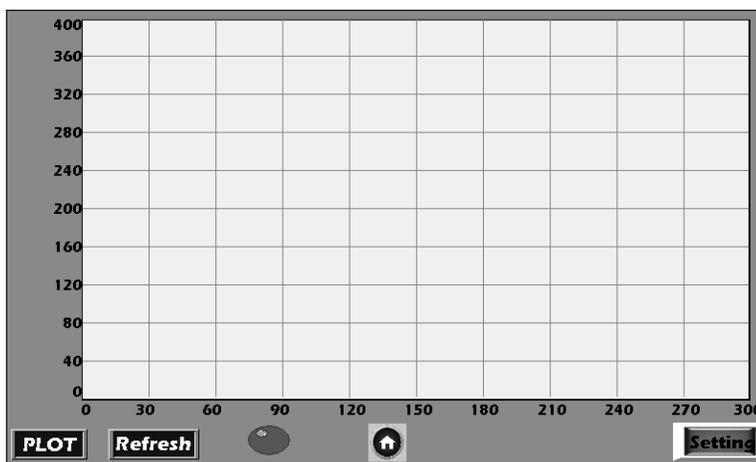
Note: The LOW and HIGH values must be updated by the user as soon as system is powered on.

Note: The trend graph will not be plotted continuously; it needs to be refreshed manually. To refresh the trend screen, press the HOME button to return to the HOME screen and then re-enter the trend screen by pressing trend button.

4.7.13.2 T_CYCLE

Similar to the above function, the T_Cycle button displays a graph of group concentration versus cycles.

The T_Cycle is display is shown below.

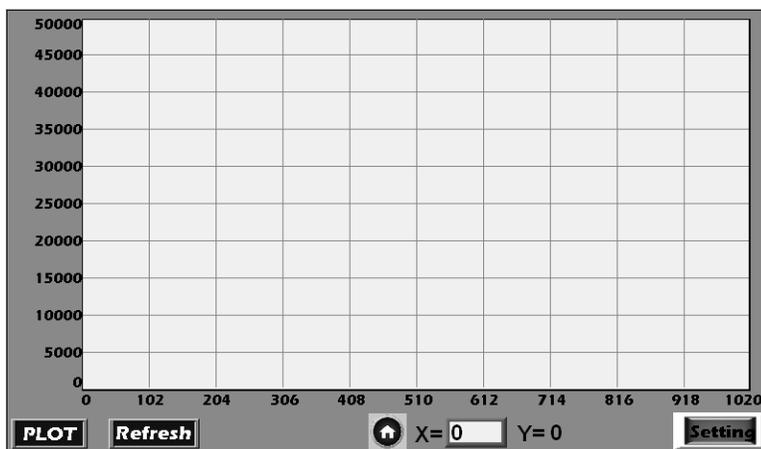


Both X-axis (number of cycles) and y-axis (concentration) can be changed by touching the “Setting” button. The maximum number of cycles that can be plotted is 300.

4.7.13.3 CHROMATOGRAM

The Chromatogram function is available from the HOME screen using the “Chromatogram” button on the lower right corner of the screen. This function displays the ADC count as a function of the number of samples taken (seconds). It is useful for troubleshooting as well as setting up new applications.

Selecting “Chromatogram” from the HOME screen brings up the following screen:



Touching the “PLOT” button will display the graph on the screen and touching the “Refresh” button will clear it. Low and high limits on both the X and Y axis can be changed by touching the “Setting” button. This will cause the following screen to appear:

Note: The Chromatogram will be displayed for maximum 1020 samples. The chromatogram will not be displayed if the total sum of the forward and backward phase duration is greater than 1020 seconds.

Note: User can view the Y axis value in digital format by entering the corresponding X axis value in the field provided with X= symbol.

Values for the X and Y axis are entered by touching the input box. A numerical keypad appears that allows for numeric entry. Press ENTER on the keypad to enter the value into the appropriate box and dismiss the keypad. Repeat for each input box requiring an entry or change. Upon final entry, press Chromatogram button to return to the Chromatogram screen. The new X-axis and Y-axis values will be displayed on the screen. The limit for X-High is 1020 i.e., 1020 seconds. So the maximum cycle time which is the sum of the Forward and Backward phase duration should not exceed 1020 seconds (17 min) for the chromatogram.

4.7.13.4 VS COUNT

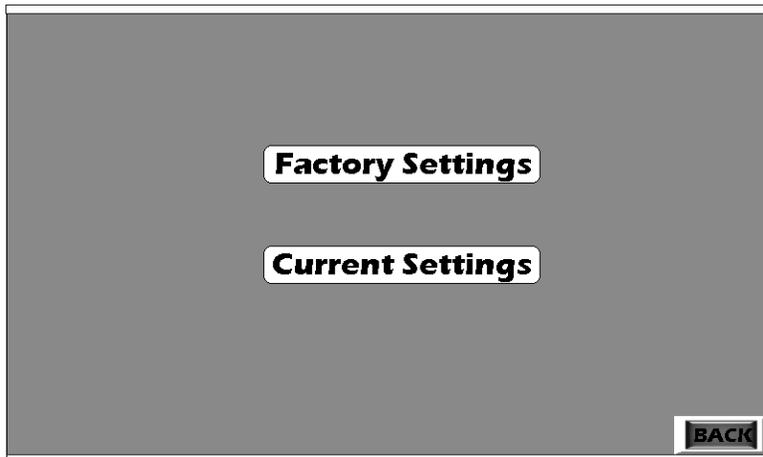
The VS (Volt-seconds) count is a measure of the conditioned signal coming from the detector. It corresponds to the strength of the output signal from the detector. The VS measure is a relative value and has no absolute relationship to concentration between groups.

4.7.13.5 COLD BOOT

The “Cold Boot” button on the HOME screen provides the user with the option of resuming the system with user configured settings or restoring the analyzer back to the default factory settings for all parameters.

The Cold Boot function is a password protected function. The default password is ‘11111’. If the password has been changed (see Section 4.7.12.5) then the new password must be entered to gain entry into the function that allows a change from the current setting.

Pressing “Cold Boot” from the HOME screen brings up the following screen:



Selecting “Current Setting” causes the analyzer to use all the functions and settings that are presently in force, i.e. no change to the presently saved system configuration. A confirmation window pops up whereby selecting ‘OK” causes the instrument to start up as normal with the present configuration. Pressing “Cancel” reverts the display to the previous screen with no change.



However, if Factory Settings is selected, a Password Entry screen will display requiring the user to input the system password (Default Password is “11111”). After the password is input an “Access Check” pop up window will display requiring the Password to be re-entered. Press “OK” when done.



The validation LED should glow green which means the password has been entered correctly otherwise, the password is incorrect and you will be required to enter it again.

Since this function may drastically alter the settings on the analyzer, once the password has been re-entered correctly and “OK” is pressed, a final Warning screen will appear.



Pressing “OK” will then reset the analyzer to the default configuration with the parameters set as described in Appendix C.

Maintenance & Troubleshooting

WARNING: *DANGEROUS HIGH VOLTAGES EXIST INSIDE THIS INSTRUMENT.*



THERE ARE NO USER SERVICEABLE PARTS WITHIN THE COVER ON THE INSIDE OF THE DOOR, INSIDE THE ISOTHERMAL CHAMBER, (SAMPLE SYSTEM), AND ON THE ELECTROMETER-AMPLIFIER PC BOARD. WORK IN THESE AREAS MUST BE PERFORMED BY AUTHORIZED AND TRAINED PERSONNEL ONLY.

BEFORE STARTING ANY OF THESE MAINTENANCE AND TROUBLESHOOTING PROCEDURES, READ THE CAUTIONS AND WARNINGS INCLUDED IN THE SECTION TITLED "ADDITIONAL SAFETY WARNINGS". PAY SPECIFIC ATTENTION TO THE PROCEDURES FOR REMOVAL OF INTERNAL INACCESSIBLE SHOCK HAZARDS. IF THE INSTRUMENT MUST BE TURNED ON DURING ANY OF THESE MAINTENANCE AND TROUBLESHOOTING PROCEDURES, BE CAREFUL AND WORK WITH THE ONE HAND RULE:

Work with one hand only.

Keep the other hand free without contacting any other object. This reduces the possibility of a ground path through the body in case of accidental contact with hazardous voltages.

CAUTION: *MANY OF THE ELECTRICAL PARTS WITHIN THE ANALYZER ARE SUSCEPTIBLE TO DAMAGE FROM ELECTROSTATIC DISCHARGE (ESD). USE ESD SAFE PROCEDURES WHEN HANDLING OR WORKING WITH ELECTRONIC COMPONENTS.*



If the analyzer is suspected of incorrect operation, always evaluate performance with zero or span gas flowing in the sample path. Never

attempt to evaluate performance on sample gas. If analyzer sensitivity is questionable, use the span gas. For all other evaluations, use the zero gas and low range for maximum sensitivity. The important consideration is to control as many variables as possible. Using cylinder-supplied gases of known hydrocarbon content eliminates the possibility of introducing an unknown variable.

Do not overlook the seemingly obvious. Check to see that power is available for the instrument (and of the proper voltage, etc.), and that connections are correct. Also verify that support/calibration gases are not depleted.

5.1 Measuring Circuit Electrical Checks

If the analyzer performs erratically on span gas, the trouble can be related to either the integral gas control systems, or the electronics. To isolate the problem, the two systems must be separated. To isolate the electronics, employ the following procedure:

- Open the door to the analyzer, remove and disconnect the collector cable from the sensor leaving it attached to the electrometer board. (Consult schematic and assembly drawings for circuitry and location). With this cable disconnected, the electronic circuitry is completely isolated from the gas control system and cell.

5.1.1 Anode Voltage Check

If the output can be adjusted by the zero control (the above section, step 2), the cell anode voltage should be verified as follows:

WARNING: *THESE PROCEDURES SHOULD BE CARRIED OUT ONLY BY PERSONNEL FAMILIAR WITH HIGH VOLTAGE CIRCUIT BOARDS. THE ANODE-IGNITER UNIT AND ASSOCIATE CIRCUITRY INVOLVE DANGEROUSLY HIGH VOLTAGES.*



Refer to the cell wiring diagram. Using a voltmeter set to measure 125 VDC, check the voltage on either of the anode-igniter electrodes, as follows:

1. Connect the **negative** voltmeter lead to ground and the **positive** lead to either electrode. Be careful not to short the circuit by touching both an electrode and the cell body simultaneously. The reading obtained should be 125±10 VDC.

2. If no reading is obtained, disconnect the anode-igniter cable and check for the voltage on pin “J4-1” of the connector located at PC board part number B74671. If the proper voltage is still not present, replace the flame guard and anode power supply PC board. If it is, check the wiring in the anode-igniter cable plug. If necessary, the circuit board can be replaced by first turning off the power, then removing 4 screws holding the board.

WARNING: *DO NOT TOUCH CAPACITOR C1 OR C2 OR THEIR RELATED CIRCUIT FOILS. A SHOCK HAZARD MAY EXIST.*



3. Carefully remove the circuit board without touching any connections which might lead to C1 or C2. After removal, discharge the two capacitors by placing a jumper wire across each.
4. The anode voltage may also disappear or be greatly diminished when condensation inside the sensor has occurred, shorting the igniter to the sensor body across the wet insulator. This usually occurs when the flame is turned on, if the sensor has not been preheated for at least 1 hour.

5.1.2 Electronic Stability

If the checks outlined above indicate that conditions are normal, allow the analyzer to run electronically with the collector cable disconnected for several hours in the lowest range, and with the zero offset value adjusted so that the recorder is reading midscale. If all is normal electronically, a noise-free (pen width) recording, showing absolutely no instability, should be obtained for as long as the analyzer is allowed to run in this configuration. If the recording obtained is noisy or erratic, replace the electrometer-amplifier PC board.

5.1.3 Printed Circuit Board Replacement

If performance is not adequate, then the analyzer must be recalibrated as described in Section 4.7.10.1: *Span* before being placed back in service.

Whenever the flame guard and anode power supply printed circuit board have been replaced the analyzer must be recalibrated.

If the instrument performs as outlined in this section, the problem is not related to the measuring circuit electronics.

5.1.4 Collector Cable

Before reconnecting the collector cable, check the continuity of the center wire of the cable with an ohmmeter by measuring between the center pins at each plug on the lowest resistance scale of the meter. Flex the cable while making this measurement to be sure that there is not an intermittent open circuit. If there is, replace the cable. Do not attempt to repair the cable, as special tooling is required to disassemble and reassemble the cable plugs.

5.2 Temperature Control Electronic Check

If the heating circuit fails, the output of the analyzer will tend to drift with changes in ambient temperature. Such a failure will be more evident in the low range. If the temperature environment surrounding the analyzer is closely regulated, failure in this circuit might go unnoticed after the initial failure. If the environment follows day and night temperature changes, the analyzer will show a diurnal, bi-directional drift when operated on zero gas. The magnitude of the drift will be a function of the temperature differential experienced by the analyzer. To check the circuit, employ the following procedure:

Consult the GC-Pro FID schematic and assembly drawings, as well as the temperature control PC board schematic and assembly drawings at the rear of the manual for circuit details and component placement.

An indicator light behind the analyzer door cycles on and off with the heating element; the light is on when the heater is on, and vice versa. Failure of the light to come on at all when the cell compartment is cold indicates a problem in the temperature sensing or control circuitry or the wiring that interconnects the thermistor to the circuit. If the light stays on constantly, but the compartment does not heat up, then a problem with the heating element or connecting wiring is indicated.

1. Check the sensing thermistor by measuring the resistance between its connecting wires. Disconnect one of the thermistor wires from terminal strip on the temperature controller board, P/N B30927, the wires out of the thermistor are yellow, and



measure resistance between that wire and the remaining undisturbed terminal. Resistance of the thermistor varies with its surrounding temperature. A reading of between 10KOhms and 16Kohms at around 25°C may be measured. (Under very cold conditions, the resistance could be as high as 50KOhms; under hot conditions, just a few thousand ohms.) If the thermistor measures anywhere in this range, it is most likely OK. Otherwise, if the circuit is short or open, check the wires leading to the thermistor,

2. Check the heating element by measuring its resistance. Disconnect one of the heater wires from either terminal 2 or terminal 4 on the temperature control board P/N B30927, heater wires are black, and check the resistance between that wire and the remaining undisturbed terminal. If a reading of approximately 100 Ohms, then the heating element is most likely OK. If an open circuit is found, check the heater wires and a possible connector between the heater and temperature control board. If no problems are found, and the heater circuit is open, then replace the heater element.

Note: If any of the components located inside the isothermal chamber has failed, the instrument must be removed for service. If no problems are found with either the thermistor or the heater circuits, then replace the temperature control board.

5.3 Ignition and/or Flame Guard Circuit Checks

If the flame guard circuit will not hold the flame-out lamp off when the ignition procedure is employed (see section 4.6 *Flame Ignition*), perform the following procedure to isolate the problem (consult the system schematic for details of the circuit):

1. Disconnect the anode-igniter/flame guard thermistor cable from the socket.
2. Check the flame guard sensing thermistor by measuring the resistance between pins J4-3&4 of PCB part number B74671, disconnect the cable plug. The reading should be about 100 K Ω at room temperature. The actual resistance is not important, since the thermistor experiences radical changes in resistance as the temperature changes. No indication in a sufficiently high range on

the ohmmeter indicates an open thermistor. (If the thermistor is hot, the resistance will be much lower.)

3. Check the anode-igniter coil for continuity by measuring between pins J4-1&2 of the disconnected cable plug. The ohmmeter should indicate a short circuit.
4. If either step 2 or 3 does not check as indicated, remove the electrode assembly of the detection cell and replace it. If the quartz flame tip is damaged, the top section of the cell may be removed by disconnecting the vent line, and removing the screws around its flange. Return the unit complete with attached electrode cable. If steps 2 and 3 both check out properly, reconnect the anode-igniter cable.
5. Check K1 and K2 relays operation as the analyzer is RE-IGNITING. If the relays do not energize, remove the flame guard power supply board and check the forward and backward resistance of its transient suppression diode by measuring pins 13 and 14 of the relay socket. The ohmmeter should indicate a short circuit resistance in one direction and some resistance value when the leads are reversed. If the indication is a short circuit, then the diode must be replaced.

Note: If, after replacing a defective diode, the circuit still does not work properly, the flame guard circuit components have been damaged, and the PC board must be replaced.

6. If the preceding steps check out correctly, the flame guard portion of the circuitry on the flame guard/anode power supply PC board is defective.

IMPORTANT: If the circuit proves defective, the analyzer will have to be recalibrated after the board is replaced.

5.4 Sampling System

If the procedures outlined above do not correct the problem, the fault must be related to the gas control systems. Plugged or faulty regulators, plugged restrictors, or leaks within the system can cause erratic performance. TAI recommends that the factory or an authorized representative be contacted before attempting any repairs to the sample or supporting gas systems within the analyzer.



5.5 Printed Circuit Board Descriptions

The electronic circuitry of the analyzer is designed with the latest integrated circuit technology. The individual circuits which are required to process the incoming signal and condition it to provide the various outputs, alarms, indicators, etc.,

5.5.1 Flame Guard and Anode Power Supply PCB

Schematic No. B-74672

Assembly Dwg. No. B-74671

Anode Power Supply: The high voltage anode power supply components are mounted on the flame guard and anode power supply printed circuit board. High voltage regulation is achieved through the use of zener diodes. The simplicity of this circuit's design can be attributed to the extremely low current demand of the anode circuit. The positive output voltage is nominally 125 volts. Output tolerance is ± 10 volts from the specified 250 volts, due to variation in components from unit to unit.

Flame Guard Circuit: A thermistor-controlled, comparator circuit is employed to operate relays in the event of a flame-out condition. A panel indicator light is turned on by the relay to alarm personnel that a flame-out condition has occurred.

The controlling thermistor is located within the upper section of the cell assembly. The electronic circuit components and relays are mounted on the same printed circuit board as the anode power supply. The indicator light on the control panel.

The thermistor is located in the circuit so that it controls the input of comparator. The circuit is factory set so that with the flame burning, the output of comparator is low. The microprocessor senses the low input and in turn sends 5VDC to turn on Q1, this holds the relay energized. When energized, the relay extinguishes the Flame Out indicator light. Conversely, if the flame goes out, bias to the switching transistor is lost, the relay drops out, and the Flame Out light receives power through normally closed contacts.

During ignition, the flame heats the thermistor, holding the relay in the energized condition and the indicator light off. If the Flame Out light comes on as the analyzer returns analyzing mode, then the flame is not burning, and the ignition procedure must be repeated.

5.5.2 Proportional Temperature Controller PCB

Schematic No. B-30974

Assembly Dwg. No. B-30927

The temperature of the chamber to be controlled is regulated by a thermistor-directed electronic circuit. The thermistor and heating element are located in the chamber, and the balance of the circuit components are mounted on the temperature controller printed circuit board, which plugs into a connector on the motherboard.

The control temperature is determined by the value of resistor R3 and C3 on the temperature controller printed circuit board, selected (at the time of manufacture) from the chart on schematic B-30974 to provide the desired control point.

The thermistor used in the circuit is a negative temperature coefficient (NTC) device; as the chamber temperature increases, the resistance of the thermistor decreases, and vice versa.

The resistance of the thermistor in the circuit is compared with the value of resistor R3; when their resistance is equal, or when the resistance of R3 is less than that of the thermistor, the heating circuit is activated.

When a temperature deficiency is sensed by the thermistor, integrated circuit A1, acting as a zero-crossing switch, applies a pulsed signal to triac Q1, which in turn applies full wave power to the heating element.

IC A1 employs a diode limiter, a zero-crossing (threshold) detector, an on-off sensing amplifier (differential comparator), and a Darlington output driver (thyristor gating circuit) to provide the basic switching action. The DC operating voltages for these stages are provided by an internal power supply, with only capacitor C4 added externally.

The on-off sensing amplifier in this circuit is configured as a free-running multivibrator. This scheme adds proportional control, which takes over when the comparator inputs are at the design differential voltage.

Initially, when cold, the thermistor resistance is large, and the voltage at pin 7 is larger than that at pin 8. As the temperature of the controlled chamber begins to rise, the resistance of the thermistor decreases, thus reducing the voltage at pin 8. During this warm-up time



the thyristor gating circuit is continuously delivering gate current from pin 4 of A1, thus maintaining constant full wave AC power to the heater.

When the temperature reaches the selected control point, pin 13 voltage is about the same as pin 9 voltage, and proportional control takes over. The rate at which thyristor (triac) Q1 conducts and allows power to be delivered to the heater is determined by the combination of components R2 & R3, R4, C3, R5, and the thermistor resistance at the control temperature. Consequently, the balance point of the bridge formed by this combination of components can be altered by the selection of R3, causing the circuit to seek a temperature at which the thermistor resistance balances the bridge.

Because IC A1 triggers the thyristor at zero-voltage points in the supply voltage cycle, transient load current surges and radio frequency interference (RFI) are substantially reduced. In addition, use of the zero-voltage-switch reduces the rate of change of on-state current (di/dt) in the thyristor.

5.5.3 Electrometer-Amplifier PCB

Schematic No. B79159

Assembly Dwg. No. B79153A

The ions formed in the process of burning hydrogen in the presence of hydrocarbon components of the sample gas cause an electrical conduction between two electrodes in the combustion chamber (or detector cell) that is amplified by a high sensitivity and high input impedance electrometer-amplifier circuit. The electrical output of the electrometer-amplifier is directly proportional to the quantity of flame ionizable hydrocarbons present.

The electrometer amplifier PC board is located on the side of sample module, interconnected to the electronic circuitry by means of a single 8 pins cable, so that the ease of replacement of a board is maintained. The high input impedance requires a shield, or cover, which is removable for access, as well as a shielded input conductor. Interconnection with the collector is made by a coaxial cable.

Although the cable and fittings are intended for coaxial service, the cable is actually being used as a shielded single-conductor connection. The collector cable plugs into a coaxial connector on the electrometer amplifier PC board, which is located at the side of the sample module.

The circuit consists of an electrometer amplifier and an operational amplifier. It is a very high-gain, current-to-voltage converter circuit, having an input impedance measuring in the billions of ohms. It is static sensitive and highly susceptible to contamination, and special handling precautions must be taken.

Because of its high impedance, the input circuitry to the electrometer has had careful design consideration. The resistors (R2 and R3) in the input gain circuit (see schematic) are installed on Teflon-insulated standoffs, instead of directly to the printed circuit, to eliminate the possibility of leakage currents.

To eliminate any possibility of contamination of the insulating materials employed, the completed PC board is ultrasonically cleaned in laboratory grade alcohol. **Under no circumstances should the parts described be handled with bare fingers.** A freshly-scrubbed finger, stroked along one of the glass resistors, would deposit enough skin oil to completely upset the range division of the attenuator circuit.

Resistor R3 is a 1000 M Ω resistor used in the feedback circuit of the amplifier. R2 has a resistance of 10,000 M Ω and is used in series with the zero potentiometer slider. This circuit is used to nullify any offset signal introduced by the signal electrode. Trimmer P1 is used to nullify the offset signal generated by the electrometer amplifier.

The output of the circuit is standardized against gases with known hydrocarbon concentrations by zero and span calibration, so that the meter and/or recorder indicate the hydrocarbon concentration of the gas being used.

The positive and negative operating voltage required by the electrometer amplifier is furnished by a switching power supply circuit, mounting at the back panel of the Analyzer

The stability of the electrometer circuit can be tested as follows:

1. Disconnect the collector cable.
2. Place the analyzer in the auto range.
3. Adjust zero offset value so that the recorder reads at some point upscale, and record a 24 hour chart.

Appendix

A.1 Specifications and Initial Settings:

Range(s):	Refer to Addendum and Testing Results in Appendix C.
Power Requirements:	Refer to Addendum and Testing Results in Appendix C.
Signal Output:	Ten assignable 4-20 mA DC analog channels with Channel 0 and Channel 2 having gain and offset capability. Channel 0 equipped with Wave Function for ADC count display. User configurable as: Benzene, other aromatics, Total HC, etc. and assignable peak traces.
Alarms:	Two Concentration Alarm 'C' Type relay contacts. User configurable. One System Alarm for AC power failure and flame out, fail safe, 'C' type relay contacts.
Calibration Contact:	Calibration Contact, 'A' Type Relay contact for span mode indication.
RS-232 Output:	Four selectable RS-232 modes
Ambient Temp:	0 – 40° C. Install in a well ventilated area

A.2 Recommended Spare Parts List

Qty.	P/N	Description
1	B74671A	PC board, Flame guard & anode power supply
1	B79153A	PC board, Electrometer
1	B84337A	Micro-processor PC board
1	B84389A	9261 Controller PCB
1	B84392A	Back Panel/Power Supply PCB
1	B84385A	Heater Controller PCB
1	B84371A	Signal Conditioning PCB
1	B84349A	Analog DAQ PCB
1	CP2540	Coaxial cable
1	B79154	Sensor Assy.
1	F77	Fuse, 6.25A (3 AG)
1	L156	Lens, red
1	L154	LED, red
1	A33748	Thermistor assembly
1	V825	10 Port Switching Valve with Actuator, Electronic Control, and Power Supply
1	G481	Pressure Gauge, 0-15psig

IMPORTANT: Orders for replacement parts should include the part number and the model and serial number of the system for which the parts are intended.

Send orders to:

TELEDYNE ELECTRONIC TECHNOLOGIES

Analytical Instruments

16830 Chestnut Street
City of Industry, CA 91748

Telephone: (626) 934-1500
Fax: (626) 961-2538

Web: www.teledyne-ai.com
or your local representative.

Web: www.teledyne-ai.com
or your local representative.

Email: ask_tai@teledyne.com

A.3 Drawing List

(Refer to the *Addendum and Testing Results* section of Appendix C for actual drawing list for your application.)

C76068	Piping Diagram
D86107	Wiring Diagram
B79159	Schematic, Electrometer PCB
B74672	Schematic, Flame Guard, Anode Power Supply PCB
B79154	FID Electrode Sub Assy.
D79158	FID Sensor Assembly

Appendix B

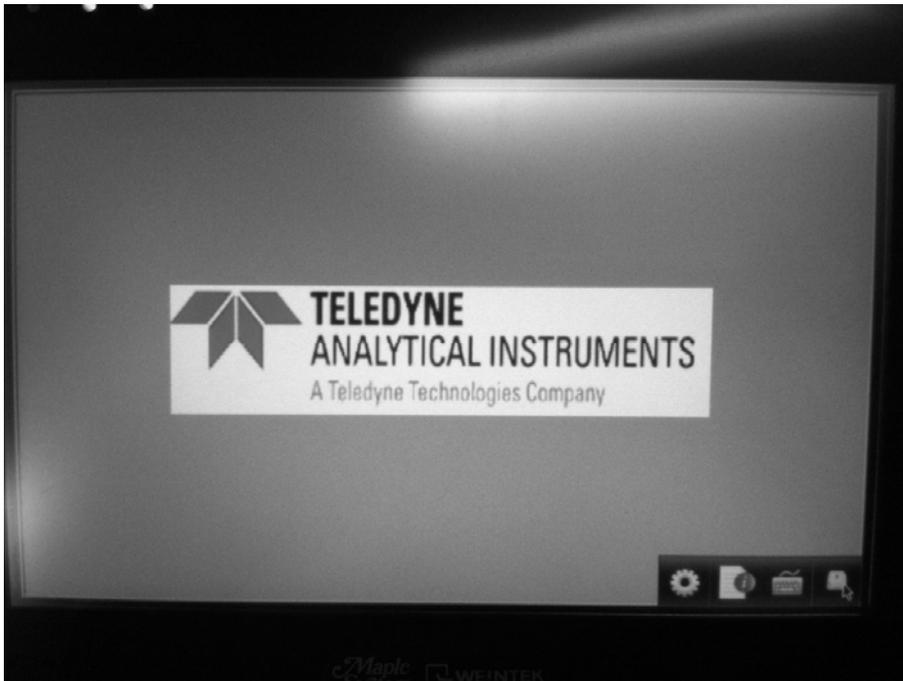
B1. VNC for GC-Pro FID

To gain access to the GC Pro remotely over a VNC connection you must enable the VNC function on the GC Pro display settings. To do this, follow the instructions below.

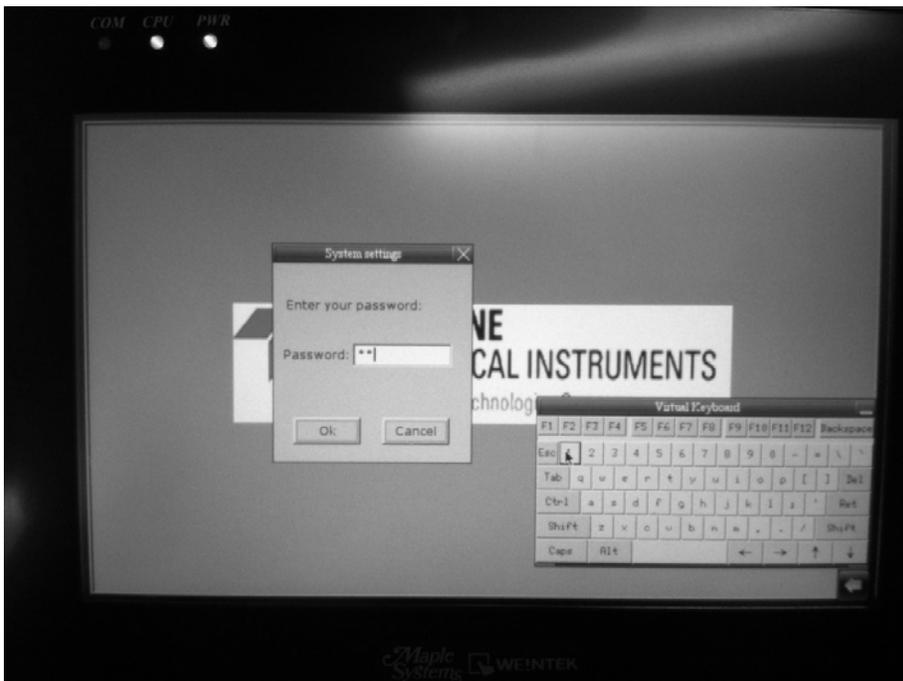
1. Power up GC-Pro and connect an Ethernet cable from the router to the back of the GC-Pro.
2. Touch the arrow icon on the lower right-hand corner of the screen.



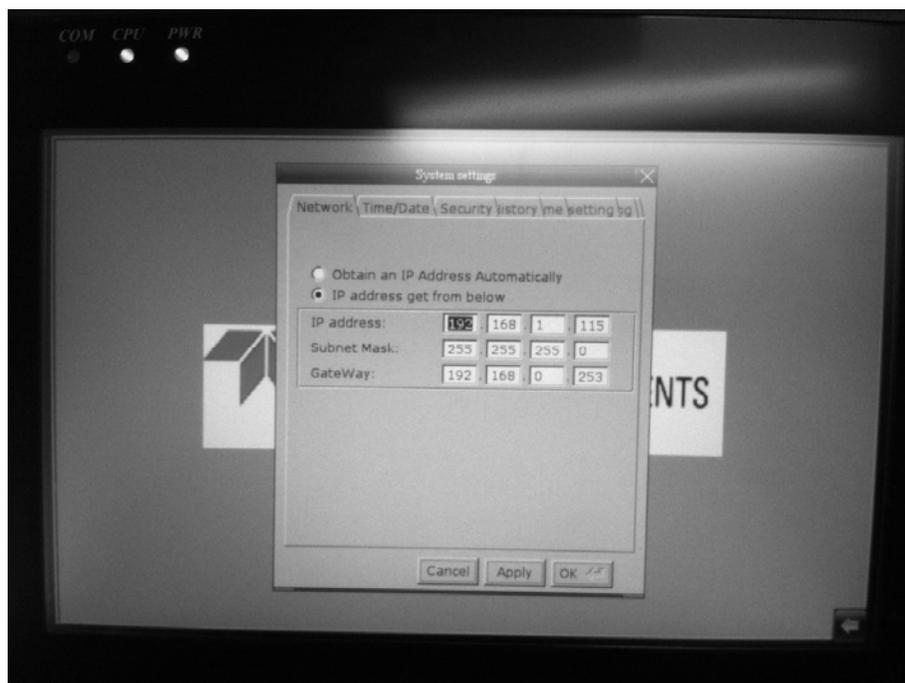
3. More icons will appear, press the gear icon that appears on the bottom taskbar.



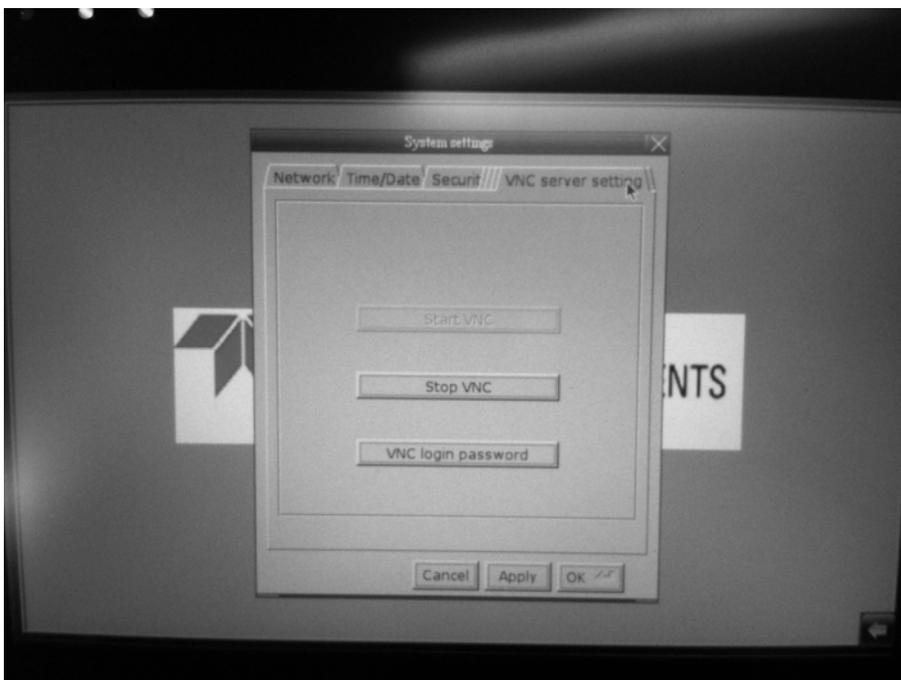
4. A password will be requested. Enter the default password 111111 using the touch screen keyboard.



5. A new pop up window will appear. Select the Network tab, select 'IP address select from below' and enter the IP address desired on the now editable fields. Press the apply button.



6. Select the 'VNC Server setting' tab. This tab can be hard to see. It may appear as a tiny sliver or partially covered by other tabs. Press the 'Start VNC' button and then the 'Apply' button.



7. Close the pop up windows by pressing the 'X' button on the top right corner of the pop up window. The GC Pro is set for VNC and ready.
8. Now install a VNC application on your computer or ipad/tablet that connects to the same network as the GC Pro. A VNC application is a third party software not developed by TAI. A quick search over the internet will offer many of those applications by different developers. TAI has tested 'Real VNC' with success. Their website is at: <http://www.realvnc.com/>

TAI, however, is not responsible nor able to provide any support for these products. See the picture below of an ipad that has the VNC viewer application installed. The ipad is connected to the network through wi-fi.



9. Enter the IP address for the GC Pro, and enter a name so that it is saved with that name, then connect. If you are prompted to enter a password, enter same default password 111111.



10. VNC app should now be connected to the GC Pro. Whatever screen shows on the GC Pro should also display on the VNC app and you can control it remotely.

Note: There is a small cursor that you must drag to the icon or button you want to press, thus operation is by dragging a mouse cursor and then pressing, not like an ipad/tablet touchscreen.

Appendix C

C1 Addendum and Testing Results