ABB
LGR-ICOS™ Gas Analyzer
User Manual
HAZLOC X-Purge C1D1 & 2
& HAZLOC Z-Purge C1D2

P/N: 950-0000-0001-ULR5

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Table of Contents

Warning! 	Service to the *LGR-ICOS* Gas Analyzer is to be performed only by Certified Service Personnel trained on servicing this instrument. User/operator adjustments inside the instrument neither necessary nor recommended by the manufacturer.

Patent

The *LGR-ICOS*™ Gas Analyzer technology is protected by patents:

- 7,468,797
- 6,839,140
- 6,795,190
- 6,694,067

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ABB provides product support services worldwide. To receive product support, either in or out of warranty, contact the ABB office that serves your geographical area, or the office indicated below:

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Important: Please be prepared to provide the serial numbers of all units.

1 Introduction

This manual contains basic information on using the *LGR-ICOS* Gas Analyzer, as well as instrument operational safety, maintenance, and troubleshooting information. This information relates to a fully-loaded instrument. Your instrument may or may not have all the options available.

This manual describes the various menu and data screens and what information they provide. It also provides instructions to allow the user to calibrate the instrument to its traceable certified bottle gases, adjust data sampling rates, and transfer data through various means, when equipped with specific options.

Even though this user manual provides additional information on the instrument hardware components and their particular functions, it is recommended to have an ABB Service Personnel address any issues encountered with the *LGR-ICOS* Gas Analyzer.

2 Safety

The following pages provide important safety precautions.

Class of Laser Equipment

The *LGR-ICOS* Gas Analyzer is a Class 1 laser instrument when the front panel is secured into position.

Certification

The *LGR-ICOS* Gas Analyzer offers the following safety certification options:

Table 1 *LGR-ICOS* Gas Analyzer Safety Certifications

Certification	X-Purge Standards Tested & Met	Z-Purge Standards Tested & Met
North American Certifications	Class I Division 1 (or 2) Group B, C, D, and Zone 1 (or2) Group IIB+H2 Temperature Code T4	Class I Division 2 Group B, C, D, and Zone 2 Group IIB+H2 Temperature Code T4
C SA® US	NEC and CEC, 61010-1, NFPA 496, NEMA 250, UL 1203 C22.2 No. 30 UL 913, C22.2 No. 157 UL 60079-0 UL 60079-1 UL 60079-2 UL 60079-11	NEC and CEC, 61010-1 NFPA 496 NEMA 250 ISA 12.12.01 UL 60079-0 UL 60079-2 UL 60079-15
Ex	II 2G Ex db ib pxb IIB+H2 T4 Gb -20 C < Ta < +50C – IP54 ATEX Zone 1 or 2 2014/34/EU ATEX Directive: EN 60079-0, EN 60079-2, EN 60079-15 EN 61010, EN 61010-2-101 Laser Safety, EN 60825-1 2004/108/EC EMC Directive, EN 61326-1.	II 3G Ex nA pzc IIB+H2 T4 Gc -20 C < Ta < +50C – IP54 ATEX Zone 2 2014/34/EU ATEX Directive: EN 60079-0, EN 60079-2, EN 60079-15 EN 61010, EN 61010-2-101 Laser Safety, EN 60825-1 2004/108/EC EMC Directive, EN 61326-1.
IECEx	Zone 1 or 2 Ex db ib pxb IIB+H2 T4 Gb	Zone 2 Ex nA pzc IIB+H2 T4 Gc
CE	2014/34/EU (ATEX), EN60079-0 2004/108/EU (EMC), EN61326-1	2014/34/EU (ATEX), EN60079-0 2004/108/EU (EMC), EN61326-1
FDA	Title 21 Code of Federal Regulations, chapter 1, sub-chapter J	Title 21 Code of Federal Regulations, chapter 1, sub-chapter J.

Figure 1 *LGR-ICOS* Gas Analyzer Certification Labels

WEEE Directive

The *LGR-ICOS* Gas Analyzer product is not subject to WEEE Directive 2002/96/EC (Waste Electrical and Electronic Equipment) or relevant national laws (e.g. ElektroG in Germany).

The product must be disposed of at a specialized recycling facility. Do not use municipal garbage collection points. According to the WEEE Directive 2002/96/EC, only products used in private applications may be disposed of at municipal garbage facilities. Proper disposal prevents negative effects on people and the environment, and supports the reuse of valuable raw materials.

Symbols

The following symbols may be used in the documentation or on the instrument:

Table 2 Documentation Symbols

Symbols	Meaning
	Important information
	Danger: Failure to comply may result in death. Warning: Failure to comply may result in serious injury. Caution: Follow instructions carefully to avoid equipment damage or personal injury.
	Hot surface
	High voltage

Labels

The following labels are affixed at specific locations on or in the *LGR-ICOS* Gas Analyzer. They identify hazardous areas.

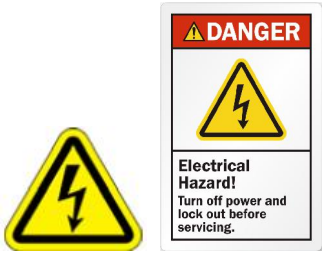
Figure 2 Heavy Object Label

This label is affixed to the outer covers of the *LGR-ICOS* Gas Analyzer. The instrument weights ~ 248 pounds.

Figure 3 Pinch Point Label

This label is located on the enclosure covering the ICOS cell held in place with latch snaps, and also on the front panel when at the close position.

Figure 4 High Voltage Label



This label is located within the right side panel, next to the AC power terminal block, the filter AC line powering the instrument, and on the purge controller.

Figure 5 Laser Radiation Label

These labels are located on the enclosure covering the ICOS cell. The fiber laser is visible only when the insulated enclosure is removed from the ICOS cell.

Figure 6 Burn Hazard Label

This label is located on the enclosure covering the ICOS cell. A few heater units used to control gas temperature can be set to very high temperatures. Contact with the heaters is only possible if the safety insulated enclosure is removed.

Figure 7 Fire Hazard Label

During scheduled preventive maintenance (PM), chemicals used to clean the ICOS cell mirror are flammable.

Operator Safety

When its front panel is closed and locked into position, the *LGR-ICOS* Gas Analyzer runs safely, without risk to the operator. Operating the instrument in any other condition can damage the equipment or injure personnel. Follow these general safety guidelines at all times.

NOTE: The LGR-ICOS Gas Analyzer is a Category II (overvoltage category) installation.

Do not operate the Gas Analyzer when the front panel is opened.

- The panel protects against electrical shock and explosion due to gas leakage in the surrounding area.
- Should a spark occur, the Gas Analyzer is designed to 1) maintain a specific internal pressure, 2) dilute and purge the instrument of possible internal gas leak(s), and 3) contain explosions.
- Only the X-Purge Gas Analyzer has an internal pressure bypass switch. Do not use the bypass switch when the instrument inlet gas line is connected to a flowing customer gas line.

Danger! 	Bypassing the internal pressure interlock switch to open the front panel during instrument operations can cause serious bodily injury or death due to possible explosion and/or direct exposure to customer gas from possible internal leaks.

Heavy Objects

The Gas Analyzer, which weighs approximately 248 lbs., qualifies as a heavy object.

Caution!	The *LGR-ICOS* Gas Analyzer should not be hand-carried. It is recommended that the unit be rolled to its final mounting site with a floor forklift or a wheeled table. Lifting the instrument to the final mounting location should be accomplished, with guidance, with a hoist or forklift.

When lifting heavy objects:

- Use a mechanical hoist, if available.
- Use a minimum of three people for lifting, moving and mounting the Gas Analyzer.
- Use proper lifting techniques:
  - Do not lift with your legs straight or from a forward bent position.
  - Bend your knees and lower your hips, using your leg muscles to lift.
  - Make sure that you stay as close to the load as possible.
- Test the load to make sure that you are able to lift it safely. If so, lift the load while keeping it as close to your body as possible.
- Avoid sudden movements and NEVER twist your body. A bending and twisting motion could cause the discs in your spine to rupture. If you have to turn the instrument, make sure that your hips and shoulders are always aligned; move your feet first so that you face the area where you can safely put down the load.
- If the load is not safe to lift by yourself, make sure that you get help. When two persons (or more) are performing the lift, make sure that your actions are synchronized. You must communicate with each other to avoid injury, and it is best for one person to make the calls so that you can lift together.
- Avoid lifting heavy objects with one hand. Always try to balance the load in both hands or get a cart.

Figure 8 Heavy Object Label and Location

Pinch Point Hazards

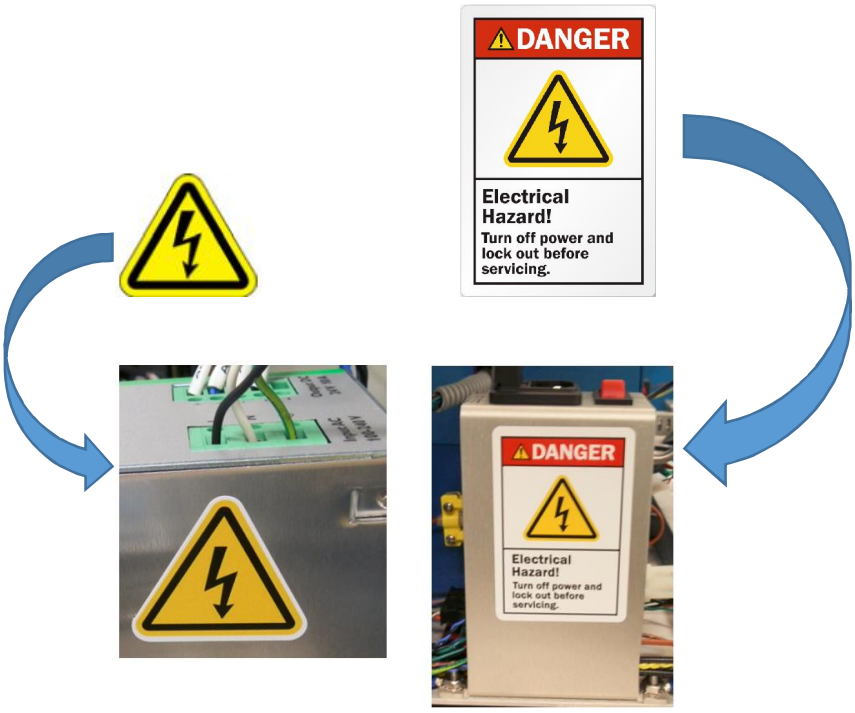
There are several pinch point hazards to personnel on or inside the Gas Analyzer. Pinch point hazard locations are marked with a pinch point label. One is next to the clamp that locks the blue heat shield in place, and the other is located on the instrument side panel.

Figure 9 Pinch Point Label and Location

Hazardous Voltages

There are two voltage potentials operating above 30 volts RMS on the *LGR-ICOS* Gas Analyzer. They provide 117V AC and are located at the power entry module that feeds the AC-to-DC voltage converter. Components at these two locations are marked with the electrical hazard label.

Figure 10 Electrical Hazard Label and Locations



Safety Provisions

The insulation and enclosure protect instrument operators from contact with hazardous voltages during normal system operation. If a short circuit or other over-current condition occurs, the internal fuse protects individual power supplies and disconnects the power line from the incoming power supply.

Location of Hazardous Voltages

Electrical hazard warning labels are applied wherever the removal of the panel can create an opportunity for contact with hazardous voltages.

Electrical Safety Task Types

When a procedure contains a task that takes place where direct exposure to electricity may happen, the task type is identified according to the *SEMI S2-93A* standard.

Should a technician or engineer perform additional communication connections on the *LGR-ICOS* Gas Analyzer, be aware of the electrical task type encountered while performing these connections. Table 3 provides a list of *SEMI S2-93A* task types and their definitions.

Table 3 Electrical Safety Task Types

Type	Definition
Type 1	• Equipment is fully de-energized (electrically “cold”)
Type 2	• Equipment is energized • Live circuits are covered or insulated • Work is performed at a remote location to preclude accidental shock
Type 3	• Equipment is energized • Live circuits are exposed and accidental contact is possible • Potential exposures are less than 30 volts RMS, 42.2 volts peak, 240 volt-amps, and 20 joules
Type 4	• Equipment is energized • Live circuits are exposed and accidental contact is possible • Voltage potential are greater than 30 volts RMS, 42.2 volts peak, 240 volt-amps, 20 joules, or radio frequency (RF) is present
Type 5	• Equipment is energized • Measurements and adjustments require physical entry into the equipment, or equipment configuration will not allow the use of clamp-on probes

Electrical Hazards During Normal Operation

Normally, when the Gas Analyzer front panel is closed, the instrument is a Type 2 electrical safety task.

The insulation and front panel protect operators from electrical hazards. The front panel must remain in place during normal operation. The safety interlock, the internal pressure switch on the X-Purge configured instruments, protects operators from accidental exposure to Type 3 electrical hazards. The Z-Purge configured instruments pressure switch will only provide an alarm to the user and will not perform a power removal from the instrument when the front panel is opened.

Electrical Hazards During Service Operation

Service to the *LGR-ICOS* Gas Analyzer should only be performed by a person that has completed the service training for the instrument.

Personnel are not exposed to live circuit unless the front panel is opened and the pressure switch is bypassed. Most service tasks require opening the front panel. During these tasks, service personnel are potentially exposed to Type 3 electrical hazards. A Type 4 electrical hazard will be encountered when validating AC power from the facility while the cover plate from the AC inlet and purge outer case is removed.

There are no Type 5 tasks required for the Gas Analyzer.

Laser Hazards

There are up to two (2) lasers used in the *LGR-ICOS* Gas Analyzer. The laser wavelength is determined by the type of gas to measure. Under normal operation, with the instrument front panel closed, the Gas Analyzer spectroscopy instrument is a *Class 1 Laser Product* in accordance with *Title 21 Code of Federal Regulations, chapter 1, sub-chapter J*.

Class 1 Laser Product

Lasers used in the *LGR-ICOS* Gas Analyzer are rated Class 3B, > 5 mW. Lasers are enclosed and not accessible unless the enclosure is removed for servicing. Laser warning labels are affixed to the enclosure covering the laser(s).

Figure 11 Laser Radiation Labels & Interlock Switch

Lasers in the Gas Analyzer are not field serviceable. Should a laser failed in the field, the whole ICOS module will be replaced containing a complete aligned measurement optics. There is only one type of user-serviceable parts in the Gas Analyzer ICOS module: the ICOS mirrors that can be clean during preventive maintenance (PM) of the instrument.

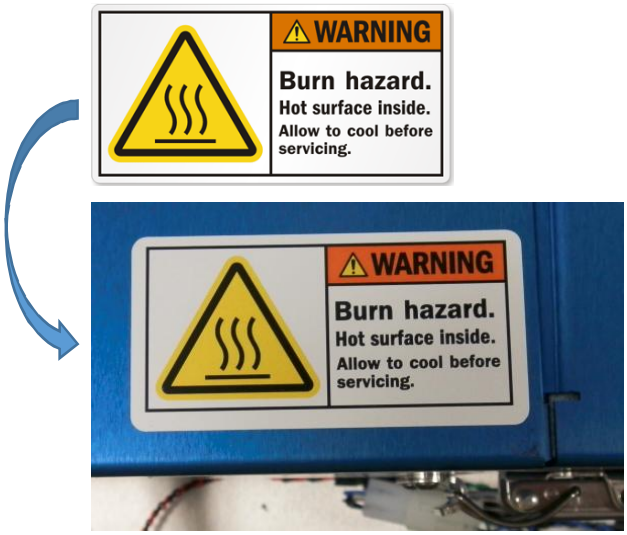
A laser Interlock Switch is attached to the left side blue thermal shield such that when the shield is removed for access to the ICOS Assembly, the Interlock Key will be separated from the lock thus removing power to the laser through the Laser Controller PCB.

NOTE: Laser replacement requires the removal of the ICOS module from the main enclosure. The laser is contained within the ICOS module. The removed ICOS module can be ship back to ABB for repair.

Burn Hazards

Burn hazards are defined as components that can cause physical burns upon contact. The Gas Analyzer is designed to measure high-temperature gases at up to 105°C through the inlet gas line and throughout the ICOS module. The ICOS module is heated, and its temperature can be set up to maintain a 175°C operating temperature. The temperature set point of the ICOS module depends on the gas to be analyzed. Burn hazard labels are placed in the area of the instrument's inlet gas line and the ICOS insulated enclosure to help identify burn hazards inside the assembly.

Figure 12 Burn Hazard Label and Location



Burn hazards may be encountered during replacement or check of the ICOS heater, filter, thermocouple, and/or valve. Allow the system to cool off after it has been powered down for maintenance.

Fire Hazards

Small amounts of methanol and acetone are used to clean surfaces on the Gas Analyzer. A typical service procedure requires the use of less than 25 milliliters of such chemicals. These chemicals present a fire hazard. Use these chemicals only in accordance with local regulations and standards. Do not use these chemicals near open flames, sparks, or heat. Wipes soaked in such chemicals must be disposed of in accordance with requirements of 40 CFR, local fire department and environmental jurisdictions.

Figure 13 Fire Hazard Label

Safety Provisions

Follow these precautions when dealing with all chemicals:

- Keep all chemical containers away from heat, sparks, and open flames.
- Use only on grounded equipment and with non-sparking tools.
- Store in a cool, dry, and well-ventilated place, away from incompatible materials.

In case of a spill:

- Make sure all handling equipment is electrically grounded.
- Mop or wipe up, and then place all chemical-soaked items in containers approved by the US Department of Transportation (DOT) or the appropriate local regulatory agency.

Internal Pressure Switch

The *LGR-ICOS* Gas Analyzer is equipped with an internal pressure switch. The pressure switch's main purpose on the X-Purge configured instrument is to cut off the AC power to the Gas Analyzer and prevent operators or service personnel from operating the instrument when the front panel is opened in a gaseous environment. This prevents possible explosions from sparks generated when connecting component(s) or probing electronics in the Gas Analyzer when it is energized. This same switch on the Z-Purge configured instruments will only notify the customer, if connected to the customer equipment monitoring center, that the front panel is open but will not shut down the AC power to the instrument.

Purging Air From Within the Gas Analyzer After Service

To prevent possible explosions upon power up, air inside the Gas Analyzer enclosure needs to be purged whenever the front panel was opened. To achieve this, the internal pressure interlock switch, part of the X-Purge controller, will not transfer power to the Gas Analyzer through its relay switch until the purge process is completed and the front panel is closed and sealed. Air within the Gas Analyzer enclosure will be diluted and replaced with either CDA from the customer facility to prevent any possibility of ignition. This process is automatically set on the X-Purge by the purge controller and takes about 22 minutes with the following condition: The source CDA pressure provided by the customer facility is ≥ 50 psi with the flow rate ≥ 57 LPM (2 SCFM).

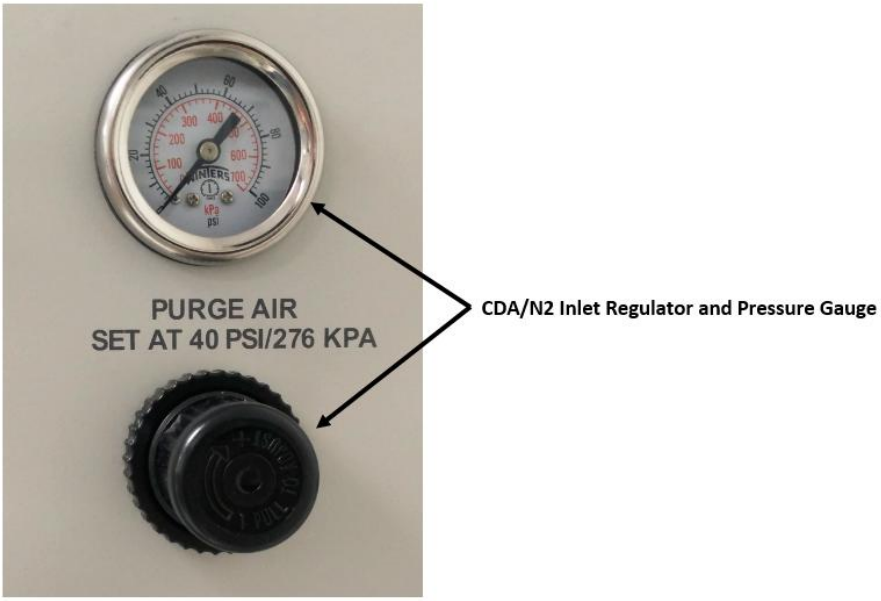
To purge air from a X-Purge configured enclosure:

STEP 1 Remove the internal pressure interlock switch bypass key from the bypass switch.

STEP 2 Close the front panel and secure it into place with all the locking clamps. If there is an air leak at the front panel while the instrument is pressurizing, the internal pressure interlock switch in the X-Purge configured instrument will not trip to allow power to pass through to the Gas Analyzer.

STEP 3 Verify there a pressure of at least 40 psi registers on the CDA inlet regulator.

Figure 14 Purge Gas Valve



STEP 4 Wait for the purge controller to finish purging air from within the Gas Analyzer enclosure, after about 22 minutes, the Gas Analyzer will restart for X-Purge configured instruments.

To purge air from a Z-Purge configured enclosure:

STEP 1 Close the front panel and secure it into place with all the locking clamps. If there is an air leak at the front panel while the instrument is pressurizing, the internal pressure interlock switch will trigger with an alarm, but will not stop the instrument from powering up.

STEP 2 Verify there a pressure of at least 40 psi registers on the CDA inlet regulator. If it does not register 40 psi, resolve the air leak and test again.

STEP 3 Wait for the purge controller to finish purging air from within the Gas Analyzer enclosure, after about 22 minutes, turn on the power from the GUA junction box to power on the Gas Analyzer.

Danger!	Failure to properly purge air from the instrument prior to its restart may cause injury or death from unexpected explosion.

3 Features and Measurement Theory

The *LGR-ICOS* Gas Analyzer is a cavity-based Spectroscopy instrument. The cavity design of the *LGR-ICOS* Gas Analyzer enhances the absorption of laser light by the target gas molecule. The enhancement improves the signal to noise ratio over conventional laser sensors enabling trace gas measurement and sensitive monitoring. The type of gas that the *LGR-ICOS* Gas Analyzer can measure is based upon the laser wavelength used. There are various *LGR-ICOS* Gas Analyzer models, each targeting gases that various industries are interested in monitoring. All measurements are taken in real time.

Main Features

The Gas Analyzer main features are:

- Measurement and processing time down to 10 seconds for certain gases
- Reduced data cross interference
- Sensitivity up to ppb

The external interface supports:

- Modbus/TCP (RJ-45): Customer-configured analog gas concentration output data
- Ethernet (RJ-45): Communication link with the Gas Analyzer computer
- USB (live disconnect module): Data transfer between USB flash drive and Gas Analyzer computer
- 5.08 mm terminal block: Gas concentration and alarms: 4–20 mA analog output

Purging

The Gas Analyzer is operating in an active internal purge enclosure where regulated CDA (clean air) is pumped in the enclosure to evacuate any gas build-up. This is designed in compliance with Class 1 Division 2 Group B, C, and D; Temperature Code T3, and ATEX Zone 2 requirements.

The CDA air is not used to maintain the electronics at operating temperature within the Gas Analyzer. The supporting electronics selected within the Gas Analyzer are military-grade and can withstand a higher operating temperature without significant impact on operational life. The expected internal operating temperature should be between +10°C and +15°C above the temperature outside the instrument.

Theory of Operation

For gas measurements based on conventional laser-absorption spectroscopy, a laser beam is directed through a sample and the mixing ratio (or mole fraction) of gas is determined from the measured absorption using Beer's Law, which may be expressed with equation 1.

Equation 1 $$\frac{I_v}{I_o} = e^{-SL_xP\phi_v}$$

where:

- I_v = the transmitted intensity through the sample at frequency *v*
- I_o = the (reference) laser intensity prior to entering the cell
- *S* = the absorption line strength of the probed transition
- *L* = the optical path length of the laser beam through the sample
- *X* = the mole fraction
- *P* = the gas pressure
- Φ_v = the line-shape function of the transition at frequency *v*

In this case:

Equation 2 $$\int \phi(v)dv = 1$$

If the laser line width is much narrower than the width of the absorption feature, high-resolution absorption spectra may be recorded by tuning the laser wavelength over the probed feature.

Integration of the measured spectra with the measured values of:

- Gas temperature
- Gas pressure
- Path length
- Line strength of the probed transition

allows one to determine the mole fraction directly from the relation:

Equation 3 $$x = \frac{-1}{SLP}\int_v ln\left(\frac{I_v}{I_o}\right)dv$$

This equation is used to determine gas concentrations, even in hostile environments, without using calibration gases or reference standards.

The values measured are:

- Mixtures containing several species
- Flows at elevated temperatures and pressures

Calibrated gases would normally be used to verify measurement accuracy, as a monitor to a fix process and for troubleshooting.

LGR Off-Axis ICOS

Off-Axis integrated-cavity output spectroscopy (ICOS) uses a high-finesse optical cavity as an absorption cell. Unlike multi-pass detectors, which are typically limited to path lengths of less than two-hundred meters, an off-axis ICOS absorption cell effectively traps the laser photon so that, on average, it makes thousands of passes before leaving the cell. As a result, the effective optical path length may be several thousands meters using high-reflectivity mirrors and thus the measured absorption of light after it passes through the optical cavity is significantly enhanced. For example, for a cell composed of two 99.99% reflectivity mirrors 25 cm apart, the effective optical path length is 2500 meters.

Because the path length depends only on optical losses in the cavity and not on a unique beam trajectory (like conventional multi-pass cells or cavity-ring-down systems), the optical alignment is very robust, allowing for reliable operation in the field. The effective optical path length is determined routinely by simply switching the laser off and measuring the necessary time for light to leave the cavity (typically tens of microseconds).

As with conventional tunable-laser absorption-spectroscopy methods:

- Laser wavelength selection is based upon the selected absorption feature of the target gas to be measured.
- The measured absorption spectra is recorded and used to determine a quantitative measurement of mixing ratio directly and without external calibration when combined with the recorded:
    - Measured gas temperature and pressure in the cell
    - Effective path length
    - Known line strength

4 User Interface Operation

Upon powering up the system, the first screen displayed is the program loading screen, as shown in Figure 15.

Figure 15 Program Loading Screen

After the programs are loaded, the Gas Analyzer launches into the Numeric screen displaying the gas concentration(s) (see Figure 17) measured within the *LGR-ICOS* cell. If the Gas Analyzer has been deactivated for more than 10 minutes, the gas lines leading to *LGR-ICOS* cell need to be brought up to measurement temperature. Initially they will be below their targeted measurement temperature, thus generating a warning error, and possibly an alarm. Allow instrument heaters time to bring the system up to the correct operating temperature before accepting any data generated from the instrument. The time necessary for instrument heaters to reach, overshoot and come back down to control the gas line and the *LGR-ICOS* cell temperature will vary depending on the environment in which the instrument is located. At a normal ambient temperature of 20°C, the instrument temperature should stabilize within 20 minutes.

Control Bar

In the Control Bar (see Figure 16), operators have the option of selecting the type of information that will be displayed on the monitor screen. Types of information to display on the monitor screen are Display, Rate, Files, Setup, and Exit.

Figure 16 Control Bar

Operators select an option by tapping the required button on the touchscreen or by using a keyboard/mouse and moving the pointer to click the required button.

Display

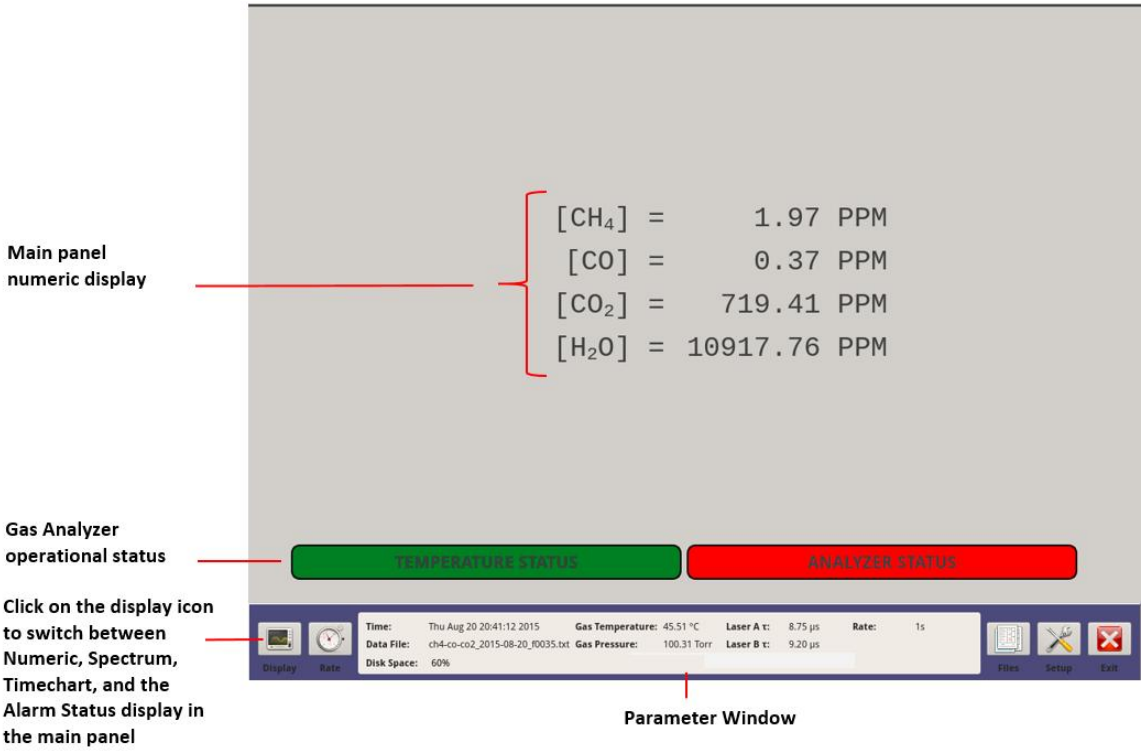
In the Control Bar, the Display button (see Figure 16) allows operators to select the type of display:

- Numerical (Figure 17)
- Spectrum (Figure 18)
- Timechart (Figure 19)
- Alarms Status (Figure 20)

Numerical Display

The Numerical display is one of the simplest screen for go/no go decisions based strictly on gas concentration measurements. The sample gas(es) measured are in ppm, and possibly in ppb. Figure 17 is an example of a Numerical data display for measurement of four different gas samples.

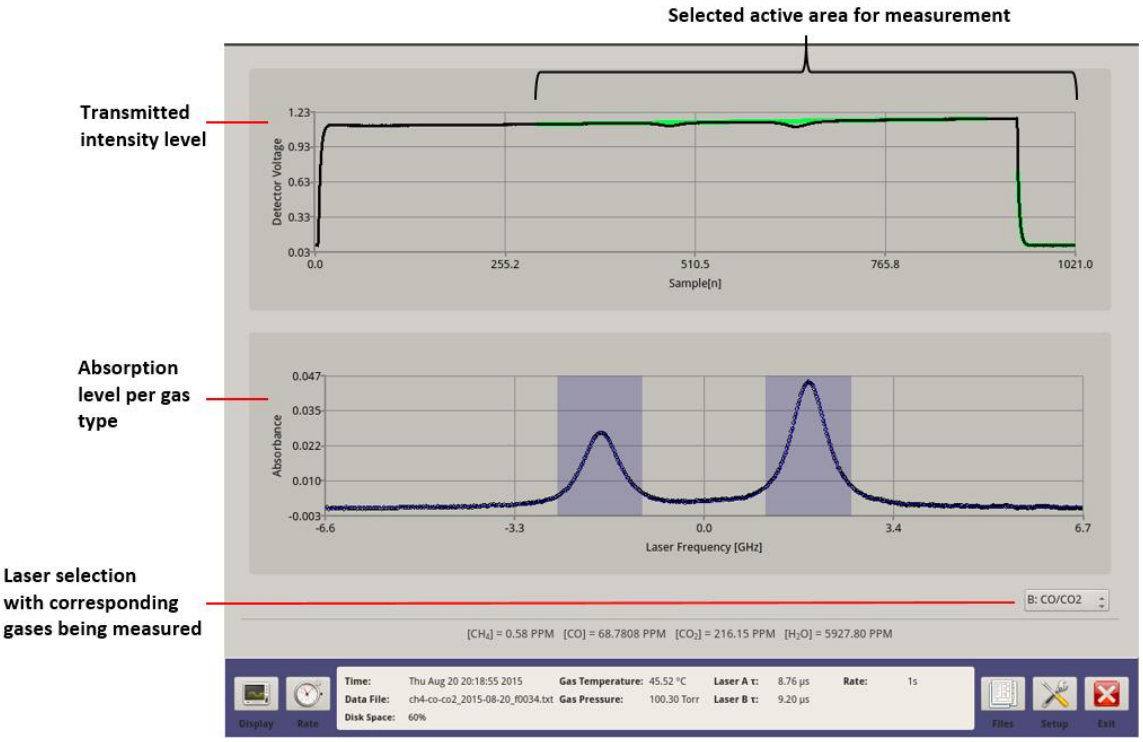
Figure 17 Numerical Display Screen



Spectrum Display

The sample spectrum display in Figure 18 provides additional information concerning the measured gas: the Gas Analyzer sensitivity level seen in the Transmitted Intensity diagram, the absorption level, the theoretic fit of the targeted gas, and the ring-down time indicating the need to clean the astigmatic mirrors.

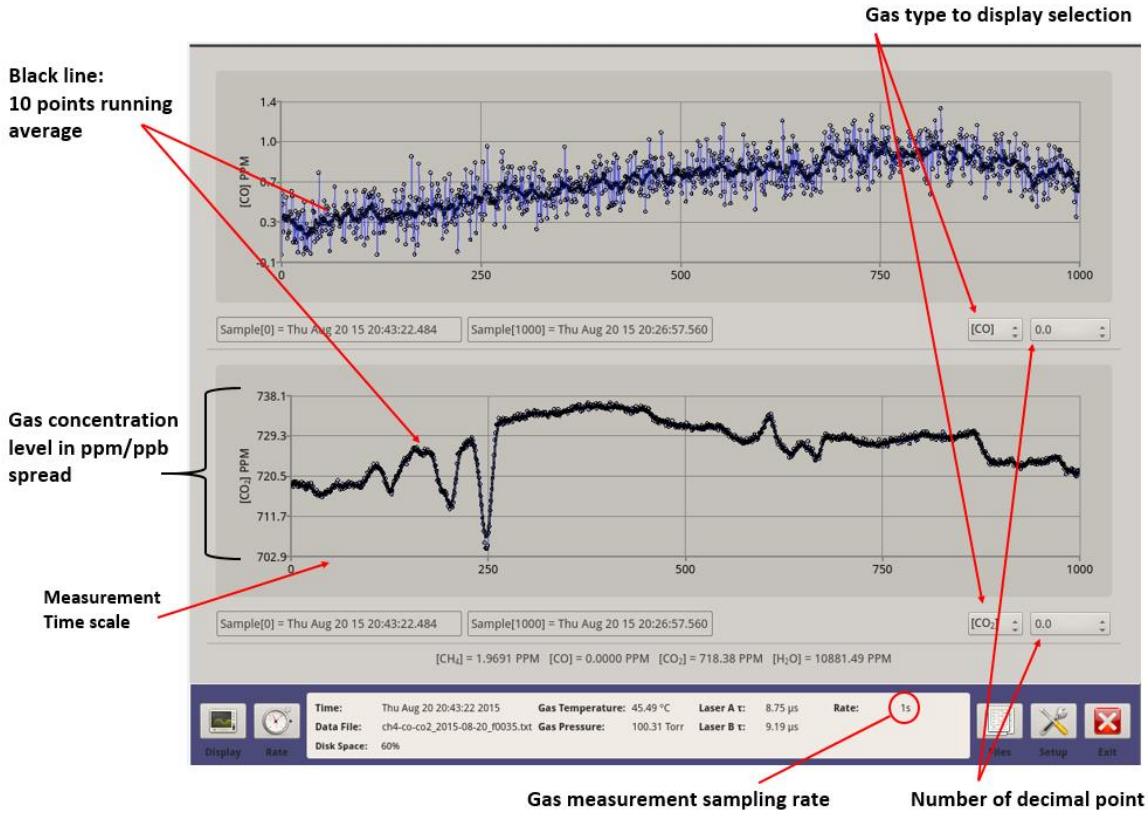
Figure 18 Spectrum Display Screen



Timechart Display

The Timechart display in Figure 19 provides the absorption (in ppm or ppb) of the sample gas measured. Each dot represents a measured level at a customizable interval “rate”. The solid black line is a running average of the last 10 data points.

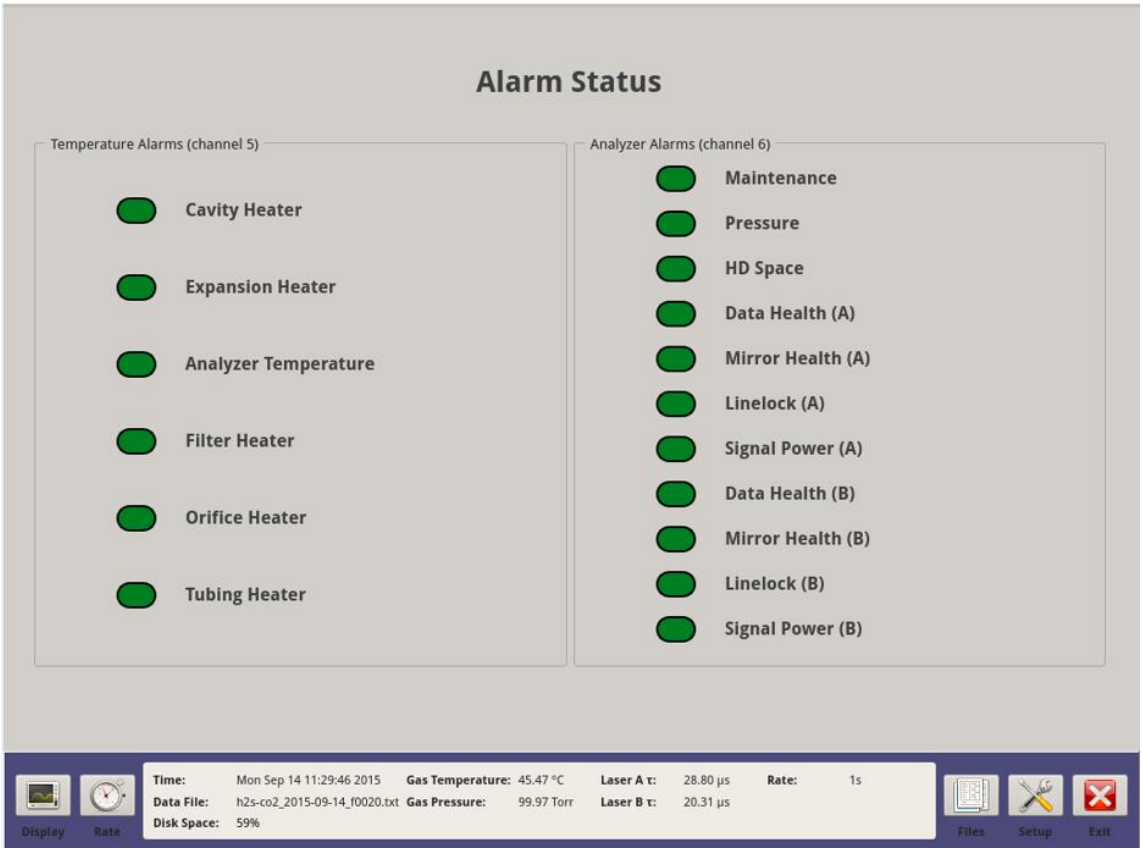
Figure 19 Timechart Display



Alarm Status Display

The Alarm Status display (see Figure 20) provides operators with the Gas Analyzer operational status. The Alarm Status display uses a traffic light metaphor. Green means no problem. Yellow means it is out of spec and the data may not be reliable or maintenance is required soon. Red means the Gas Analyzer requires maintenance to correct an identified fault and resume operation at a performance level meeting instrument specifications. A description of the cause of the alarm is displayed by selecting the relevant alarm button.

Figure 20 Alarm Status Display



Rate Button

By clicking Rate in the Control Bar, operators can change the rate at which data is written to the log file. Figure 21 displays the Rate window along with the Rate Control Adjustment panel.

Figure 21 Rate Control Display

Data is acquired at a rate of 1 Hz and averaged for a selected interval (1 to 100 seconds) before being written into the data file and plotted on the time chart. Longer averaging periods (or equivalently, slower data acquisition rates) yield better measurement precision than shorter averaging periods.

File Button

By clicking File in the Control Bar, operators access the File Transfer menu for transferring measurement data saved by the Gas Analyzer. The first screen displayed will be the path to the data folder:

/home/lgr/data

Within the *data* folder is an active daily file being saved, and the archive of past files. Operators will see:

yyyy-mm-dd (active data measurement file)

archive (folder of past measurement data points)

Whenever the Gas Analyzer application software is launched, the Gas Analyzer will automatically create a file name to save the measured data. New file names are automatically generated every 24 hours. The file name is set in the following order:

- The first 6 characters represent the Gas Analyzer model.
- The next 10 characters represent the date (yyyy-mm-dd).
- The last set of characters are for the file number in defining the sequence of the data taken.

To access the *archive* files, click on the *archive* folder. If you need to go back to the previous screen, click the arrow that is pointing up to the right of the file path line */home/lgr/data/archive*. Data files are written in text format (ASCII) and contain labeled columns that show:

- Data column with time
- Gas concentration
- Cell pressure
- Cell temperature
- Ambient temperature
- Ring-down time

The data format can be changed by clicking *Setup* in the Control Bar.

File Transfer

For C1D2 certified instruments, file transfer with a USB memory stick requires a connection through a cable gland on the instrument left side panel.

Figure 22 USB Cable Gland Dongle

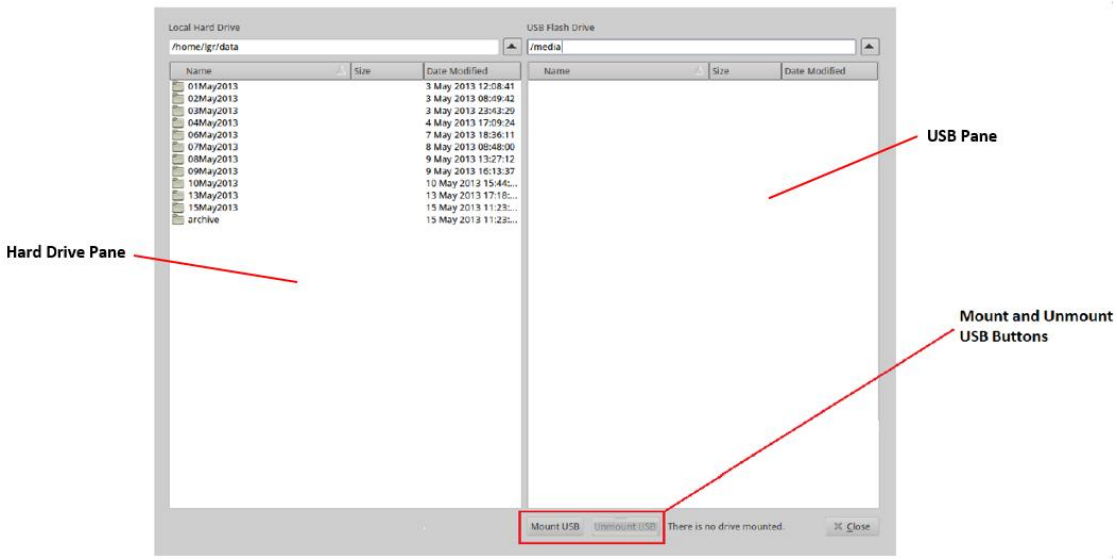
The USB memory stick needs to be in a Fat32 format before any file is transferred to it. Once the USB memory stick is properly formatted to receive data files from the Gas Analyzer hard drive:

STEP 1 Install the USB memory stick into the cable gland dongle (see Figure 22).

STEP 2 Insert the cable gland, with the USB memory stick enclosed, in the cable gland USB port on the left side of the Gas Analyzer enclosure.

STEP 3 Click on Mount USB (see Figure 23).

Figure 23 User Interface for Mounting the USB Memory Stick



STEP 4 Transfer file(s) by dragging them from the Local Hard Drive pane and dropping them to the USB Flash Drive pane.

STEP 5 Click Unmount to stop communication with the USB memory stick before removing the USB memory stick.

STEP 6 Click Close to exit the Data Files screen.

When the hard drive is showing > 75% full, it is time to perform data clean up.

To do so:

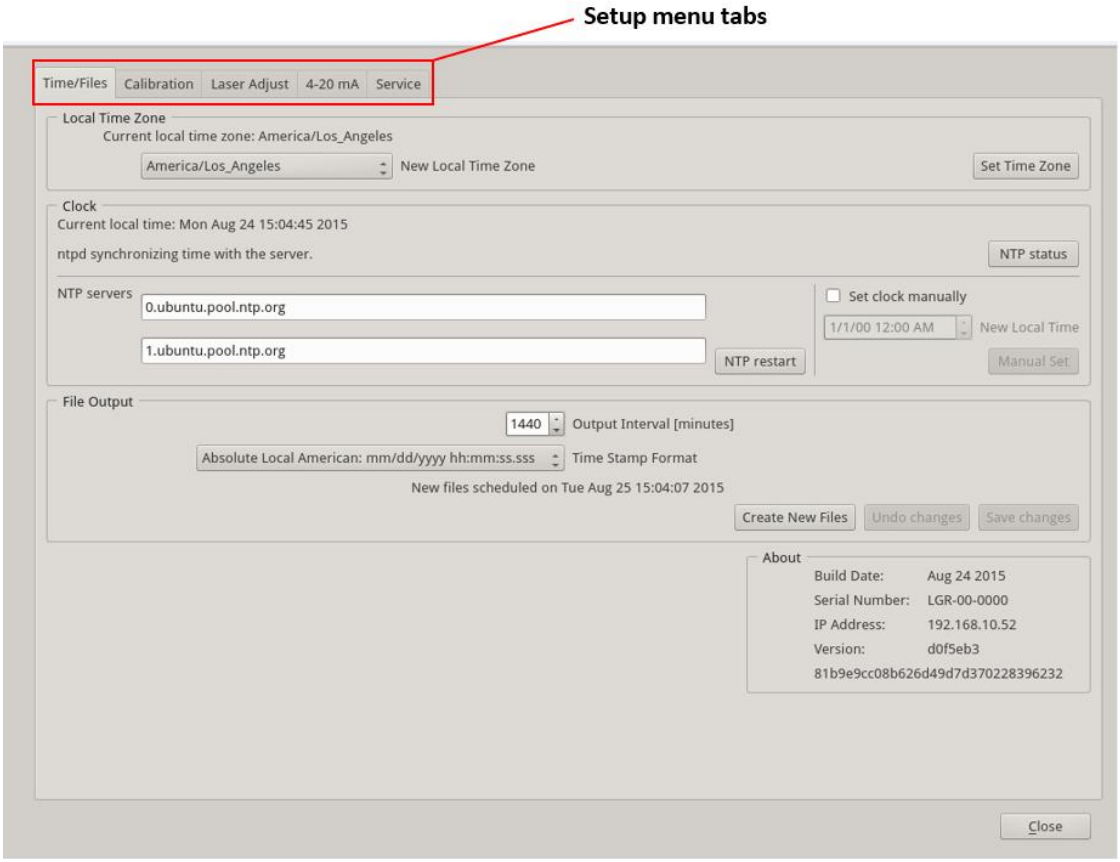
STEP 1 Using the touchscreen and highlight the file to be deleted.

STEP 2 Select Delete on the display screen.

Setup Button

When clicking Setup, the Setup screen appears, giving operators access to additional configuration and service menus. When entering Setup mode, the Time/Files tab is displayed by default (see Figure 24).

Figure 24 Setup Screen



Options in the Setup screen are:

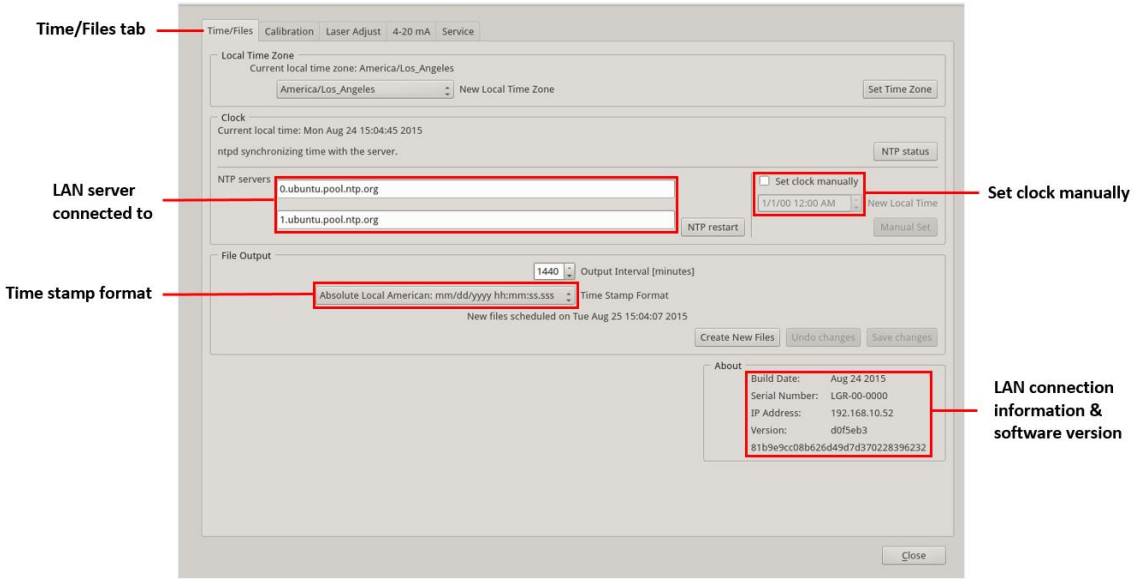
- Time/Files (for setting time and file format)
- Calibration (single point calibration using a known reference standard)
- Laser Adjust (to manually fine tuning laser wavelength for GOF if necessary)
- 4–20 mA (for setting the scale for concentration-to-mA conversion)
- Service (only accessible by ABB service personnel)

Time/Files

The Time/Files tab allows operators to configure the LAN server to which it is connected (NTP Server box). Also, the About box provides LAN connection information between the Gas Analyzer and the customer network to which it is connected.

The Set Clock section lets operators adjust the current time and date for the Gas Analyzer (see Figure 25). The time zone and daylight savings enable/disable feature are also set there.

Figure 25 Adjustable Parameters in Time/Files Tab



On this tab, operators can also set the current time and date. The available time stamp formats are listed in Table 4.

Table 4 Time Stamp Formats

Time Stamp Name	Format
Absolute Local American	mm/dd/yyyy, hh:mm:ss.sss
Absolute Local European	dd/mm/yyyy, hh:mm:ss.sss
Absolute GMT American	mm/dd/yyyy, hh:mm:ss.sss
Absolute GMT European	dd/mm/yyyy, hh:mm:ss.sss
Relative Seconds After Power On	ssssss.sss
Relative Seconds in Hours, Minutes, Seconds	hh:mm:ss.sss

Calibration

The Calibration tab provides operators with the tools to calibrate the Gas Analyzer without having to send the instrument back to the factory. Before performing calibration on the Gas Analyzer, the operator needs to have the following information available:

- Traceable regulated gas type
- Traceable regulated gas type concentration

To perform a gas calibration, connect the traceable regulated bottle gas to the Gas Analyzer gas inlet line (see Figure 26 for the parameter fields identified in the procedure):

STEP 1 In Setup → Calibration tab, check the Calibrate box in the Reference Gas Settings pane.

STEP 2 In the traceable regulated bottled gas, enter the gas concentration for the gas type listed to the left of the gas concentration entry box.

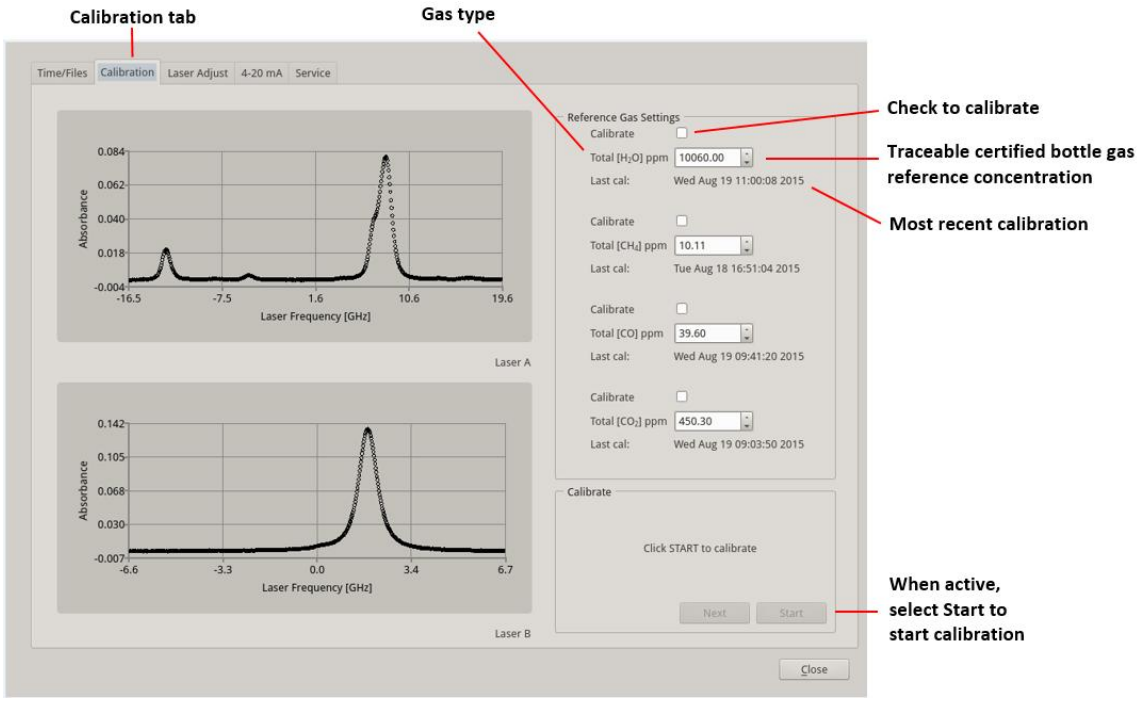
STEP 3 Click Start to start the calibration.

STEP 4 Repeat these steps for all gases measured by the Gas Analyzer.

STEP 5 After calibration is complete, click OK. The Gas Analyzer will then resume its normal measurement mode.

STEP 6 Click Close to exit the calibration screen.

Figure 26 Calibration Tab



Laser Adjust

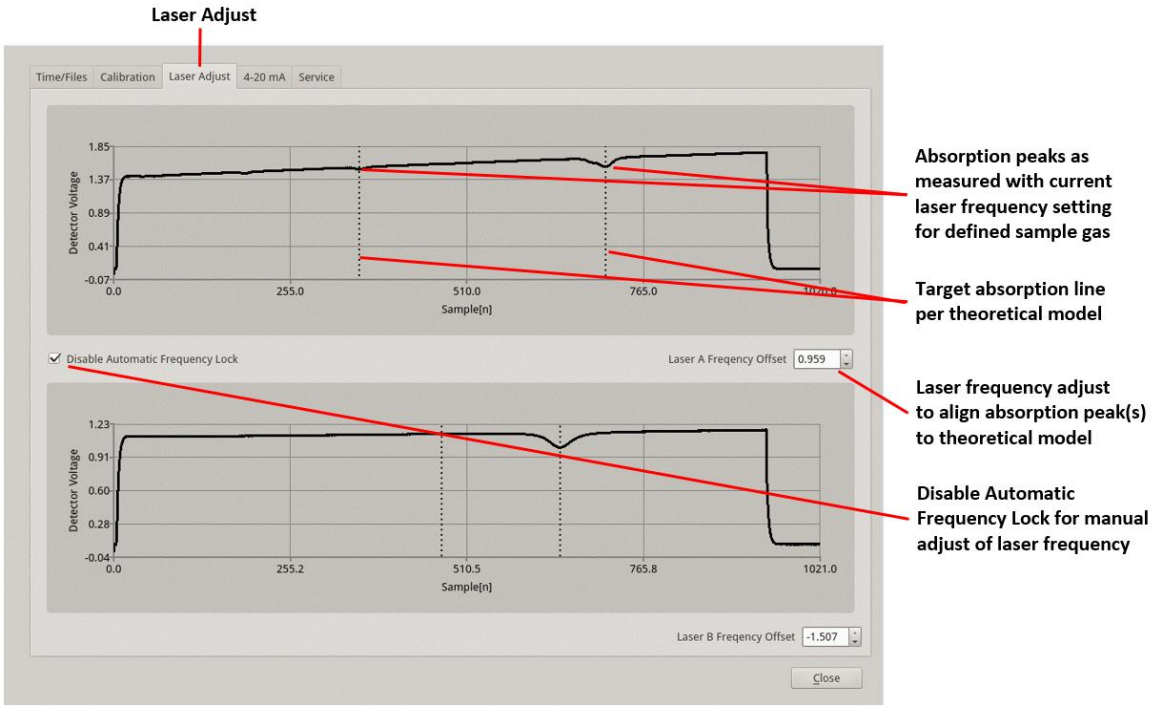
The Laser Adjust tab allows operators to tune the laser wavelength. Laser adjustment may be needed for the following reasons:

- The laser's wavelength has drifted beyond the target range of the analyzer.
- The analyzer is operated outside the recommended temperature range.

Check the parameter field *Disable Automatic Frequency Lock* for manual adjust of the laser wavelength. Unchecked this same parameter field *Disable Automatic Frequency lock* to have the Gas Analyzer to auto-adjust the laser wavelength during normal operation to compensate for any laser wavelength drift over time to align with the measured absorption peak(s).

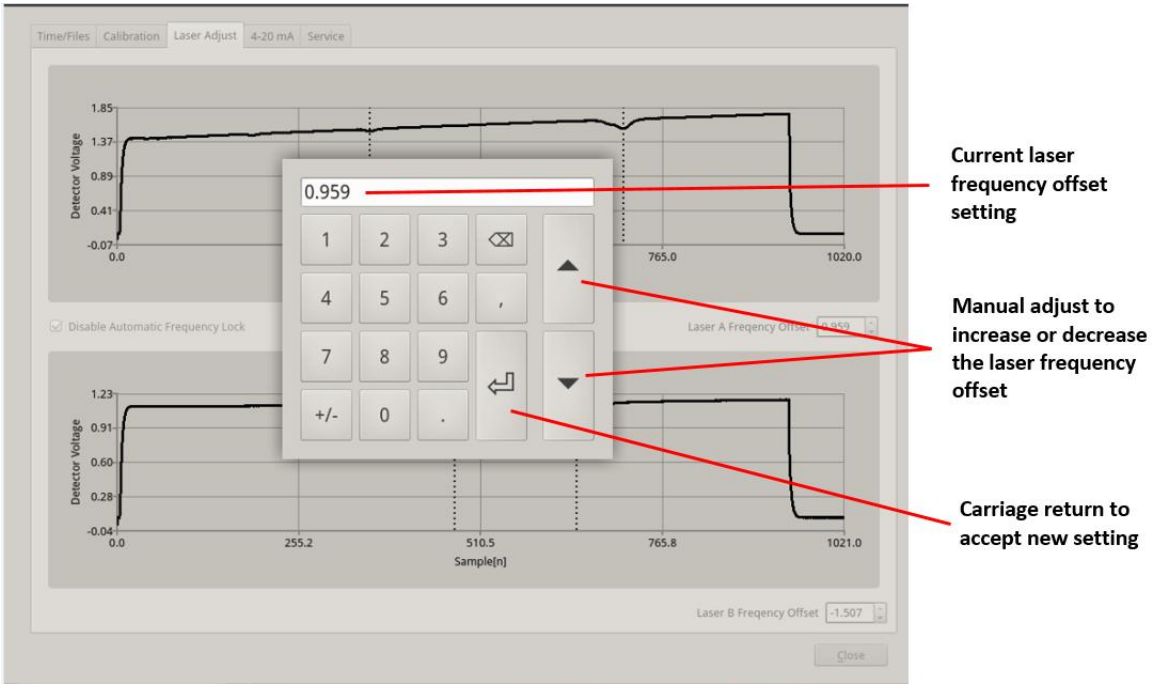
In Figure 27, the Laser Adjust tab displays the current gas sample measurement intensity profile and the corresponding absorption frequency by dips in the profile. The vertical dotted lines in the same profile screen are the expected target absorption line. To compensate for this difference, the laser wavelength is modified to have the bottom of the profile dip to center around the dotted line, the theoretical target. To achieve this, the voltage driving the fiber laser is modified to move the laser operating wavelength. If the Gas Analyzer has two lasers, each laser can be fine-tuned to have the measured absorption in line with the theoretical target.

Figure 27 Laser Adjust for Optimizing Measurement Calibration



When selecting the laser frequency offset (for laser A or B), the frequency offset adjust box (see Figure 28) appears and the operator can change the laser operating frequency.

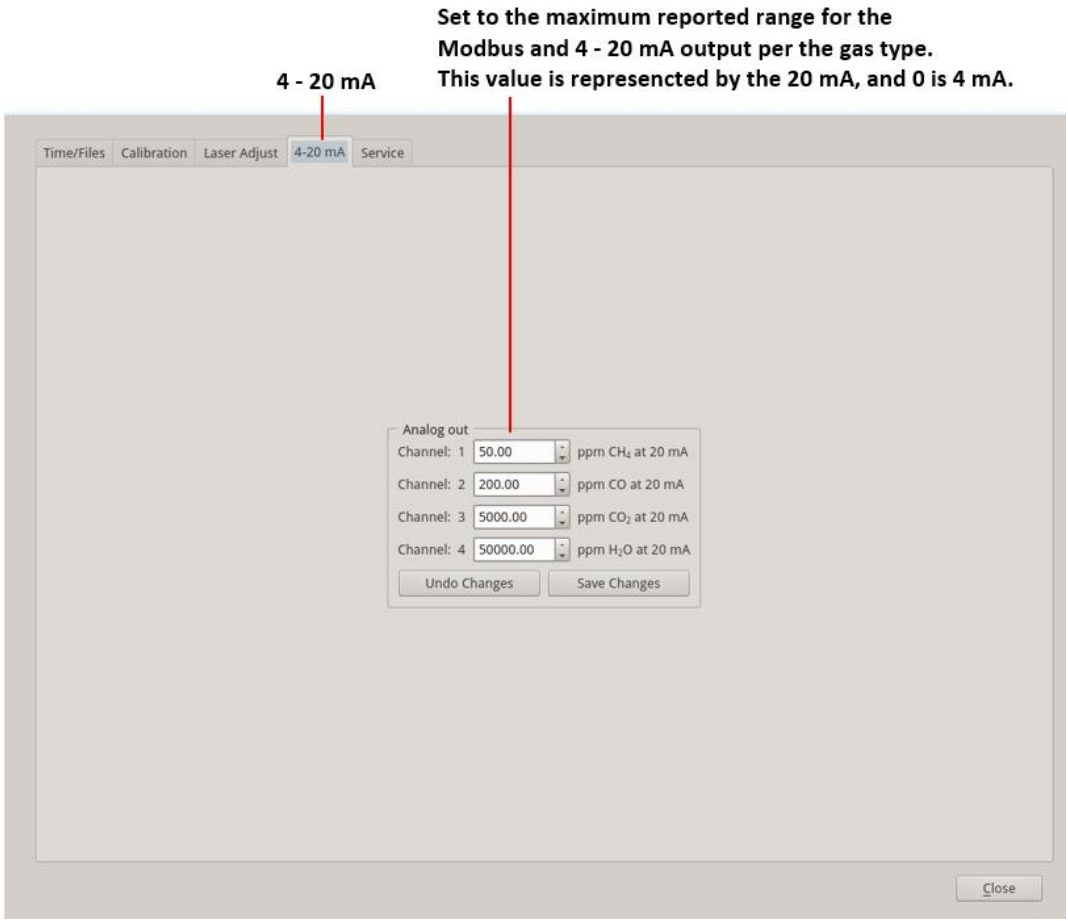
Figure 28 Laser Frequency Offset Adjust Screen



4–20 mA Gas Concentration Range Adjust

The 4–20 mA tab allows operators to set the 4–20 mA output corresponding to the measured gas concentration for each gas type. The number of available 4–20 mA output adjustable channels is dependent on the Gas Analyzer model.

Figure 29 4-20 mA Analog Out Adjustment



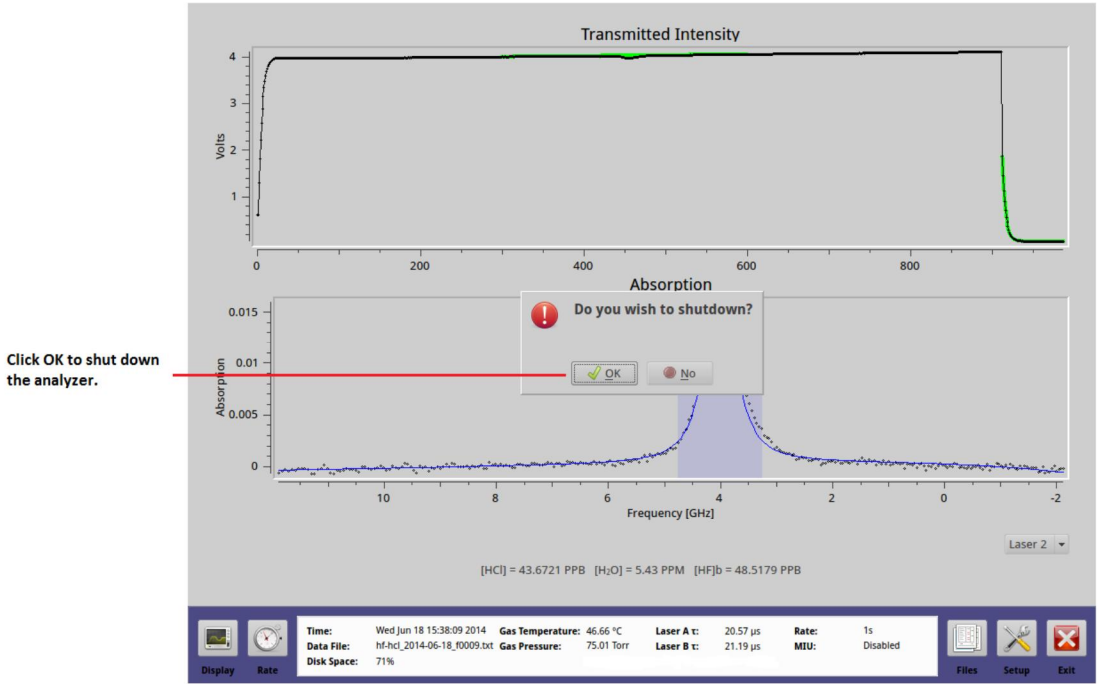
Service Tab

The Service tab is only accessible by ABB-trained field service engineers; it is password protected.

Gas Analyzer Shutdown

To properly shutdown the Gas Analyzer, always perform a soft shutdown by first selecting *Exit*. When the dialog box appears with the question "*Do you wish to shutdown?*" (see Figure 30), click OK.

Figure 30 Shutdown Screen



4–20 mA

The Gas Analyzer is equipped with a 4–20 mA output for gas measurement data, and for system alarm status, should one use it for remote data monitoring. The interface for the 4–20 mA is through a cable gland that is located and marked on the left side of the Gas Analyzer enclosure (see Figure 32).

Modbus TCP/IP

The Modbus TCP/IP is configured from the factory where the measured gas concentration goes to the processing electronics in the form of an analog signal in the 0 to 5 VDC range. This analog signal is then scaled to parts per million (ppm) to match an output value in terms of gas concentration to that of the traceable bottle gas used to calibrate the instrument. 0 volts would represent 0 ppm and 5 volts would represent some established value based upon the measurement of the traceable bottle gas as a reference point. This 5 volts value should match the number set in the Setup → 4-20 mA menu screen as seen in Figure 29.

The Modbus TCP/IP also provides operators with real-time instrument alarm status. For the alarms, a voltage-to-mA conversion of 0 volt is equal to 4 mA, and 5 volts is equal to 20 mA. The interface to the Modbus is through a cable gland that is located and marked on the left side of the Gas Analyzer enclosure (see Figure 32).

Purge Controller

The C1D1 or 2 Gas Analyzer is equipped with a purge controller to ensure operational safety. The Gas Analyzer is purged continuously with CDA. In X-Purge configured instruments, an internal pressure switch within the Gas Analyzer enclosure is used to automatically remove the AC power to the instrument should there be a loss in internal pressure (for example, when the front panel is opened). This feature prevents possible sparks from igniting the surrounding environment if someone is performing maintenance on the instrument or is trying to bypass the safety protocol by inserting electronic devices in the interface panel that could cause a spark in a gaseous environment, thus creating an explosion. A signal line pair provides notification of the purge controller status. This is located on the right side of the X-Purge enclosure (see Figure 32).

For Z-Purge configured instruments, the internal pressure switch offers an internal pressure fault line that would be monitor by the facility to identify if the equipment encounter an internal pressure fault. It does not remove power from the instrument should a fault be encountered.

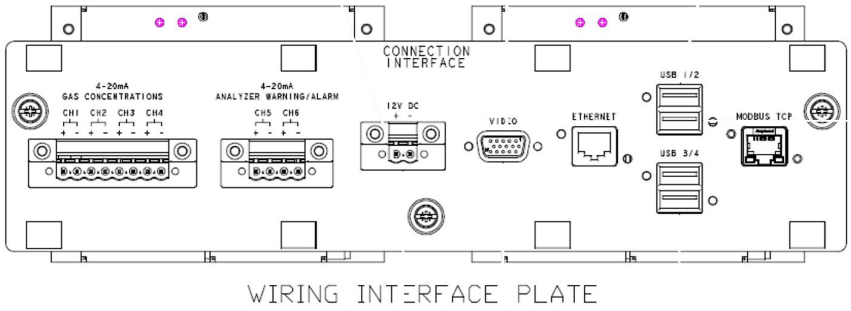
5 Communications – Data and Alarms

I/O Interfaces

The input/output interfaces provided by the *LGR-ICOS* Gas Analyzer on the internal connection interface panel (see Figure 31) are:

- Ethernet (RJ-45)
- Modbus/TCP (RJ-45)
- USB (live disconnect module)
- 4–20 mA analog out (5.08mm terminal block)

Figure 31 Connection Interface Panel



Ethernet and Modbus cable length is limited to the type of cable used. For example: 100BaseTX is limited to 100 meters using a RJ-45 connection type (see Table 5 of IEEE 802.3u.)

Table 5 RJ-45 Cable Guide

Parameter	RJ-45
Cable specification	Category 5[a] UTP[b], 22 to 24 AWG
Maximum segment length	100 m (328 ft) for 100BaseTX
Maximum network length	200 m (656 ft) with one repeater

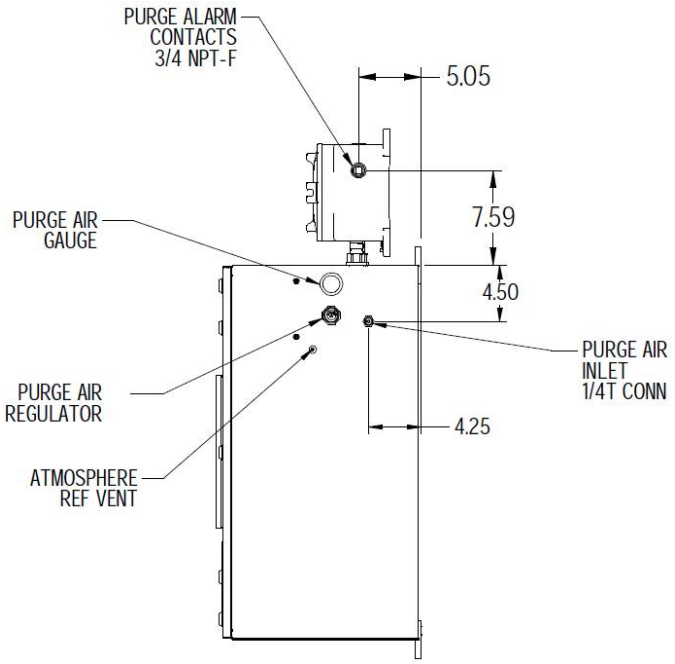
These interfaces allow operators to capture and transfer to another storage location the measured data that is logged in the *LGR-ICOS* Gas Analyzer computer hard drive.

All cables going in these communication ports need to be routed through a “cable gland” located on the left side panel, and then in their designated sockets (see Figure 32). The Ethernet cable(s) used for Ethernet and Modbus TCP communication should be a Cat 6 SF/UTP (4 pairs are surrounded by a metallic foil and overall braided shield within a LSZH jacket) shielded Ethernet cable. The *LGR-ICOS* Gas Analyzer does not come with cable glands installed for both the Ethernet and the Modbus TCP.

Warning!	Only authorized personnel may open the Gas Analyzer to perform internal maintenance. Follow the “Lockout/Tag out” procedure for the AC/DC supply power when servicing the Gas Analyzer.

[a] EIA/TIA-568 TSB or EIA-TIA-568 compliant
[b] Category 5 UTP RJ-45 or 150 Ohm STP MII cable

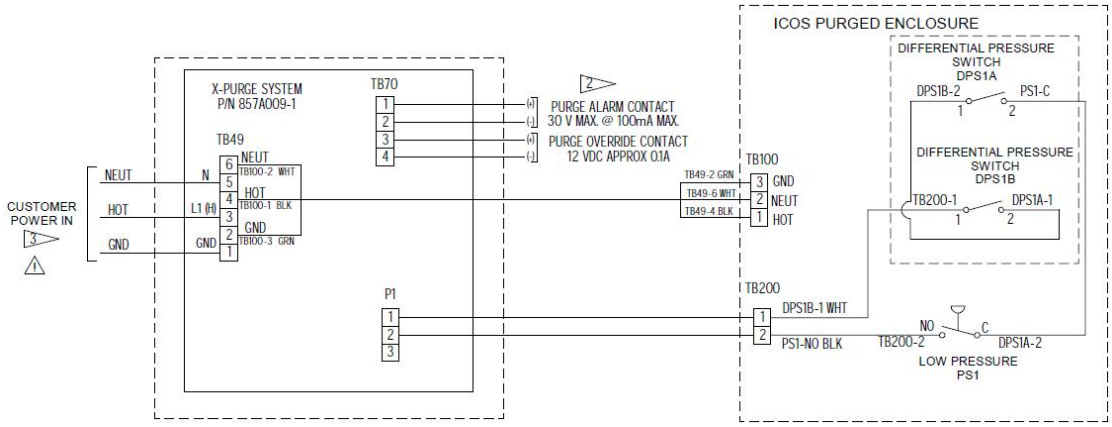
Figure 32 *LGR-ICOS* Gas Analyzer Right Side View (X-Purge Equipped Gas Analyzer Only)



On the right side of the instrument, there is a purge controller containing a terminal block TB100 (see Figure 33). The purge controller provides a "close" circuit when the enclosure internal air purge is completed during the purge cycle, and the internal pressure and air flow rate are in spec for safe operation before transferring AC power to the Gas Analyzer. A Key Bypass Switch is available to allow the Service Engineer to operate the instrument with the front panel open in troubleshooting the instrument upon a failure. This Key Bypass Switch should never be used by operators that are not trained in service and support of the instrument.

Danger!	Do not leave the Purge Controller Bypass Key in the Key Bypass Switch in purge circuit. Failure to properly purge air from the instrument prior to its restart may cause injury or death from unexpected explosion.

Figure 33 Purge Controller Circuit



The one pair wire set error when in an open position is as defined in Figure 33 and Table 6. Connection to these dry contacts needs to be through a cable gland mounted to the Purge Alarm Contact port opening as shown in Figure 32. When the purge alarm is in a "close" state, it means there is no air purge or flow alarm and all is well. In this state, there should be around +20V at 100mA across TB70 pin 1and pin 2. If TB70 pin 1 and pin 2 registered ~ 0V, there is a fault with the instrument purge system.

Table 6 Purge Controller Alarms

TB70 Contact No.	Purge Alarm Signal Description	Wire End Labeled
1	Loss of purge pressure/flow alarm	X2-1
2	Loss of purge pressure/flow alarm-return	X2-2

Remote I/O Data Access

Ethernet

The *LGR-ICOS* Gas Analyzer is designed to run the Unix operating system. Data files stored on the internal hard drive of the *LGR-ICOS* Gas Analyzer can be accessed via a Windows Share Drive over a local area network (LAN) Ethernet connection. For this feature to work, the Gas Analyzer must:

- Be connected to a local area network (LAN) via the RJ-45 Ethernet connection through the cable gland located on the left side of the Gas Analyzer enclosure.
- Receive a response to a DHCP (Dynamic Host Configuration Protocol) request when the Gas Analyzer is initialized. If the Gas Analyzer does not receive a reply, it will:
    - Disable the Ethernet port
    - Not attempt another DHCP request until the Gas Analyzer is restarted

When both conditions are met, the data directory can be accessed using a Windows computer on the same LAN. To access the Windows Share Drive:

STEP 1 Select Start → Run and enter: \\LGR-XXXX-XXXXX

STEP 2 Press [Enter].

After the communication link is established, a Windows Share Drive directory window will appear as subdirectory *lgrdata*.

STEP 3 Double-click the *lgrdata* directory to display the data files stored on the internal hard drive.

STEP 4 Open or transfer any of the data files as you would with any other Windows Share Drive.

Note: At the time of the writing of this manual, and the application software that was installed on the Gas Analyzer instrument, Ethernet connection protocol between the instrument and Windows may have changed. If problem arise in trying to establish communication between the Gas Analyzer using the Ethernet, contact ABB Technical Support for assistance to rectify the problem encountered.

Modbus

A Moxa application CD (P/N: 1112012001031) and associated instructions are shipped with each *LGR-ICOS* Gas Analyzer in support of the ioLogik E1240 Modbus. This allows operators to link and configure the Modbus to their desired format. Modbus outputs are the gas concentration measured and the warning/fault signals. The Modbus measured gas concentration results are connected to input lines shown in Table 7.

Table 7 Modbus Gas Concentration Line Setting

Input Lines	Gas
AI0+	Temp Warning/Alarm
AI0–	
AI1+	Analyzer Warning/Alarm
AI1–	
AI2+	Gas #1 Concentration
AI2–	
AI3+	Gas #2 Concentration
AI3–	
AI4+	Gas #3 Concentration
AI4–	
AI5+	Gas #4 Concentration
AI5–	

Local Data Access

USB

The *LGR-ICOS* Gas Analyzer only supports up to USB 2.0. Refer to the

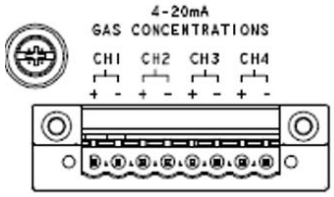
File Transfer section on page 29 for instructions on transferring data from the Gas Analyzer to a USB 2.0 memory stick.

Gas Concentrations

4–20 mA Analog Outputs

4 to 20 mA gas concentration values are provided/ported out through the 5.08 mm terminal block. Depending on the Gas Analyzer model purchased, up to four individual gases can be analyzed, and output results translated into 4–20 mA values. The four individual gases are output through CH1, CH2, CH3, and CH4 on the connection interface panel shown in Figure 31. Figure 34 displays the connection points used to sample gas concentrations. The information output is in real time.

Figure 34 Gas Concentration Phoenix Connection Point



Warning/Alarm

4–20 mA Signal Outputs

Instrument warning/alarm data is provided/ported out through the terminal block in a 4–20 mA signal format. There are two independent instrument fault channels, CH5 and CH6, provided on the connection interface panel as shown in Figure 35.

Figure 35 Gas Analyzer Warning/Alarm Phoenix Connection Point

Table 8 and Table 9 provide the current outputs in milliamps (mA) and their corresponding warning/alarm description within the *LGR-ICOS* Gas Analyzer.

Table 8 Channel 5 Analyzer Warnings/Alarms

Warning / Alarm	Current (mA)	UI Display 4–20 mA Alarm Status	Detected Problem
Alarm	4 ± 0.1	Cavity Heater	Cavity temperature is too high or too low
Alarm	5 ± 0.1	Expansion heater	Expansion chamber temperature is too high or too low
Alarm	6 ± 0.1	Bulkhead temperature (Only on Bulkhead option)	Bulkhead temperature is too high or too low

Warning / Alarm	Current (mA)	UI Display 4–20 mA Alarm Status	Detected Problem
Alarm	7 ± 0.1	Filter temperature	Filter temperature is too high or too low
Alarm	8 ± 0.1	Orifice temperature	Orifice temperature is too high or too low
Alarm	9 ± 0.1	Inlet Tubing temperature	Inlet Tubing temperature is too high or too low
Alarm	10 ± 0.1	Analyzer temperature	Ambient temperature is outside of alarm set point range
Warning	12 ± 0.1	Cavity temperature	Cavity temperature is above or below normal
Warning	13 ± 0.1	Expansion temperature	Expansion chamber temperature is above or below normal
Warning	14 ± 0.1	Bulkhead temperature (Only on Bulkhead option)	Bulkhead temperature is above or below normal
Warning	15 ± 0.1	Filter temperature	Filter temperature is above or below normal
Warning	16 ± 0.1	Orifice temperature	Orifice temperature is above or below normal
Warning	17 ± 0.1	NaN reading	NaN (Not a Number). Faulty random number/character result being displayed
Warning	18 ± 0.1	Inlet Tubing temperature	Inlet Tubing temperature is above or below normal
No issue	20 ± 0.1		No warning/alarm

Table 9 Channel 6 Analyzer Warnings/Alarms

Warning / Alarm	Current (mA)	UI Display 4-20 mA Alarm Status	CH6 Detected Problem
Alarm	4 ± 0.1	Data Health (A)/(B)	Laser A and/or B goodness of fit is poor
Alarm	5 ± 0.1	Pressure	Pressure is not in operating range
Alarm	6 ± 0.1	HD Space	HD Space is low, deleting oldest files
Alarm	7 ± 0.1	Mirror Health (A)/(B)	Mirror health has degraded, clean mirrors
Alarm	8 ± 0.1	Linelock (A)/(B)	Laser A and/or B peak position is outside of control range, contact customer support
Alarm	9 ± 0.1	Signal Power (A)/(B)	Laser A and/or B power has degraded, contact customer support
Alarm	10 ± 0.1	Maintenance	Maintenance is needed on system now
Warning	12 ± 0.1	Data Health (A)/(B)	Laser A and/or B goodness of fit is not optimal
Warning	13 ± 0.1	Pressure	Pressure is noisy
Warning	14 ± 0.1	HD Space	HD Space is low
Warning	15 ± 0.1	Mirror Health (A)/(B)	Mirror health is degrading, clean mirrors soon
Warning	16 ± 0.1	Linelock (A)/(B)	Laser A and/or B peak position is moving very fast

Warning / Alarm	Current (mA)	UI Display 4-20 mA Alarm Status	CH6 Detected Problem
Warning	17 ± 0.1	Signal Power (A)/(B)	Laser A and/or B power is degrading, contact customer support soon
Warning	18 ± 0.1	Maintenance	Maintenance is needed on system soon
No issue	20 ± 0.1		No warning/alarm

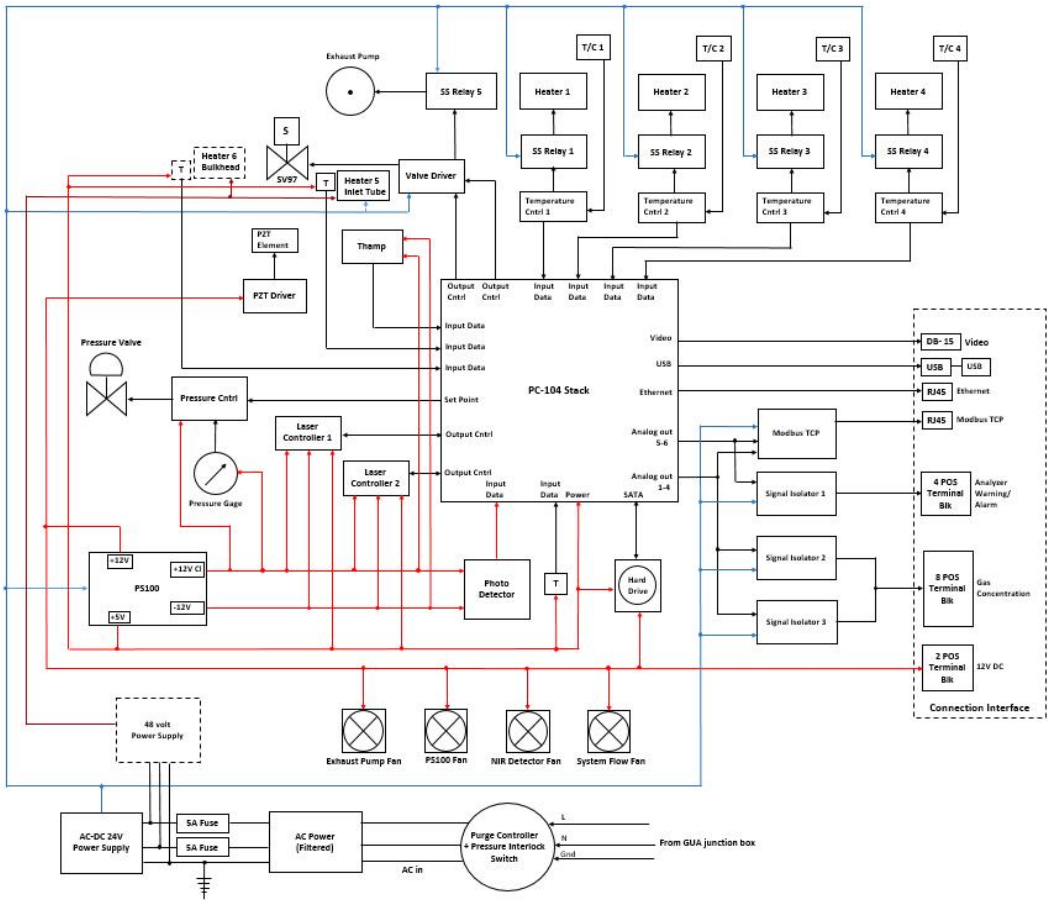
NOTE: If the Gas Analyzer has been deactivated for more than 10 minutes, the gas lines leading to LGR-ICOS cell need to be brought up to measurement temperature. Initially they will be below their targeted measurement temperature, thus generating a warning error, and possibly an alarm. Allow instrument heaters time to bring the system up to the correct operating temperature before accepting any data generated from the instrument. The time necessary for instrument heaters to reach, overshoot and come back down to control the gas line and the LGR-ICOS cell temperature will vary depending on the environment in which the instrument is located. At a normal ambient temperature of 20°C, the instrument temperature should stabilize within 20 minutes.

6 Maintenance

Block Diagram

The block diagram in Figure 36 is a simplified layout of the *LGR-ICOS* Gas Analyzer, excluding the internal pressure interlock switch and the VGA monitor.

Figure 36 *LGR-ICOS* Gas Analyzer Block Diagram



Warning!	Only authorized personnel may open the *LGR-ICOS* Gas Analyzer to perform internal maintenance. Follow the "Lockout/Tag out" procedure for the AC/DC supply power when servicing the Gas Analyzer. It is recommended that ABB field service engineers perform all repairs and PM services to the Gas Analyzer.

Danger! 	Whenever the front panel is opened for any reason and is later closed and locked into position to resume operation, air within the enclosure needs to be purged. To perform this, look at the CDA/N_2 inlet pressure gauge and verify that the gauge registers ≥ 40 psi. In about 22 minutes later, the Gas Analyzer will restart, once the purge controller finishes purging the air within the Gas Analyzer enclosure. Failure to perform this step may cause injury or death from unexpected explosion. If the instrument was set to bypass mode, the instrument can be energized without proper purging of the air within.

Danger! 	Do not power on the purge controller unless the area has been properly tested and is known not to contain explosive materials.

PC104 Stack

The *LGR-ICOS* Gas Analyzer operates with a single board computer (PC104 Stack) equipped with an Intel Atom microprocessor. This single board computer is integrated with a digital signal processor (DSP) board along with a multiple I/O (MIO) board that collects signals from the ICOS detector for both processing the light signal and controlling the light source intensity to maintain the level of sensitivity of the ICOS module. All input/output communications such as USB, Ethernet, VGA, and RS232 originate from the single board computer. The design is focused on:

- Low noise communications between the computer and the ICOS assembly (data acquisition and processing)
- Monitoring of various control signals
- Providing an interface to operators

Temperature and Pressure Control

Several factors control measurement stability. One factor is temperature. The incoming gas sample requires temperature control to keep the electrons in the gas atom at a fixed energy level. By injecting a specific wavelength of light into the gas environment, the gas electrons would absorbed the photon's energy and moves the electron from one energy state to another energy state. When heat is applied or removed from the gas, the kinetic energy of the electrons in the gas molecules changes shifting the spectra/absorption lines. The spectra/absorption lines define the wavelengths of light that the gas electrons can absorb to move it from one energy state to another. This is the reason for establishing and maintaining a consistent measurement environment is to improve measurement repeatability because the laser is set to operate at a specific frequency band. There are other reasons why the gas sample is heated, but they will not be discussed in this manual as they are proprietary to ABB.

Because of that, the temperature of the gas going through the ICOS system is controlled. To control the temperature of the gas sample going into the ICOS system, the path is heated. To maintain the heat level, a closed loop feedback is achieved by thermocouples attached to the tubes and ICOS cavity, parts through which gas samples pass to be analyzed. Operating temperatures measured by the thermocouples are fed back to several PID temperature controllers. To drive heaters, temperature controllers turn on or off a relay switch that feeds DC power directly to the heaters.

The kinetic energy of the gas molecule also changes with pressure. If there is an increase in gas pressure in a fixed volume measurement chamber, the gas molecules will be moving faster and are bounces more often against other molecules in a denser environment. These electrons in the gas molecule will be at a higher energy state and requires less photon energy from absorption to move it from state to another thus shifting the spectra/absorption line. If both pressure and temperature of the measurement gas is maintained throughout the measurement, a more stable repeatable measurement will result.

This is the reason why the ICOS pressure is constantly monitored. In a leak-free ICOS system, the pressure is maintained by a fixed orifice. Pressure drops are normally the result of a leak in the connection points, at the link between the inlet sample gas line and the 10µm filter, from gas expansion, at the 2µm filter, at the pressure valve connected to the ICOS cell, or at the pressure gauge connected to the ICOS cell.

Laser(s) and Astigmatic Mirrors

The final factors that impact measurement stability and accuracy are laser signal strength, operating frequencies, and the astigmatic mirrors within the ICOS Gas Analyzer. Mirrors have an impact on the "effective path length" and the lasers have an impact on "transmission intensity" through the sample solution. This is as defined in equations 1 to 4 of the Theory of Operation chapter on page 21 of this manual.

Also, astigmatic mirror reflectivity efficiency drops over time due to surface contamination from the gas. When this happens, measurement results can be seen with a shorter "ring-down" time. In the short term this will lead to reduced measurement sensitivity and, in the long term. inaccurate measurements.

Laser intensity is controlled through the laser control PCA to provide a constant output signal strength. Feedback intensity level is provided through the Near Infra-Red (NIR) detector and is ported to the computer stack. On the "intensity profile", the maximum intensity level will vary depending on the lasers selected for the particular gas type. When lasers decay, intensity profiles move downward to a lower level. The maximum decay limit is 10% off the original recorded measurement when the product was first installed on site.

Figure 37 Transmitted Intensity & Absorption Profile Data

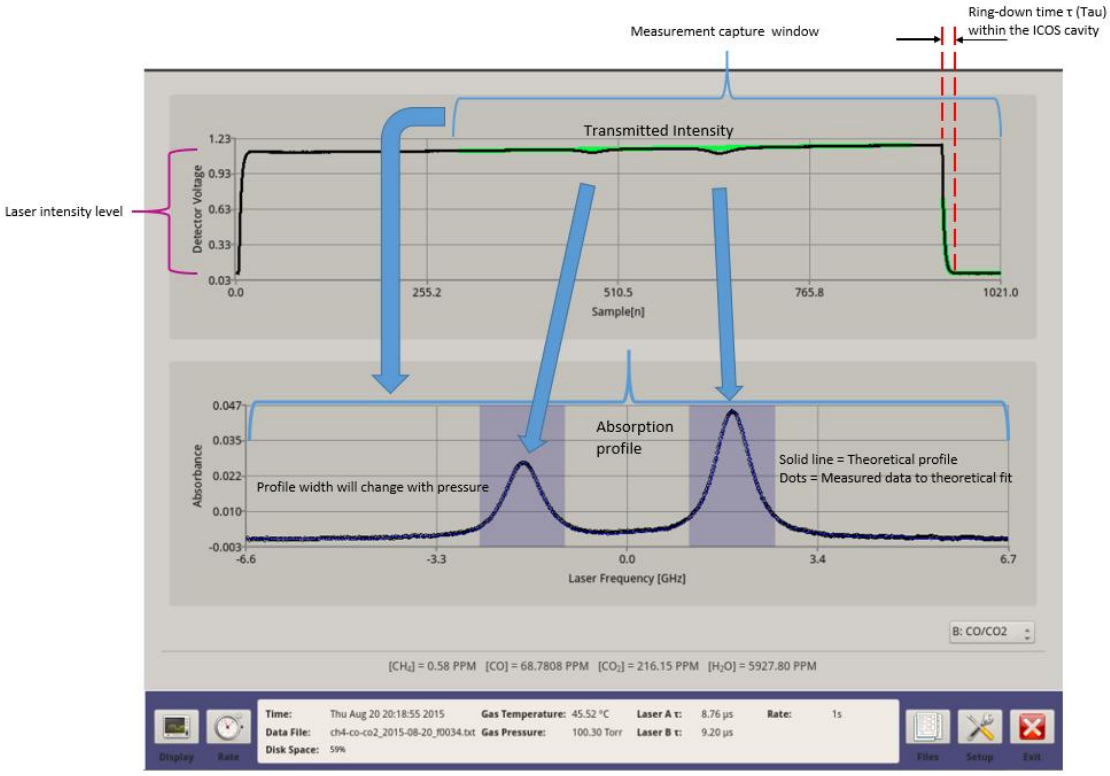


Table 10 *LGR-ICOS* Measurement Components Function & Impact

Components	Function	Impact
PC104 Stack	System communications	System operations
Heaters / Relays / Thermocouple / Temperature Controller	Temperature control of gas sample	Measurement shift
Pressure Valve, Fixed Orifice	ICOS pressure control	Absorption level
Laser	Gas probing light source	Transmitted intensity
Astigmatic Mirrors	Cavity length	Ring-down time

Self Correction

Small drifts in laser wavelength are compensated by adjusting the laser temperature, thus providing a dynamic response. To deactivate this feature, uncheck the box *Disable Laser Frequency Lock* in the *Laser Adjust* screen on page 33. Deactivate this feature only if the peaks are visible but outside target window and the user changes the laser adjust to get the peak on target.

Output Data

The measured output data collected and processed by the PC104 stack provides a DC signal level representing the ppm in the Numerical display of the measured gas sample. A signal isolator converts this DC voltage signal, ranging from 0 to 5 volts, to a 4–20 mA signal. This DC voltage signal is also ported to the Modbus, also providing operators with a 4–20 mA output after conversion. The output signal from the Modbus is user-configurable to the desired output unit: mA or volts.

Data Analysis

The *LGR-ICOS* Gas Analyzer runs the Linux operating system. All menu screens are created and all data is processed and saved using the Linux programing language. Collected measured data is written in text (ASCII) format with labeled columns. This allows for data plotting in Microsoft Excel for review and analysis over time. From plotting out data over time, anomalies should be questioned as to whether there is a problem with the gas sample or with the instrument.

To determine which of the two possibilities is the problem, plot out the gases measured, the “cell pressure” (in Torr units) and the “cell temperature”. Lay down one plot over the other. Does the measured gas data trend/shift follow each other, including cell pressure and temperature over the same period of time? See Table 11 for gas or instrument issues based on the collected measurement data.

Table 11 Gas/Instrument Issue Table

Case	Gas Sample 1	Gas Sample 2	Gas Sample 3	Gas Sample 4	Cell Pressure	Cell Temp	Issue Possibility: Gas/Instrument
1	Yes	No	No	No	No	No	Gas
2	Yes	Yes	Yes	Yes	No	Yes	Instrument
3	Yes	Yes	Yes	Yes	Yes	No	Instrument
4	Yes	Yes	Yes	Yes	No	No	Gas/Instrument

In “Case 1”, where there is a notable trend or shift in 1 or 2 gas sample measurements, but the remaining gases are stable, and there is no change in both the instrument measured pressure or temperature, the problem will

most likely be that the gas composition has changed. To validate this conclusion, use a “traceable, tested, and regulated” bottled gas of the gas type that shows a trending/shift issue, to determine whether the resulting answer measured by the instrument is correct or not.

In “Case 2” and “Case 3”, where all gases measured are trending/shifted and the cell temperature or pressure is moving, the problem is with the instrument. See Table 8) to determine the cause of the issue. It is recommended at this point to call ABB for the problem encountered.

In “Case 4”, where all gases are trending/shifted but there are no changes in cell temperature or pressure, there could still be issues with the instrument laser, detector, or mirrors within the ICOS cell.

With the laser and detector, the possibilities could be:

- Output power is lower, as seen by the detector
- Laser is drifting
- Detector is noisy
- PZT failure
- Dirty mirrors

On the gas sample side, the problem could be contamination on the lines feeding the instrument. The best way to check this out is to take multiple measurements using a “traceable, tested, and regulated” bottled gas for repeatability and stability at the targeted wavelength.

Hardware Troubleshooting

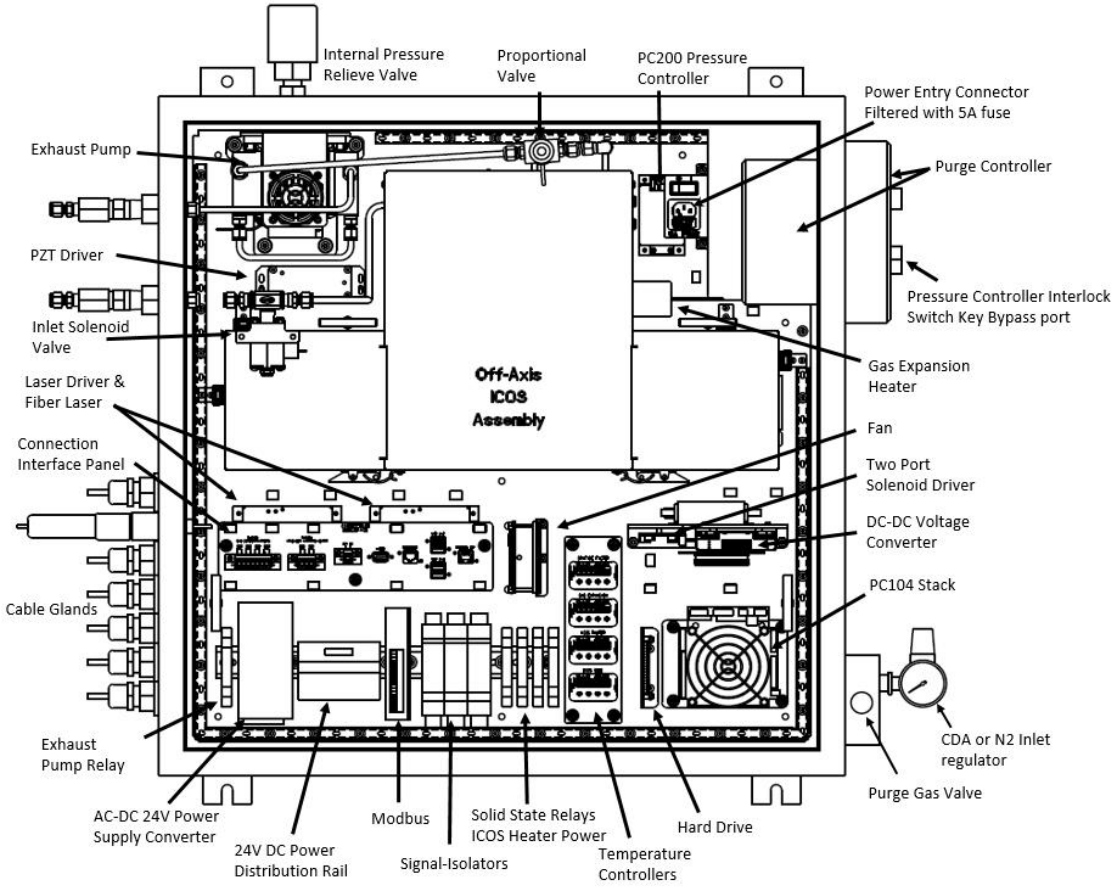
There is very limited hardware troubleshooting on the instrument. Personnel not trained in the service and support of the instrument should not be performing troubleshooting and repair of the instrument. Make sure that the instrument is powered off before any components are removed and replaced. Use grounding wrist straps connected to the instrument chassis to avoid possible ESD issues when touching any electronics components.

The few hardware components that can be replaced by the technician are:

- AC/DC 24V power supply
- DC/DC power supply
- Temperature controller
- Solid state relays
- PC104 stack
- Hard drive
- Signal isolators
- Modbus
- 5-amp fuse
- 2-port solenoid driver
- Exhaust pump
- Inlet solenoid valve
- PC-200 pressure controller
- Proportional pressure valve

Figure 38 provides the location of replaceable components inside the *LGR-ICOS* Gas Analyzer.

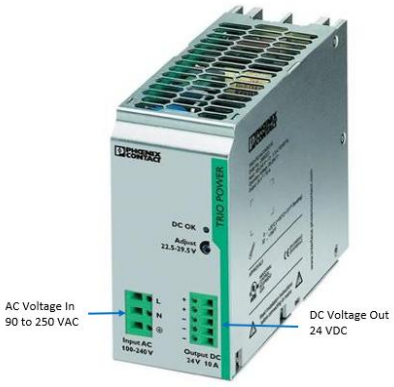
Figure 38 *LGR-ICOS* Internal Components Layout



AC/DC 24V Power Supply Converter

The AC/DC 24V power supply converter (see Figure 39) provides DC power to the instrument. The AC power feeding to this AC/DC power supply comes directly from a filter inlet with a 5A fuse (power entry connector) connected to the main AC terminal block source on the purge controller panel. The AC voltage should read between 90 to 250 VAC. The output DC voltage should read 24V. The 24 VDC output can be fine-tuned. With a volt meter, measuring between “L” and “N” should provide an AC voltage between 90 VAC and 250 VAC. The DC output should register 24V between the “+” and “–” terminals. When the instrument is operating properly, the DC OK LED should be lit.

Figure 39 AC/DC Power Supply Converter



This AC/DC power supply converter is connected to the rail by a spring-loaded clamp at the base of the unit.

Warning! 	When defeating the internal pressure switch to access any component inside the *LGR-ICOS* Gas Analyzer, the instrument is still energized and can cause injury or death to personnel servicing/probing it. All work performed on the instrument is considered an “Electrical Task Type 3”, save for when working on the AC power, such as when probing the inlet AC power on the AC/DC power supply converter or at the power entry connector, which then becomes an “Electrical Task Type 4”. It is recommended to power down the instrument prior to removing and replacing parts.

To remove the unit, insert a blade screw driver into the base slot of the unit and pull outward to pull back the spring and release the clamp. The base slot clamp is not shown in Figure 38.

To install/re-attach the unit to the rail, reverse the process by pulling the spring slot outward, inserting the back of the unit to clamp back on the rail and releasing the front spring-loaded slot to have the front side latched to the front of the rail.

DC/DC Voltage Converter

The DC-to-DC voltage converter takes the 24 VDC supply from the AC/DC power supply and provides the output DC voltages in support of system electronics. The DC voltage coming out of the DC/DC voltage converter is color coded. The wire color for voltage levels is listed in Table 12.

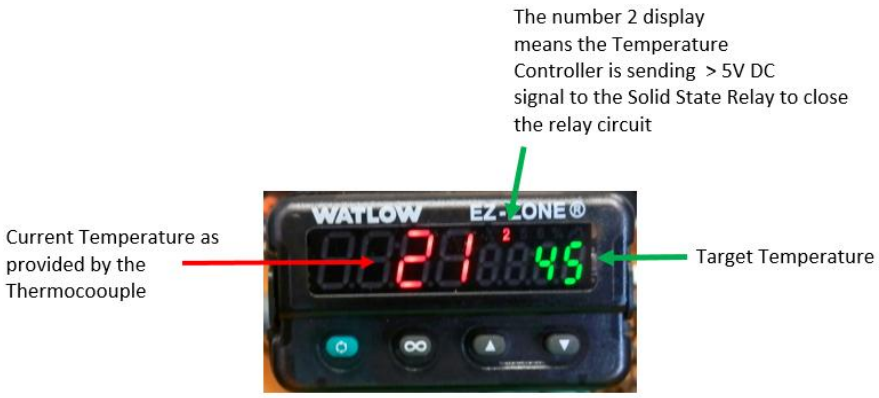
Table 12 Wire Color to DC Voltage Association

Wire Color	DC Voltage
Black	Common
Red	+5 volts
Green	+12 volts
Purple	+12 volts
Blue	+15 or +24 volts
White	–12 volts
Orange	–15 or –24 volts

Temperature Controller

The number of temperature controllers on the instrument depends on the model. The temperature controller requires an input from a thermocouple to respond properly. If the thermocouple connected to the temperature controller has failed, an error message is displayed in red on the temperature controller readout.

Figure 40 Temperature Controller



When the temperature controller is operating properly, numbers 1 and 2 above the green number display will act as such:

- Number 2 will stay lit while the temperature controller provides >5 VDC to the solid state relay, thus enabling the 24 VDC to feed the heaters it controls.
- Number 2 blinks when the thermocouple registers a temperature reading (red number on the left of the temperature controller) that has reached the target temperature (green number on the right). At this time, the temperature controller will turn the solid state relay on and off to maintain the target temperature.
- If the target temperature is reach and exceeded, the temperature controller will turn off the relay. At this point, the number 2 will be off.

NOTE: Even though the temperature reading may/will exceed the target temperature, it will take some time for the temperature to drop back down. This is normal.

Other possible failure modes are:

- Incorrect reading of the thermocouple where the temperature reading does not move.
- Heater temperature is not in a controlled state.
- Output status provided to the PC104 Stack is incorrect.

Temperature controllers can be swapped between units to assist in verifying whether the problem encountered moves with the controller or not.

Solid State Relays

Solid state relays are used to control the heaters on the ICOS assembly and also to provide continuous power to the exhaust pump. Solid state relays for the heaters get their “enable/disable” commands from the temperature controller. The temperature controller would provide the >5 VDC to close the relay and allow 24 VDC from the DIN rail to energize the heater and heat the ICOS assembly.

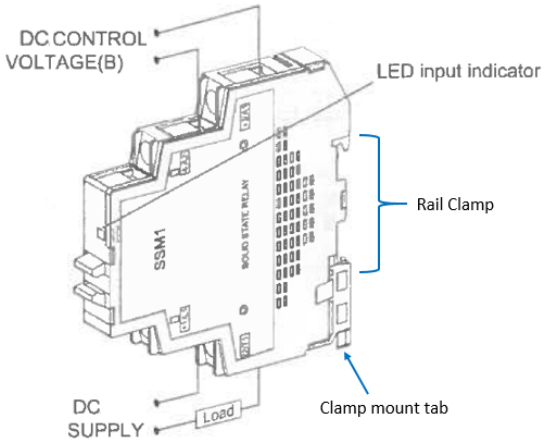
The solid state relay providing power to the exhaust pump is controlled by the 2-port solenoid driver. The exhaust pump should be continuously on to pump gas through the ICOS assembly.

When solid state relays are enabled (energized), the green LED on top will be lit. To replace solid state relays, use a blade screw driver and insert it on the bottom tab of the assembly facing out from the cable guide and pull the slot with the screw driver toward the cable guide. This will release the clamp holding the relay to the rail. This

is the same clamp setup as with the AC/DC power supply converter. To re-install the relay, reverse the operation by pushing on the slot at the bottom of the relay to clamp it back on the rail.

Solid state relays can be swapped between units to assist in troubleshooting by verifying whether the problem encountered moves with the controller or not.

Figure 41 Solid State Relay



PC104 Stack & Hard Drive

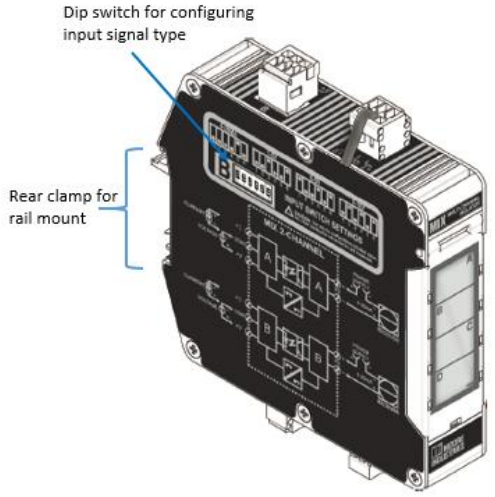
The PC104 stack contains three boards. The stand-alone CPU board is on top. Underneath it is the S310 DSP board, for signal processing and distribution, and at the bottom is a S320 PCA MIO. These three boards are replaced as one unit after failure.

The hard drive containing the source code is only 320 GB in size. Maintenance should be performed routinely to reduce the amount of data collected on the hard drive. Data processing will slow down and get worse when 75% of the hard drive has been filled. File corruption will occur when the instrument is not properly powered down. Improper power down means instant removal of power to the system. When that happens, files being written to are in an open state, with end-creating address pointers that go nowhere and cause the instrument to lock up. Lack of available disk space can also cause software failure. It is recommended to routinely compress and archive files that are saved in the instrument to another storage destination. Once this is done, it is recommended to delete those files from the instrument hard drive. Should a hard drive failure occur, operators/tool owners will need to contact ABB for a replacement drive and provide ABB with the instrument serial number and all software updates applied after the instrument was installed. It is the responsibility of the operator/tool owner to know the last software update installed on the instrument.

Signal Isolators

Signal isolators (see Figure 42) on the *LGR-ICOS* Gas Analyzer are used to convert gas concentration data from a 0-to-5 VDC signal format to a 4–20 mA signal format, and to provide clean output signals for external communication.

Figure 42 2-Channel Signal Isolator



The number of signal isolators on the instrument depends on the number of gases that the instrument can measure. If only two gas types can be measured, the instrument will only carry two signal isolators. One would be used to provide the two gas concentration data, while the other would provide the alarms that the instrument would encounter, should there be a problem. If the instrument is set up to measure three or four gas types, the instrument would contain three signal isolators. Only two input channels are available per signal isolator. Each signal requires a return line meaning that of the four wires going in the signal isolator, only two are are used for signals with the other two as return lines for the respective pair.

To determine if there is an issue with the signal isolator, use a DVM to probe the input analog signal going to the Modbus. If there is a DC voltage displayed on the DVM, then the problem is with the signal isolator for that particular signal. Signal isolators are aligned from left to right. The left-most represents Channel 1 (Ch1) and Channel 2 (Ch2) of the 4–20 mA connection interface panel. The next signal isolator to the right provides the output of Channel 3 (Ch3) and Channel 4 (Ch4). See Figure 34 for the location of 4–20 mA channels 1 through 4. The signal isolator on the very right will always be set for instrument alarms. Gas concentration data sent out to both the signal isolator and the Modbus are from the same output port on the PC104 stack. The signal isolator converts this voltage signal to a current signal, whereas the Modbus can keeps the signal in volts or convert it to a different units of measure. Analog gas concentration signals received by the Modbus for Channel 1 through 4 are defined in Table 13.

Table 13 Modbus Input Gas Concentration Analog Signals

Gas Concentration Channel	Modbus Input Port
Channel 5 Signal	AI0+
Channel 5 Return	AI0–
Channel 6 Signal	AI1+
Channel 6 Return	AI1–
Channel 1 Signal	AI2+
Channel 1 Return	AI2–
Channel 2 Signal	AI3+
Channel 2 Return	AI3–
Channel 3 Signal	AI4+
Channel 3 Return	AI4–
Channel 4 Signal	AI5+
Channel 4 Return	AI5–

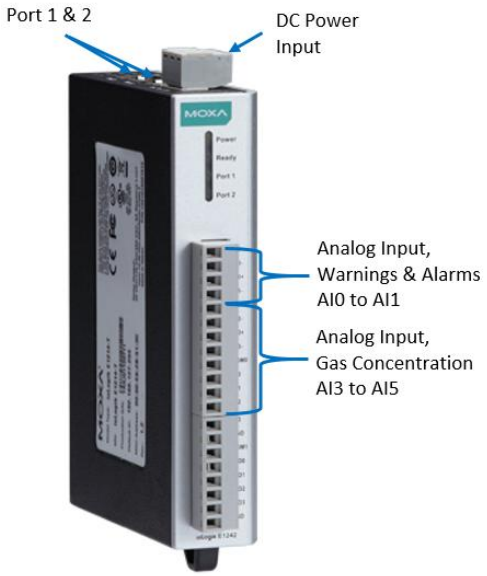
To replace a signal isolator, pull it upward. The signal isolator clamp is a flex clamp. To insert a new signal isolator back on the DIN rail, latch the fixed clamp edge to the rail and press down.

Modbus/TCP

The instrument's Modbus main objective is to provide remote access to gather gas concentration data and warnings/alarms through a TCP interface that runs on Ethernet. The Modbus is factory-configured when the *LGR-ICOS* Gas Analyzer is installed. The warnings/alarms are configured to give a 4–20 mA output, and the gas concentration for each gas type is configured to give a ppm or ppb output. The Modbus application disk from the Modbus manufacturer is provided with the instrument to allow the operator/tool owner to set it up to specific protocol for data acquisition and distribution. Gas concentration data is provided to the Modbus analog input lines as defined in Table 13. The output signal is bus through the Ethernet line mounted on the connection interface panel as seen in Figure 31 and labelled *Modbus/TCP*.

To replace the Modbus, use a blade screw driver and insert it to the tab on the bottom of the assembly facing out toward the cable guide and pull the slot with the screw driver toward the cable guide. This will release the clamp holding the Modbus to the rail. This is the same clamp setup with the AC/DC power supply converter. To re-install the Modbus, reverse the operation by pushing in the slot on the bottom of the Modbus to clamp it back on the rail.

Figure 43 Modbus



2-Port Solenoid Driver

The 2-port solenoid driver PCA is used to control the ICOS Gas Analyzer exhaust pump and inlet solenoid valve.

Exhaust Pump

The exhaust pump only expels the gas sample that has passed through the ICOS system. It should be running continuously. If the exhaust pump fails, the ICOS system internal pressure should increase dramatically, as if the exhaust was plugged. Control for the exhaust pump comes from the 2-port solenoid driver. The control line is ported to the exhaust pump relay. It should have >5 VDC going between the signal line and return line; it can be measured at the relay. When the relay is closed, 24 VDC will be supplied to the exhaust pump.

Inlet Solenoid Valve

The inlet solenoid valve controls whether or not the gas sample to be measured enters into the ICOS cell. If the inlet solenoid valve fails, gas will not flow through the instrument. The inlet solenoid valve is in a normally closed state when no voltage drives the valve open.

PC-200 Pressure Controller

The PC-200 pressure controller is used to control the proportional valve in evacuating the gas sample in the ICOS cell. At J1 between pin 1 (valve drive signal) and pin 3 (Gnd) on the board, 0 volt feeding the proportional valve means that the valve is closed, and 4 volts means that the valve is fully opened. The voltage measured between these two pins cannot exceed 5 volts; otherwise the valve driver will be damaged. If there is a failure on this PCA, the proportional valve will remain closed.

Proportional Pressure Valve

The proportional pressure valve is used to adjust the size of the ICOS cell valve and maintain a target pressure within the cell. The valve opening size increases to reduce the ICOS cell pressure. The valve size decreases to increase pressure within the ICOS cell. If this valve fails, or if the PC-200 pressure controller fails to drive this valve, the ICOS cell pressure will increase dramatically or become unstable. The proportional pressure valve is normally closed when there is no drive signal power to open it.

Alarms/Warnings

Channels 5 and 6 of the connection interface panel provide 4–20 mA output signal for error reporting. From the Modbus, channels AI0+ and AI0– provide the same data as Channel 5 but the output can be either in 4 – 20 mA current or in 0 – 5 volt voltage level. Moreover, channels AI1+ and AI1– output data of the Modbus can be either in 4–20 mA current for in 0 – 5 volt voltage level and provides the same data as Channel 6. The Modbus output units are user-configurable. Definitions are given in Table 14 and Table 15.

Table 14 Channel 5 and AI0+ Temperature Problem Descriptions

Warning / Alarm	Current (mA)	Volts	Detected Problem
Alarm	4 ± 0.1	0	Cavity temperature is too high or too low
Alarm	5 ± 0.1	0.312	Expansion chamber temperature is too high or too low
Alarm	6 ± 0.1	0.625	Bulkhead temperature is too high or too low (This is a tool option)
Alarm	7 ± 0.1	0.937	Filter temperature is too high or too low
Alarm	8 ± 0.1	1.25	Orifice temperature is too high or too low
Alarm	9 ± 0.1	1.56	Inlet Tubing temperature is too high or too low
Alarm	10 ± 0.1	1.875	Ambient temperature is outside of alarm set point range
Warning	12 ± 0.1	2.5	Cavity temperature is above or below normal
Warning	13 ± 0.1	2.812	Expansion chamber temperature is above or below normal
Warning	14 ± 0.1	3.125	Bulkhead temperature is above or below normal (This is a tool option)
Warning	15 ± 0.1	3.437	Filter temperature is above or below normal
Warning	16 ± 0.1	3.75	Orifice temperature is above or below normal
Warning	17 ± 0.1	4.06	NaN (Not a Number). Faulty random number/character result being displayed
Warning	18 ± 0.1	4.375	Inlet Tubing temperature is above or below normal
No issue	20 ± 0.1	5	No warning/alarm

Table 15 Channel 6 and AI1+ Gas Analyzer Issues

Warning / Alarm	Current (mA)	Volts	Detected Problem
Alarm	4 ± 0.1	0	Laser A and/or B goodness of fit is poor
Alarm	5 ± 0.1	0.312	Pressure is not in operating range
Alarm	6 ± 0.1	0.625	HD Space is low, deleting oldest files
Alarm	7 ± 0.1	0.937	Mirror health has degraded, clean mirrors
Alarm	8 ± 0.1	1.25	Laser A and/or B peak position is outside of control range, contact customer support
Alarm	9 ± 0.1	1.56	Laser power drop exceeded 20% from date of install
Alarm	10 ± 0.1	1.875	Maintenance is needed on system now
Warning	12 ± 0.1	2.5	Laser A and/or B goodness of fit is not optimal
Warning	13 ± 0.1	2.812	Pressure is noisy
Warning	14 ± 0.1	3.125	HD Space is low
Warning	15 ± 0.1	3.437	Mirror health is degrading, clean mirrors soon
Warning	16 ± 0.1	3.75	Laser A and/or B peak position is moving very fast
Warning	17 ± 0.1	4.06	Laser A and/or B power is degrading, contact customer support soon
Warning	18 ± 0.1	4.375	Maintenance is needed on system soon
No issue	20 ± 0.1	5	No warning/alarm

Preventative Maintenance

The *LGR-ICOS* Gas Analyzer requires yearly preventative maintenance (PM) to maintain its measurement performance. There are four categories of PM parts:

- Parts that need to be replaced every year
- Parts that need maintenance, but not replacement, every year
- Parts that need to be replaced every five years
- Parts that need to be replaced every ten years

Parts to replace every year are:

- 10µm screen filter at the inlet solenoid valve on the gas inlet side
- Exhaust pump diaphragm

Parts to replace every five years are:

- Exhaust pump
- 10µm filter/orifice at the orifice filter/heater assembly

Parts to replace every ten years are:

- 2µm ICOS filter/heater
- 2µm ICOS exhaust filter

Parts requiring maintenance every year are:

- System hard drive
- Astigmatic mirrors

Hard drive maintenance requires that some of the older data stored in the archive folder be removed from the instrument and put into another storage location. The tool owner should be notified of this action and provide the alternate storage location. It is not advisable to delete all measured and stored data from the instrument. Older data provides operators/service engineers a recorded performance baseline of the instrument when it was working properly. This data will serve as a reference of working performance data when servicing or repairing the instrument in the future.

Cleaning the two ICOS astigmatic mirrors are required when processed gases contaminate and coat the mirrors, reducing its effectiveness and resulting in reduced measurement precision and/or inaccurate data.

Preventive maintenance should be performed by trained personnel that have successfully completed the maintenance course on the *LGR-ICOS* Gas Analyzer.

Appendix A: Gas Transmitted Intensity & Absorption Profiles

Figure 44 O_2 Typical Profile

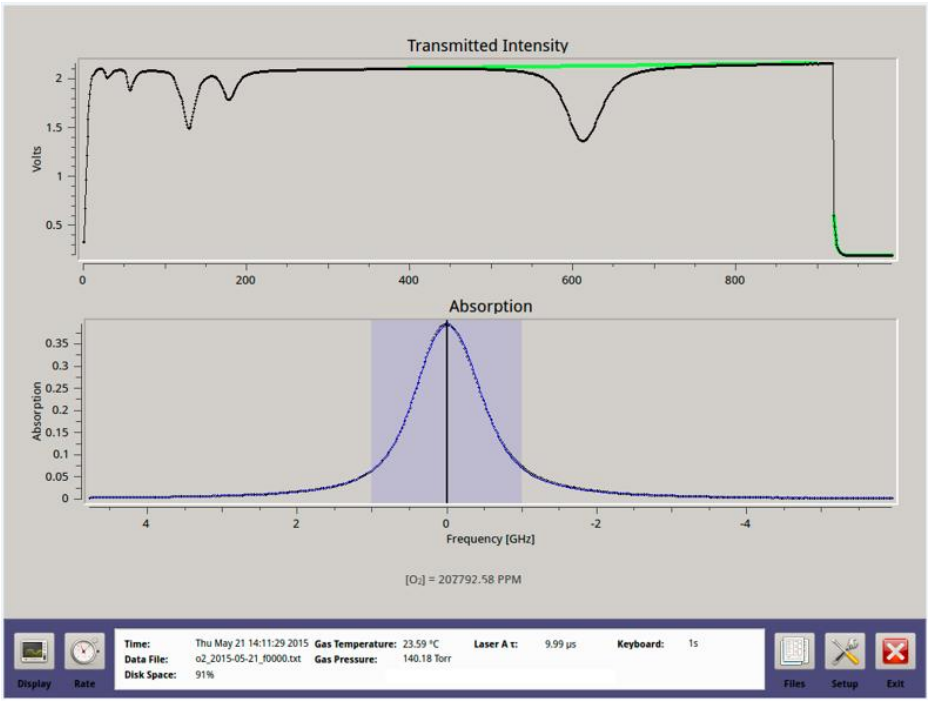


Figure 45 O_2 Incorrect Profile

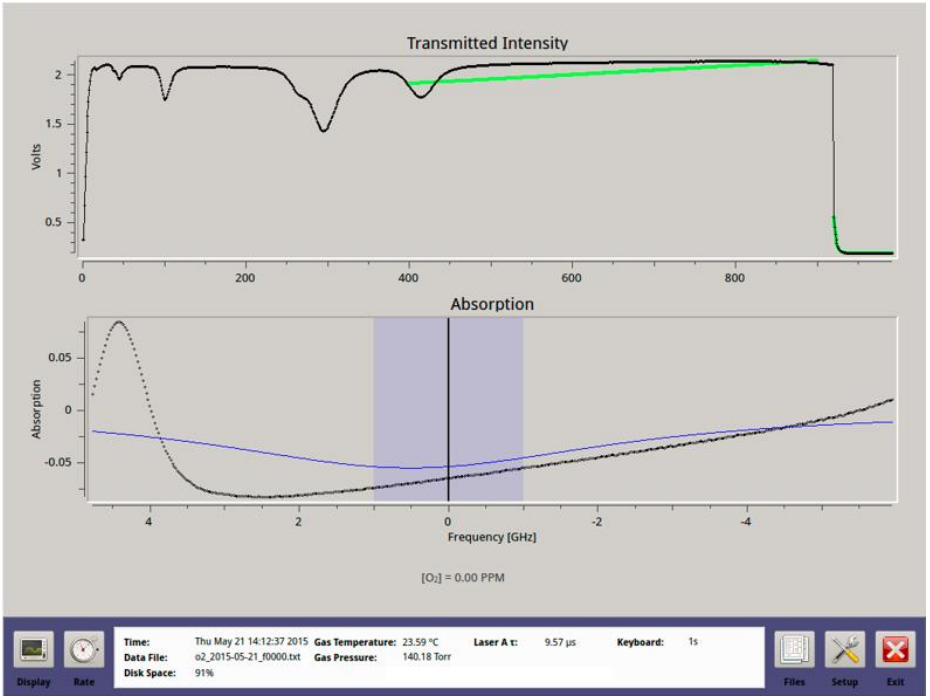


Figure 46 H_2S Typical Profile

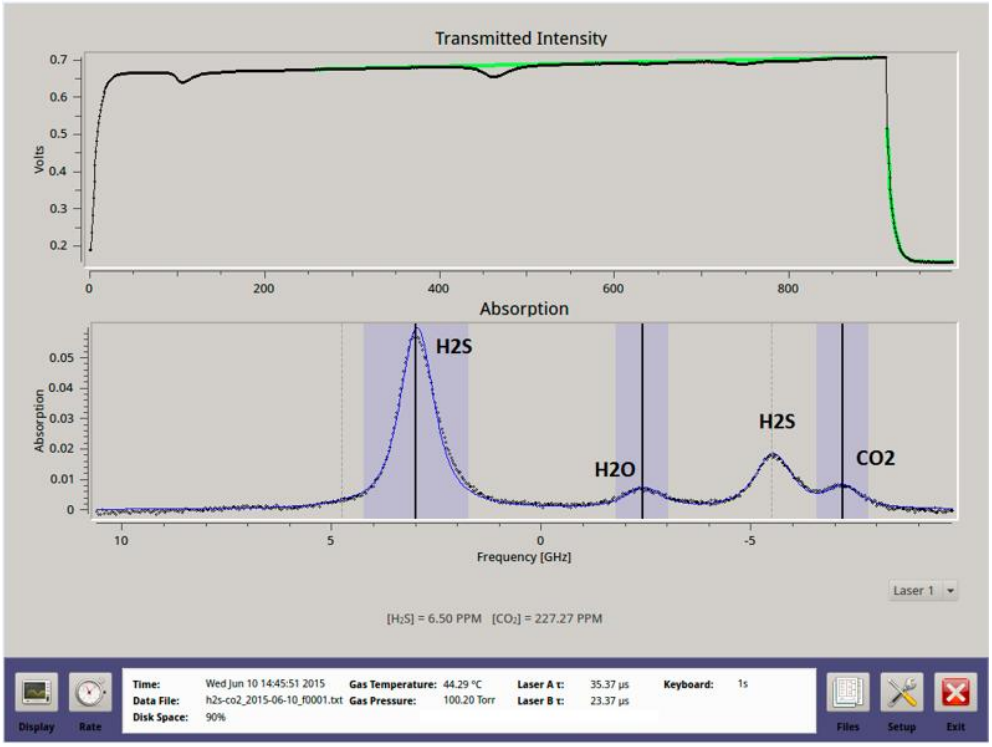


Figure 47 CO_2 Typical Profile

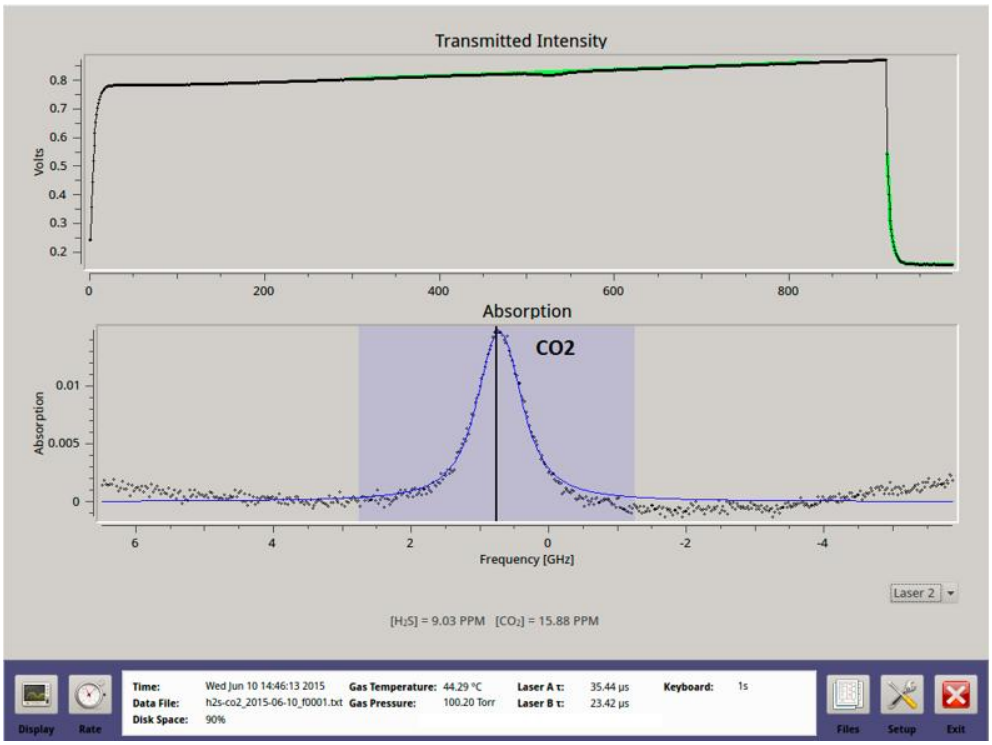


Figure 48 CH_4/H_2O Typical Profile

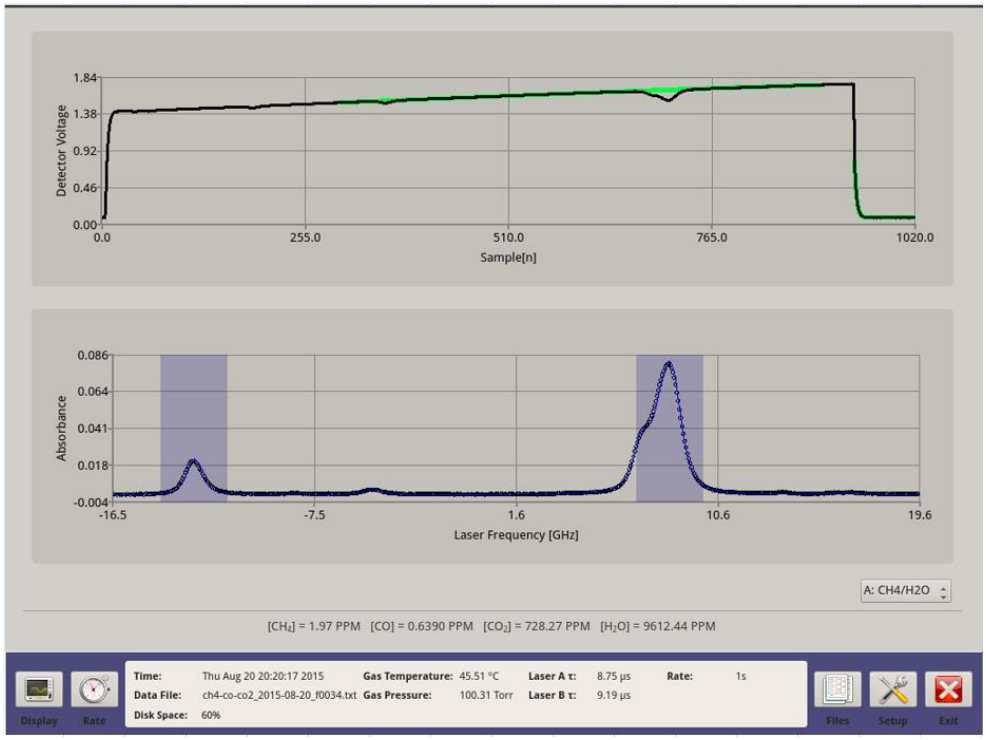
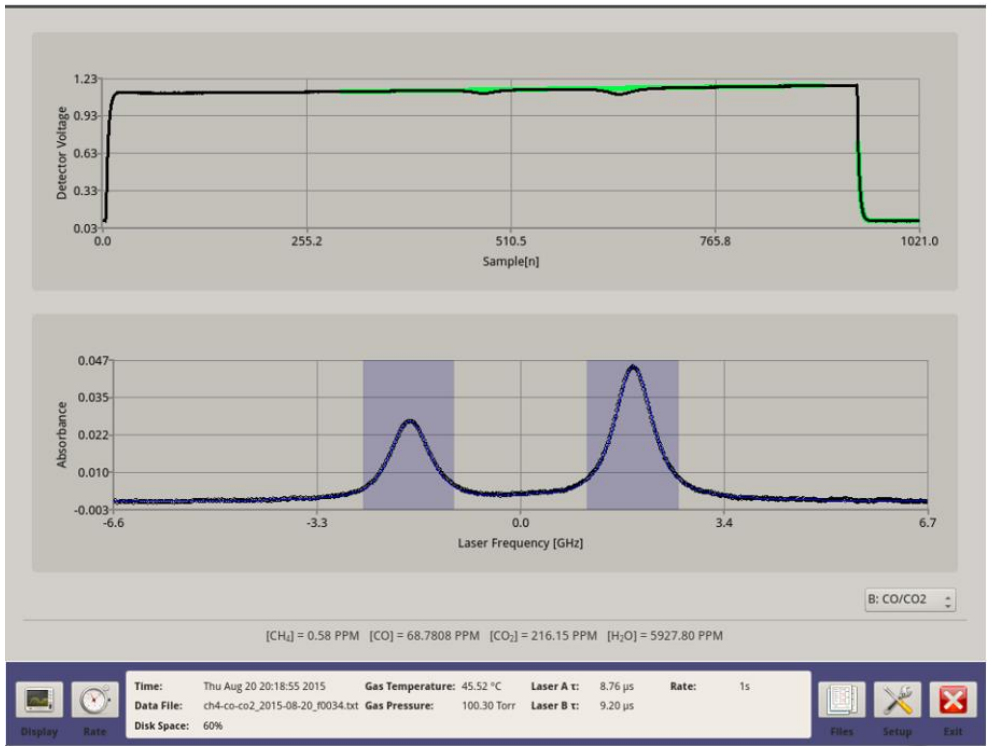


Figure 49 CO/CO_2 Typical Profile



Appendix B: Material Safety Data Sheets

This chapter provides material safety data sheets for the chemicals typically used in *LGR-ICOS* Gas Analyzer instruments. Each chemical has an MSDS, which lists the product name, supplier contacts (including emergency numbers), chemical and safety information, and other information as determined by the chemical manufacturer.

NOTE: The MSDS in this chapter is for reference only. MSDS documents come from different manufacturers, and are subject to change. Refer to the site-specific MSDS at your location for additional material safety information.

Methanol MSDS

1. PRODUCT AND COMPANY IDENTIFICATION

1.1 Product identifiers

Product name:	Methanol
Product number:	414719
Brand:	Fluka
Index-No.:	603-001-00-X
CAS-No.:	67-56-1

1.2 Relevant identified uses of the substance or mixture and uses advised against

Identified uses:	Laboratory chemicals, Manufacture of substances

1.3 Details of the supplier of the safety data sheet

Company:	Sigma-Aldrich 3050 Spruce Street SAINT LOUIS MO 63103 USA
Telephone:	+1 800-325-5832
Fax:	+1 800-325-5052

1.4 Emergency telephone number

Emergency Phone #:	(314) 776-6555

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

GHS Classification in accordance with 29 CFR 1910 (OSHA HCS)

Flammable liquids (Category 2), H225
Acute toxicity, Oral (Category 3), H301
Acute toxicity, Inhalation (Category 3), H331
Acute toxicity, Dermal (Category 3), H311
Specific target organ toxicity - single exposure (Category 1), H370
For the full text of the H-Statements mentioned in this Section, see Section 16.

2.2 GHS Label elements, including precautionary statements

Pictogram

Signal word	Danger
Hazard statement(s)	
H225	Highly flammable liquid and vapor.
H301 + H311 + H331	Toxic if swallowed, in contact with skin or if inhaled
H370	Causes damage to organs.
Precautionary statement(s)	
P210	Keep away from heat/sparks/open flames/hot surfaces. - No smoking.
P233	Keep container tightly closed.
P240	Ground/bond container and receiving equipment.
P241	Use explosion-proof electrical/ ventilating/ lighting/ equipment.
P242	Use only non-sparking tools.
P243	Take precautionary measures against static discharge.
P260	Do not breathe dust/ fume/ gas/ mist/ vapors/ spray.
P264	Wash skin thoroughly after handling.
P270	Do not eat, drink or smoke when using this product.
P271	Use only outdoors or in a well-ventilated area.
P280	Wear protective gloves/ protective clothing/ eye protection/ face protection.
P301 + P310	IF SWALLOWED: Immediately call a POISON CENTER or doctor/ physician.
P303 + P361 + P353	IF ON SKIN (or hair): Remove/ Take off immediately all contaminated clothing. Rinse skin with water/ shower.
P304 + P340	IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing.
P307 + P311	IF exposed: Call a POISON CENTER or doctor/ physician.
P322	Specific measures (see supplemental first aid instructions on this label).
P330	Rinse mouth.
P361	Remove/Take off immediately all contaminated clothing.
P363	Wash contaminated clothing before reuse.
P370 + P378	In case of fire: Use dry sand, dry chemical or alcohol-resistant foam for extinction.
P403 + P233	Store in a well-ventilated place. Keep container tightly closed.
P403 + P235	Store in a well-ventilated place. Keep cool.
P405	Store locked up.
P501	Dispose of contents/ container to an approved waste disposal plant.

2.3 Hazards not otherwise classified (HNOC) or not covered by GHS – none

3. COMPOSITION/INFORMATION ON INGREDIENTS

3.1 Substances

Synonyms:	Methyl alcohol
Formula:	CH_4O
Molecular weight:	32.04 g/mol
CAS-No.:	67-56-1
EC-No.:	200-659-6
Index-No.:	603-001-00-X
Registration number:	01-2119433307-44-XXXX

Hazardous components

Component	Classification	Concentration
Methanol		
	Flam. Liq. 2; Acute Tox. 3; STOT SE 1; H225, H301 + H311 + H331, H370	<= 100 %

For the full text of the H-Statements mentioned in this Section, see Section 16.

4. FIRST AID MEASURES

4.1 Description of first aid measures

General advice
Consult a physician. Show this safety data sheet to the doctor in attendance. Move out of dangerous area.

If inhaled
If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

In case of skin contact
Wash off with soap and plenty of water. Take victim immediately to hospital. Consult a physician.

In case of eye contact
Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician.

If swallowed
Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

4.2 Most important symptoms and effects, both acute and delayed

The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed

No data available

5. FIREFIGHTING MEASURES

5.1 Extinguishing media

Suitable extinguishing media
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

5.2 Special hazards arising from the substance or mixture
Carbon oxides

5.3 Advice for firefighters
Wear self-contained breathing apparatus for firefighting if necessary.

5.4 Further information
Use water spray to cool unopened containers.

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures
Wear respiratory protection. Avoid breathing vapors, mist or gas. Ensure adequate ventilation. Remove all sources of ignition. Evacuate personnel to safe areas. Beware of vapors accumulating to form explosive concentrations.
Vapors can accumulate in low areas.
For personal protection see section 8.

6.2 Environmental precautions
Prevent further leakage or spillage if safe to do so. Do not let product enter drains.

6.3 Methods and materials for containment and cleaning up
Contain spillage, and then collect with an electrically protected vacuum cleaner or by wet-brushing and place in container for disposal according to local regulations (see section 13).

6.4 Reference to other sections
For disposal see section 13.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling
Avoid contact with skin and eyes. Avoid inhalation of vapor or mist.
Use explosion-proof equipment. Keep away from sources of ignition - No smoking. Take measures to prevent the buildup of electrostatic charge.
For precautions see section 2.2.

7.2 Conditions for safe storage, including any incompatibilities
Keep container tightly closed in a dry and well-ventilated place. Containers which are opened must be carefully resealed and kept upright to prevent leakage.

7.3 Specific end use(s)
Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1 Control parameters

Components with workplace control parameters

Component	CAS-No.	Value	Control parameters	Basis
Methanol	67-56-1	TWA	200.000000 ppm	USA. ACGIH Threshold Limit Values (TLV)
	Remarks	Headache Nausea Dizziness Eye damage Substances for which there is a Biological Exposure Index or Indices (see BEI® section) Danger of cutaneous absorption		
		STEL	250.000000 ppm	USA. ACGIH Threshold Limit Values (TLV)
		Headache Nausea Dizziness Eye damage Substances for which there is a Biological Exposure Index or Indices (see BEI® section) Danger of cutaneous absorption		
		TWA	200.000000 ppm 260.000000 mg/m3	USA. NIOSH Recommended Exposure Limits
		Potential for dermal absorption		
		ST	250.000000 ppm 325.000000 mg/m3	USA. NIOSH Recommended Exposure Limits
		Potential for dermal absorption		
		TWA	200.000000 ppm 260.000000 mg/m3	USA. Occupational Exposure Limit (OSHA) - Table Z-1 Limits for Air Contaminants
		The value in mg/m3 is approximate.		

Biological occupational exposure limits

Component	CAS-No.	Parameters	Value	Biological specimen	Basis
Methanol	67-56-1	Methanol	15.0000 mg/l	Urine	ACGIH – Biological Exposure Indices (BEI)
	Remarks	End of shift (As soon as possible after exposure ceases)			

Derived No Effect Level (DNEL)

Application Area	Exposure Routes	Health effect	Value
Workers	Skin contact	Long-term systemic effects	40mg/kg BW/d
Consumers	Skin contact	Long-term systemic effects	8mg/kg BW/d
Consumers	Ingestion	Long-term systemic effects	8mg/kg BW/d
Workers	Skin contact	Acute systemic effects	40mg/kg BW/d
Consumers	Skin contact	Acute systemic effects	8mg/kg BW/d

Consumers	Ingestion	Acute systemic effects	8mg/kg BW/d
Workers	Inhalation	Acute systemic effects	260 mg/m3
Workers	Inhalation	Acute local effects	260 mg/m3
Workers	Inhalation	Long-term systemic effects	260 mg/m3
Workers	Inhalation	Long-term local effects	260 mg/m3
Consumers	Inhalation	Acute systemic effects	50 mg/m3
Consumers	Inhalation	Acute local effects	50 mg/m3
Consumers	Inhalation	Long-term systemic effects	50 mg/m3
Consumers	Inhalation	Long-term local effects	50 mg/m3

Predicted No Effect Concentration (PNEC)

Compartment	Value
Soil	23.5 mg/kg
Marine water	15.4 mg/l
Fresh water	154 mg/l
Fresh water sediment	570.4 mg/kg
Onsite sewage treatment plant	100 mg/kg

8.2 Exposure controls

Appropriate engineering controls
Avoid contact with skin, eyes and clothing. Wash hands before breaks and immediately after handling the product.

Personal protective equipment

Eye/face protection
Face shield and safety glasses Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin protection
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Full contact
Material: butyl-rubber
Minimum layer thickness: 0.3 mm
Break through time: 480 min
Material tested: Butoject® (KCL 897 / Aldrich Z677647, Size M)

Splash contact
Material: Nitrile rubber
Minimum layer thickness: 0.4 mm
Break through time: 31 min
Material tested: Camatril® (KCL 730 / Aldrich Z677442, Size M)
data source: KCL GmbH, D-36124 Eichenzell, phone +49 (0)6659 87300, e-mail sales@kcl.de, test method: EN374
If used in solution, or mixed with other substances, and under conditions which differ from EN 374, contact the supplier of the CE approved gloves. This recommendation is advisory only and must be evaluated by an industrial hygienist and safety officer familiar with the specific situation of anticipated use by our customers. It should not be construed as offering an approval for any specific use scenario.

Body Protection
Complete suit protecting against chemicals, Flame retardant antistatic protective clothing., The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Respiratory protection
Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multipurpose combination (US) or type AXBEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN(EU).

Control of environmental exposure
Prevent further leakage or spillage if safe to do so. Do not let product enter drains.

9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

a) Appearance Form:	liquid
Color:	colorless
b) Odor	pungent
c) Odor	Threshold No data available
d) pH	No data available
e) Melting point/freezing point	
Melting point/range:	-98°C (-144°F) - lit.
f) Initial boiling point and boiling range	64.7°C (148.5°F)
g) Flash point	9.7°C (49.5°F) - closed cup
h) Evaporation rate	No data available
i) Flammability (solid, gas)	No data available
j) Upper/lower flammability or explosive limits	
Upper explosion limit:	36%(V)
Lower explosion limit:	6%(V)
k) Vapor pressure	130.3 hPa (97.7 mmHg) at 20.0°C (68.0°F) 546.6 hPa (410.0 mmHg) at 50.0°C (122.0°F) 169.27 hPa (126.96 mmHg) at 25.0°C (77.0°F)
l) Vapor density	1.11
m) Relative density	0.791 g/cm^3 at 25°C (77°F)
n) Water solubility	completely miscible

o) Partition coefficient: noctanol/water	log Pow: -0.77
p) Auto-ignition temperature	455.0°C (851.0°F) at 1,013 hPa (760 mmHg)
q) Decomposition temperature	No data available
r) Viscosity	No data available
s) Explosive properties	Not explosive
t) Oxidizing properties	The substance or mixture is not classified as oxidizing.

9.2 Other safety information

Minimum ignition energy	0.14 mJ
Conductivity	< 1 µS/cm
Relative vapor density	1.11

10. STABILITY AND REACTIVITY

10.1 Reactivity

No data available

10.2 Chemical stability

Stable under recommended storage conditions.

10.3 Possibility of hazardous reactions

Vapors may form explosive mixture with air.

10.4 Conditions to avoid

Heat, flames and sparks. Extremes of temperature and direct sunlight.

10.5 Incompatible materials

Acid chlorides, Acid anhydrides, Oxidizing agents, Alkali metals, Reducing agents, Acids

10.6 Hazardous decomposition products

Other decomposition products - No data available
In the event of fire: see section 5

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity

LDLO Oral - Human - 143 mg/kg
Remarks: Lungs, Thorax, or Respiration: Dyspnea. Ingestion may cause gastrointestinal irritation, nausea, vomiting and diarrhea.

LD50 Oral - Rat - 1,187 - 2,769 mg/kg

LC50 Inhalation - Rat - 4 h - 128.2 mg/l

LC50 Inhalation - Rat - 6 h - 87.6 mg/l

LD50 Dermal - Rabbit - 17,100 mg/kg

No data available

Skin corrosion/irritation

Skin - Rabbit
Result: No skin irritation

Serious eye damage/eye irritation

Eyes - Rabbit
Result: No eye irritation

Respiratory or skin sensitization

Maximization Test (GPMT) - Guinea pig
Does not cause skin sensitization.
(OECD Test Guideline 406)

Germ cell mutagenicity

Ames test
S. typhimurium
Result: negative in vitro assay fibroblast
Result: negative
Mutation in mammalian somatic cells.
Mutagenicity (in vivo mammalian bone-marrow cytogenetic test, chromosomal analysis)
Mouse - male and female
Result: negative

Carcinogenicity

IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.
ACGIH: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by ACGIH.
NTP: No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.
OSHA: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

Reproductive toxicity

Damage to fetus not classifiable
Fertility classification not possible from current data.

Specific target organ toxicity - single exposure
Causes damage to organs.

Specific target organ toxicity - repeated exposure
The substance or mixture is not classified as specific target organ toxicant, repeated exposure.

Aspiration hazard
No aspiration toxicity classification

Additional Information
RTECS: PC1400000
Methyl alcohol may be fatal or cause blindness if swallowed.
Effects due to ingestion may include:, Headache, Dizziness, Drowsiness, metabolic acidosis, Coma, Seizures.
Symptoms may be delayed., Damage of the:, Liver, Kidney
Central nervous system - Breathing difficulties - Based on Human Evidence
Stomach - Irregularities - Based on Human Evidence

12. ECOLOGICAL INFORMATION

12.1 Toxicity

Toxicity to fish mortality	LC50 - Lepomis macrochirus (Bluegill) - 15,400.0 mg/l - 96 h NOEC - Oryzias latipes - 7,900 mg/l - 200 h
Toxicity to daphnia and other aquatic invertebrates	EC50 - Daphnia magna (Water flea) - > 10,000.00 mg/l - 48 h
Toxicity to algae	Growth inhibition EC50 - Scenedesmus capricornutum (fresh water algae) - 22,000.0 mg/l - 96 h

12.2 Persistence and degradability

Biodegradability	aerobic - Exposure time 5 d
Result:	72 % - rapidly biodegradable
Biochemical Oxygen Demand (BOD)	600 - 1,120 mg/g
Chemical Oxygen Demand (COD)	1,420 mg/g
Theoretical oxygen demand	1,500 mg/g

12.3 Bioaccumulative potential

Bioaccumulation	Cyprinus carpio (Carp) - 72 d at 20 °C - 5 mg/l

Bioconcentration factor (BCF): 1.0

12.4 Mobility in soil
Will not adsorb on soil.

12.5 Results of PBT and vPvB assessment
PBT/vPvB assessment not available as chemical safety assessment not required/not conducted

12.6 Other adverse effects

Additional ecological Information	Avoid release to the environment.
Stability in water	at 19 °C83 - 91 % - 72 h
Remarks:	Hydrolyses on contact with water. Hydrolyses readily.

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Product

Burn in a chemical incinerator equipped with an afterburner and scrubber but exert extra care in igniting as this material is highly flammable. Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed professional waste disposal service to dispose of this material.

Contaminated packaging

Dispose of as unused product.

14. TRANSPORT INFORMATION

DOT (US)

UN number: 1230	Class: 3	Packing group: II
Proper shipping name:	Methanol	
Reportable Quantity (RQ):	5000 lbs	
Poison Inhalation Hazard:	No	

IMDG

UN number: 1230	Class: 3 (6.1)	Packing group: II EMS-No: F-E, S-D
Proper shipping name:	METHANOL	

IATA

UN number: 1230	Class: 3 (6.1)	Packing group: II
Proper shipping name:	Methanol	

15. REGULATORY INFORMATION

SARA 302 Components

No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 Components

The following components are subject to reporting levels established by SARA Title III, Section 313:

Methanol	CAS-No.	Revision Date
	67-56-1	2007-07-01

SARA 311/312 Hazards

Fire Hazard, Acute Health Hazard, Chronic Health Hazard

Massachusetts Right To Know Components

Methanol	CAS-No.	Revision Date
	67-56-1	2007-07-01

Pennsylvania Right To Know Components

Methanol	CAS-No.	Revision Date
	67-56-1	2007-07-01

New Jersey Right To Know Components

Methanol	CAS-No.	Revision Date
	67-56-1	2007-07-01

California Prop. 65 Components

WARNING: This product contains a chemical known to the State of California to cause birth defects or other reproductive harm. Methanol

	CAS-No.	Revision Date
	67-56-1	2012-03-16

16. OTHER INFORMATION

Full text of H-Statements referred to under sections 2 and 3.

Acute Tox.	Acute toxicity
Flam. Liq.	Flammable liquids
H225	Highly flammable liquid and vapor.
H301	Toxic if swallowed.
H301 + H311 + H331	Toxic if swallowed, in contact with skin or if inhaled
H311	Toxic in contact with skin.
H331	Toxic if inhaled.
H370	Causes damage to organs.

HMIS Rating

Health hazard:	2
Chronic Health Hazard:	*
Flammability:	3
Physical Hazard	0

NFPA Rating

Health hazard:	2
Fire Hazard:	3
Reactivity Hazard:	0

Further information

 The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.

Preparation Information

Sigma-Aldrich Corporation
Product Safety – Americas Region
1-800-521-8956

Acetone MSDS

1. PRODUCT AND COMPANY IDENTIFICATION

1.1 Product identifiers

Product name:	Acetone
Product Number:	154598
Brand:	Sigma-Aldrich
Index-No.:	606-001-00-8
CAS-No.:	67-64-1

1.2 Relevant identified uses of the substance or mixture and uses advised against

Identified uses:	Laboratory chemicals, Manufacture of substances

1.3 Details of the supplier of the safety data sheet

Company:	Sigma-Aldrich 3050 Spruce Street SAINT LOUIS MO 63103 USA
Telephone:	+1 800-325-5832
Fax:	+1 800-325-5052

1.4 Emergency telephone number

Emergency Phone #:	(314) 776-6555

2. HAZARDS IDENTIFICATION

2.1 Classification of the substance or mixture

GHS Classification in accordance with 29 CFR 1910 (OSHA HCS)

Flammable liquids (Category 2), H225
Eye irritation (Category 2A), H319
Specific target organ toxicity - single exposure (Category 3), Central nervous system, H336
For the full text of the H-Statements mentioned in this Section, see Section 16.

2.2 GHS Label elements, including precautionary statements

Pictogram

Signal word Danger

Hazard statement(s)

H225	Highly flammable liquid and vapor.
H319	Causes serious eye irritation.
H336	May cause drowsiness or dizziness.

Precautionary statement(s)

P210	Keep away from heat/sparks/open flames/hot surfaces. - No smoking.
P233	Keep container tightly closed.
P240	Ground/bond container and receiving equipment.
P241	Use explosion-proof electrical/ ventilating/ lighting/ equipment.
P242	Use only non-sparking tools.
P243	Take precautionary measures against static discharge.
P261	Avoid breathing dust/ fume/ gas/ mist/ vapors/ spray.

P264	Wash skin thoroughly after handling.
P271	Use only outdoors or in a well-ventilated area.
P280	Wear protective gloves/ eye protection/ face protection.
P303 + P361 + P353	IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water/shower.
P304 + P340 + P312	IF INHALED: Remove person to fresh air and keep comfortable for breathing. Call a POISON CENTER or doctor/ physician if you feel unwell.
P305 + P351 + P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P337 + P313	If eye irritation persists: Get medical advice/ attention.
P370 + P378	In case of fire: Use dry sand, dry chemical or alcohol-resistant foam to extinguish.
P403 + P233	Store in a well-ventilated place. Keep container tightly closed.
P403 + P235	Store in a well-ventilated place. Keep cool.
P405	Store locked up.
P501	Dispose of contents/ container to an approved waste disposal plant.

2.3 Hazards not otherwise classified (HNOC) or not covered by GHS

Repeated exposure may cause skin dryness or cracking.

3. COMPOSITION/INFORMATION ON INGREDIENTS

3.1 Substances

Formula	: C_3H_6O
Molecular weight	: 58.08 g/mol
CAS-No.	: 67-64-1
EC-No.	: 200-662-2
Index-No.	: 606-001-00-8
Registration number	: 01-2119471330-49-XXXX

Component Classification Concentration

Acetone

Flam. Liq. 2; Eye Irrit. 2A;
STOT SE 3; H225, H319,
H336
<= 100 %

For the full text of the H-Statements mentioned in this Section, see Section 16.

4. FIRST AID MEASURES

4.1 Description of first aid measures

General advice

Consult a physician. Show this safety data sheet to the doctor in attendance. Move out of dangerous area.

If inhaled

If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

In case of skin contact

Wash off with soap and plenty of water. Consult a physician.

In case of eye contact
Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician.

If swallowed
Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

4.2 Most important symptoms and effects, both acute and delayed
The most important known symptoms and effects are described in the labelling (see section 2.2) and/or in section 11

4.3 Indication of any immediate medical attention and special treatment needed
No data available

5. FIREFIGHTING MEASURES

5.1 Extinguishing media
Suitable extinguishing media
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

5.2 Special hazards arising from the substance or mixture
Carbon oxides

5.3 Advice for firefighters
Wear self-contained breathing apparatus for firefighting if necessary.

5.4 Further information
Use water spray to cool unopened containers.

6. ACCIDENTAL RELEASE MEASURES

6.1 Personal precautions, protective equipment and emergency procedures
Use personal protective equipment. Avoid breathing vapors, mist or gas. Ensure adequate ventilation. Remove all sources of ignition. Evacuate personnel to safe areas. Beware of vapors accumulating to form explosive concentrations. Vapors can accumulate in low areas. For personal protection see section 8.

6.2 Environmental precautions
Prevent further leakage or spillage if safe to do so. Do not let product enter drains.

6.3 Methods and materials for containment and cleaning up
Contain spillage, and then collect with an electrically protected vacuum cleaner or by wet-brushing and place in container for disposal according to local regulations (see section 13).

6.4 Reference to other sections
For disposal see section 13.

7. HANDLING AND STORAGE

7.1 Precautions for safe handling

Avoid contact with skin and eyes. Avoid inhalation of vapor or mist. Use explosion-proof equipment. Keep away from sources of ignition - No smoking. Take measures to prevent the buildup of electrostatic charge. For precautions see section 2.2.

7.2 Conditions for safe storage, including any incompatibilities

Keep container tightly closed in a dry and well-ventilated place. Containers which are opened must be carefully resealed and kept upright to prevent leakage. Storage class (TRGS 510): Flammable liquids

7.3 Specific end use(s)

Apart from the uses mentioned in section 1.2 no other specific uses are stipulated

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1 Control parameters

Components with workplace control parameters

Component	CAS-No.	Value	Control parameters	Basis
Acetone	67-64-1	TWA	500.000000 ppm	USA. ACGIH Threshold Limit Values (TLV)
	Remarks	Central Nervous System impairment Hematologic effects Upper Respiratory Tract irritation Eye irritation Adopted values or notations enclosed are those for which changes are proposed in the NIC See Notice of Intended Changes (NIC) Substances for which there is a Biological Exposure Index or Indices (see BEI® section) Not classifiable as a human carcinogen		
		TWA	500 ppm	USA. ACGIH Threshold Limit Values (TLV)
		Central Nervous System impairment Hematologic effects Upper Respiratory Tract irritation Eye irritation Adopted values or notations enclosed are those for which changes are proposed in the NIC See Notice of Intended Changes (NIC) Substances for which there is a Biological Exposure Index or Indices (see BEI® section) Not classifiable as a human carcinogen		
		STEL	750.000000 ppm	USA. ACGIH Threshold Limit Values (TLV)
		Central Nervous System impairment Hematologic effects Upper Respiratory Tract irritation Eye irritation Adopted values or notations enclosed are those for which changes are proposed in the NIC See Notice of Intended Changes (NIC) Substances for which there is a Biological Exposure Index or Indices		

(see BEI® section)
Not classifiable as a human carcinogen

STEL	750 ppm	USA. ACGIH Threshold Limit Values (TLV)

Central Nervous System impairment
Hematologic effects
Upper Respiratory Tract irritation
Eye irritation
Adopted values or notations enclosed are those for which changes are proposed in the NIC
See Notice of Intended Changes (NIC)
Substances for which there is a Biological Exposure Index or Indices (see BEI® section)
Not classifiable as a human carcinogen

TWA	1,000.0 ppm 2,400.0 mg/m3	USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants

The value in mg/m3 is approximate.

TWA	250.000000 Ppm 590.000000 mg/m3	USA. NIOSH Recommended Exposure Limits

Biological occupational exposure limits

Component	CAS-No.	Parameters	Value	Biological specimen	Basis
Acetone	67-64-1	Acetone	50.0000 mg/l	Urine	ACGIH - Biological Exposure Indices (BEI)

Remarks End of shift (As soon as possible after exposure ceases)

Derived No Effect Level (DNEL)

Application Area	Exposure routes	Health effect	Value
Workers	Skin contact	Long-term systemic effects	186mg/kg BW/d
Consumers	Ingestion	Long-term systemic effects	62mg/kg BW/d
Consumers	Skin contact	Long-term systemic effects	62mg/kg BW/d
Workers	Inhalation	Acute systemic effects	2420 mg/m3
Workers	Inhalation	Long-term systemic effects	1210 mg/m3
Consumers	Inhalation	Long-term systemic effects	200 mg/m3

Predicted No Effect Concentration (PNEC)

Compartment	Value
Soil	33.3 mg/kg
Marine water	1.06 mg/l
Fresh water	10.6 mg/l
Marine sediment	3.04 mg/kg
Fresh water sediment	30.4 mg/kg
Onsite sewage treatment plant	100 mg/l

8.2 Exposure controls

Appropriate engineering controls

Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

Personal protective equipment

Eye/face protection

Face shield and safety glasses Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin protection

Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without
touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Full contact
Material: butyl-rubber
Minimum layer thickness: 0.3 mm
Break through time: 480 min
Material tested: Butoject® (KCL 897 / Aldrich Z677647, Size M)

Splash contact
Material: butyl-rubber
Minimum layer thickness: 0.3 mm
Break through time: 480 min
Material tested: Butoject® (KCL 897 / Aldrich Z677647, Size M)
data source: KCL GmbH, D-36124 Eichenzell, phone +49 (0)6659 87300, e-mail sales@kcl.de, test method: EN374
If used in solution, or mixed with other substances, and under conditions which differ from EN 374, contact the supplier of the CE approved gloves. This recommendation is advisory only and must be evaluated by an industrial hygienist and safety officer familiar with the specific situation of anticipated use by our customers. It should not be construed as offering an approval for any specific use scenario.

Body Protection

impervious clothing, Flame retardant antistatic protective clothing., The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Respiratory protection

Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multipurpose combination (US) or type AXBEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN(EU).

Control of environmental exposure

Prevent further leakage or spillage if safe to do so. Do not let product enter drains.

9. PHYSICAL AND CHEMICAL PROPERTIES

9.1 Information on basic physical and chemical properties

a) Appearance Form:	liquid, clear
Color:	colorless
b) Odor	No data available
c) Odor	Threshold No data available
d) pH	No data available
e) Melting point/freezing point	
Melting point/range:	-94 °C (-137 °F) - lit.
f) Initial boiling point and boiling range:	56 °C (133 °F) at 1,013 hPa (760 mmHg) - lit.
g) Flash point	-16.99 °C (1.42 °F) - closed cup
h) Evaporation rate	No data available
i) Flammability (solid, gas)	No data available
j) Upper/lower flammability or explosive limits	
Upper explosion limit:	13 %(V)
Lower explosion limit:	2 %(V)
k) Vapor pressure	533.3 hPa (400.0 mmHg) at 39.5 °C (103.1 °F)
	245.3 hPa (184.0 mmHg) at 20.0 °C (68.0 °F)
l) Vapor density	No data available
m) Relative density	0.791 g/cm3 at 25 °C (77 °F)
n) Water solubility	completely miscible
o) Partition coefficient: noctanol/water	
log Pow	: -0.24
p) Auto-ignition temperature	465.0 °C (869.0 °F)
q) Decomposition temperature	No data available
r) Viscosity	No data available
s) Explosive properties	No data available
t) Oxidizing properties	No data available

9.2 Other safety information

Surface tension	23.2 mN/m at 20.0 °C (68.0 °F)

10. STABILITY AND REACTIVITY

10.1 Reactivity
No data available

10.2 Chemical stability
Stable under recommended storage conditions.

10.3 Possibility of hazardous reactions
Vapors may form explosive mixture with air.

10.4 Conditions to avoid
Heat, flames and sparks.

10.5 Incompatible materials
Bases, Oxidizing agents, Reducing agents, Acetone reacts violently with phosphorous ox-chloride.

10.6 Hazardous decomposition products
Other decomposition products - No data available
In the event of fire: see section 5

11. TOXICOLOGICAL INFORMATION

11.1 Information on toxicological effects

Acute toxicity
LD50 Oral - Rat - 5,800 mg/kg
Remarks: Behavioral: Altered sleep time (including change in righting reflex). Behavioral: Tremor. Behavioral: Headache. Ingestion may cause gastrointestinal irritation, nausea, vomiting and diarrhea.

LC50 Inhalation - Rat - 8 h - 50,100 mg/m3
Remarks: Drowsiness Dizziness Unconsciousness

LD50 Dermal - Guinea pig - 7,426 mg/kg
No data available

Skin corrosion/irritation
Skin - Rabbit
Result: Mild skin irritation - 24 h

Serious eye damage/eye irritation
Eyes - Rabbit
Result: Eye irritation - 24 h

Respiratory or skin sensitization
- Guinea pig
Result: Does not cause skin sensitization.

Germ cell mutagenicity
No data available

Carcinogenicity
This product is or contains a component that is not classifiable as to its carcinogenicity based on its IARC, ACGIH, NTP, or EPA classification.

IARC: No component of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC.

NTP: No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.

OSHA: No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

Reproductive toxicity
No data available

Specific target organ toxicity - single exposure
May cause drowsiness or dizziness.

Specific target organ toxicity - repeated exposure
No data available

Aspiration hazard
No data available
Additional Information
RTECS: AL3150000

To the best of our knowledge, the chemical, physical, and toxicological properties have not been thoroughly investigated.

Kidney - Irregularities - Based on Human Evidence
Skin - Dermatitis - Based on Human Evidence

12. ECOLOGICAL INFORMATION

12.1 Toxicity

Toxicity to fish	LC50 - Oncorhynchus my kiss (rainbow trout) - 5,540 mg/l - 96 h
Toxicity to daphnia and other aquatic invertebrates	LC50 - Daphnia magna (Water flea) - 8,800 mg/l - 48 h
Toxicity to algae Remarks:	No data available

12.2 Persistence and degradability

Biodegradability	Result: 91 % - Readily biodegradable (OECD Test Guideline 301B)

12.3 Bio-accumulative potential
Does not bio-accumulate.

12.4 Mobility in soil
No data available

12.5 Results of PBT and vPvB assessment
PBT/vPvB assessment not available as chemical safety assessment not required/not conducted

12.6 Other adverse effects
No data available

13. DISPOSAL CONSIDERATIONS

13.1 Waste treatment methods

Product

Burn in a chemical incinerator equipped with an afterburner and scrubber but exert extra care in igniting as this material is highly flammable. Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed professional waste disposal service to dispose of this material.

Contaminated packaging

Dispose of as unused product.

14. TRANSPORT INFORMATION

DOT (US)

UN number: 1090	Class: 3	Packing group: II
Proper shipping name:	Acetone	
Reportable Quantity (RQ):	5000 lbs	

Poison Inhalation Hazard: No

IMDG

UN number: 1090	Class: 3	Packing group: II EMS-No: F-E, S-D
Proper shipping name:	ACETONE	

IATA

UN number: 1090	Class: 3	Packing group: II
Proper shipping name:	Acetone	

15. REGULATORY INFORMATION

SARA 302 Components

No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 Components

This material does not contain any chemical components with known CAS numbers that exceed the threshold (De-Minimis) reporting levels established by SARA Title III, Section 313.

Massachusetts Right To Know Components

Acetone	CAS-No.	Revision Date
	67-64-1	2007-03-01

Pennsylvania Right To Know Components

Acetone	CAS-No.	Revision Date
	67-64-1	2007-03-01

New Jersey Right To Know Components

Acetone	CAS-No.	Revision Date
	67-64-1	2007-03-01

California Prop. 65 Components

This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

16. OTHER INFORMATION

Full text of H-Statements referred to under sections 2 and 3.

Eye Irrit.	Eye irritation
Flam. Liq.	Flammable liquids
H225	Highly flammable liquid and vapour.
H319	Causes serious eye irritation.
H336	May cause drowsiness or dizziness.
STOT SE	Specific target organ toxicity - single exposure

HMIS Rating

Health hazard:	2
Chronic Health Hazard:	*
Flammability:	3
Physical Hazard	0

NFPA Rating

Health hazard:	2
Fire Hazard:	3
Reactivity Hazard:	0
Health hazard:	2
Fire Hazard:	3
Reactivity Hazard:	0

Further information

 The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.

Preparation Information

Sigma-Aldrich Corporation
Product Safety – Americas Region
1-800-521-8956