IRIS 5500

Instruction Manual
Mid-IR Laser-Based CH_4 Analyzer
Part Number 91.001824
7Nov2012

Thermo SCIENTIFIC

© 2011 Thermo Fisher Scientific Inc. All rights reserved.

Specifications, terms and pricing are subject to change. Not all products are available in all countries. Please consult your local sales representative for details.

Thermo Fisher Scientific
Air Quality Instruments
27 Forge Parkway
Franklin, MA 02038
1-508-520-0430
www.thermoscientific.com/aqi

WEEE Compliance

This product is required to comply with the European Union's Waste Electrical & Electronic Equipment (WEEE) Directive 2002/96/EC. It is marked with the following symbol:

Thermo Fisher Scientific has contracted with one or more recycling/disposal companies in each EU Member State, and this product should be disposed of or recycled through them. Further information on Thermo Fisher Scientific's compliance with these Directives, the recyclers in your country, and information on Thermo Fisher Scientific products which may assist the detection of substances subject to the RoHS Directive are available at: www.thermoscientific.com/WEEERoHS.

About This Manual

This manual provides information about installing, operating, maintaining, and servicing the IRIS 5500 Mid-IR Laser-Based CH_4 Analyzer. It also contains important alerts to ensure safe operation and prevent equipment damage. The manual is organized into the following chapters and appendices to provide direct access to specific operation and service information.

- Chapter 1 "Introduction" describes the principle of operation, provides a general description of the instrument, and lists the specifications.
- Chapter 2 "Guidelines and Instrument Layout" provides the guidelines and layout for instrument operation and startup.
- Chapter 3 "Operation" describes system outputs and communications with the instrument, the operating modes, and menu-driven firmware.
- Chapter 4 "Calibration" provides the calibration process and procedures for calibrating the instrument.
- Chapter 5 "Configuration File and Data Streaming" describes the pull down menus for the special management functions of the GUI.
- Chapter 6 "Maintenance" provides periodic maintenance procedures that should be performed on the instrument to ensure proper operation.
- Chapter 7 "Troubleshooting" provides guidelines for diagnosing problems or failures, and includes recommended actions for restoring operation.
- Chapter 8 "Optional Equipment" describes the optional equipment that can be used with the instrument.
- Appendix A "Warranty" is a copy of the warranty statement.

Safety

Review the following safety information carefully before using the instrument. This manual provides specific information on how to operate the instrument, however, if the instrument is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

Safety and Equipment Damage Alerts

This manual contains important information to alert you to potential safety hazards and risks of equipment damage. Refer to the following types of alerts you may see in this manual.

Safety and Equipment Damage Alert Descriptions

Alert		Description
	**DANGER**	A hazard is present that could result in death or serious personal injury if the warning is ignored. ▲
	**WARNING**	A hazard or an unsafe practice could result in serious personal injury if the warning is ignored. ▲
	**CAUTION**	A hazard or unsafe practice could result in minor to moderate personal injury if the warning is ignored. ▲
	**Equipment Damage**	A hazard or unsafe practice could result in property damage if the warning is ignored. ▲

Safety and Equipment Damage Alerts in this Manual

Alert		Description
	**WARNING**	The IRIS 5500 must not be submersed. ▲
		The IRIS 5500 must be maintained under IP30 guidelines. ▲
		The IRIS 5500 should be operated only from the type of power sources described in this manual. ▲
		Shut off the IRIS 5500 before plugging in or disconnecting the AC power supply. ▲
		The IRIS 5500 is a Class 1 Laser Product, and as such, use of controls or adjustments or performance of procedures other than those specified herin may result in hazardous radiation exposure. ▲
	**CAUTION**	Personal injury could occur when mounting the instrument. Assistance may be required. ▲
		Caution should be used when accessing or servicing any exposed wiring within the instrument. ▲
	**Equipment Damage**	Do not attempt to lift the instrument by the cover or other external fittings. ▲
		Whenever the IRIS 5500 is shipped, care should be taken in repackaging it with the original factory provided packaging. It is recommended to cap all rear panel inlet fittings. ▲
		Damage could occur if not installed in a horizontal position. ▲
		Damage may occur to the instrument if not maintained under IP30 guidelines. ▲
		Equipment damage may occur to instrument if power inputs or fuse type exceeds specified ranges. ▲
		Equipment damage may occur if exhaust port is blocked or port covers are not in place if unused. ▲
		It should be noted that the IRIS 5500 can be powered from any line with a voltage between 100-240 volts A.C., 50 to 60 Hz. Fuses should be changed on conversion between 120 VAC and 240 VAC; otherwise, no other adjustments are needed. ▲
		At no time should liquid water enter the sampling tubing. ▲
		Please note that the important purpose of the filters is to protect the pump and optical sample cell assemblies. ▲

Alert	Description
	At no time should the IRIS 5500 be running without a filter in place, otherwise serious damage to the pump components may result. ▲
	Plugging or unplugging any external equipment (e.g., computer, modem, alarm circuitry, etc.) should be made only while both the IRIS 5500 and the external equipment are shut off, in order to prevent damage or interference due to transient electrical effects. ▲
	It is recommended to turn the instrument and computer OFF before making a connection. ▲
	Contact Thermo Fisher Scientific when error messages or other operational problems occur—in most cases the IRIS 5500 should be returned to the factory. Under no circumstances should the user attempt to diagnose and fix any internal components. For more information, see Chapter 6,"Troubleshooting". ▲
	If the IRIS 5500 instrument is unresponsive or appears to have become contaminated with dust or debris, contact Thermo Fisher Scientific immediately. Do not attempt to open the sensor chamber of the instrument. ▲
	Some internal components can be damaged by small amounts of static electricity. Access to the internal IRIS 5500 components by unauthorized individuals will void the warranty and may result in serious permanent damage to the instrument. ▲

Environmental Constraints and Certifications

The IRIS 5500 is designed to be used in an enclosed, controlled environment; it is neither weather resistant nor weatherproof, and therefore not meant to be exposed to the elements.

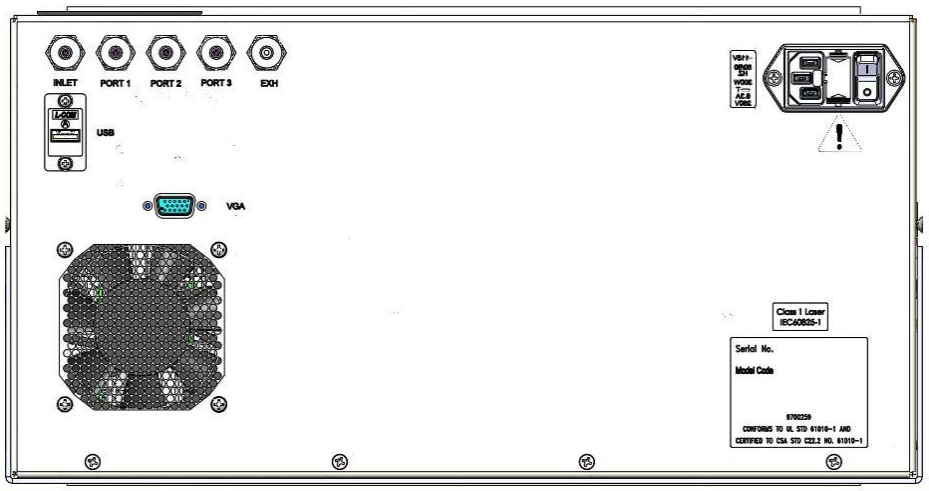
The IRIS 5500 is certified for compliance with the electromagnetic radiation limits for a Class B digital device, pursuant to part 15 of the FCC Rules. The unit also complies and is marked with the CE (European Community) approval for both immunity to electromagnetic radiation and absence of excessive emission interference. The IRIS 5500 system is a Class 1 laser product, and as such, use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

The unit also complies with:

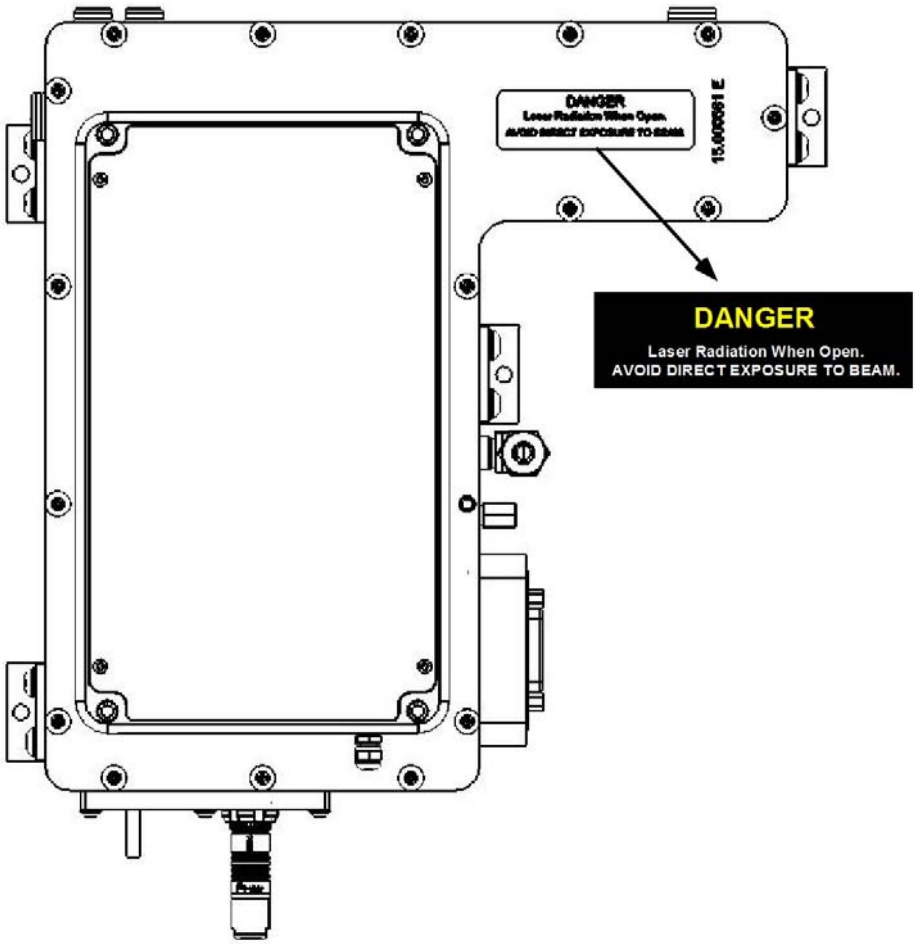
- ANSI/UL 61010-1:2005, 2nd Edition, Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use – Part 1: General Requirements
- CAN/CSA C22.2 No. 61010-1:2004 2nd Edition, Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use – Part 1: General Requirements
- CENELEC EN 61010-1
- IEC 61326-1
- FCC 47 CFR 15B cIB
- 21 CFR 1040.10

Label Identification

The IRIS 5500 is a Class 1 Laser Product, and as such, use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure. The IRIS 5500 is compliant with 21 CFR 1040.10 and 1040.11. The following figures show the locations of the warning labels on the instrument and the laser chamber within the IRIS 5500. The laser chamber within the IRIS 5500 contains Class 3B laser radiation and is sealed and bolted shut to prevent exposure. This sub-assembly is closed during normal system operation and is only to be opened by trained technicians. Failure to comply may damage the IRIS 5500 system and void the warranty. Please note their content of the labels and follow safe laser practices when operating the IRIS 5500 system. The following is a figure of the rear view of the IRIS 5500 showing the location of the classification and compliance labels.



The following is a figure of the top view of the laser/detector chamber showing the location of the safety label.



WEEE Symbol

The following symbol and description identify the WEEE marking used on the instrument and in the associated documentation.

Symbol	Description
	Marking of electrical and electronic equipment which applies to electrical and electronic equipment falling under the Directive 2002/96/EC (WEEE) and the equipment that has been put on the market after 13 August 2005. ▲

Where to Get Help

Service is available from exclusive distributors worldwide. Contact one of the phone numbers below for product support and technical information or visit us on the web at www.thermoscientific.com/aqi.

1-866-282-0430 Toll Free

1-508-520-0430 International

We continue to support our customers with advanced online resources. Our Air Quality Instruments Online Library allows our customer's access to product documents and information on a constant basis.

Available 24-hours a day and seven-days a week, the online library provides quick access to information regardless of time zone or office hours.

To register for an account or log in, please visit www.thermoscientific.com/aqilibrary.

Contents

Figures

Figures

Tables

Chapter 1
Introduction

The Thermo Scientific IRIS 5500 is a real-time CH_4 (methane) analyzer designed for operation in enclosed, remote or on-site locations. The unit is designed for continuous unattended monitoring with continuous real-time data transmission to a central location and/or data logging. The analyzer is designed to be used in conjunction with external sampling interfaces, such as sampling tubes from flux monitoring towers or other ambient sampling stations. The analyzer includes an external larger particulate filter as well as an internal membrane filter that should both be serviced at regular intervals depending on the degree of particulate loading.

The IRIS 5500 incorporates state-of-the-art mid-infrared laser absorption spectroscopy, which provides a quantitative measurement of methane concentration with high specificity and sensitivity. Long-term, precise and low drift measurements of methane concentrations with sub-ppb precision are assured by a unique combination of single frequency tunable laser operation in the mid-infrared and a small optical multipass cell. This approach has been refined and proven over the last decade.

The IRIS 5500 determines methane dry mole fractions in real-time with ppb-level sensitivity, with no interferences from other common ambient species such as water vapor. Water vapor concentrations are also measured spectroscopically, to enable the dry mole fraction determination.

An Ethernet connection is provided to enable remote access to the instrument control functions and concentration data. For details of the analyzer's principle of operation, a description of the instrument and product specifications, see the following topics:

- "Principle of Operation" on page 1-2
- "General Description" on page 1-3
- "Specifications" on page 1-6

Thermo Fisher Scientific is pleased to supply this high accuracy methane analyzer. We are committed to the manufacture of instruments exhibiting high standards of quality, performance, and workmanship. Service personnel are available for assistance with any questions or problems that may arise in the use of this analyzer. For more information on Servicing, see Chapter 5, "Maintenance".

Principle of Operation

The technology to measure methane absorbance is *Tunable Diode Laser Absorbance Spectroscopy* (TDLAS). Higher sensitivity is attained by coupling TDLAS with *Difference Frequency Generation* (DFG) to result in a mid-infrared laser source. This technique uses exquisite tuning and wavelength resolution of diode lasers to access a single absorption line of gas. In other instruments, filters or spectrometers are coupled with broadband light sources to measure methane absorbance with less selectivity and sensitivity. The advantages of using a tunable laser source include:

- High throughput to minimize the impact of optical losses
- High directionality to couple with multiple pass cells
- Fast dynamical response for signal detection strategies and integration
- High spectral resolution to efficiently sample absorbance lines relative to other lines and non-absorbing baseline

The basic measured quantity is light hitting a detector that carries varying amount of loss due to methane absorbance, according to *Beer's Law*:

$$A = \ln\left(\frac{I_0}{I}\right) = \varepsilon b C$$

A is termed the 'absorbance' of light, which is linear with concentration *C*. *I0* and *I* are the intensities of light detected, absent absorbance (*I0*) and with absorbance (*I*). The parameters ε and *b* are both constant: ε is the absorption coefficient of the methane, and *b* is the path length across which it is sampled.

It is common practice with TDLAS to reduce the pressure of gas in the sampled volume, which further enhances performance. In the IRIS 5500 analyzer, this is done with an internal pump that does not require external mounting and connection that complicate the instrument installation.

These features of the IRIS 5500 analyzer provide methane measurement typically to ppb levels and lower, and water vapor measurement to under 0.01% absolute humidity, with high linearity and dynamic range, with stable accuracy, and with durability and low cost of ownership.

General Description

The IRIS 5500 is designed to provide the user with continuous measurements of the absolute concentrations of methane and water vapor. The water concentration measured in the sample is used to provide the correction to the methane concentration data to obtain the dry mole fraction of methane in the sample. Dry mole fraction is the typical figure of merit for atmospheric monitoring applications.

The IRIS 5500 samples the air through a 1/4-inch outer diameter inlet, which can be plumbed to appropriate sampling fixtures. The IRIS 5500 employs a solenoid actuated gas manifold such that the system can switch between gases from different sources including the calibration and sampled gases. The sampled air stream passes through two particulate filters at the inlet, one of which can be replaced outside of the case cover. Downstream of the gas manifold, a flow controller is used to maintain a constant gas flow during the measurement.

Reference should be made to Figure 2–4 and Figure 2–5 of this manual for the location and identification of various components and interface elements of the IRIS 5500, described in this and subsequent sections of this manual.

The IRIS 5500 analyzer is controlled via an internal computer, which can be accessed via the Ethernet port on the front panel, which provides the basic user control and diagnostic interfaces. The averaging time, for example, can be controlled via the software interface by connecting the system to an external computer using Windows Remote Desktop.

After the inlet assembly, the stream enters the optical sensing cell where the instantaneous concentration of methane and water vapor is measured by high resolution laser absorption spectroscopy in the mid-infrared spectral region. The associated concentrations are determined using a standard “Beer’s Law” analysis, which relates the strength of the measured optical absorption to the absolute methane and water vapor concentrations. Both temperature and pressure are simultaneously measured to enable precise calculation of the concentrations. The IRIS 5500 analyzer measures discrete “rovibrational” absorption “fingerprints” for methane and water vapor at extremely high frequency resolution across the full absorption lineshape, providing an unambiguous and highly quantitative methane concentration measurement. The laser is approximately 100 times narrower in frequency than the intrinsic absorption linewidth, and sweeps continuously in frequency through the associated lines at a repetition rate of 500Hz. Both water vapor and methane absorption lines are measured with each sweep, providing an instantaneous measurement of the two gases to produce the dry mole fraction methane data.

After the methane has been sensed in the optical cell, the air stream passes through the diaphragm pump and out of the exit port. The pump is used in a "puller" mode to avoid particulate contamination from the diaphragm membrane as it wears. The sample cell pressure is maintained at a nearly constant value using a control loop (with the pressure measurement data) of the pump speed. The sampling flow rate through the instrument is set at the factory for optimum stability of the internal cell pressure, which is kept under vacuum during the measurement time. Some time is required for the cell to equilibrate to a constant pressure after starting the system (typically a few minutes).

After passing through the flow assembly, the air is exhausted from the IRIS 5500 enclosure through a small bulkhead fitting. This exhaust port can also be used as a flow return in special sampling applications where the inlet of the IRIS 5500 is connected to an environment at either positive or negative pressure (with respect to ambient).

The IRIS 5500 accepts a universal A.C. power input (100-240 VAC, 50/60 Hz). The A.C. power is diverted to internal D.C. power supplies.

The measured concentration of methane and water vapor is displayed in real time on the IRIS 5500 LCD readout, and provided digitally via Ethernet or memory download via USB. The measured data is logged internally into files for subsequent downloading to an external device. The Ethernet port also serves to link to an external PC for programming operating parameters of the IRIS 5500 (e.g., logging period, measurement averaging time, calibration constant, etc.).

The IRIS 5500 is CE certified, and is protected to IP30 (cover on).

The IRIS 5500 is a compact, rugged and totally self-contained instrument designed for rapid deployment and unattended operation, on a bench top or in a standard 19" rack mount enclosure.

The IRIS 5500 covers a wide methane measurement range: from 500 ppb to 20 ppm, with a nominal operating range close to ambient (2 ppm). This range is read out on the 4-line display on the front of the unit in addition to a system status designation.

In addition to the real-time concentration readout, the IRIS 5500 offers the user a wide range of information via Graphical User Interface (GUI) which is accessed via the remote desktop connection through the Ethernet jack.

Operating parameters selected, diagnostic information, and calibration menus are also available within the IRIS 5500 GUI. From the instrument display panel the user can only read the respective methane and water vapor concentrations and general system status.

Via the GUI, the user can:

- Enable continuous sampling
- Enable/Schedule a calibration
- Adjust display average time and logging interval
- View logs and top level diagnostics

Furthermore, the IRIS 5500 features complete, large capacity internal data log files with retrieval through an externally connected computer via Ethernet port. The stored information (> 10GB available storage) includes time and date, measured concentration, gas pressure, and various system operating parameters (temperatures, pressures, voltages). The data can also be imported to standard spreadsheet or data analysis packages (e.g., Microsoft Excel™).

The IRIS 5500 combines, easy to use software, and advanced diagnostics to offer unsurpassed flexibility and reliability. The IRIS 5500 specifications follow.

Specifications

Table 1–1 lists the specifications for the IRIS 5500.

Table 1–1. IRIS 5500 Specifications

Concentration measurement range[1]	500-20,000 ppb
Precision	< 0.5 ppb (1 sigma, 10 second averaging)
Variation (24 hr, constant ambient temperature)	< 2 ppb (peak-to-peak, 60 minute averaging)
Ambient Temperature Dependent Variation	< ± 1 ppb, 15-30 °C
Accuracy	1% of reading traceable to NIST calibration gas
Power consumption	240 W on startup, < 120 W in continuous operation within operating temperature range
Resolution	<1 ppb absolute concentration
Flow rate range	Typically < 500 sccm, set at factory. Other ranges may be available on request.
Concentration display updating interval	Adjustable, 0.1 to 10 seconds
Concentration averaging time	Adjustable, 0.1 to 10 seconds
Data logging interval	Same as averaging time
Total number of data points that can be logged in memory	> 20,000,000
Available storage space	>10 GB
Logged data	Time and date, concentration data, temperature, gas cell pressure, system operating and diagnostic parameters, data fit parameters
Elapsed time range	0 to 100 hours (resets to 0 after 100 hours)
Time keeping and data retention	Variable based on chosen number of averages, 1 year default
Front panel display	4-line LCD 20 characters (4 mm height)
System interface	Ethernet (remote desktop), High Speed USB
Computer requirements (for remote desktop interface)	IBM-PC compatible, Windows™ XP or higher
AC source	100-240 VAC 50-60 Hz
Fuses	6.3 amp, time delay fuse at 100-120 VAC, 3.15 amp time delay fuse at 240 VAC
Operating environment	10 to 35 °C (14 to 122 °F), 10 to 95% RH, non-condensing

Storage environment:	-20 to 70 °C (-4 to 158 °F)
Physical dimensions	16.75" (W) X 8.62" (H) X 23" (D)
Weight	72 lbs.

[1]Note: Dry mole fraction (corrected for humidity)

Chapter 2
Guidelines and Instrument Layout

This chapter includes unpacking and parts identification, positioning and handling of the instrument, monitoring applications, instrument layout, and external computer requirements.

Lifting

When lifting the instrument, use procedure appropriate to lifting a heavy object, such as, bending at the knees while keeping your back straight and upright. Grasp the instrument at the bottom in the front and at the rear of the unit. Although one person can lift the unit, it is desirable to have two persons lifting, one by grasping the bottom in the front and the other by grasping the bottom in the rear.

Equipment Damage Do not attempt to lift the instrument by the cover or other external fittings. ▲

Unpacking and Parts Identification

Carefully unpack the IRIS 5500 from the shipping container. The IRIS 5500 is provided to the user with the following standard accessories:

- Power cord (110 or 220)
- Ethernet communications cable
- Gas inlet filter (Stainless Steel, 7 micron pore size)
- Instruction manual

If any parts are missing, please contact Thermo Fisher Scientific immediately.

Equipment Damage Do not attempt to lift the instrument by the cover or other external fittings. ▲

Note Do not discard the packaging material. ▲

Handling

The IRIS 5500 is a sophisticated optical/electronic instrument and should be handled accordingly. Although the IRIS 5500 is very rugged, it should not be subjected to excessive shock, vibration, temperature or humidity outside the stated specifications.

WARNING The IRIS 5500 must not be submersed. ▲

WARNING The IRIS 5500 must be maintained under IP30 guidelines. ▲

If the IRIS 5500 has been exposed to low temperatures (e.g., in the trunk of a car during winter) for more than a few minutes, care should be taken to allow the instrument to return near room ambient temperature before operation. This is advisable because water vapor may condense on the interior surfaces of the IRIS 5500 causing temporary malfunction or erroneous readings. Once the instrument warms up to ambient temperature, such condensation will have evaporated. Re-zeroing and calibrating is recommended upon installation.

Equipment Damage Whenever the IRIS 5500 is to be shipped, care should be taken in repackaging it with the original factory provided packaging. It is recommended to cap all rear panel inlet fittings. ▲

Safety

Review the following information carefully:

- Read and understand all instructions in this manual.
- Do not attempt to disassemble the instrument. If maintenance is required, return unit to the factory for qualified service or contact technical support.
- Shut off IRIS 5500 and any external devices before connecting or disconnecting them.

WARNING The IRIS 5500 should be operated only from the type of power sources described in this manual. ▲

WARNING Shut off the IRIS 5500 before plugging in or disconnecting the AC power supply. ▲

WARNING The IRIS 5500 is a Class 1 Laser Product, and as such, use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure. ▲

Positioning

The IRIS 5500 real-time high accuracy methane monitor should be operated in a horizontal position such as secured to a standard 19" equipment rack. The system may also be placed on a benchtop using the feet provided. The system is not intended for use outdoors or in an uncontrolled interior environment.

The IRIS 5500 can be rack mounted using four #10-32 rack mounting screws through the flanges located on the front left and right sides of the enclosure. If required, these mounting flanges can be removed. For details, see "Mounting Options" on page 8-2.

Regardless of the IRIS 5500 operating configuration, care should be taken to ensure that the top lid of the unit can be opened without hindrance, and that free access is provided to the connectors and the gas inlet and exhaust ports on the rear of the enclosure. The lid is attached to the unit by 2 self-clinching, low-profile panel fasteners located on each side of the IRIS 5500 system.

It is important to ensure free access to the sampling inlet. For ambient air monitoring, standard 1/4-inch polymer or metal tubing can be used. The fan intakes on the rear of the unit should not be obstructed by nearby objects, in order to ensure adequate cooling.

Under typical operating conditions, the IRIS 5500 enclosure should be closed. The lid should be opened only to replace either the filters, or for other maintenance.

CAUTION Personal injury could occur when mounting the instrument. Assistance may be required. ▲

Equipment Damage Damage could occur if not installed in a horizontal position. ▲

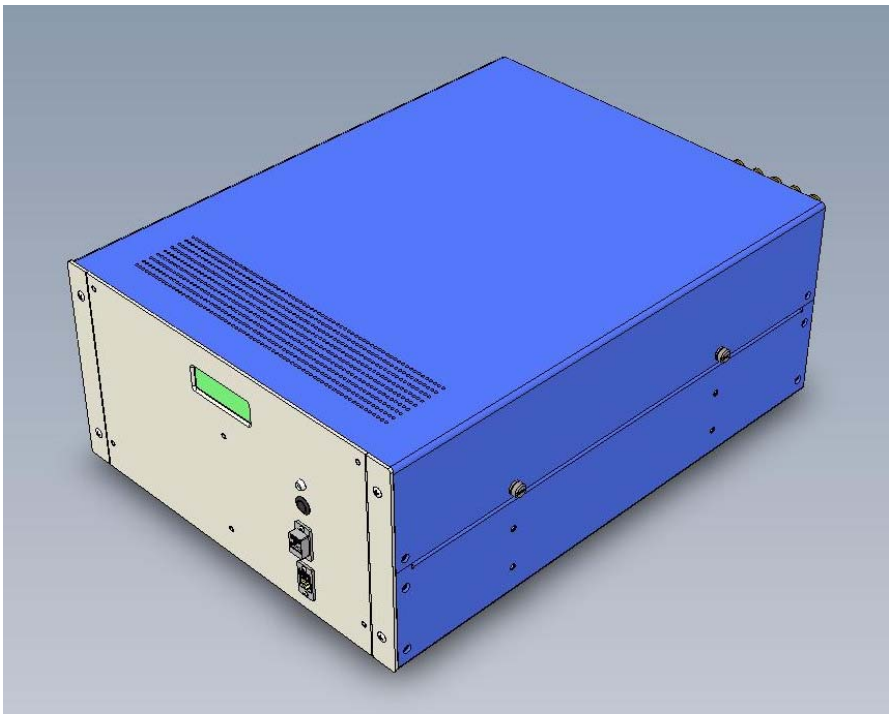


Figure 2–1. IRIS 5500 Benchtop Configuration

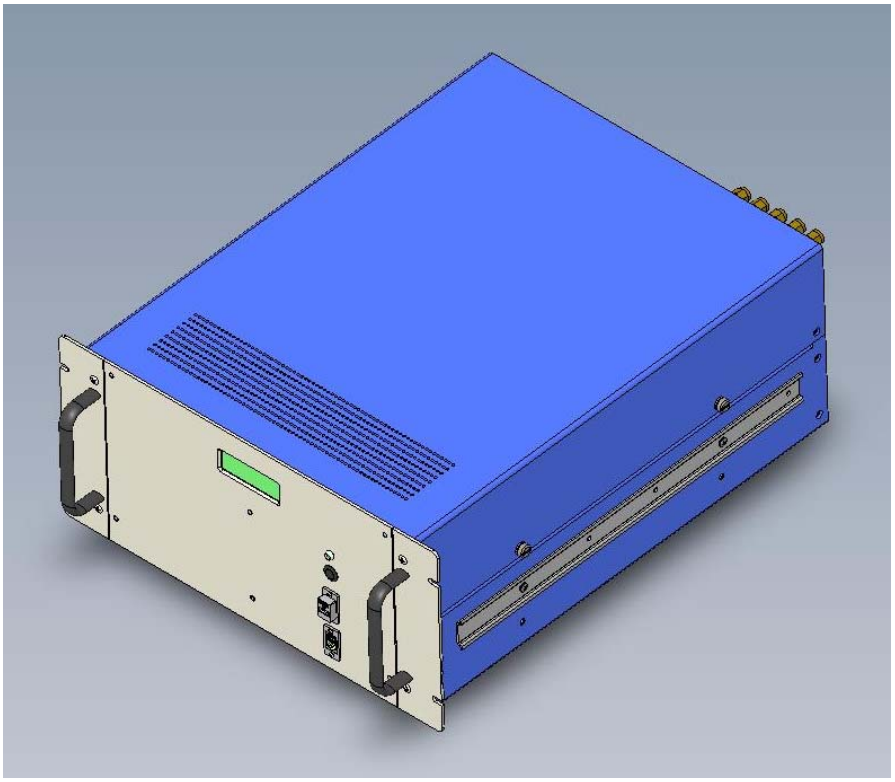


Figure 2–2. IRIS 5500 Rack Mount Configurations

Sampling Guidelines

For ambient air sampling, the inlet tube should be routed through the external filter assembly and into the INLET port located on the back panel. Figure 2–3 shows the section of the back panel where the Swagelok feedthroughs are located. Care must be taken to assure non-condensing moisture conditions, especially in start up (e.g. a cool instrument in warm humid conditions). There are several other gas ports located on the back panel. These include three ports for reference/calibration gases and an exhaust port. On receipt by the customer, these ports will be sealed, and should be stored in this fashion when the system is not in use for extended periods of time.

Non-ambient extractive sampling may be pursued (e.g., from a chamber, duct, stack, etc.) but precautions must be taken to condition sample intake. The IRIS 5500 Methane monitor is not intended for use in corrosive or high temperature applications.

Questions on sampling and guidance on unusual applications or situations may be directed to the Thermo Fisher Scientific Service Department.

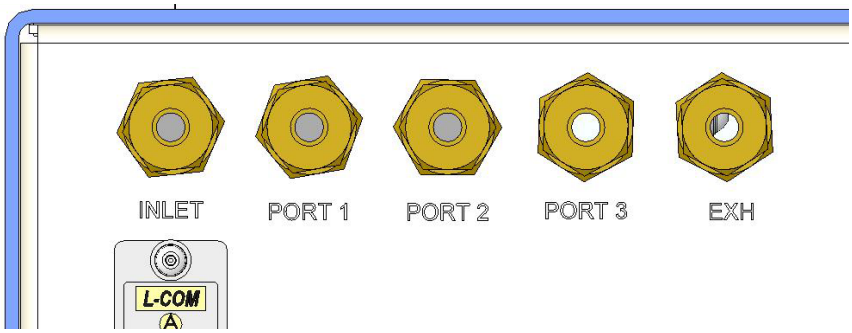


Figure 2–3. Back Panel Showing the Gas Ports

Equipment Damage Damage may occur to the instrument if not maintained under IP30 guidelines. ▲

Instrument Layout

The user should become familiar with the location and function of all externally accessible controls, connectors and other features of the IRIS 5500. Refer to Figure 2–4 and Figure 2–5. All related functions are externally accessible.

Qualified Thermo Fisher Scientific personnel should perform all repair and maintenance. Please contact the factory if any problem should arise. Do not attempt to disassemble the IRIS 5500, except as described in Chapter 5, "Maintenance", otherwise voiding of instrument warranty will result.

CAUTION Caution should be used when accessing or servicing any exposed wiring within the instrument. ▲

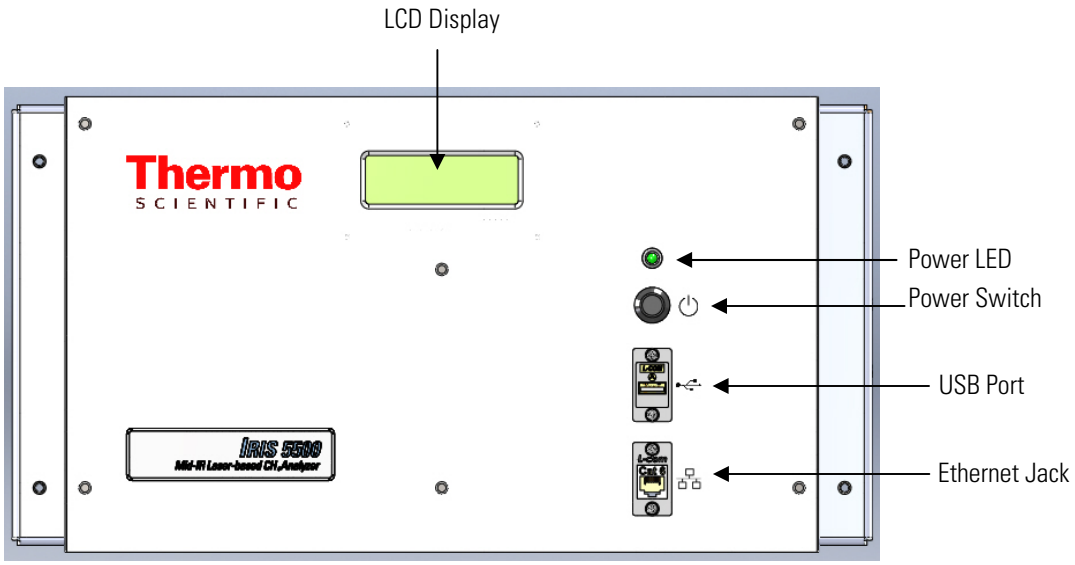


Figure 2–4. IRIS 5500 Front View

Front Panel Display

The front panel contains a 4-line, backlit liquid crystal display (LCD) screen which provides feedback from IRIS 5500 operation, an Ethernet jack required for configuring or remotely operating the instrument, and a USB port that can be used to connect an external device (*e.g.*, hard drive, keyboard, mouse). The LCD is used to indicate both measured concentration of Methane and Water Vapor (time averaged at the specified interval) and system status messages.

Refer to Figure 2–4 for the location of the ports and display.

Rear View

There are several critical components to the back panel of the IRIS 5500: the universal AC power port (100-240 VAC 50/60 Hz), sample and calibration gas inlet ports, system exhaust port, USB jack, a 15-pin VGA, and connector and a cooling fan. Refer to Figure 2–5 below for the location of these items on the bottom of the IRIS 5500.

Equipment Damage Equipment damage may occur to instrument if power inputs or fuse type exceeds specified ranges. ▲

Equipment Damage Equipment damage may occur if exhaust port is blocked or port covers are not in place if unused. ▲

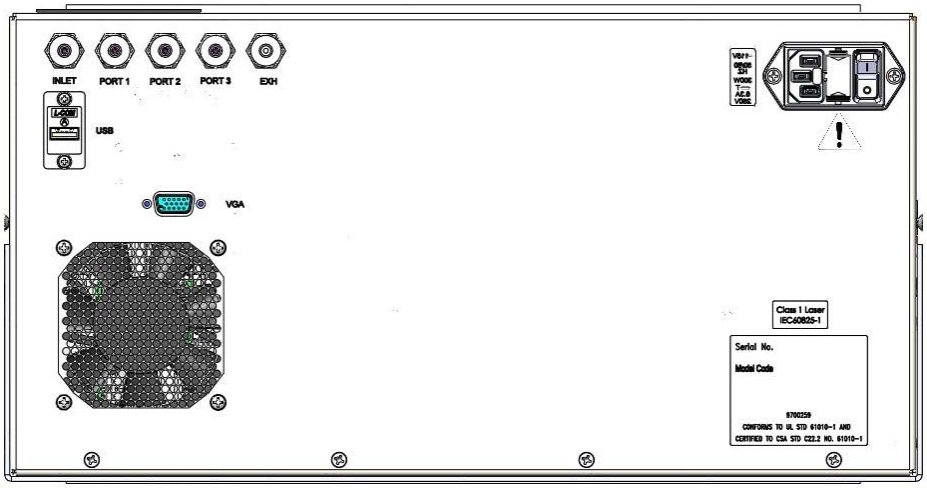


Figure 2–5. IRIS 5500 Rear View

Preparation for Operation

To begin using the IRIS 5500, the user must first verify that AC power is connected to both the instrument and suitable wall socket, and that the gas inlets are connected or sealed, and that the exhaust port is open.

AC Power Connection

The IRIS 5500 requires a stable AC Power Supply (100-240 VAC 50/60 Hz). No other power is required. The IRIS 5500 as received from the factory is provided with an A.C. power cord and U.S. or E.U. three-prong plug. Fuse ratings are also selected for U.S. or E.U. (see specification Table 1–1). The user can therefore connect the IRIS 5500, as received, into an A.C. outlet to operate the system.

Equipment Damage It should be noted that the IRIS 5500 can be powered from any line with a voltage between 100-240 volts A.C., 50 to 60 Hz. Fuses should be changed on conversion between 120 VAC and 240 VAC; otherwise, no other adjustments are needed. ▲

Installing the Inlet

Install a clean section of sample tubing to the inlet filter assembly and check that the inlet pressure is within the specified range. Inlet may be pressurized or simply intake from ambient pressure. If the inlet pressure is too high the flow controller will not function properly and the system will not achieve stable operation at the desired cell pressure. The inlet pressures from the sample, calibration, or span gases should not exceed approximately 5 psig (5 psi above ambient pressure).

The IRIS 5500 is shipped from the factory with an external “prefilter” (stainless steel, 7 micron pore size) as well as a high-capacity PTFE membrane filter immediately upstream of the optical cell assembly. The external filter (Swagelok SS-4FW-7) and the internal filter will require servicing at intervals determined by the local particle loading of the sample stream. Under normal conditions, the filters should be replaced annually. This can be done in the field by either a qualified end-user or field technician.

Equipment Damage At no time should liquid water enter the sampling tubing. ▲

Equipment Damage Please note that the important purpose of the filters is to protect the pump and optical sample cell assemblies. ▲

Equipment Damage At no time should the IRIS 5500 be running without a filter in place, otherwise damage to the pump or optical components may result. ▲

Equipment Damage Plugging or unplugging any external equipment (e.g., computer, etc.) should be made only while both the IRIS 5500 and the external equipment are shut off, in order to prevent damage or interference due to transient electrical effects. ▲

Powering Analyzer On

When the analyzer is ready to be powered, the inlet should be sampling ambient air to assure proper internal warm up and stabilization.

At the back of the AC power port is a mains switch with designation “I” and “O”. This should be in the “on” position (“I” pressed in).

When the power port switch is in the on position, the front panel push button should be pressed. This immediately activates the illumination of the green LED. Wait ~ 30 seconds, and the LCD panel should illuminate and show text (refer to Chapter 3, “Operation” for Operating Modes).

Communications with an External Computer

The IRIS 5500 may be run via "remote desktop" using an external computer that is connected to the instrument via an Ethernet jack. The external computer should at a minimum be:

- IBM-PC compatible running Windows XP or later with Remote Desktop installed

Thermo Fisher Scientific custom hardware and software provided with IRIS 5500 as standard accessories:

- Ethernet communications cable

Software Installation Procedure

The IRIS 5500 data logging and analysis software is pre-installed on the internal computer. Updates to the software may be installed via a USB drive plugged into either of the two USB ports (one on the front, one on the back) on the IRIS 5500 unit or by Ethernet using remote desktop connection from a different computer. Refer to the next section for details on interfacing with the IRIS 5500.

Communication between IRIS 5500 and Computer

The IRIS 5500 instrument has an Ethernet connector on the front panel capable of up to 1 Gb/s data rate. The connection is auto-sensing, so it may be plugged into an existing network connection or directly to a PC without any special cabling.

Upon connection, the IRIS 5500 instrument is configured for dynamic IP addressing assignment using DHCP by default. If a DHCP server is not available, then the instrument will use APIPA to randomly assign an address in the 169.254.xxx.yyy block. In either case, the IP address and netmask are displayed on the instrument's front panel LCD at 30 second intervals after startup. With no connection, there will be no IP address messaging on the LCD.

Windows Remote Desktop is used to communicate with the instrument from a local PC.

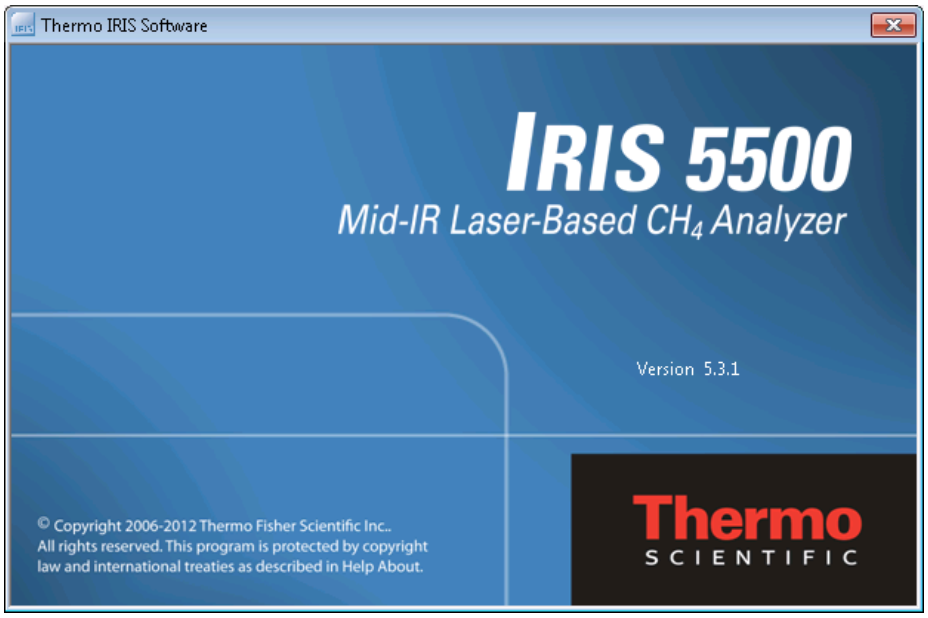
- Connect the IRIS 5500 unit to the network or directly to the local computer's Ethernet port using the supplied Ethernet communication cable. Any standard Cat-5 or better Ethernet cable will suffice if the factory supplied cable is unavailable.
- Turn ON the PC and the IRIS 5500 system via the power button on the front panel. The IP address is automatically configured and displayed on the front-panel LCD after power-up if there is connection to a server or computer. For more information, see Outputs and Communications > LCD Output on page 3-2.

- On the local PC, go to the Start Menu and select ALL PROGRAMS > ACCESSORIES > COMMUNICATIONS > REMOTE DESKTOP CONNECTION (Windows 7 and Windows XP). In the Remote Desktop Connection window enter the IP address of the IRIS 5500 system in the box labelled "Computer", and click the CONNECT button.
- Upon entry via Remote Desktop, a new login window will appear. Enter the User Name and password, and click OK. Successful login will result in the IRIS 5500's internal computer desktop being visible on the local computer. The default user name and password are **Thermo** and **IrisSeries1**, respectively.
- Enabling sharing of your local computer on networks is required for file transfer via Remote Desktop. Sharing is enabled by accessing the "Properties" window of the local computer C: drive in Windows Explorer.

In addition to Remote Desktop, direct access to the IRIS 5500 unit may be achieved by connecting a USB keyboard and USB mouse to the available USB ports and a monitor to the VGA connector that is provided on the back of the IRIS 5500 unit (Figure 2–5).

Equipment Damage It is recommended to turn the instrument and computer OFF before making a VGA connection. ▲

Most operations with the pre-installed software program are self-evidently labelled.

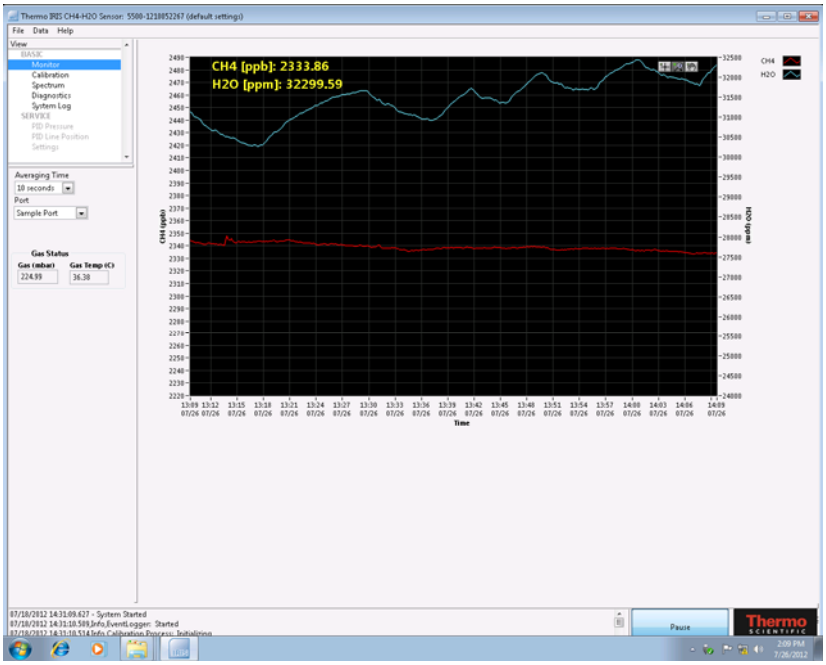


The following operating/logging parameters of the IRIS 5500 can be selected (edited) via the graphical user interface (GUI):

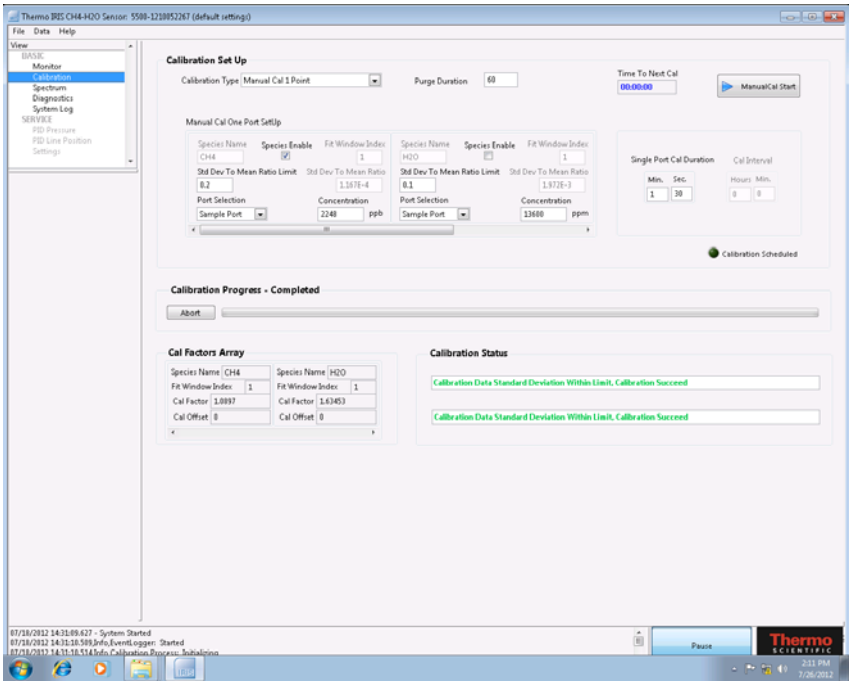
- Current date (year, month and day of the month)
- Current time (hour, minute and second)
- Averaging time (100 ms, 200 ms, 500 ms, 1 s, 2 s, 5 s and 10 s)
- Calibration and calibration schedule

From the GUI, select from the following display views:

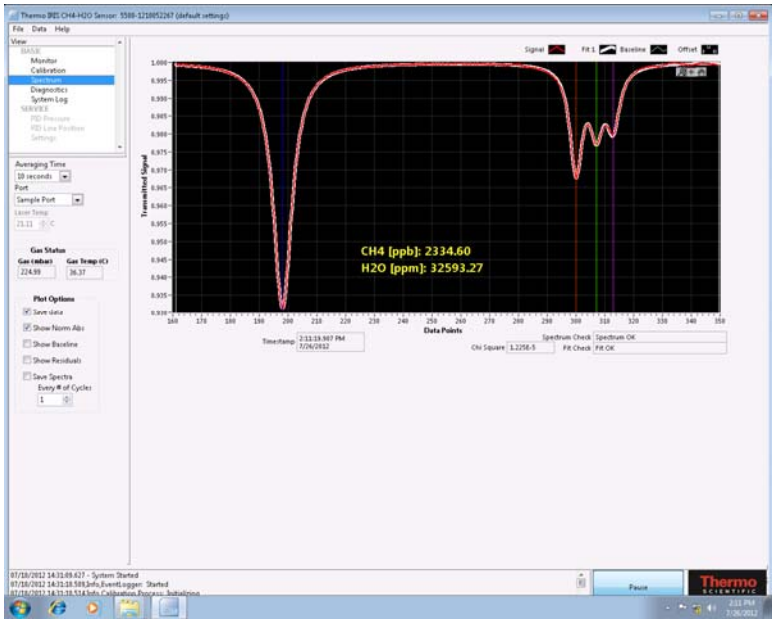
Monitor. This is the initial view for the IRIS 5500 software. This view displays computed methane concentration (in ppb) and water concentration (in ppm) in real-time. This screen also allows the user to select the averaging time and inlet port on the gas manifold that will introduce the sample be analyzed.



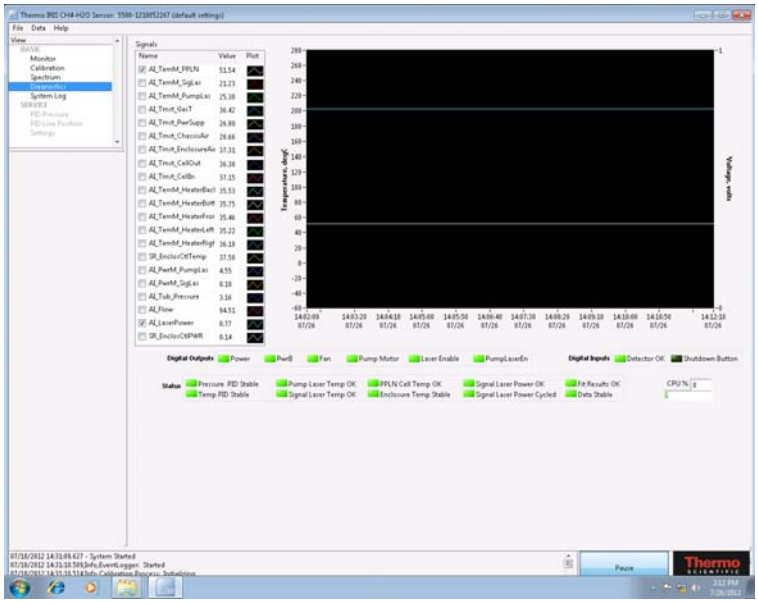
Calibration. This software view allows the user to configure the calibration settings for the IRIS 5500 system. Manual calibration and Schedule calibrations may be setup in this view. The user supplies calibration information and duration and clicks the start button the initiate the calibration process.



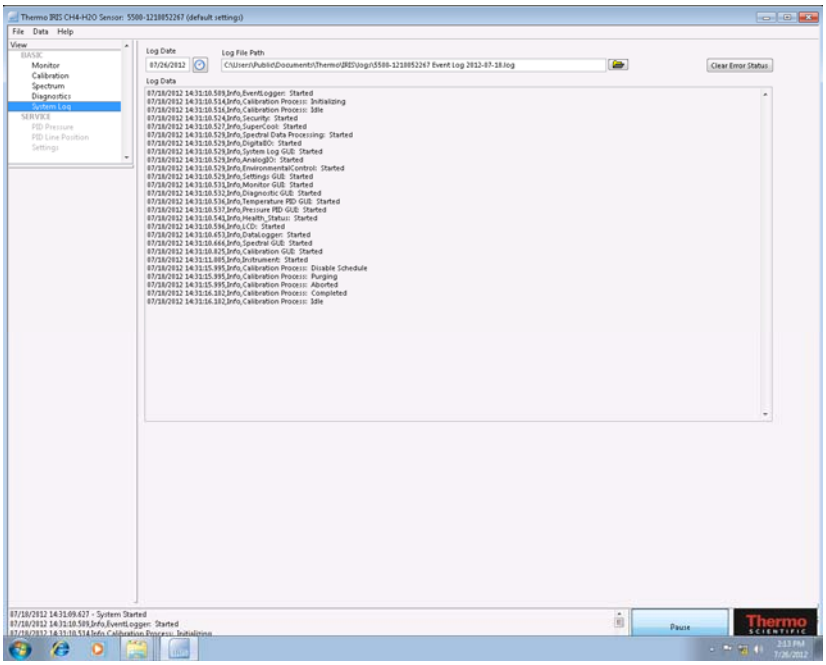
Spectrum. This view shows the average spectrum obtained from the IRIS 5500 instrument. The methane and water absorption lines are fit and the concentrations (in ppb for methane and ppm for water) are computed. This screen also allows the user to select the averaging time and inlet port on the gas manifold that will introduce the sample be analyzed.



Diagnostics. This screen allows the user to monitor the instrument status. This screen displays various temperature, pressure, laser power, and flow readings within the IRIS 5500 instrument.



System Log. This screen displays the system log data. At start-up a system check is performed and as various processes start the time, date, and status is displayed in the window. Any errors are also displayed. This screen also allows the user to change the file path for the stored log data.



The screens described above show “BASIC” level operation by the user. Grayed out “SERVICE” level items are also visible in the screen view, which provide enhanced interactions that are outside of the scope of regular operation and which can result in instrument error or even damage if accessed.

Warm Up

Upon initial start up, the IRIS 5500 requires warm up routines and diagnostics to result in successful operation. In particular:

- Initial temperature control on internal lines and optics must reach a threshold operating temperature
- Once operating temperature is achieved, flow and sample pressure must stabilize
- Laser control parameters must result in successful spectrum with proper line fitting.

Depending on conditions, a warm up may take between 5 and 30 minutes. For instance, if the system is started "cold" in a 10 °C environment, it would take longer to achieve internal operating temperatures.

On all GUI screens shown during this section, the bottom section contains LED indicator lights for indicating system status. During correct warm up, the following sequence of indicators should be expected:

1. 'Data OK' indictor is RED, 'Started' indicator is YELLOW, and "Instrument Warming Up" window on display (Figure 2–6).

2. 'Data OK' indictor is RED, 'Warming Up' indicator is YELLOW (flow and sample pressure stabilizing)

3. 'Data OK' indicator is GREEN, 'Warmed Up' indicator is GREEN

Figure 2–6. View of Warm Up screen

Chapter 3
Operation

This chapter describes the various outputs that enable communication with the IRIS 5500 and describes the operation and functionality of the software. For details, see the following topics:

Outputs and Communications

This section describes the various outputs that enable communication with the 5500.

LCD Output

The IRIS 5500 system has a four line LCD located on the front panel. This display is used to provide important information to the user during system operation. The four lines of the LCD during typical operation contain:

Line1: Methane result

Line2: Water result

Line3: Status message

Line4: UP time tally or IP address (alternates every 30 seconds); UP time also indicates 'Data OK' or 'Data Not OK' every third second.

During start up and other non-operating modes, LCD will display 'STANDBY,' 'RUNNING,' and other messages, as described elsewhere.

Ethernet Communications

The Ethernet port located on the front of the IRIS 5500 instrument allows the user to interface with the instrument using an external computer. Connection to the IRIS 5500 via the Ethernet permits access to the internal computer via a remote desktop application. In this mode of operation the user may change the system parameters, view real-time data, and transfer data either to the external computer or to a USB memory stick. Refer to the section "Communications with an External Computer" beginning on page 2-14 for details for establishing a remote desktop connection.

Serial Communications

The IRIS 5500 has two Universal Serial Bus (USB) ports: one on the front located below the Ethernet port, and one on the back below the gas ports. These ports allow the user to interface with the internal computer. With a monitor connected to the VGA port (on the back of the instrument, Figure 2–5) a USB mouse and keyboard may be plugged into the system to control the IRIS 5500 unit.

The USB ports also serve as a means for performing system updates or data download via a USB memory stick. In order to update the IRIS 5500 software or download the data, it is recommended that an external computer be connected to the system via the Ethernet port. See "Communications with an External Computer" beginning on page 2-14 for information on connecting an external computer with the IRIS 5500.

Operating Modes

The IRIS 5500 has five modes of Operation that are visible on the front panel LCD:

4. *Start-up.* This is accomplished by pressing the ON/OFF button on the front panel whereby the system status will display on the LCD display.

5. *Run Mode.* This is when the instrument is measuring methane concentration and operating with an active flow rate. The default mode of operation has the instrument set for continuous data logging.

6. *Standby*. This mode is shown during warm up cycle time and when the GUI is in 'Pause' mode (selected by user).

7. *Calibration.* This mode is used to calibrate the response of the IRIS 5500. During this mode of operation the user is required to utilize known reference gas samples. This mode may be either manual or scheduled. Details of the calibration process are discussed in Chapter 4, "Calibration".

8. *Shutdown.* Accomplished by pressing the ON/OFF button on the front panel and the LCD powers down so that text on screen is no longer visible. The instrument is off.

For more information on LCD Output, refer "Outputs and Communications" on page 3-2.

Software Overview

The embedded computer within the IRIS 5500 instrument contains the GUI, including data acquisition and analysis processes. A brief overview of the IRIS 5500 software was presented in Chapter 2 in the section entitled "Communication between IRIS 5500 and Computer" on page 2-14. When the IRIS 5500 system is powered up the internal computer boots and the software is executed. Once the software is running there is a delay to allow internal system checks to stabilize before the fitting routine and data logging begin. This allows the system to start and 'warm-up' to avoid any transients in the signal. A cold start will usually result in a longer warm-up time (possibly up to twenty minutes).

Before starting the IRIS 5500, it is recommended that the user become familiar with the functionality of the software. Note that changes to system operating parameters may only be made through the software via the remote desktop interface or direct peripheral connection. Following is a detailed description of the software features; however, the calibration functionality is reserved for Chapter 4, "Calibration". The software referred to in this manual is release version 5.3.

Monitor

The Monitor view is the default screen that is seen when the IRIS 5500 software initiates, and can be accessed by clicking on "Monitor" in the view frame. The main portion is view shows the logged methane and water concentration in a "chart recorder" plot window. The left ordinate displays the measured methane concentration while the right ordinate shows the measurement water concentration. The abscissa has tick labels that correspond to the time and date of the measurement. Scaling options are available through right and left mouse clicks on the tick labels: Right clicking results in a pop up menu that can check and uncheck autoscaling on the plot; left clicking on highest and lowest values allows numerical entry of scale.

This screen also allows the user to change the time the IRIS 5500 samples and averages before fitting the spectrum to obtain the concentration. The default value is 10 sec averaging, which corresponds to 5000 samples at the 500 Hz laser scan rate. Below the Averaging Time control is the Port Selection control which allows the user to select the inlet port through which the gas is sampled. This selection controls the manifold on the sample inlet. Below these controls is a box that displays the Gas Status. The information provided here is the pressure and temperature of the gas within the sample cell.

Several indicator "lights" can be seen lower right-hand corner of the software window to let the user know the status of the system. These include DATA OK, WARMED UP and CALIBRATING. The IRIS 5500 checks the data to make sure the measured spectral features are correct and no anomalies are present. If this check passes, the DATA OK indicator will turn bright green. When the instrument has warmed up and therefore achieved stable operating conditions, the WARMED UP indicator will turn bright green. Spectral fitting and data logging will not begin unless the system has suitably warmed up. The CALIBRATING indicator only lights when the calibration procedure is being implemented. Refer to Chapter 4, "Calibration" for details regarding the calibration process.

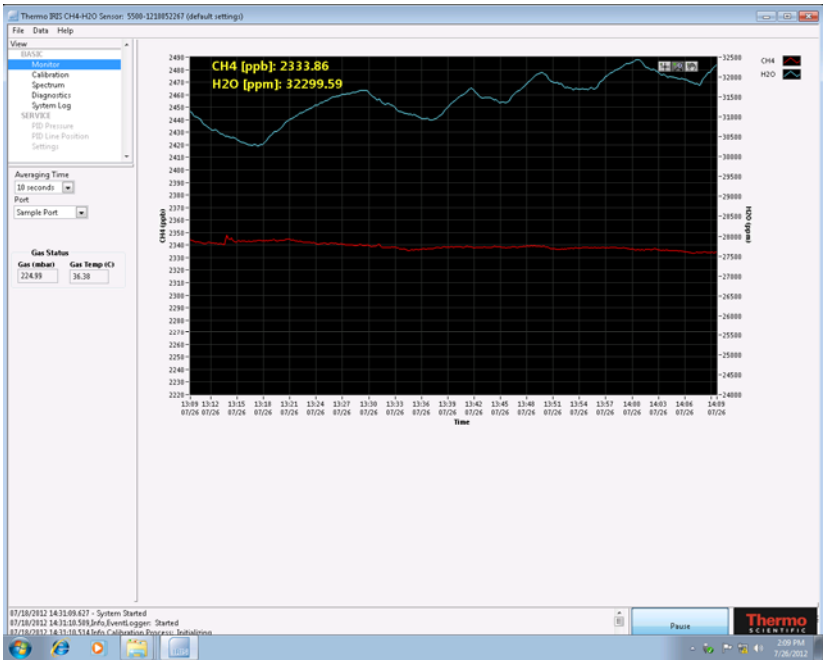


Figure 3–1. Screenshot of the monitor view of the IRIS 5500 software which displays the logged concentration data for methane and water

Additional system information/controls may be found in the status window below the plot window. On the left-hand side the IRIS 5500 software displays system events with time and date stamps. These include the initiation of the system and various subroutines. Any errors associated with the system will also be displayed in this area. To the right of this status bar is the Pause/Run button. This button is used to suspend data collection for calibration and configuration changes, and results in "STANDBY" status being displayed on the LCD.

Finally, pull down menus are located in the top bar of the Monitor and other views to provide capabilities of configuration file management, data streaming, and identifying software version. These are discussed in detail in Chapter 5, "Configuration File and Data Streaming".

Calibration

The Calibration view of the software is seen by clicking on calibration in the View frame on the left side of the IRIS 5500 software window. The calibration screen and process is discussed in detail in Chapter 4, "Calibration".

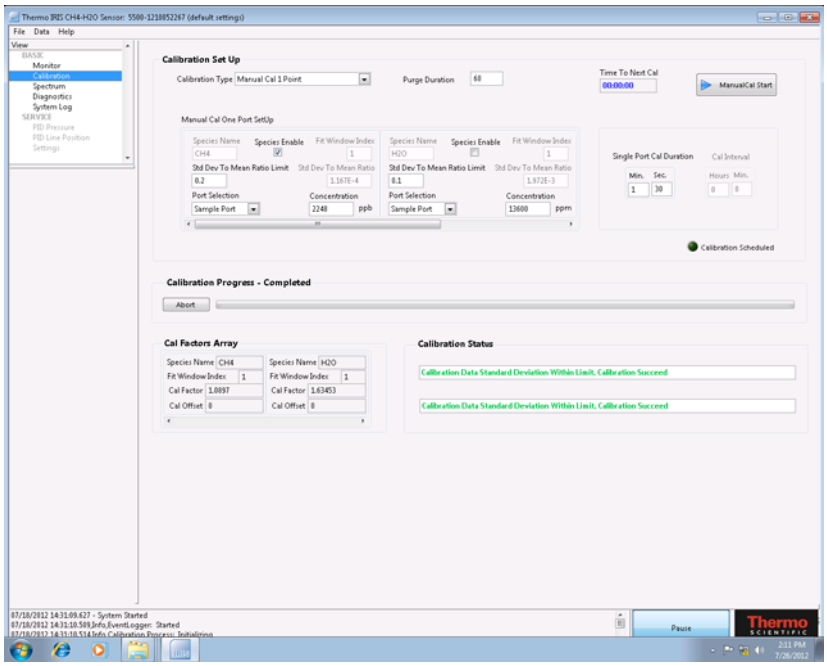


Figure 3–2. Screenshot of the Calibration View of the IRIS 5500 Software

Spectrum

The Spectrum is activated by clicking on "Spectrum" in the View frame on the left side of the IRIS 5500 software window. The Spectrum view provides information about the observed data and the ability to save that data. The main portion of the Spectrum view is a plot window that shows the measured spectrum of the gas in the sample cell. The normal view shows the entire ramped signal of detected laser light through the sample cell (red line in Figure 3–3). This ramp signal (expressed in volts) includes the three methane lines that are fit to obtain the concentration as well as a water line that is fit and used in determining the mole faction. Two vertical bars within the plot window indicate the boundary of the fit window. Within this region a multi-line curve fitting algorithm is used to fit absorption spectrum. The resultant fit is shown as a white line on top of the ramp signal. As with the Monitor view, the Spectrum view allows the user to change the averaging time that is performed to obtain each concentration measurement. The gas status information is also provided in this view.

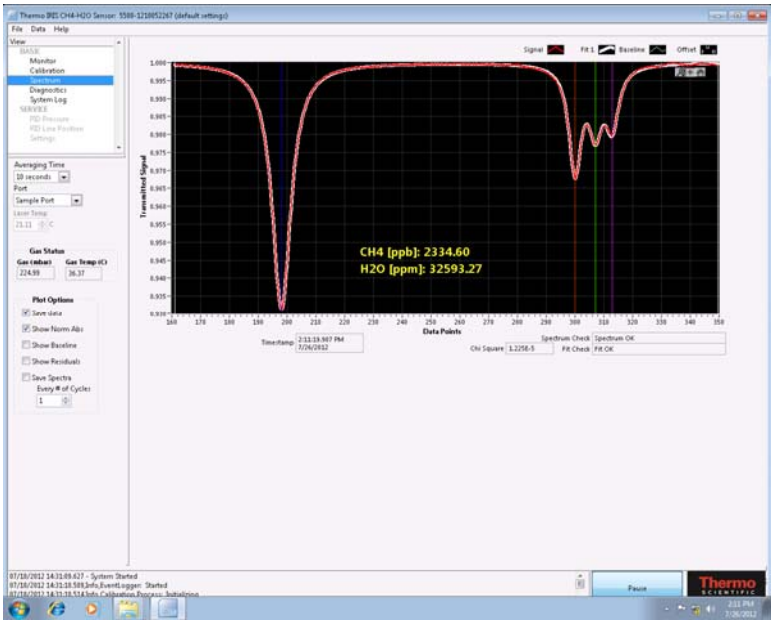


Figure 3–3. Screenshot of the spectrum view of the IRIS 5500 software

Below the gas status box there is another box titled Plot Options. The controls within this box allow the user view and save the data in different ways. The available options are:

- Save Data
- Show Normalized Absorption
- Show Baseline
- Show Residuals
- Save Spectra
  - Every # of Cycles

Each of these items is discussed below.

Save Data (default) When the Save Data box is checked the IRIS 5500 software saves the concentration and additional system data to a file on the internal computer's hard drive. This data may be retrieved using the remote desktop feature to access the embedded computer.

Show Normalized Absorption When Show Normalized Absorption is checked the spectrum shown in the plot window is replotted to show the normalized transmission spectrum. The region that is displayed includes the water line and the three methane absorption lines. Before the spectrum

is normalized, the baseline is subtracted which removes the ramp associated with the tuning of the laser. Figure 3–4 shows a screenshot of the Spectrum View with the Show Normalized Spectrum box checked. The fit to the spectrum can be seen as the yellow line underneath the red data.

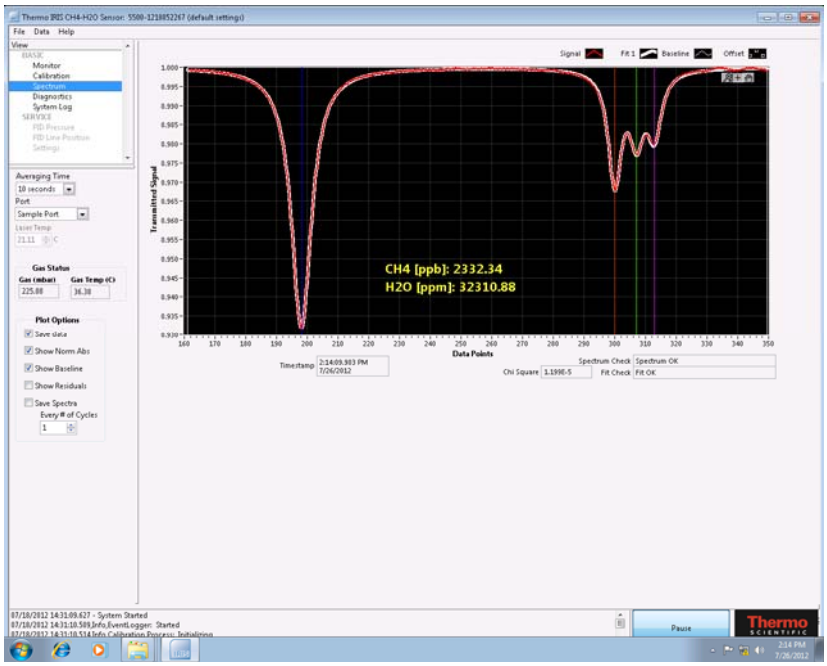


Figure 3–4. Screenshot of the Spectrum View with the Show Normalized Spectrum box is checked

Show Baseline When Show Baseline is selected the IRIS 5500 software includes the signal baseline in the plot of the spectrum. The baseline is the background signal that serves as a reference point for the spectral fitting. The baseline may be seen in Figure 3–4.

Show Residuals When the Show Residuals option is selected the IRIS 5500 software displays the residuals associated with the fitting of the methane and water vapor lines. The main plot window is reduced in height and a secondary plot window appears below. The residuals are the difference between the measured data and the fit based on the line fitting algorithm. Figure 3–5 shows a screenshot of the Spectrum view with the Show Residuals option enabled.

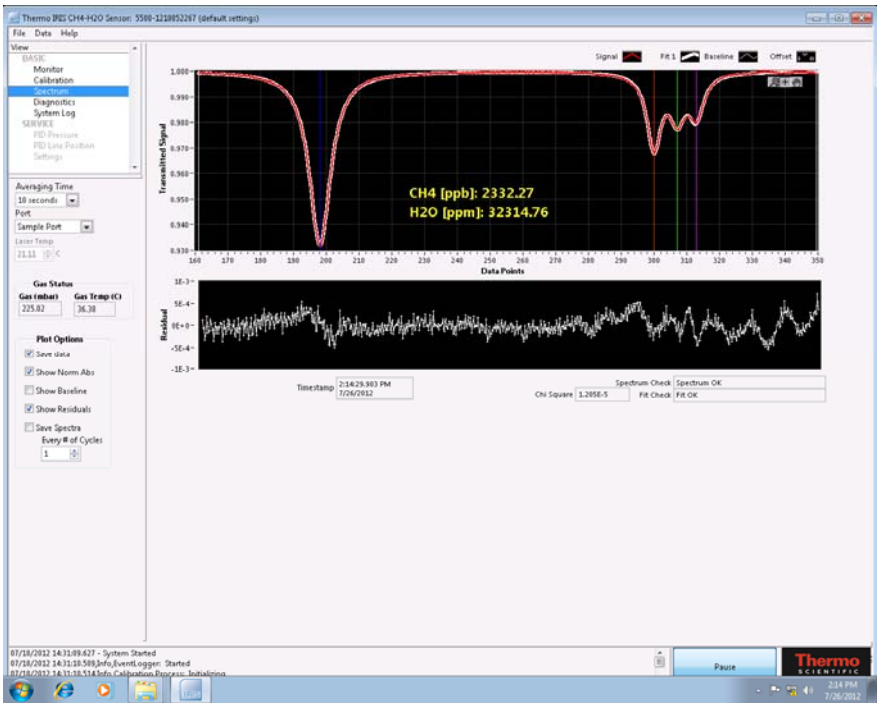


Figure 3–5. Screenshot of the Spectrum View with Show Residuals enabled

Save Spectra When the Save Spectra option is selected the IRIS 5500 software will write the measured spectrum to a text file on the system's internal hard-drive. Below the Save Spectra option if a box that allows the user to input the number of cycles between each saved spectrum. Choosing a number other than 1 will record only one spectrum over that number.

Diagnostics

The Diagnostics is activated by clicking on "Diagnostics" in the View frame on the left side of the IRIS 5500 software window. This view provides useful information about the status of the IRIS 5500 instrument: For typical operation the diagnostics are not critical to understanding the methane measurement. There is a single diagnostic plot area, with various diagnostic parameters displayed in a list on the left. Clicking the box to the left for any parameter toggles that parameter to be displayed or not displayed; a check mark indicates that the parameter is actively being displayed. The following list explains each of the items seen in the legend for the plots.

- AI_TemM_PPLN – Temperature of the PPLN crystal
- AI_TemM_SigLas – Temperature of the signal laser in the compact DFG laser
- AI_TemM_PumpLas – Temperature of the pump laser in the compact DFG laser
- AI_Tmst_GasT – Temperature of the gas flowing into the sample cell
- AI_Tmst_PwrSupp – Temperature in the chassis near the power supply
- AI_Tmst_ChassisAir – Temperature of the air inside the chassis
- AI_Tmst_EnclosureAir – Temperature of the air inside the thermal enclosure
- AI_Tmst_CellOut, AI_Tmst_CellIn – Temperature of local surfaces in the optical cell assembly
- AI_TemM_HeaterBack, AI_TemM_HeaterBottom, AI_TemM_HeaterFront, AI_TemM_HeaterLeft, AI_TemM_HeaterRight – Temperatures located at various active heaters on the outer surface of the thermal enclosure (but underneath insulation).
- SR_EncloseCtlTemp – Temperature of the thermal enclosure controller output
- AI_PwrM_PumpL – Power of the pump laser in the compact DFG laser
- AI_PwrM_SigLas – Power of the signal laser in the compact DFG laser
- AI_Tub_Pressure – Pressure within the optical chamber
- AI_Flow – Flow rate of the gas being pumped through the IRIS 5500 system
- AI_LaserPower – Power of the detected mid-IR emission from the compact DFG laser
- SR_EnclosCtlPW – Fractional operating point of the driver for the thermal enclosure controller. This reading will range from -1 to +1, where -1 corresponds to 100% power for heating and +1 corresponds to 100% for cooling.1: 100% heating

Note All laser powers displayed in the plot are expressed in Volts and not Watts. ▲

The Diagnostics view (Figure 3–6) also displays the status of the various digital outputs of the IRIS 5500. The status of these outputs is indicated by lights below the lower plot area. A bright green light indicates that the particular output is enabled. The digital status indicators represent:

- Power Enabled – primary power supply within the IRIS 5500 control unit
- Power B Enabled – secondary power supply within the IRIS 5500 control unit
- Fan Enabled – cooling fan within located within the IRIS 5500 control unit
- Pump Motor Enabled – vacuum pump for drawing the sample into the gas cell
- Laser Enabled – Mid-IR laser used for absorption measurements
- Pump Laser Enabled – pump laser in compact DFG assembly for generating Mid-IR light

In addition, status indicators for two digital inputs are shown to the right of the digital output indicators. These input indicators are:

- Detector OK
- Shutdown Button

These indicators will illuminate when the appropriate condition is satisfied; the Detector OK indicator will light when the detector is properly powered and receiving signal while the Shutdown Button will illuminate when the system shutdown button on the front panel has been clicked.

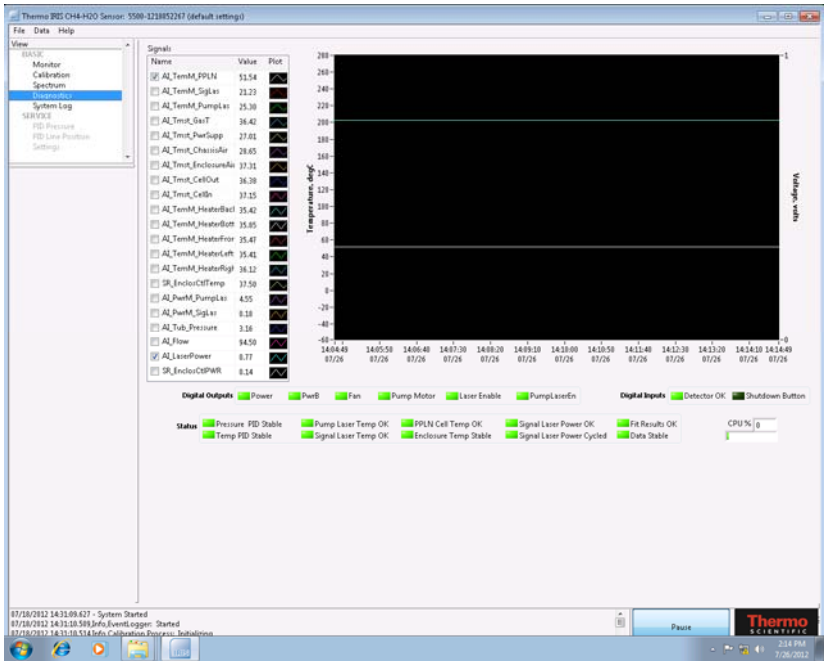


Figure 3–6. Screenshot of the Diagnostics view of the IRIS 5500 software

Located below the digital indicators is another cluster of indicators for various analog signals. These indicators turn bright green when the parameters lie within the proper operating conditions. These system statuses are:

- Pressure Stable – the gas pressure within the sample cell stabilized to within 5% of the set point (default 225 mbar) for a predefined time (default 30 sec.).
- Signal Laser Temp Stable – the temperature of compact DFG signal laser stabilized to within 5% of its set point value (default 22°C).
- Pump Laser Temp OK – the temperature of the compact DFG pump laser stabilized within the predefined range (default T_{max} = 100°C and T_{min} = 0°C).
- PPLN Laser Temp OK – the temperature of the PPLN crystal stabilized within the predefined range (default T_{max} = 80°C and T_{min} = 30°C).
- Fit Results OK – the spectral fit algorithm converged.
- Enclosure Temp Stable – the temperature of the thermal enclosure has remains with 5% of the predefined set point (default T_{enc} = 37.5°C) for a predefined time (default 30 sec.).
- Laser Power OK – the power (in volts) emitted from the compact DFG signal laser is within operating specifications (default V_{max} = 5 V and V_{min} = 0 V).

- Signal Laser Temp OK – the temperature of compact DFG signal laser is below the maximum permitted temperature (T_{max} = 40°C). If the signal laser temperature exceeds T_{max} the laser will shutdown for a predefined cool-down period (default 30 sec.).
- Laser Power Cycled – the compact DFG laser source was properly power cycled during start-up.
- Data Stable – the absorption lines in acquired spectral signal do no deviate by more than ±2 data points for a predefined period (default 30 sec.).

To the right of the analog signal LED panel is a numerical readout and bar indictor for CPU usage. This feature is provided for diagnostic value should other errors in operation arise. On its own, it is not a performance indicator.

System Log

The System Log screen is activated by clicking on “System Log” in the View frame on the left side of the IRIS 5500 software window. This screen allows the user to see the system log data that is recorded after the initiation of the IRIS 5500 software. The data is time and date stamped and presented in the main panel of this view. The user may select event log files using the ‘Log Date’ selection and icon (that looks like a timepiece): Figure 3–8 shows the window that pops up when the icon next to the date is pressed. The date is set by choosing the desired day on the displayed calendar or by clicking the button labelled SET TIME TO NOW, which will pull up the current day event log. When the time and date are set press the OK button to store this data and close the pop up window. If no files are available for the selected date, the Log Data panel will be blank. The path for the data log file is shown in the bar to the right of the date. This path may be changed by either typing in the bar or pressing the folder icon next to the input field. Pressing the icon button causes a window to appear (Figure 3–9) allowing the user to navigate the system directory and input the desired name of the log file. When the desired location is selected and file name input, press the OK button to save the log file and close the window.

Additionally, on the System log screen there is a button “Clear Error Status.” This clears error messaging on the LCD on the instrument front panel.

Note Setting the time in the Windows operating system automatically updates times in system and data logs. The user should be aware of potential gaps and overlaps in log data that would result from time changes. ▲

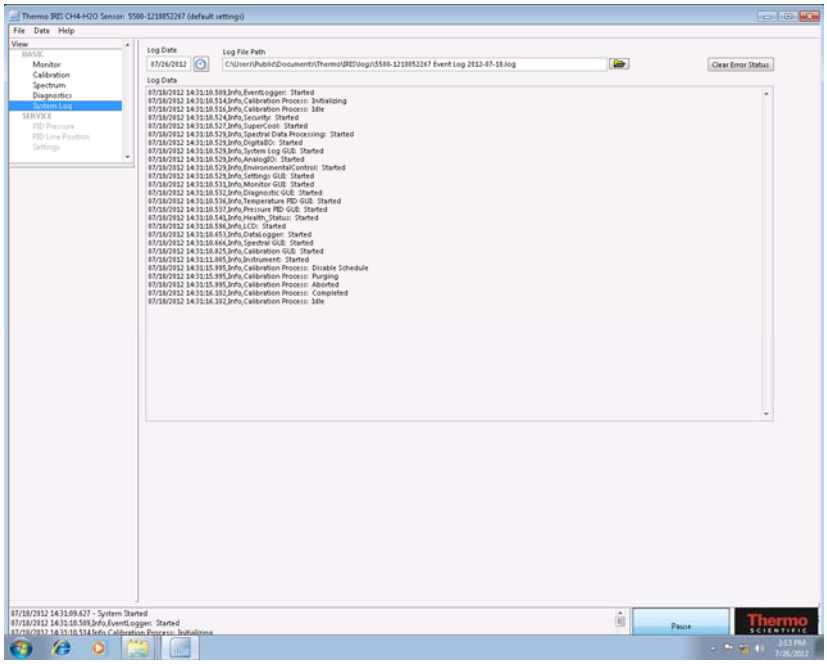


Figure 3–7. Screenshot of the System Log view in the IRIS 5500 software

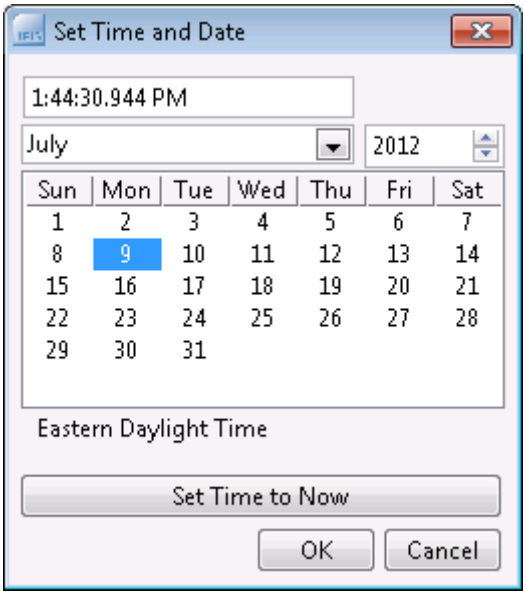


Figure 3–8. Pop-up windows that appears when the icon next to the date is clicked

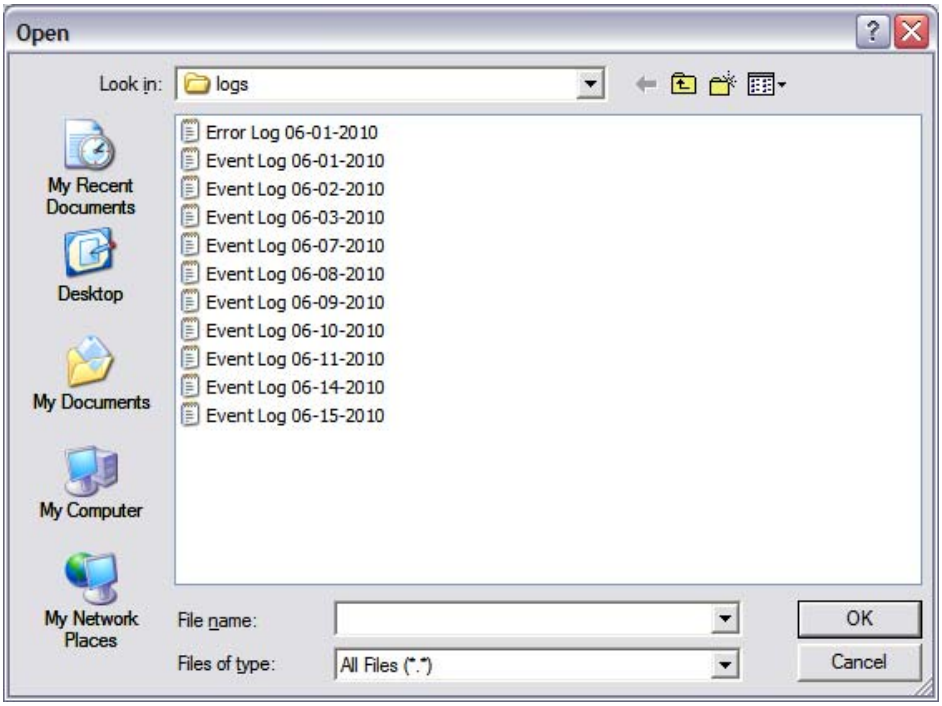


Figure 3–9. Dialog box that appears when the folder icon is clicked allowing the user to change the path for the log file

Log Files

There are four types of log files:

- Event log files are ASCII text strings, non-delimited. They are generated any time there is a GUI start up, a GUI shut down, or an error generated. The start up and shut down processes follow a prescribed sequence of events which will be common to all Event log files, which are the same as shown on the System Log view in Figure 3–7. Time stamps are provided for each event. Event log files are titled "Event Log" with date, as shown in Figure 3–9, and are located in the path set forth by the System Log panel in the GUI.
- Error log files are like Event log files, except only generated errors are logged. Error log files are titled "Error Log" with date, and are located in the path set forth by the System log panel in the GUI.
- Calibration log files keep are described in Chapter 4, "Calibration" and are kept in the local computer path C:\Users\Public\Documents\Thermo\IRIS\data
- Data log files are the recorded information of the methane and moisture result, and provide a comprehensive tracking of various internal diagnostics. These files are described in detail over the remainder of this section.

Data log files are tab delimited ASCII text. Their maximum duration is 24 hours. They are generated under the following conditions:

- A full GUI start up
- A configuration file re-load
- Cycle-clicking the Pause/Start button on the GUI
- When the local set time passes through midnight and change of date.

Data log files are found in the local computer path C:\Users\Public\Documents\Thermo\IRIS\data. They are usually titled with the instrument name (i.e., the serial number), with the date stamp of first creation. See Figure 3–10.

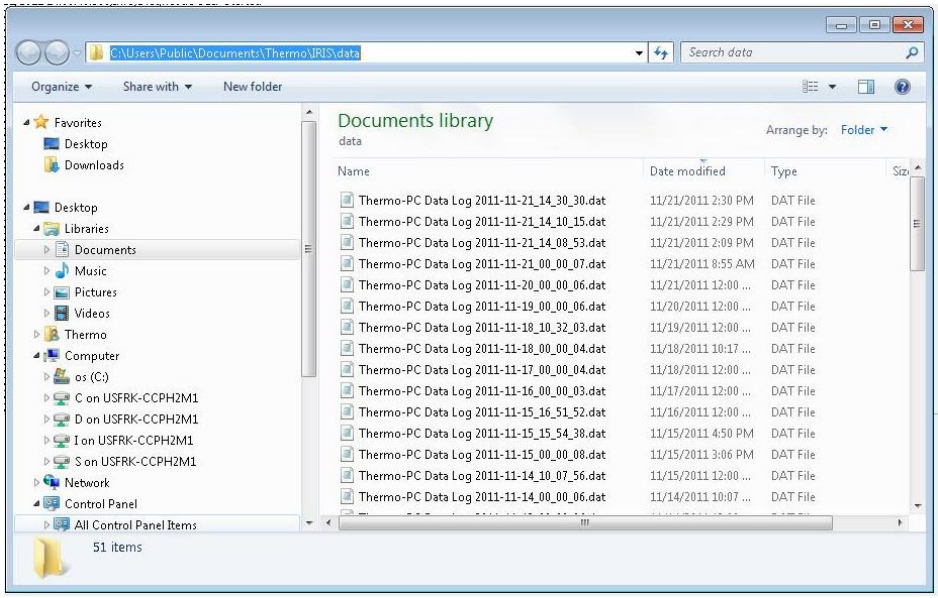


Figure 3–10. Screenshot of the Data Log Files

Data log files are tab delimited and can be opened in any spreadsheet or word processor. In order to properly organize the information, it is strongly recommended to use a spreadsheet or other type of data analysis software that can open ASCII text.

The following itemizes the columns displayed when loaded into a spreadsheet, with detailed descriptions:

- Local Time Stamp and UTC Time Stamp: UTC is the Coordinated Universal Time that corresponds to Greenwich Mean Time (GMT). These are numerical and may be converted into various specific Date/Time formats in spreadsheets.

- "Fit1_CH4_corrected (ppb):" The primary instrument result, expressing methane as dry mole fraction. The result contains calibration correction as well.
- "Fit1_CH4_C1," "Fit1_CH4_C2," and "Fit1_CH4_C3:" Calculated ppb results for each peak fit in the methane triplet. These are non-essential for the proper operation and understanding of the IRIS 5500.
- "Fit1_H2O_corrected (ppm):" The measured moisture, which is used in the calculation for dry mole fraction.
- "Fit1_H2O_C1:" The calculated ppb result for the water peak fit. This is non-essential for the proper operation and understanding of the IRIS 5500.
- "Data OK:" Generates a '1' for good data, or a '0' for data that coincides with an internal diagnostic error. A '0' result does not automatically correlate with a measurement error.
- "Calibrating" and "Purging:" Either generates a '1' if the process is active, or a '0' if not. Thus, in normal operation, these will both read '0.'
- "Cal_gain" and "Cal_offset:" These return the calibration factors that arise from the GUI calibration process. Defaults are "1" and "0" respectively, or the Factory calibration for "Cal_gain" on first receipt of the instrument. During calibration runs, the values are also "1" and "0" respectively.
- "Temp(C)" and "Pressure (mbar):" The conditions for the gas as measured in the instrument. They are essential for the ideal gas and partition calculations that result in the methane result in ppb.
- "SpectralCheckCode," and all subsequent columns starting with "Fit1:" Health checks and coefficients for the fitting routine. Four peaks total are captured in the fitting (methane triplet and water singlet), along with a polynomial background fit. These are available for diagnostics by trained Thermo Fisher Scientific service staff, and are otherwise non-essential for the proper operation and understanding of the IRIS 5500.
- Columns starting with "_AO_:" Analog outputs for PID controls. These are available for diagnostics by trained Thermo Fisher Scientific service staff, and are otherwise non-essential for the proper operation and understanding of the IRIS 5500.
- Columns starting with "_AI_:" Analog inputs from various sensors embedded throughout the instrument. Most are associated with thermistor or other control temperature feedback. These are available for diagnostics by trained Thermo Fisher Scientific service staff, and are otherwise non-essential for the proper operation and understanding of the IRIS 5500.

- "CPU Util" column: Provides the tally of CPU usage in Windows OS environment. This is available for diagnostics by trained Thermo Fisher Scientific service staff, and is otherwise non-essential for the proper operation and understanding of the IRIS 5500.
- "Enclosure Ctl" columns: Provides control data for embedded heat exchanger. These are available for diagnostics by trained Thermo Fisher Scientific service staff, and are otherwise non-essential for the proper operation and understanding of the IRIS 5500.
- "_DO_status," "_DI_status," and "StatusData:" Hex code indicators. These are non-essential for the proper operation and understanding of the IRIS 5500.
- "LaserPower:" The detected signal of laser light. This may indicate errors in operation and cell alignment if near zero or negative. Otherwise, variation is to be expected.

Chapter 4
Calibration

The following sections discuss the calibration process and procedures for calibrating the instrument:

Factory Calibration

Each IRIS 5500 system is tested using known concentration reference sources to insure that the unit functions properly and the calibration routine is accurate. The calibration gases used at the factory are traceable to the National Institute of Standards and Testing (NIST).

The primary factory reference method consists of flowing continuously a known concentration of methane into the IRIS 5500. The absorption is measured in the usual way and compared against the reference concentration to define the calibration factor. Record of the calibration factor is retained in product software and text files.

Water vapor calibration is not conducted at the factory. This activity requires specialized apparatus and control. Further, the expected accuracy of the default calibration of '1' falls within the error that may be introduced in the dry mole fraction calculation.

Calibration Guidelines

Periodic calibration of the IRIS 5500 system is performed by a user to assure the integrity of the computed sample concentration. Within the GUI, calibration settings are found in the 'Calibration' view which is selected on the left-hand side of the software window. Figure 4–1 shows a screenshot of the IRIS 5500 software (with *Manual Cal 1 Point* Calibration view active, see below).

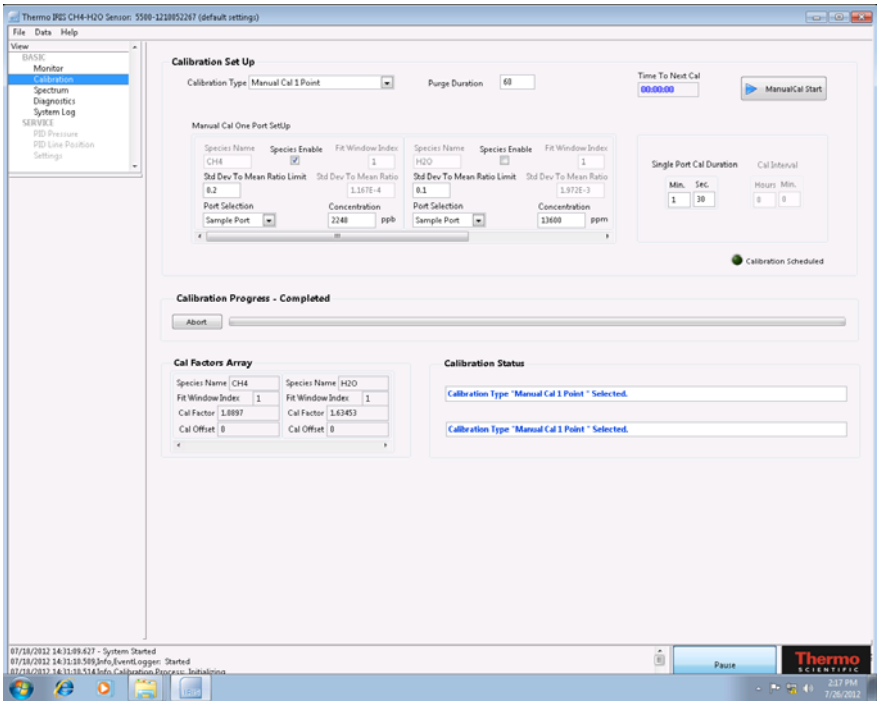


Figure 4–1. Screenshot of the IRIS 5500 software window showing the calibration view

Five different calibration types may be selected, combining single point span vs. two point calibration, and the option to operate automated calibrations on schedule – each of these have a dedicated view and interface in the GUI:

- Manual Cal 1 Point (as shown in Figure 4–1)
- Manual Cal 2 Point
- Scheduled Cal 1 Point
- Scheduled Cal 2 Point
- Scheduled Cal 2 Point & Archive

The Calibration Type is selected by a pull down menu located in the upper left corner of all views (Figure 4–2).

Regular calibration of the instrument is appropriate for ensuring the integrity of the measurement; moreover, calibration cycles within 24 hours can improve intrinsic variation in system specifications set forth in Table 1–1.

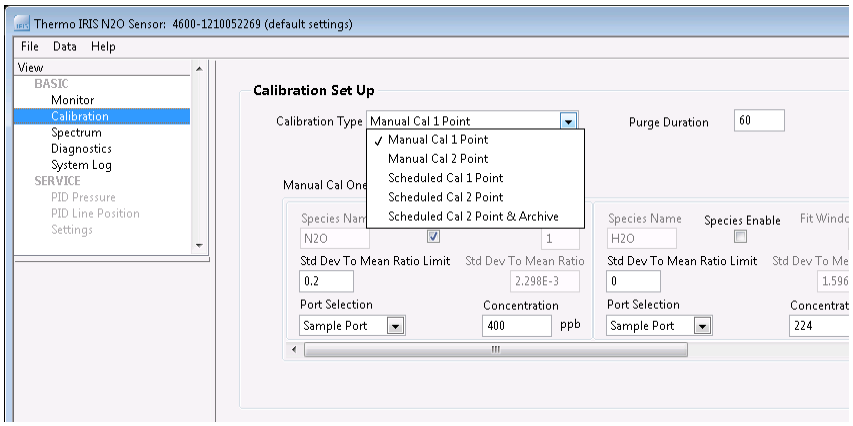


Figure 4–2. Calibration Type Pull-Down Menu

Manual or Scheduled Cal 1 Point calibration uses a single standard concentration gas (or "span" gas) assuming a true zero offset. Manual or Scheduled Cal 2 Point calibrates from two different standard concentration gases and calculates the y-axis intercept or zero offset value as well as the calibration factor.

The IRIS 5500 Calibration process consists of a sequence of purge segments and Calibration segments. Purge segments allow sufficient time for turnover of the sample volume from selected gas to another selected gas, such as between calibration cylinders and sample air. Time for each segment is explicitly defined by the user.

Calibration factors are compiled in calibration log files, showing factors and offsets under time stamps that are generated at completion. These calibration records are stored in the file path C:\Users\Public\Documents\Thermo\IRIS\data (same as data log files).

Before initiating the calibration process, be sure that the desired reference sources are connected to the correct inputs and that all fittings are properly tightened.

If a calibration is stopped for any reason, the previously stored calibration factor and offset are retained in the software, and no record is logged in the Calibration Log file.

Calibration Screen Layout

Figure 4–1 shows a screen shot of the calibration view with Manual Cal 1 Point type selected.

Selecting different calibration types will result in slightly different views, specifically in the Calibration Setup area, to reflect the specific inputs and outputs associated with each type.

Certain sections of the calibration view do not change with Calibration Type.

- Calibration Progress
- Cal Factors Array
- Calibration Status

These are shown as a close up in Figure 4–3.

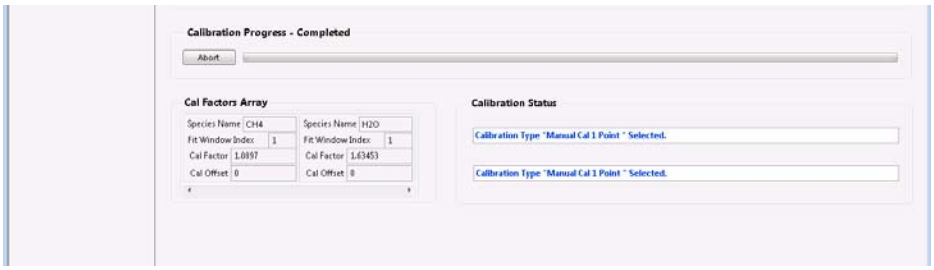


Figure 4–3. Screenshot of Calibration Progress, cal Factors Array and Calibration Status

The *Calibration Progress* visually tracks the duration of calibration. At the left hand side of the bar is a button that aborts a calibration run in progress On top of the bar is an additional status message, indicating the active Port and whether the segment is “Purging” or “Calibrating.” The progress of the bar is determined against each step of calibration, including purge times. When “Abort” is pressed for any reason during calibration, calibration is stopped and a final purge sequence is initiated before starting normal sampling again. Pressing “Abort” a second time will suspend the purge and immediately start normal sampling.

The *Calibration Factors Array* shows the resultant numbers for Cal Factor and Offset for the previous calibration process in normal operation. The Species name are always CH_4 and H_2O for the IRIS 5500, and the Fit Window Index is always 1. During normal operation the GUI shows the Factor and Offset for calculation of the gas concentrations. During the calibration process, the numbers are always ‘1’ for Cal Factor and ‘0’ for Cal Offset, as these are the default conditions for calculating new factors. Single Point Calibration always generates a result of ‘0’ for the Cal Offset.

Note There is grayed out and inactive content visible that would apply when more than one gas is measured; this is not a feature for the IRIS 5500 as it measures just CH_4 gas. ▲

Calibration Status is provided by text messages in two text boxes, conveying similar or different messages depending on the situation. Most of the time, a prior calibration result status will be conveyed in green text. When scheduled calibration information is newly entered correctly (see Calibration Set Up, below), green text will inform that auto calibration may proceed. Conversely, unstable performance or incorrect set up will prevent calibration from proceeding, and will be indicated in any one of the following red messages:

- Manual Cal Not Available when Data Is Not Stable
- Two Ports Should Not Be Identical When user selected two identical ports
- Any Cal Interval Must Be Longer Than The Sum of Cal and Purge Durations
- Calibration Is Not Available Before System Is Warmed Up (new)

Figure 4–4 shows a close up view of the Calibration Setup area for Manual Cal 1 Point type (being the least complex calibration approach). In this view, features that are shared for all calibration types can be identified:

- Purge Duration is the time in seconds for calibration gas to displace prior sample gas when a calibration sequence is enabled. **It is necessary to set the purge duration for at least 4 minutes** to reflect the intrinsic speed of response of the sampling system in IRIS 5500 and attain good calibration results. Purges are applied at the start of calibration sequence, at the end of calibration sequence, and between steps when selecting 2 point calibrations.
- Time to Next Cal should be **00:00:00** whenever a Manual Cal type is active. When a scheduled Cal type is active, it acts as a countdown clock to the next calibration.
- The button “ManualCal Start” starts the calibration process. This consists of the purge sequence, calibration sequence, a follow up purge sequence. During calibration, the button will read “ManualCal Stop” but will be grayed out.

  When a Scheduled Cal type is selected this same button will read “Autocal Arm” or “Autocal DisArm.” Pressing “Autocal Arms” starts the scheduled calibration immediately and tracks the scheduling to next calibration. Pressing “Autocal DisArm” disables scheduling. During a calibration sequence, the DisArm button is grayed out.

(Note: Recall the "Abort" button located near *Calibration Progress* stops calibration in progress.)

If a calibration is stopped for any reason, the previously stored calibration factor and offset are retained in the software, and no record is logged in the Calibration Log file.

- Below the Start/Arm button are the calibration duration and interval. Interval denotes time between scheduled calibrations, and is grayed out (inactive) for Manual Calibration types. Duration is the desired time of measurement on calibration gas, not including purge duration. It is a single number duration that is applied to one point calibration and each cycle in a two point calibration.

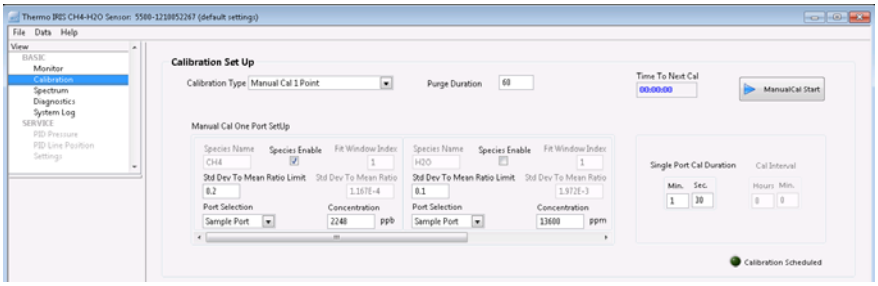


Figure 4–4. Screenshot of Calibration Setup for Manual Cal 1 Point

NOTE that CH_4 and H_2O calibrations are tied together; that is, for selecting a port and duration for either gas, the same port and duration is selected for both. For applications where a cylinder standard only is available, no moisture calibration is possible (there is no or minimal moisture content in cylinder gases).

The remaining information specifies setup specific to the Manual Cal 1 Point type.

- Species Name are always CH_4 and H_2O for the IRIS 5500, and so is grayed out (inactive).
- Species Enable checkbox for CH_4 should show a check mark. In most typical applications, H_2O will not be checked (it is not common to operate a moisture standard). If neither gas is checked, calibration will not proceed.
- "Std Dev to Mean Ratio Limit" allows screening of calibrations to remove arbitrarily noisy, changing, or otherwise suspect data for each gas enabled. The Limit is arbitrary, and its factory default is "1" unless a different value is entered and saved into configuration.

  To the right, the "Std Dev To Mean Ratio" is a read only indicator (grayed out) that shows the result of the previous calibration.

  The Std Dev is the statistical standard deviation of data stream during process of each calibration, and the mean is the value used against

standard concentration to determine the Cal Factor. The measured ratio is displayed as read only to the right of the Limit entry, and is the result. If 2000 ppb is measured with 0.5 ppb standard deviation, the ratio will be 0.00025.

- The “Port Selection” and “Concentration” define the rear panel input fitting and cylinder concentration used for the calibration for each gas. Entered data only applies if the gas is enabled, so the data does not require entry and can be ignored when ‘Species Enable’ is unchecked.

  Only one port can be selected: Two gases are not allowed to have different ports.

- “Fit Window Index” and all other grayed out information relate to potential measurement applications outside of IRIS 5500 measurement of CH_4 gas and water vapor.

Scheduled Cal 1 Point type contains the same information as above for Manual Cal 1 Point type, but with the Cal Interval active and requiring an input, while the Start button designates “AutoCal Arm.”

Figure 4–5 shows a close up view of Manual Cal 2 Point type. Here, additional entry of Cal Port and Concentration for the second cylinder used in calibration is required. Similarly, Scheduled Cal 2 Point type contains the same information as for Manual Cal 2 Point type, but with the Cal Interval active and requiring and input, and the Start button designates “AutoCal Arm.”

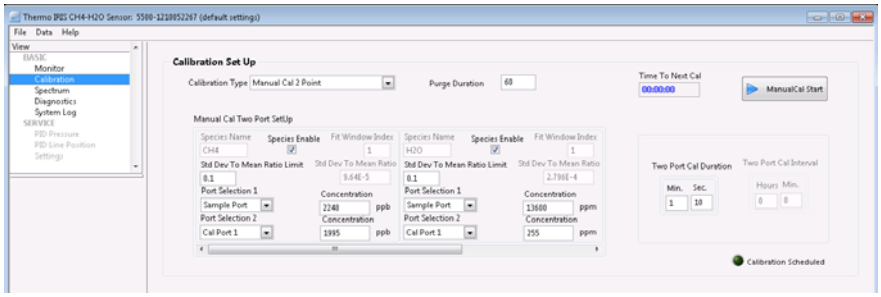


Figure 4–5. Screenshot of Calibration Setup for Manual Cal 2 Point

Note If two similar concentrations are entered as part of a two point calibration for selected ports, the result will likely be unstable and result in an error. ▲

Note If the sum of calibration duration with purge times is in excess of the calibration interval, calibration will not proceed, and messaging will alert this status. ▲

Scheduled Cal 2 Point & Archive allows setting up a third port/and concentration for maintaining an archive of cylinder gas measurements to supplement ongoing 2 point scheduled calibrations. The archive step immediately follows the two point calibration. The Concentration entry for the archive is not used for operation.

Calibration Process

Calibration may only proceed when the instrument is properly warmed up and in correct operation mode.

When a calibration is started:

- All entry fields are grayed out.
- The Cal Factor and Offset will display ‘1’ and ‘0,’ and the Calibration Progress bar will show the relative status of the calibration process.
- The Calibrating indicator light on the GUI will illuminate green, and the Data OK indicator light will illuminate red.
- The LCD on the instrument front panel will display “Calibrating” and provide a time countdown to the end of calibration.
- The Calibration Progress will start, indicating “Purging” if non-zero purge time has been entered, or “Calibrating” at the selected Cal Port.
- Stopping a calibration by hitting “Abort” near the progress bar immediately stops a calibration and initiates a final purge stage; hitting ‘Abort’ a second time will immediately start normal sampling mode.
- Stopping a calibration results in return of the prior calibration factors.
- When calibration completes, new calibration factors are displayed and a calibration log entry is performed.

Chapter 5
Configuration File and Data Streaming

This chapter describes the pull down menus that relate specifically to special management functions of the GUI. The headings for these pull down menus are “File,” “Data,” and “Help.”

The “File” pull down menu is shown in Figure 5–1, and allows the following:

- Exiting the software (this is also achieved by clicking the red “X” in the upper right corner of the GUI).
- Configuration file management. Three commands include “Load Configuration,” “Save Configuration,” and “Save Configuration to File.” Configurations allow the user to retain and track desired features that are “configured” in the GUI for future start ups and activities.
- Login and Logout: These are for enabling advanced capabilities of instrument performance and configuration, only to be operated by trained Thermo Fisher Scientific field or customer service technicians.

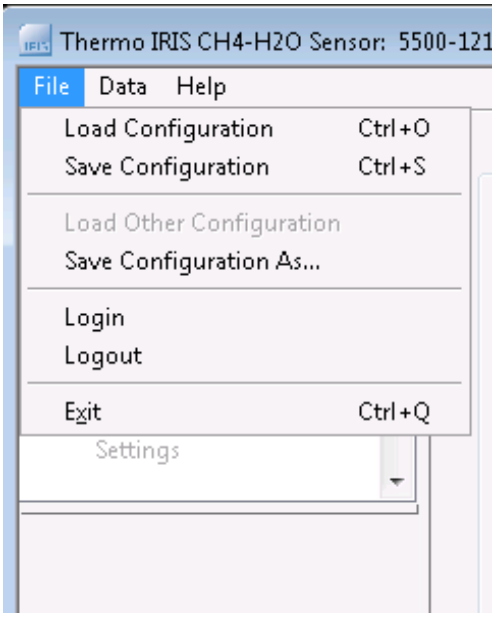


Figure 5–1. Screenshot of the “File” pull down menu

Configuration

Configuration options are under the “File” pull down menu. Options relate to a config.xml file that is accessed at every start up. Aspects of instrument operation that may be retained in a config file include:

- Averaging Time
- Port
- Calibration Data (intervals, values, etc.)
- Checked Plot Options

The GUI only ever accesses a uniquely named “config.xml” file. Saving and loading relates to the unique config.xml.

When saving, new information is written automatically into the config.xml file. Prior information is retained to a file that has a date/time stamp, e.g. config.04222012-111843.xml relates to the file created at April 22, 2012, at the time of 11:18:43 AM when the user performed “Save Configuration.” To restate: Old information is stored in the created files: New information is written into the default config.xml file.

“Save Configuration As” is a feature that allows saving information to a different file name.

To load a different config.xml file for the GUI to read on start, Windows Explorer features must be used. The path for the configuration file folder is:

```
C:\ProgramData\Thermo\IRIS\settings
```

Within this folder, the user may re-name the existing config.xml file to a name of choice (or delete, though it is not recommended), then to re-name a desired dated or specially named configuration file to config.xml. Re-starting the GUI will then load the desired operational parameters listed above.

WARNING Attempting to edit configuration files risks instrument failure. No efforts should be made to open these files by end users. ▲

Data Streaming

Data Streaming is under the “Data” pull down menu. Data streaming is provided strictly over an Ethernet connection via the front panel of the instrument, using TCP/IP protocol. This allows the acquisition of data into a text file using such tools as Hyperterminal or other in-house TCP/IP manager. The streamed data is space delimited.

The one selection under the Data menu is the call for the TCP Configuration. This opens a new window over the GUI as shown in Figure 5–2.

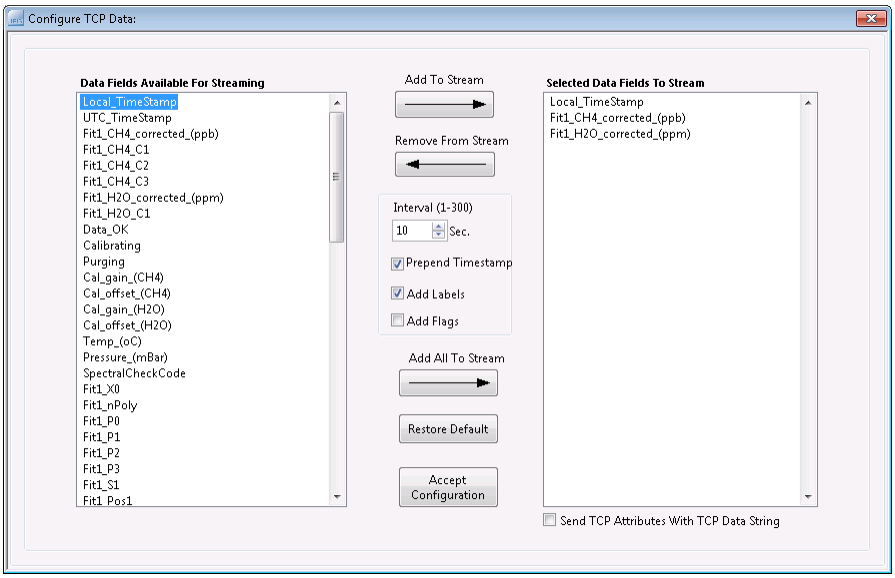


Figure 5–2. Screenshot of Data Streaming

The TCP Configuration allows the selection of those parameters to be streamed. Obviously, the more parameters, the larger any resultant data file. The defaults are only the time stamp and the results for CH_4 and H_2O, as shown in the right hand panel in Figure 5–2. The left hand panel shows all the available data columns. These are described in the Log Files section of Chapter 3, “Operation”.

The data to be streamed is added and removed by the two arrows in the middle top of the window. Options to add all data to streaming, and to restore the default of just time stamp and concentration are also provided. A checkbox “Prepend Timestamp” duplicates the function of physically moving the timestamp for ease of use.

The Interval setting sets the desired rate of updates via the TCP. The TCP Configuration does not determine data time stamps: It reads those generated by the program logging. As such, it is recommended to set the interval to be the same as the averaging time (set in the GUI, Chapter 3).

- If Interval is less than the averaging time in the GUI (e.g. 10 seconds) the update will default to the GUI rate.
- If interval is greater than the averaging time in the GUI, it will update after the TCP is in receive mode AND when an averaged string is sent out from the data sometime thereafter.

Three additional checkboxes are available, described below:

- Checking "AddLabels" places labels in front of each data string every update. (If data is eventually transferred to a spreadsheet, this option is not advised.)
- Checking "AddFlags" provides a hexadecimal string for diagnostics. This is intended only as a service function.
- Checking "Send TCP Attributes with TCP Data String" allows configuration with a TCP Client, where three reads are required in the Client:
  - Size of Attribute String (first 4 bytes converted to integer)
  - TCP Attributes, including: "With/without label" (True/False) and Stream Time interval
  - Byte size of TCP Data String

If reading with a TCP listener such as HyperTerminal the "Send TCP Attributes…" box should remain unchecked.

Note If using a TCP listener such as HyperTerminal, the Port# must be set to 9881. ▲

Chapter 6
Maintenance

This chapter describes the periodic maintenance procedures that should be performed on the instrument to ensure proper operation. Since usage and environmental conditions vary greatly, the components should be inspected frequently until an appropriate maintenance schedule is determined.

This chapter includes the following preventive maintenance information:

General Guidelines

The IRIS 5500 is designed to be serviced at the factory. The only field serviceable components are the external filter used on the gas inlets, the internal filter, and the vacuum pump. Access to these and other internal components should only be conducted by a qualified Thermo Fisher Scientific field technician.

Equipment Damage Contact Thermo Fisher Scientific when error messages or other operational problems occur—in most cases the IRIS 5500 should be returned to the factory. Under no circumstances should the user attempt to diagnose or fix any internal components. For more information see Chapter 6, "Troubleshooting". ▲

Instrument Storage

During storage always maintain the unit with the rear panel fittings covered to protect the sensing optics from gradual dust or moisture contamination. The IRIS 5500 should be stored in a dry environment.

Cleaning of Optical Sensing Chamber

Although the IRIS 5500 incorporates two-stage filtering to remove particulate matter from the air stream, there is a chance that dust or other contamination may gradually build-up in the sample chamber and on the optics. The sensing chamber is sealed within the IRIS 5500 chassis and is not accessible to the user. If the user notices changes in system performance that may be related to contamination of the optics in the laser subassembly and/or sample gas cell, contact Thermo Fisher Scientific to arrange for the unit to be returned for cleaning and validation.

WARNING The IRIS 5500 is a Class 1 Laser Product, use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure. ▲

Equipment Damage If the IRIS 5500 instrument is unresponsive or appears to have become contaminated with dust or debris, contact Thermo Fisher Scientific immediately. Do not attempt to open the sensing chamber of the instrument. ▲

Equipment Damage Some internal components can be damaged by small amounts of static electricity. Access to the internal IRIS 5500 components by unauthorized individuals will void the warranty and may result in serious permanent damage to the instrument. ▲

External Filter Replacement

The only user replaceable component on the IRIS 5500 system is the external filter. This component is inline with the sample inlet tube. The external filter is a Swagelok SS-4FW-7. One filter is supplied with the IRIS 5500 upon shipping. Additional filters are recommended when connecting to the other inlet ports on the back of the IRIS 5500 (Figure 2–3). This external filter is the pre-filtering stage for the gas sampling. A second filter assembly is located within the IRIS 5500 instrument and may be accessed and inspected for replacement by a qualified Thermo Fisher Scientific field technician, at intervals determined by the local particle loading of the sample stream. Under normal conditions, both filters should be replaced annually.

WARNING The IRIS 5500 is a Class 1 Laser Product, use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure. ▲

Equipment Damage If the IRIS 5500 instrument is unresponsive or appears to have become contaminated with dust or debris, contact Thermo Fisher Scientific immediately. Do not attempt to open the sensing chamber of the instrument. ▲

Equipment Damage Some internal components can be damaged by small amounts of static electricity. Access to the internal IRIS 5500 components by unauthorized individuals will void the warranty and may result in serious permanent damage to the instrument. ▲

Pump Maintenance

Annual pump maintenance is recommended. Contact Thermo Fisher Scientific Service department for field maintenance, or return instrument to Thermo Fisher Scientific.

WARNING The IRIS 5500 is a Class 1 Laser Product, use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure. ▲

Equipment Damage If the IRIS 5500 instrument is unresponsive or appears to have become contaminated with dust or debris, contact Thermo Fisher Scientific immediately. Do not attempt to open the sensing chamber of the instrument. ▲

Equipment Damage Some internal components can be damaged by small amounts of static electricity. Access to the internal IRIS 5500 components by unauthorized individuals will void the warranty and may result in serious permanent damage to the instrument. ▲

Chapter 7
Troubleshooting

The IRIS 5500 is designed to be a continuously operating instrument, with few moving parts and thus few failure modes due to wear and tear or aging.

It is recommended that pump and internal filter undergo a yearly inspection and maintenance routine by a trained Thermo Fisher Scientific field technician.

Malfunctions should be reported to the Thermo Fisher Scientific Service Department for guidance on repair and troubleshooting. Troubleshooting of internal components need to be conducted only by a trained Thermo Fisher Scientific technician.

Table 7–1 summarizes basic troubleshooting tasks that may be checked by the user.

Table 7–1. Troubleshooting General Guide

Malfunction	Possible Cause	Action
No power	Main fuses are blown or missing	Check voltages from power supply.
	Disconnected power cable	Verify power cable connections.
No flow	Blocked inlet	Verify inlet is not blocked at rear panel.
	Clogged filter (external)	Replace filter.
No communication	Wrong IP Address	Verify IP Address
	Disconnected cable	Verify cable.
	Defective external USB cable	Replace cable.

Service Locations

Service is available from exclusive distributors worldwide. Contact one of the phone numbers below for product support and technical information or visit us on the web at www.thermoscientific.com/aqi.

1-866-282-0430 Toll Free

1-508-520-0430 International

Chapter 8
Optional Equipment

The IRIS 5500 is available with the following options:

Mounting Options

The IRIS 5500 can be installed in the configuration described in Table 8–1 and shown in Figure 8–1 through Figure 8–4.

Table 8–1. Mounting Options

Mounting Type	Description
Bench	Positioned on bench, includes mounting feet and front panel side-trim handles.
EIA rack	Mounted in an EIA-style rack, includes mounting slides and front panel EIA-rack mounting handles.
Retrofit rack	Mounted in an EIA-style rack, includes mounting slides and front panel EIA-rack mounting handles. This configuration is intended for direct replacement of a C-series instrument in an existing rack. The rail mounting location is lower on the case and the front mounting screw slots have non-standard EIA locations.

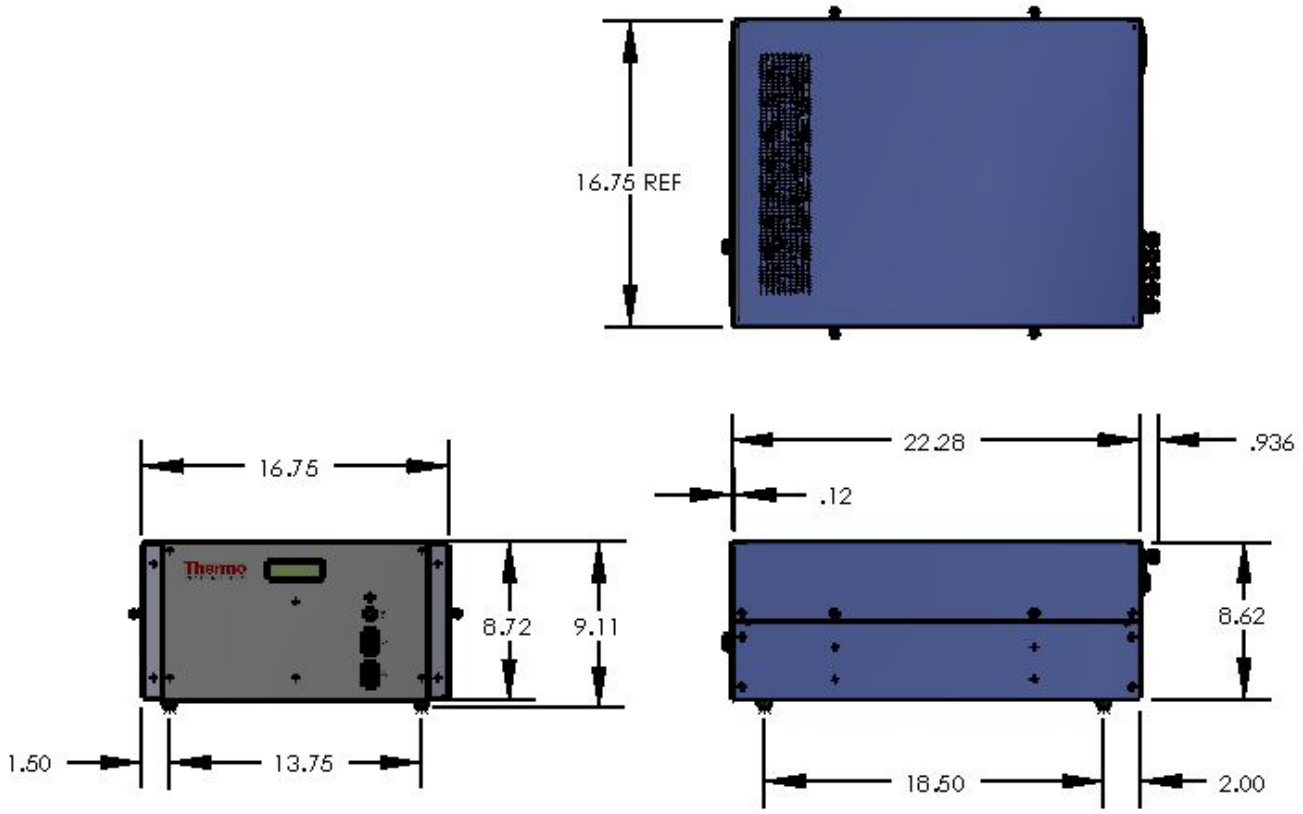


Figure 8–1. Bench Mounting

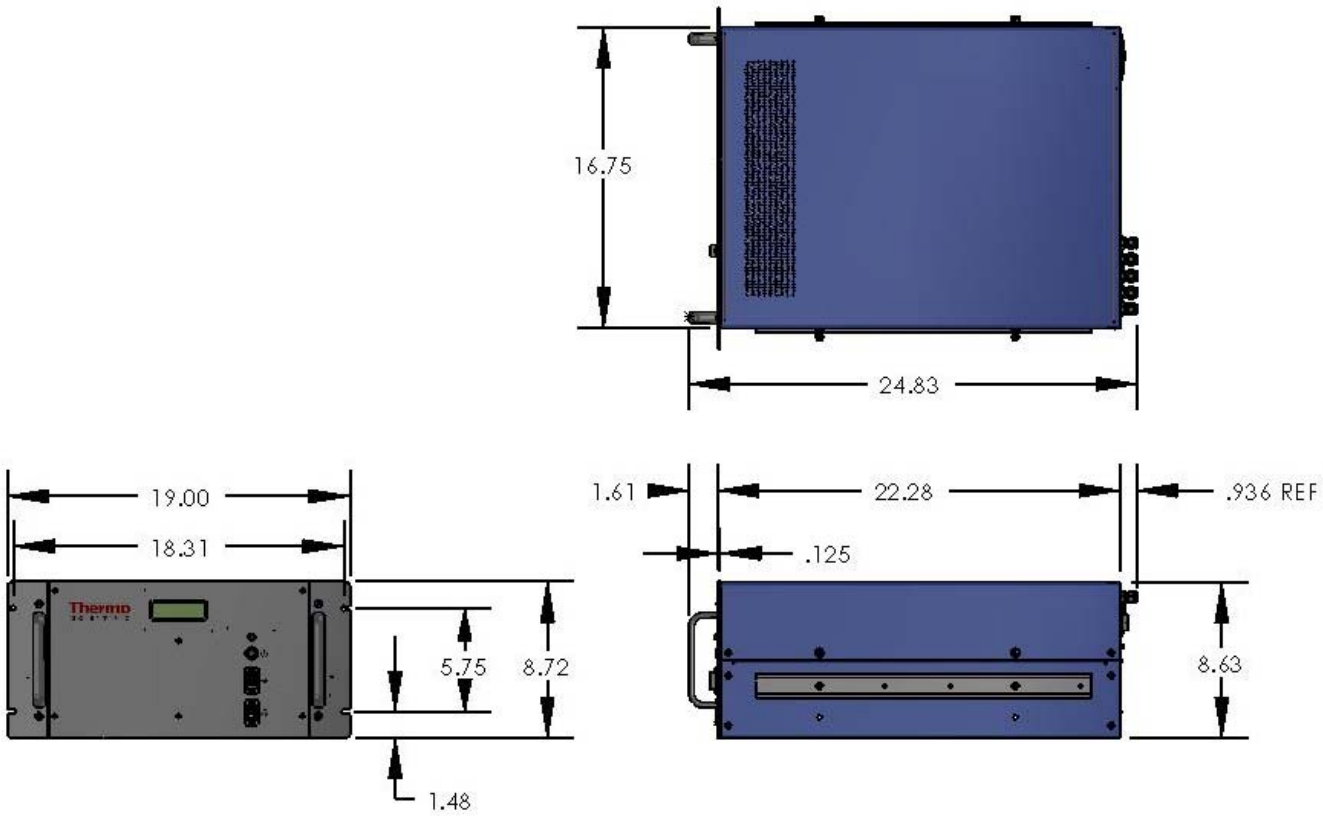


Figure 8–2. EIA Rack Mounting

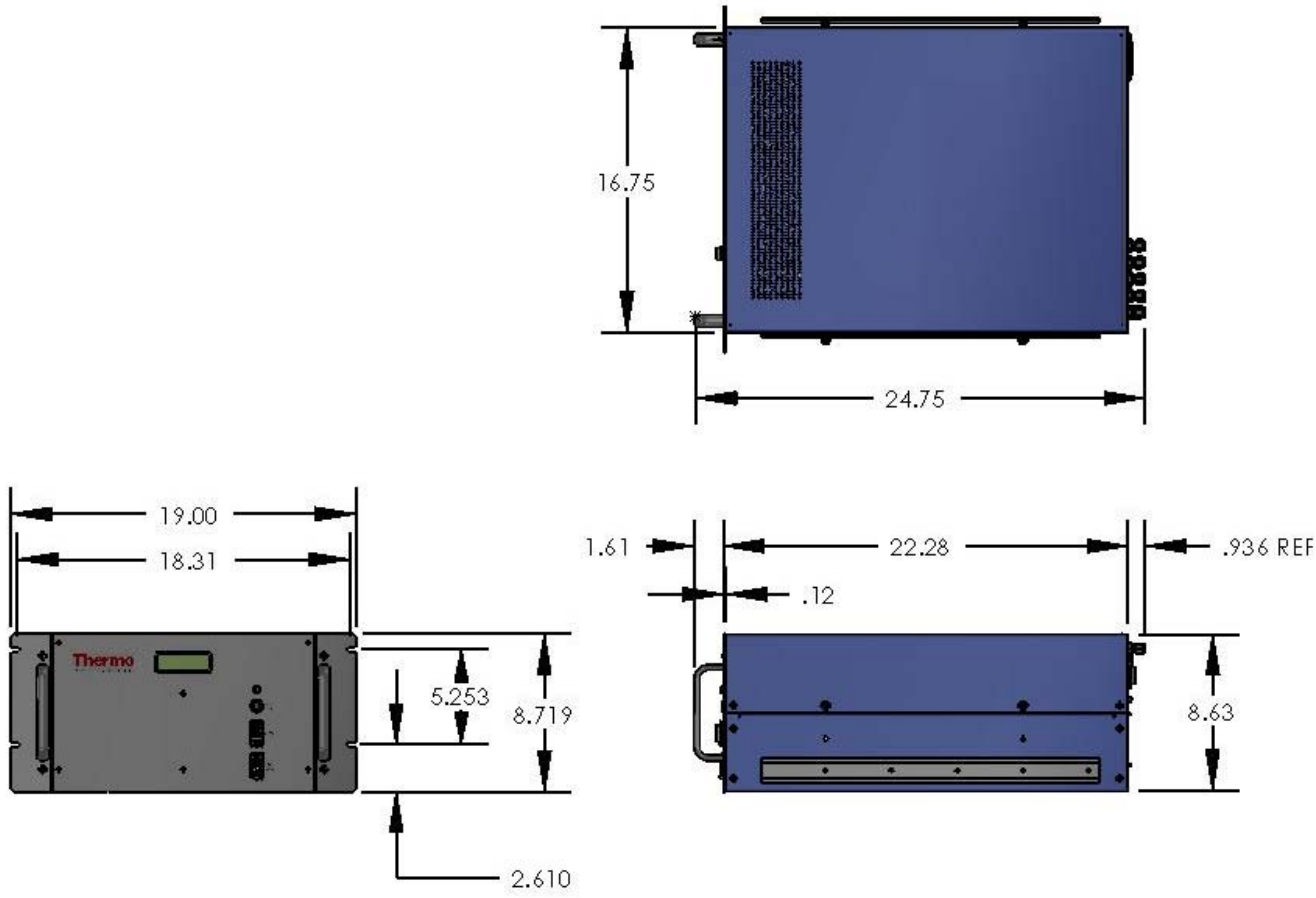


Figure 8–3. Retrofit Rack Mounting

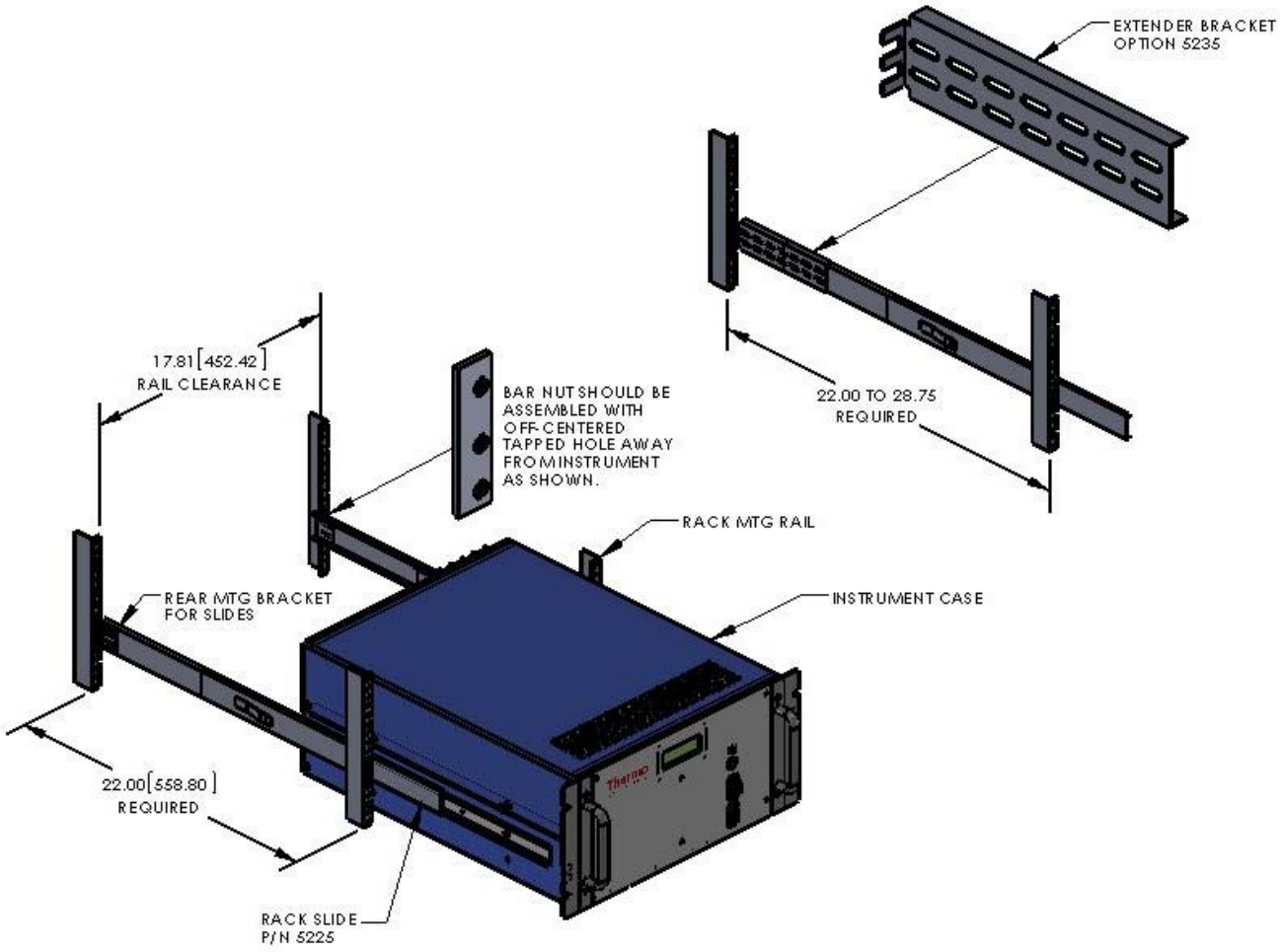


Figure 8–4. Rack Mount Option Assembly

Appendix A
Warranty

Seller warrants that the Products will operate or perform substantially in conformance with Seller's published specifications and be free from defects in material and workmanship, when subjected to normal, proper and intended usage by properly trained personnel, for the period of time set forth in the product documentation, published specifications or package inserts. If a period of time is not specified in Seller's product documentation, published specifications or package inserts, the warranty period shall be one (1) year from the date of shipment to Buyer for equipment and ninety (90) days for all other products (the "Warranty Period"). Seller agrees during the Warranty Period, to repair or replace, at Seller's option, defective Products so as to cause the same to operate in substantial conformance with said published specifications; provided that (a) Buyer shall promptly notify Seller in writing upon the discovery of any defect, which notice shall include the product model and serial number (if applicable) and details of the warranty claim; (b) after Seller's review, Seller will provide Buyer with service data and/or a Return Material Authorization ("RMA"), which may include biohazard decontamination procedures and other product-specific handling instructions; and (c) then, if applicable, Buyer may return the defective Products to Seller with all costs prepaid by Buyer. Replacement parts may be new or refurbished, at the election of Seller. All replaced parts shall become the property of Seller. Shipment to Buyer of repaired or replacement Products shall be made in accordance with the Delivery provisions of the Seller's Terms and Conditions of Sale. Consumables, including but not limited to lamps, fuses, batteries, bulbs and other such expendable items, are expressly excluded from the warranty under this warranty.

Notwithstanding the foregoing, Products supplied by Seller that are obtained by Seller from an original manufacturer or third party supplier are not warranted by Seller, but Seller agrees to assign to Buyer any warranty rights in such Product that Seller may have from the original manufacturer or third party supplier, to the extent such assignment is allowed by such original manufacturer or third party supplier.

In no event shall Seller have any obligation to make repairs, replacements or corrections required, in whole or in part, as the result of (i) normal wear and tear, (ii) accident, disaster or event of force majeure, (iii) misuse, fault or negligence of or by Buyer, (iv) use of the Products in a manner for which

they were not designed, (v) causes external to the Products such as, but not limited to, power failure or electrical power surges, (vi) improper storage and handling of the Products or (vii) use of the Products in combination with equipment or software not supplied by Seller. If Seller determines that Products for which Buyer has requested warranty services are not covered by the warranty hereunder, Buyer shall pay or reimburse Seller for all costs of investigating and responding to such request at Seller's then prevailing time and materials rates. If Seller provides repair services or replacement parts that are not covered by the warranty provided in this warranty, Buyer shall pay Seller therefor at Seller's then prevailing time and materials rates. ANY INSTALLATION, MAINTENANCE, REPAIR, SERVICE, RELOCATION OR ALTERATION TO OR OF, OR OTHER TAMPERING WITH, THE PRODUCTS PERFORMED BY ANY PERSON OR ENTITY OTHER THAN SELLER WITHOUT SELLER'S PRIOR WRITTEN APPROVAL, OR ANY USE OF REPLACEMENT PARTS NOT SUPPLIED BY SELLER, SHALL IMMEDIATELY VOID AND CANCEL ALL WARRANTIES WITH RESPECT TO THE AFFECTED PRODUCTS.

THE OBLIGATIONS CREATED BY THIS WARRANTY STATEMENT TO REPAIR OR REPLACE A DEFECTIVE PRODUCT SHALL BE THE SOLE REMEDY OF BUYER IN THE EVENT OF A DEFECTIVE PRODUCT. EXCEPT AS EXPRESSLY PROVIDED IN THIS WARRANTY STATEMENT, SELLER DISCLAIMS ALL OTHER WARRANTIES, WHETHER EXPRESS OR IMPLIED, ORAL OR WRITTEN, WITH RESPECT TO THE PRODUCTS, INCLUDING WITHOUT LIMITATION ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. SELLER DOES NOT WARRANT THAT THE PRODUCTS ARE ERROR-FREE OR WILL ACCOMPLISH ANY PARTICULAR RESULT.