OPERATING INSTRUCTIONS FOR

LGA-4000

Laser Gas Analyzer

P/N MXXXX

ECO:

DANGER

Toxic gases and or flammable liquids may be present in this monitoring system.

Personal protective equipment may be required when servicing this instrument.

Hazardous voltages exist on certain components internally which may persist for a time even after the power is turned off and disconnected.

Laser radiation hazard is present in this instrument.

Only authorized personnel should conduct maintenance and/or servicing. Before conducting any maintenance or servicing, consult with authorized supervisor/manager.

Warranty

This equipment is sold subject to the mutual agreement that it is warranted by us free from defects of material and of construction, and that our liability shall be limited to replacing or repairing at our factory (without charge, except for transportation), or at customer plant at our option, any material or construction in which defects become apparent within one year from the date of shipment, except in cases where quotations or acknowledgements provide for a shorter period. Components manufactured by others bear the warranty of their manufacturer. This warranty does not cover defects caused by wear, accident, misuse, neglect or repairs other than those performed by Teledyne or an authorized service center. We assume no liability for direct or indirect damages of any kind and the purchaser by the acceptance of the equipment will assume all liability for any damage which may result from its use or misuse.

We reserve the right to employ any suitable material in the manufacture of our apparatus, and to make any alterations in the dimensions, shape or weight of any parts, in so far as such alterations do not adversely affect our warranty.

Important Notice

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

The safety of personnel is ultimately the responsibility of those who control process conditions. While this instrument may be able to provide early warning of imminent danger, it has no control over process conditions, and it can be misused. In particular, any alarm or control systems installed must be tested and understood, both as to how they operate and as to how they can be defeated. Any safeguards required such as locks, labels, or redundancy, must be provided by the user or specifically requested of Teledyne at the time the order is placed.

Therefore, the purchaser must be aware of the hazardous process conditions. The purchaser is responsible for the training of personnel, for providing hazard warning methods and instrumentation per the appropriate standards, and for ensuring that hazard warning devices and instrumentation are maintained and operated properly.

Teledyne Analytical Instruments, the manufacturer of this instrument, cannot accept responsibility for conditions beyond its knowledge and control. No statement expressed or implied by this document or any information disseminated by the manufacturer or its agents, is to be construed as a warranty of adequate safety control under the user's process conditions.

Specific Model Information

Instrument Serial Number: ______________________

Instrument Range: _______________

Calibrated for: _______________

Background Gas: _______________

Zero Gas: _______________

Span Gas: _______________

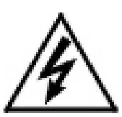
Safety Messages

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

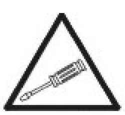
A safety message alerts you to potential hazards that could hurt you or others. Each safety message is associated with a safety alert symbol. These symbols are found in the manual and inside the instrument. The definition of these symbols is described below:

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

CAUTION: LASER RADIATION HAZARD: This warning is specific to laser light emission and associated dangers. Failure to heed the warning could result in serious eye damage.



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



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

No Symbol

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

CAUTION:

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

IF YOU USE THE ANALYZER IN A MANNER OTHER THAN THAT FOR WHICH IT WAS INTENDED,

UNPREDICTABLE BEHAVIOR COULD RESULT POSSIBLY ACCOMPANIED WITH HAZARDOUS CONSEQUENCES.

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

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

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

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List of Figures and Screens

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DANGER
COMBUSTIBLE GAS USAGE
WARNING

Depending on the selected options, some instruments may be used in hazardous environments. This may involve the measurement or monitoring of flammable or explosive gases. It is the end user's responsibility to ensure that all safety related features of this instrument are properly functioning and that the operator is fully trained in the operation of the system as well as procedures for handling the gases employed. It is the customer's responsibility to ensure safety especially when combustible gases are being analyzed since the potential of gas leaks always exist.

DANGER
LASER RADIATION
HAZARD

This instrument produces laser radiation which can cause damage to human tissue especially the eyes. Do not look at the laser beam nor open any chamber or device without first powering off the instrument.

WARNING: **THE WAVELENGTH OF THE LASER BEAM INSIDE THE LGA-4000 SERIES OF ANALYZERS IS IN THE RANGE OF 0.7 ~ 2μM. IS INFRARED AND INVISIBLE. DO NOT LOOK DIRECTLY OR WITH OPTICAL INSTRUMENT AT THE DIRECTION OF THE LASER RADIATION**

The customer should ensure that the principles of operating of this equipment is well understood by the user and that the instrument as well as any approved support equipment is properly installed. Misuse of this product in any manner, tampering with its components, or unauthorized substitution

of any component may adversely affect the certification and the safety of this instrument.

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

Introduction

1.1 Overview

The LGA-4000 Laser Gas Analyzer uses Diode Laser Absorption Spectroscopy (DLAS) to accurately measure and monitor the composition of a single or multiple gas species in a gas mixture. It is especially useful for in-situ measurements and is designed for online processes analysis. Options are available for applications involving hazardous environments.

This manual describes the installation, calibration, operation, and maintenance of the LGA system. The principles of instrument operation are detailed in Section 2.

1.2 Typical Applications

The LGA-4000 Laser Gas Analyzer is a high resolution, versatile tool for online analysis and monitoring of a gas flow process. The LGA-4000 is suitable for a wide range of industrial applications including petrochemical and steel industries where critical monitoring of process gases is vital. Depending on the gas specie or species of interest, the instrument is capable of measuring from the parts per million (ppm) to 100% range of concentration. The analyzer can be fitted with an optional pressure control module for positive pressure control in instruments manufactured for explosion proof applications.

Table 1-1 shows typical gas species and their measurement range for the LGA-4000.

Table 1-2: Typical Gas Analysis and Range

Gases	Threshold	Measurement Range
O_2	0.01%Vol.	0-1% Vol., 0-100% Vol.
HCL	0.01 ppm	0-7 ppm, 0-8000 ppm
HF	0.01 ppm	0-1 ppm, 0-10000 ppm
NH_3	0.1 ppm	0-10 ppm, 0-1% vol.
CO	40 ppm	0-8000 ppm, 0-100% Vol.
H_2O	0.03 ppm	0-3 ppm 0-70% Vol.
H_2S	2 ppm	0-200 ppm, 0-30% Vol.
CH_4	10 ppm	0-200 ppm, 0-10% Vol.
HCN	0.2 ppm	0-20 ppm, 0-1% vol.
CO_2	20 ppm	0-2000 ppm 0-100% vol.
C_2H_2	0.1 ppm	0-10 ppm 0-70% vol.
C_2H_4	1.0 ppm	0-100 ppm 0- 70% vol.

1.3 Features

Compared to conventional gas analysis systems, the LGA-4000 analyzer has the following advantages:

- On-the-spot online measurement ability
- Quick response

- High measurement accuracy
- Minimal maintenance
- No replacement parts
- No cross interference from background gas species
- Enhanced accuracy over conventional IR and photonic measurement systems

1.4 System Components

The standard LGA-4000 consists of:

- Transmitter
- Receiver
- Mounting flanges

Many options such as explosion-proof housings, purge system, and more are available that further expand the analyzer's functionality. Contact the factory for available options.

1.4.1 The Transmitter

The transmitter module contains the laser and electronics. It serves to launch a collimated modulated laser beam through the sample gas via the mounting flanges that interface with the process tube or pipe. The transmitter module also contains the analysis and control section of the system. It receives and processes data fed back from the receiver. The user interface is integral with the transmitter module and contains four keys for entering data and controlling the instrument plus an LCD readout display.

1.4.2 The Receiver

The receiver module contains the optical electronic sensor, signal processing module, power supply module, and optical components for delivering and focusing the radiation on the sensor . Its function is to collect the attenuated laser beam after transmission through the process gas and return sensor signals to the transmitter in real time.

1.4.3 Mounting Flanges

The transmitter unit and the receiver unit are coupled to the process using flanges which are welded onto the gas flow pipe. The transmitter is mounted onto one flange with special adjustable fittings while the receiver is mounted onto a similar flange diametrically opposed from the transmitter. The mounting arrangement includes isolation valves on each flange unit so individual modules can be easily removed for maintenance or repair. The modules connect to the mounting flanges using special mounting nuts that allow for optical alignment during installation.

1.4.4 Optional Purge Unit

An integral purge system can be incorporated to keep dust and gas deposits from collecting on the analysis section windows thus eliminating any interference or degradation of the laser induced signal.

Operational Theory

2.1 Introduction

The LGA-4000 Laser Gas Analyzer is a high precision gas concentration measurement and monitoring system capable of in-situ operation. It is comprised of three subsystems:

1. Transmitter
2. Receiver
3. Purge System (Optional)

In the analysis section, the transmitter launches a laser beam across the diameter of the sample gas line or pipe and into the receiver diametrically opposed to it. The resulting electrical signal is then sent back to the transmitter and analyzed to yield the gas concentration and displayed on the LCD screen.

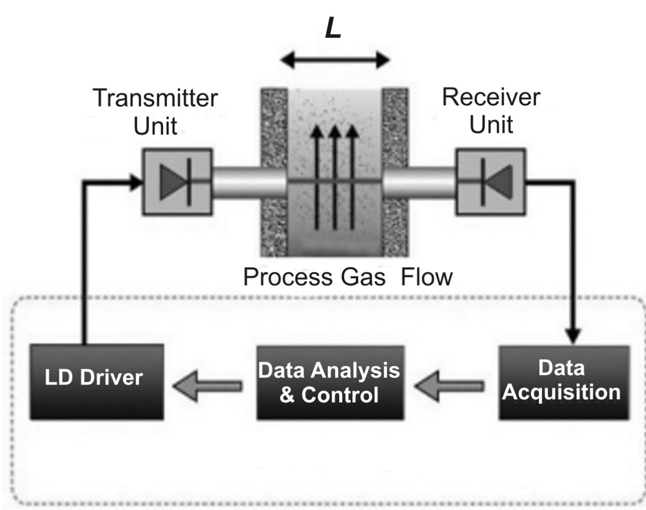


Figure 2-1: System Diagram for the LGA-4000 Series Analyzers

2.2 The Transmitter

The transmitter unit consists of a user-friendly interface, a diode laser driver, a central processing module, a diode laser and precise optical elements. See Figure 2-2. Its main function is to launch a collimated modulated laser beam throught the sample gas and onto the receiver. It also accepts the raw sensor signal returned from the receiver and processes and displays the spectrum/analysis data. The transmitter mates to the process pipe (or the calibration unit) via a mounting nut which connects to the mounting flange welded to the process pipe. An isolation valve is installed between the mounting nut and the mounting flange to allow for removal of the transmitter without comprimising the sample gas flow.

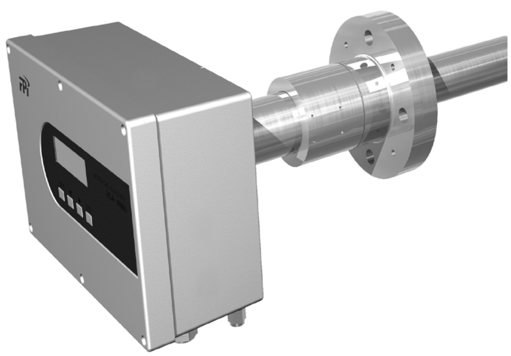


Figure 2-2: Transmitter

2.3 The Receiver

The receiver consists of an opto-electronic sensor, a signal process module, a power supply module, and precise optical elements. Its primary function is to collect the attenuated laser beam and return laser energy signals back to the transmitter for processing in real time. Like the transmitter unit, the receiver unit is connected to the process (or the calibration unit) via the mounting nut, and includes an identical isolation valve for isolating the receiver from the process gas flow during maintenance. The receiver module is shown in Figure 2-3.

Depending on the options chosen, some units have a positive pressure control module mounted on the receiver for controlling the internal housing pressure. This option is frequently incorporated in explosion proof installations.

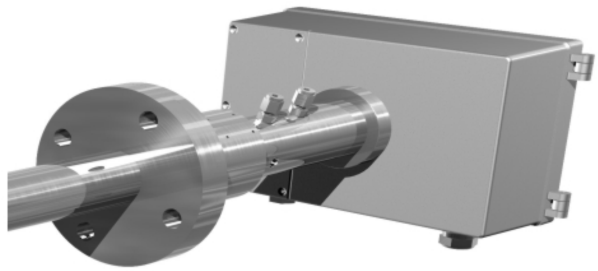


Figure 2-3: The Receiver

2.4 The Purge Unit (Optional)

The purge unit provides protection from contamination for the optical devices in the transmitter/receiver.

If dust or other pollutant concentration is relatively high in the environment under test, a purging system must be installed to protect the optical devices in the transmitter and receiver units.

In a typical purging system, the purge gas is directed through the inside of the instrument flange, the welding flange or a special purging pipe, and into the gas flow pipe. The purge gas forms an air wall to protect the optical devices. Purge flow required depends on the process environment. Usually, a purge gas flow rate in the range of 5-50 L/min is required.

Compressed air or nitrogen is the most frequently used purge gas sources. A filter should be installed to remove dust, water and oil droplets larger than 1 micron in size before entering the system to prevent the purge gas from contaminating the optical devices. TAI provides a range of purge systems for various applications and most are equipped with appropriate filters. Please contact technical support if your application requires a purge system.

A typical purge system is shown in Figure 2.4. It consists of a filter, a pressure relief valve, and a flow device for controlling the pressure and flow of purge gas.

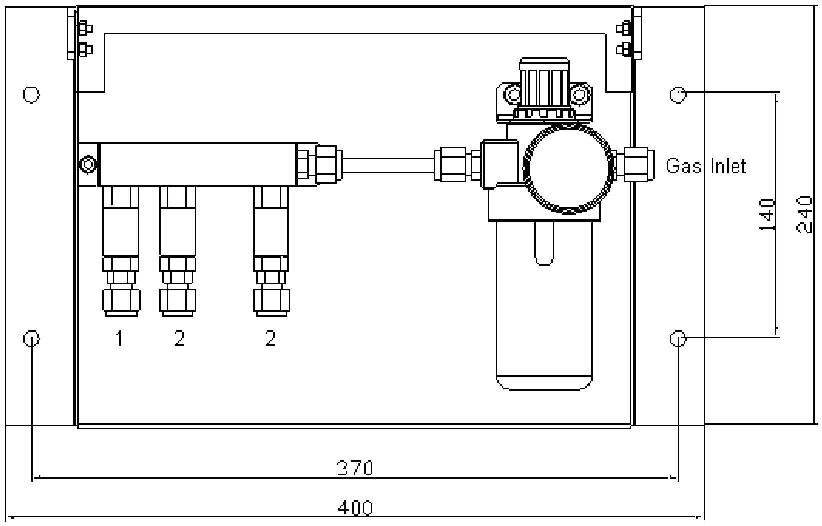


Figure 2-4: Optional Purge Unit

To install the purge unit, connect each gas outlet of the purge system to a purge inlet on the instrument flanges. Connect the inlet to a suitable purge gas supply. A regulator should be used to control the pressure to the purge system. The gas pressure depends on the particular purge system installed and will be noted on the unit.

2.5 Principles of Operation

The LGA-4000 Laser Gas Analyzer uses laser spectroscopy to generate a signal based on the composition of a gas mixture. While similar in nature to other photonic analyzers, the LGA-4000 Laser Gas Analyzer offers many advantages over these technologies.

Traditional online gas analyzers such as the Non-dispersive Infrared (NDIR) Spectroscopy Online Gas Analyzer are subject to interference from other constituents in the environment (including dust and other gas species such as water vapor). This could be especially severe when the measured gas is of low concentration. However, the LGA-4000 Laser Gas Analyzer employs advanced Diode Laser Absorption Spectroscopy (DLAS) gas analysis and measurement technology, i.e. “single-line” spectroscopic methods.

Conventional infrared spectroscopy uses light sources such as lamps or LED's that are normally non-laser and have very broad line-widths. The absorption spectrum obtained includes not only the spectral lines from the gas under test, but also those from background gas species which introduces cross interference. DLAS gas analyzers use diode lasers that have line-widths of less than 0.0001nm, or only $1/10^6$ of that of the non-laser sources. By selecting a laser that will emit a specific absorption line close to that of the gas under test and tuning its wavelength through changing its temperature and driving current, an absorption spectrum that only covers a single line of the gas under test can be obtained and eliminates cross interference.

Since the line-width of laser spectrum is much narrower than those of conventional non-laser spectra, "Single-line" Spectroscopy Technology selects a specific absorption line, which covers no lines of other gas species, to prevent cross interference from background gases. See Figure 2-5.

The diode laser output from the transmitter goes through the environment under test, gets absorbed by the target gas molecules, and the resulted attenuated light is collected by the optical sensor in the receiver unit. The attenuation is in proportion to the concentration of the target gas.

2.5.1 Laser Spectral Scanning Technology

The LGA-4000 employs a laser spectral scanning technology which periodically scans the sample gas with a modulated frequency range larger than the gas absorption spectral line-width. Within one scan period, there are two distinctive areas as shown in Figure2.4. Area I is unaffected by the gas absorption and gives T_d, whereas area II is affected and gives T_{gd}. The transmittance of the gas under test (T_g) is then calculated accurately by $T_g = T_{gd} / T_d$. The interference from dust and optical window contamination is, therefore, automatically screened out.

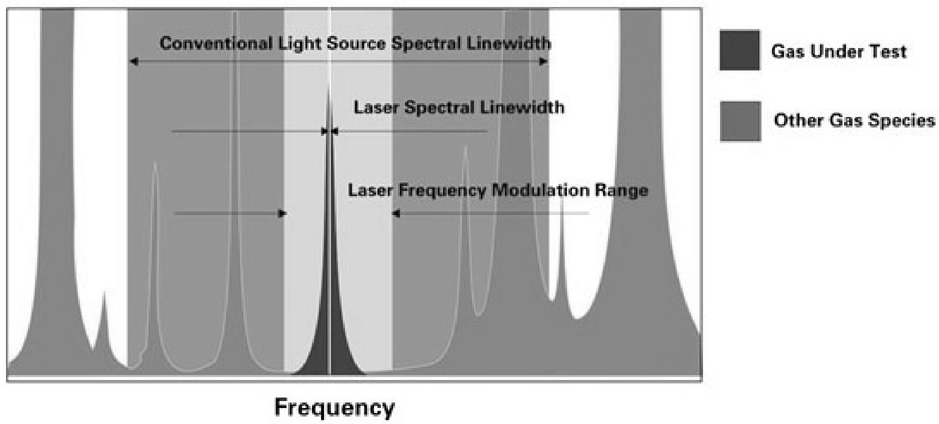


Figure 2-5: Single Line Spectroscopy Principle

The line-width of a diode laser is much narrower than that of the gas molecule absorption spectrum. The laser spectral line is depicted in the figure as a light solid line.

2.5.2 Automatic Compensation For Spectral Line Broadening

When gas temperature and pressure under measurement undergo changes, the width and height of measured gas absorption spectral line change and this affects the accuracy of the measurement. To compensate for this, the LGA-4000 incorporates a 4-20mA process temperature and pressure input and uses a proprietary algorithm to ensure measurement accuracy.

Installation

Installation of the LGA-4000 includes:

- Unpacking
- Mounting
- Flange connections
- Installing transmitter and receiver
- Electrical connections
- Optical transmission adjustments and fine tuning

3.1 Unpacking the Instrument

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

3.2 Installation Preparation

It is very important to prepare thoroughly before installing the system. This includes having all the tools needed handy, choosing a proper installation location, and correct welding of the flanges to the gas flow pipe well. See section 3.3.1. Figure 3-1 shows the general layout of the LGA-4000 Laser Gas Analyzer.

3.2.1 Installation and Adjustment Tools

The following tools will be required for proper installation:

Wrenches	M5 wrench
	Two 12” adjustable wrenches
	Two 8” adjustable wrenches
Socket screwdrivers	M6 hexagonal socket screwdriver
	M5 hexagonal socket screwdriver
Screwdrivers	6mm slotted screwdriver

3mm slotted screwdriver

Digital multimeter.

Tubing cutter.

Tube bender for 6 and 12 mm tubing

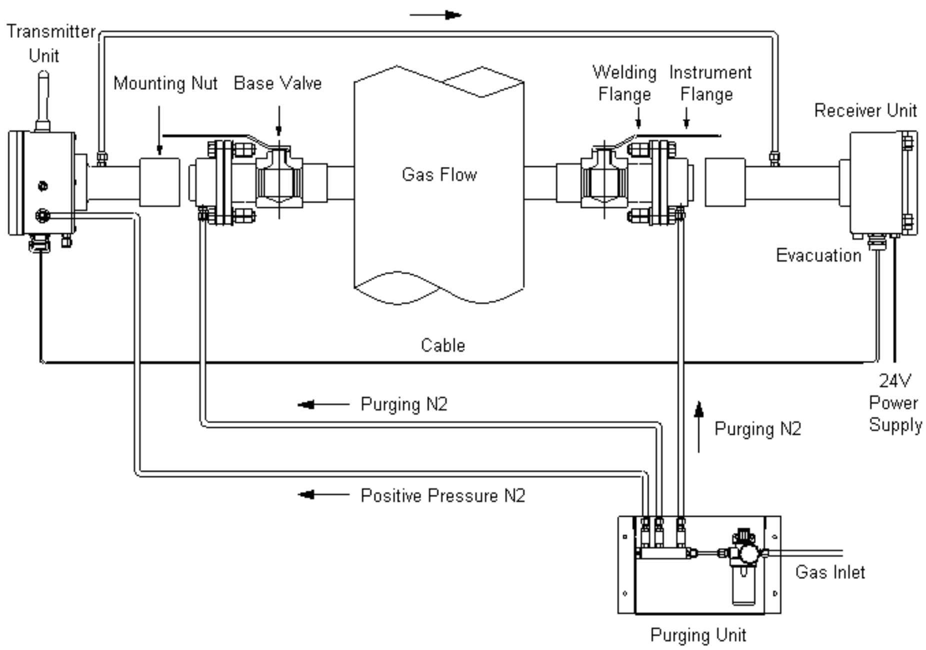


Figure 3-1: General Layout of the LGA-4000 Series Analyzer

3.2.2 Choosing Installation Spot

It is strongly recommended to install the system probes on a straight section of the gas flow pipeline to ensure uniformity of the gas flow. The length of straight pipe before the installation spot should be at least twice (5 times, recommended) as much as the diameter of the pipe, and half (twice, recommended) after the installation spot.

Note: The Laser Gas Analyzer measures the average concentration along the laser beam path (see Figure 1.2). If there is no straight pipe section for mounting the flanges, it may still be possible to get accurate measurements. (Please contact our technical support center).

In addition, the installation spot should be chosen carefully considering both safety and ergonomic factors. A platform should be constructed when the chosen spot is not fully accommodating.

3.3 Welding Flanges

The transmitter and receiver units of the analysis section are mounted on DN50 flanges and mate to corresponding flanges which must be welded onto the process pipe.

Note: The customer is responsible for correct welding of the flanges onto the process pipe. The use of a competent professional welder is required to ensure proper placement of the flanges and provide a leak-free weldment.

The precision adjustment between the welding flange and the instrument flange with the supplied O-ring can fine tune the optical transmission to a limited extent. This allows for the two welding flanges to have a limited coaxial offset between them. When welding the two welding flanges the offset angle between their axes must be held to less than 4°. Typically, the two welded flanges are positioned horizontally on the gas flow pipe well across the pipe diameter As Shown in Figure 3-2.

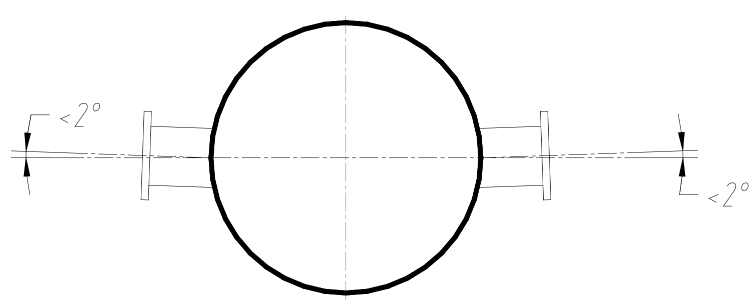


Figure 3.2: Allowed offset for welded flanges

3.3.1 Installing Instrument Flanges

After welding the flanges, the LGA-4000 can be installed. Before installing, apply a lubricant to all the screw connections. To make adjustments easier it is suggested that you use the adjusting aid tools available from TAI. These include a visible light laser pen and a scaled target for alignment.

WARNING: POWER TO THE SYSTEM MUST BE OFF DURING THE INSTALLATION OF THE TRANSMITTER AND RECEIVER UNITS. DO NOT CONNECT OR SWITCH ON THE POWER SUPPLY AT THIS STAGE. THE LASER BEAM IS INVISIBLE AND CAN CAUSE EYE DAMAGE.

Mount the two instrument flanges onto the welded welding flanges with 8 M16 bolts (with spring washer and plain washer) and 2 O-rings. Raise the instrument flanges to the same height as the welded flanges, then tighten the 8 M16 bolts to about half tight to make sure that the O-rings are sealing. Typically the distance between the instrument flange and the welding flange is around 3mm. See Figure 3.3.

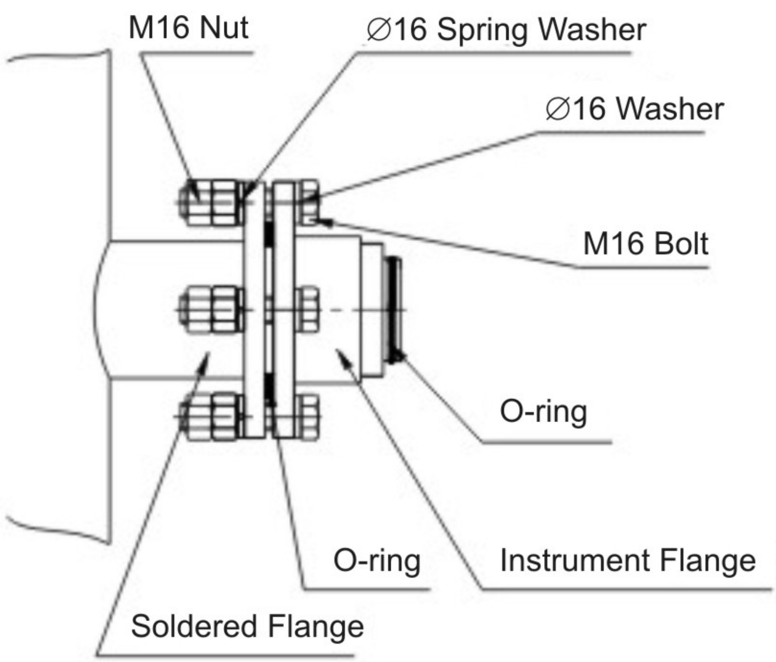


Figure 3-3: Instrument Flange

3.3.2 Checking Offset Using the Laser Pen and Target

The laser pen is an optical transmission adjustment aid tool available through TAI. The part number is listed in the Spare Parts List in the Appendix. The laser pen emits visible red light beam and is used to adjust the coaxial offset of the two instrument flanges. This assumes that the welded flanges were installed correctly and held to within 4 degrees total offset with respect to each other.

Prior to adjusting the instrument flanges the laser pen must first be checked for alignment.

3.3.3 Adjusting the Coaxial Offset of the Instrument Flanges

To adjust the coaxial offset of the two installed instrument flanges use the following procedure:

1. Tighten the laser pen on one of the instrument flanges with a mounting nut. Install the scaled target on the other instrument flange. Turn on the laser pen and check whether the light spot is on the center of the scaled target. If not, adjust (tighten or loosen) the 4 M16 bolts on the instrument flange where the laser pen is mounted until the light spot is at the center of the target. See Figure 3.4.

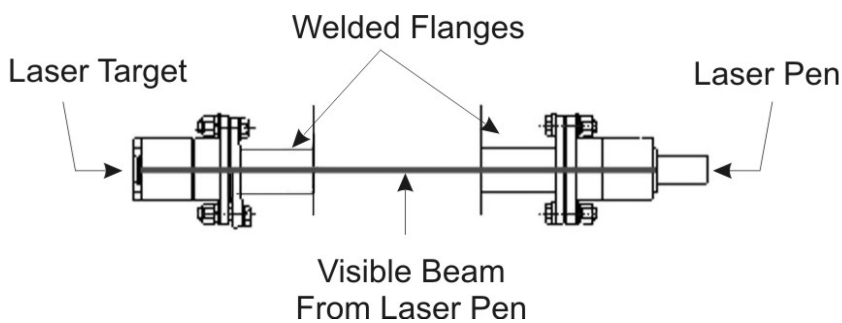


Figure 3.4 Adjusting the Instrument Flanges with Laser Pen and Target.

2. Switch the laser pen with the scaled target, and redo step 1.
3. Redo step 2 repeatedly until the light spot is always at the center of the scaled target without any adjustment.

4. Keep the laser pen on, tighten the 4 fastening screws on the instrument flange where the laser pen is mounted, and keep an eye on the light spot on the scaled target. If it moves, repeat steps 1, 2, and 3 until the light spot does not move.
5. Repeat step 4 to tighten 4 fastening screws on the other instrument flange.

3. 4 Installing the Transmitter Unit and Receiver Unit

Mount the transmitter unit on one of the instrument flanges as shown in Figure 3.1. Tighten it with the mounting nut, then tighten the fastening screw. Mount the receiver unit the same way.

3.5 Purge System Installation

If dust or other pollutant concentration is relatively high in the environment under test, a purging system must be installed to protect the optical devices in the transmitter and receiver units.

In a typical purging system, the purge gas is directed through the inside of the instrument flange, the welding flange or a special purging pipe, and into the gas flow pipe. The purging gas forms an air wall to protect the optical devices. The purge flow required depends on the process environment. Usually, a purge gas flow rate in the range of 5-50 L/min×2 is required. A typical purge unit is shown in Figure 3-5.

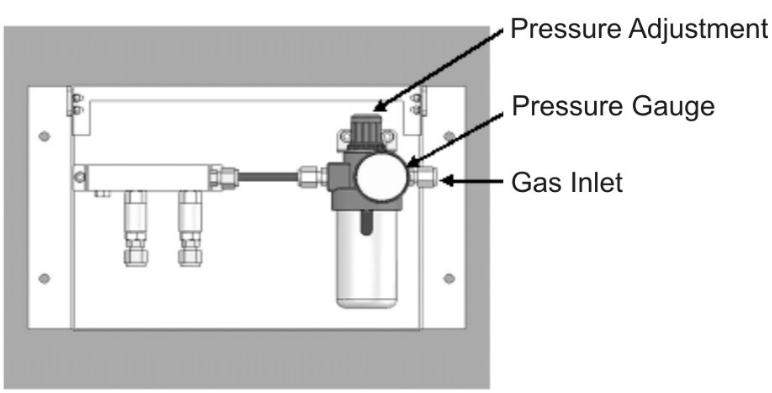


Figure 3-5: Typical Purge Unit for the LG-4000

Compressed air or nitrogen is the most frequently used purging gas sources. A filter should be installed to remove dust, water and oil droplets larger than 1 micron in size before entering the system to prevent the purge gas from contaminating the optical devices. TAI provides a range of purge systems for various applications and most are equipped with appropriate filters. Please contact customer support if your application requires a purge system.

To install the purge unit, Connect the purge gas to the gas inlet and use 8mm copper or stainless steel tubes to connect the gas outlets and the check valves on the instrument flanges.

A regulator should be used to control the pressure to the purge system. The gas pressure depends on the particular purge system installed and will be noted on the unit.

Open the gas supply and set the regulator to the proper pressure. Turn the needle valve on the flow meter to the maximum, and then adjust the needle valve adjacent to the flow meter to get the required flow rate.

CAUTION: **THE PURGE FLOW SHOULD REMAIN ON AFTER THE POWER TO THE UNIT HAS BEEN TURNED OFF. THIS PREVENTS DUST AND OTHER POLLUTANTS IN THE ENVIRONMENT UNDER TEST FROM CONTAMINATING THE OPTICAL DEVICES IN THE TRANSMITTER AND RECEIVER UNITS.**

3.6 Electric Wiring and Connection

The LGA-4000 requires 24VDC power to operate. The instrument supports multiple input and output signal interfaces: relay alarm output, 4-20mA concentration output, pressure/temperature signal input, and RS485 protocol. All input and output signal lines mate to connectors on the interface board inside the processing controller as shown in Figure 3.6.

WARNING: **TO AVOID DAMAGING THE INSTRUMENT, TURN THE POWER OFF BEFORE PERFORMING ANY ELECTRIC WIRING.**

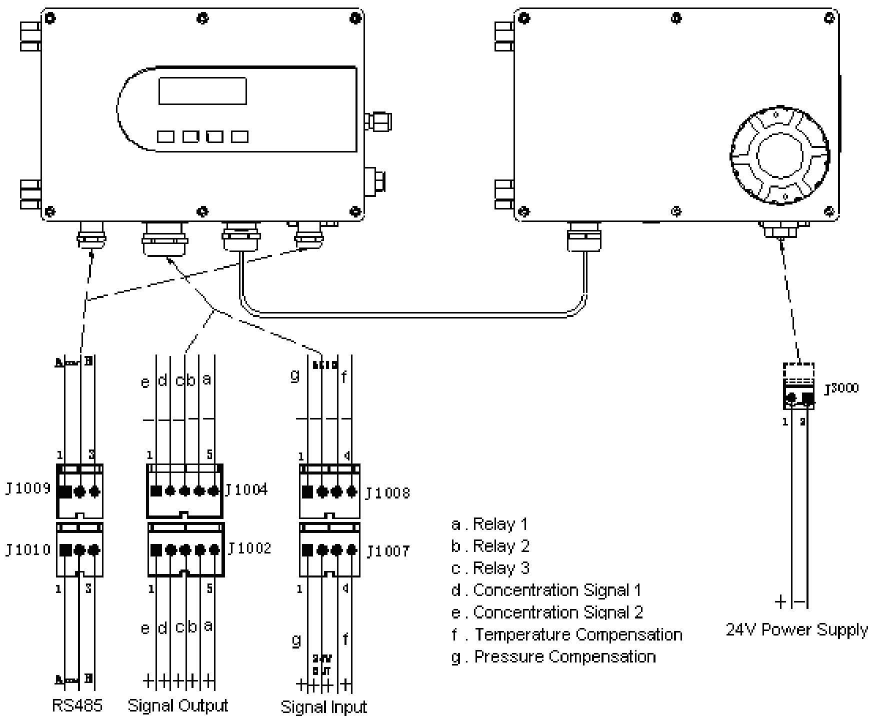


Figure 3.6: Electric Connection Diagram for the LGA-4000

3.7 Powering Up for the First Time

Before turning on the power supply, make sure the gas source, power supply, and wiring are correct.

1. If equipped with a purge unit, disconnect the gas line that connects to the purge unit, slowly open the ball valve and purge the line clean of impurities.
2. Reconnect the gas line to the purge unit, adjust the regulator to around 0.3 Mpa (44 psi).
3. Open the valve at the base of the welding flange, and power on.

For explosion proof models, continue with steps 4 to 6.

4. Turn on the positive pressure control module. Make sure the power light illuminates.
5. Observe the pressure guage on the receiver unit. Adjust the regulator so that the indicator is at the middle of the range between 500Pa and 900Pa (72-130 psi).

6. After 15 minutes, the transmitter and receiver units are powered on and the power light turns green. Note that the LCD on the transmitter unit displays “selftesting”.

3.8 Optimizing Optical Alignment

If the automatic self-test routine is successful, the LCD changes to display measurement and status information. Note the transmittance value on the status bar, if the value is greater than 80%, then the installation and adjustment steps are successful and the system is ready for operation. Otherwise, follow the steps below to fine tune and optimize the optical alignment between the transmitter unit and the receiver unit.

1. Open the receiver unit box cover.
2. Use a voltage meter to measure the voltage between 3(+) and 4(-) of the wiring extremity. When the optical transmission is optimized, the voltage is about 4.2V.
3. Loosen the 4 fastening screws on the instrument flange where the transmitter unit is mounted (see Figure 3.7). Adjust the flange by either tightening or loosening the 4 M16 bolts until the measured voltage stabilizes to its maximum value. Tighten the four fastening screws.
4. Replace the box cover.

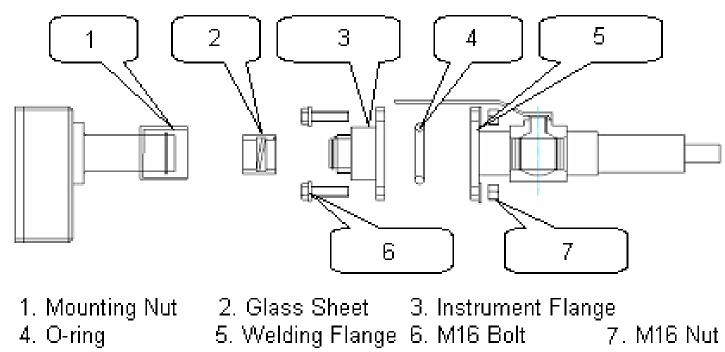


Figure 3-7: Instrument Flanges and Hardware

5. Repeat the above procedure for the receiver unit.

Operation

The executable embedded program in the MCU of the central process unit performs signal processing and data analysis, manages system I/Os including keyboard operations and LCD, and runs system self-test, calibration, and alarms. It also establishes data communication with a PC through an RS485 serial communication port, Bluetooth and GPRS modules.

4.1 Front Panel

The LGA-4000 front panel consists of a LCD screen and a 4 key membrane keyboard and is integral with the transmitter unit. The LCD screen displays system information as described in the following sections. The membrane keyboard is used to carry out all user operations such as setting alarm parameters, setting environment temperature and pressure, setting the optical path length, doing system calibration, etc. The front panel is showed in Figure 4.1.

Figure 4-1: LGA-4000 Front Panel

There are four keys on the panel. They are:

- “SET” Used to enter menu or confirm data input.
- “<” And “>” are direction keystrokes. They are used to move the cursor.
- “<” moves the cursor up or to the left.
- “>” moves the cursor down or to the right.
- “ESC” Used to exit a sub menu and go back up the menu, or to cancel the input data.

4.2 System Mode

During operation the LGA-4000 Laser Gas Analysis System can be in three different modes.

- Start-up Mode
- Normal Mode
- Error Mode

4.2.1 Start-up Mode

When the power is turned on, the system will automatically invoke the start-up mode. In this mode, the system initializes and performs the self-test routine. The LCD screen shows the progress of the self-test routine as well as the instrument model and software version. See Figure 4.2.

Figure 4.2 System Start-up Screen

Start-up and initialization normally takes about two minutes. If everything is working properly the self-test concludes and the system enters the normal mode..

4.2.2 Normal Mode

In the normal mode, the system performs gas concentration measurement and monitoring. There are two different working states within the normal mode:

Normal working status: In this state, the system is measuring normally. The LCD shows the measured gas concentration value and other system information; “Normal” is shown in the upper right of the screen. When in normal working status, the analog output port (4-20mA) sends out the corresponding measured value.

Warning working status: When the system finds that the system external input parameters (mainly the pressure and temperature of the gas under test) are abnormal or the optical transmittance is too low, it automatically switches to warning working status. In this status, the front panel of the LCD shows the corresponding warning signal (warning symbol ⚠ in MainMenu in graphics mode). The system computes the gas concentration value using default values for input parameters and sends out 4-20mA output

CAUTION: SCREEN DISPLAY OF THE MEASURED CONCENTRATION MAY BE HIGHLY INACCURATE IN THIS MODE.

4.2.3 Error Mode

When the analysis system detects any fatal error that may damage the system permanently (for instance, when the temperature in the central processing unit is too high or the temperature of the laser device is abnormal), the system automatically switches from start-up mode or normal mode to error mode. In this mode, the system will stop gas concentration measurement and most system operations, and enter protection status. The front panel on LCD shows the corresponding error information and the output ports (4-20mA and relay) send out alarm information.

4.3 System Menu

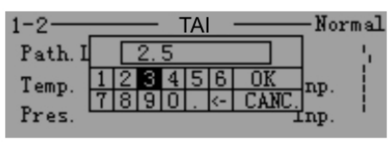
The LGA-4000 operation interface employs a user-friendly menu structure consisting of nine main menus:

- System Main Menu
- Main Setting
- Online Measurement
- Offline Cal.
- Purge Compensation
- Language
- P/S Management
- S/W Update
- Accessorial Setting

The entire menu has a simple and clear structure as shown in Figure 4.3 and is easy to operate.

4.4 The Numerical Keyboard

A numerical keyboard automatically appears onscreen whenever a menu calls for numerical input from the operator. For example, if the operator navigates to the “Path Length” screen and presses SET, the onscreen numerical keypad appears as shown below.



- Use the “</>” navigation keys to move the cursor over the desired digit.
- Use the SET key to select it. Note that the number appears in the data input box above the onscreen keypad.
- Repeat the above until the entire number including decimal point is shown in the data input box.
- Press “OK” to confirm the input and exit the screen

OR

- Place the cursor on the "←" key to cancel a previous entry.

OR

- Place the cursor on "CANC." to abort the entire input and exit the keypad screen.
- You can also press ESC to escape and back up to the previous menu.

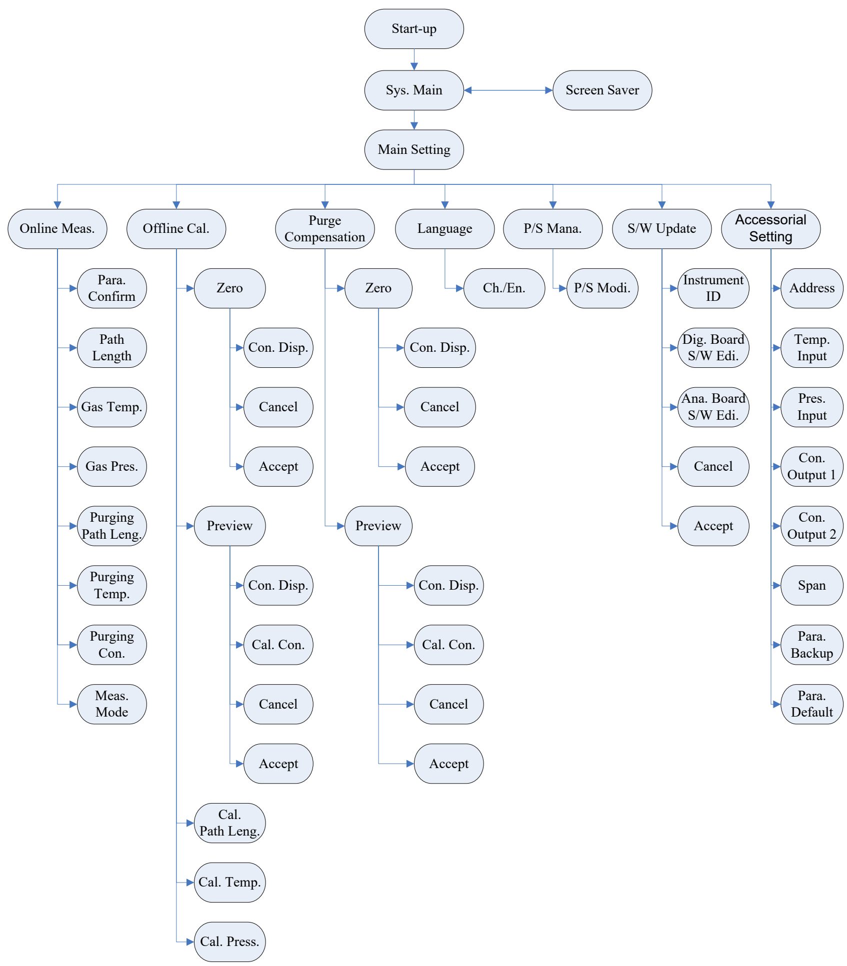
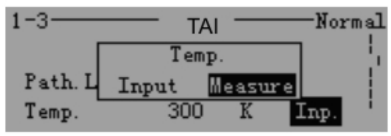


Figure 4.3: System Menu Structure

4.5 Input Method Selection

For some input screens, the operator needs to choose an input method. This can be either a direct numerical entry or an actual measured value. When such an input is required, an input method screen automatically appears onscreen as shown below for the Temperature screen.



In this case, move the cursor to “Temperature”, press “SET”, and the input method screen pops up.

- Use the “</>” keys to move the cursor to either “Input” or “Measure”.
- Press SET to accept that input method.

Selecting “Input” brings up the numerical keyboard. Selecting “Measure” inputs the current 4-20 mA value from the output port.

4.6 System Main

The System Main menu is the menu displayed after the system finishes start-up, initializing and self testing, and enters normal working status. It displays system related information to the user such as:

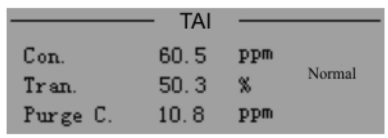
- Concentration
- Transmittance
- Temperature
- Pressure

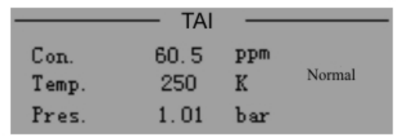
It also gives an onscreen indication of the mode the analyzer is currently in:

- Working Mode (normal)
- Warning Mode (⚠)

- Error Mode (error code)

The system main screen cycles between two screens every 3 minutes. Each screen displays system related information.





Screen 1:

Con.: Average concentration of the measured gas.

Tran.: Transmittance when the laser beam passes through the gas environment.

Purge C.: Content of the tested gas in the purge gas.

Screen 2:

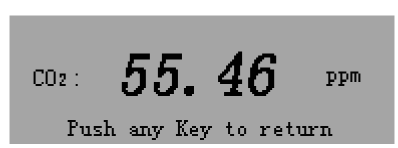
Con.: Average concentration of the measured gas.

Temp.: Temperature of the measured gas.

Pres.: Pressure of the measured gas.

Note: To reduce the effect of noise on measurements, the LGA-4000 outputs average gas concentration from the 4-20mA port.

After 2 minutes of inactivity, the display automatically reverts to the screen saver screen as shown below. The value displayed on the LCD is the concentration of measured gas.



Press any key to return to the main menu.

:

The computation method for average concentration is described below:

Average Concentration

$$\overline{g}_{new} = \frac{1}{N} g_{cur} + \left(1 - \frac{1}{N}\right)\overline{g}_{old}$$

Where:

$\overline{g}_{new}$ = Average concentration value

g_{cur} = Current concentration value

$\overline{g}_{old}$ = the average concentration value before adding the latest measurement g_{cur} stored in the system memory

N = Ave. times

The method is in equivalent to having the current concentration value pass through a low-pass filter with a cut-off frequency at $f = \frac{1}{2\pi N\tau}$, where τ is the time the system needs to finish one measurement. Typically, the LGA-4000 series instruments have τ set at ~1 second at the factory. However, it can also be set at any value in the range of 0.1~1 second upon customer request to suit particular applications that require faster response time. Contact technical support for more information.

Normally, every time the system finishes one measurement cycle, the LCD display and output at the 4-20mA output port refreshes.

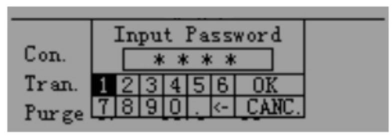
4.7 Main Menu

In the Main Menu, there are 7 submenus:

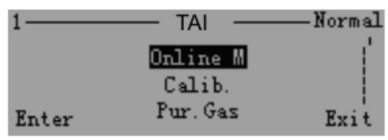
- Online Measurement
- Offline Calibration
- Purge Compensation
- Language

- P/W Modify
- S/W Update
- Accessorial Setting

Upon entering the Main Menu, the numeric keyboard will display and you will be prompted to enter a password. Use the keyboard as described in Section 4.4 to enter your password.



Upon correct password entry, the Main Menu will appear.



The number in the top left of the screen is the node number for the current menu. It will change as you enter different menus or submenus. For instance The Main Menu is the topmost menu in the hierarchy and is given the node number 1. The next menu, Online Measurement has 8 submenus and will indicate 2-X where X is the particular submenu within the Online Measurement menu.

At the far right of the screen is a series of dashes that represent the menu position of the cursor. In the above screen, the cursor is on the first menu item of 7 available selections, hence the first dash is displaced.

Press "SET" the system enters the submenu selected by the cursor.

Press "<" the cursor moves one position left. If the cursor is already on the leftmost button, the cursor moves to the rightmost position.

Press “>”—the cursor moves one position right. If the cursor is already on the rightmost button, the cursor moves to the leftmost position.

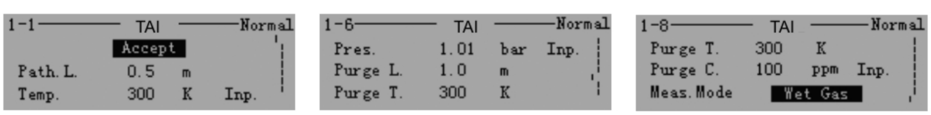
By operating the above keystrokes, you can enter any of the submenus within the Main Menu. After entry is complete, ESC brings you back to the Main Menu.

4.7.1 Online Measurement

To enter Online Measurement Menu, move the cursor to the first menu directly below the Main Menu. Press “SET” to enter Online M.. The Online M. menu consists of seven options. Use the “</>” keys to scroll up and down to view the entire set of selections. The selectable options are:

- Path Length
- Gas Temperature
- Gas Pressure
- Purging Path Length
- Purging Temperature
- Purging Concentration
- Parameter Confirm

Use “</>”, and “SET” buttons to set the parameters and “ESC” to return to the Main Menu.



Path L: Optical path length of the measured gas — 0-15m

Temp.: Temperature of the measured gas — 200-3000K, manually input or measure in the field.

There are two measurement modes for gas temperature: 4-20mA or thermal resistance (set via LGA-4000 service end S/W at the factory). If 4-20mA is selected, see Section 4.7.7.

Pres.: Pressure of the measured gas. 0-20Bar, manually input or measure in the field.

Measurement mode of gas pressure refers to 4-20mA measurement. See Section 4.7.7.

Purge L.: Purge path length. Set the purging path length — 0-15m. Refer to Figure 4.4.
Path length = (LF2+LF1+LB1+LB2+LB3)

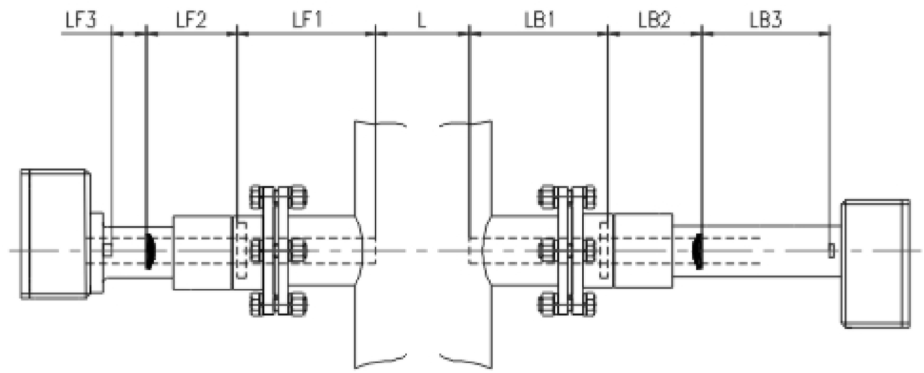


Figure 4.4: Purge Path Length

Purge T.: Purge gas temperature. Set the temperature of the purge gas (200-3000K).

Purge C.: Purge Concentration. Set the concentration of the measured gas in the purge gas. Allows manual input or field measurement.

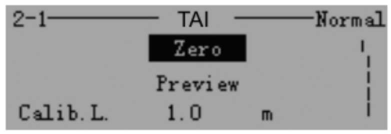
Integrated within the LGA-4000 is a purge compensation module. If "measure in the field" is chosen, the system will perform an auto compensation.

Para. Confirm: Confirm the entered parameter(s). Accepts the user specified setting and returns display to the measurement mode.

Note: The system will not store the modified parameters if ESC is pressed before selecting ACCEPT.

4.7.2 Offline Calibration (Calib.)

The second menu below the Main Menu is the Offline Calibration Menu (Calib.).



The following operations can be accomplished within this menu:

- Adjust Zero (Ad. Zero): Fill the calibration tube with zero gas (such as high purity nitrogen), and adjust the zero point of the instrument.
- Calibration Preview (Preview): Calibrate the instrument. Fill the calibration tube with standard gas (such as high purity nitrogen) containing 0% of the gas under test, and perform the calibration operation.

Note: You should adjust zero before calibration.

- Calibration Path Length (Calib. L.): Set the calibration path length using a manual input.
- Calibration Temperature (Calib. T.): Set the temperature of the sample gas. Allows manual input or field measurement.

There are two measurement modes for gas temperature: 4-20mA or thermal resistance (set via LGA-4000 service end S/W at the factory). If choosing 4-20mA, please refer to Section 4.7.7.

- Calibration Pressure (Calib. P.): Set the pressure of the sample gas. Allows manual input or field measurement.

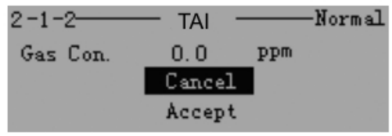
Measurement mode of gas pressure refers to 4-20mA measurement. See Section 4.7.7.

4.7.2.1 ADJUST ZERO (AD. ZERO)

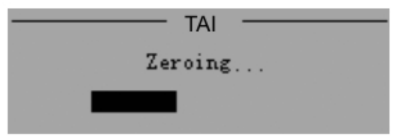
To adjust the zero point, make sure zero gas is flowing to the analyzer.

1. Enter the Offline Calibration Menu (Calib).
2. With the cursor on “Zero”, press “SET” to enter the zeroing menu. The display shows the gas concentration, and options to

cancel or accept the zeroing input. Make sure the gas concentration is set to 0.0 ppm.



3. Make sure zero gas is flowing to the analyzer. Move the cursor to “Accept” and press “SET”. This starts the zero adjust operation. Note the progress bar indicating the zeroing is in progress.

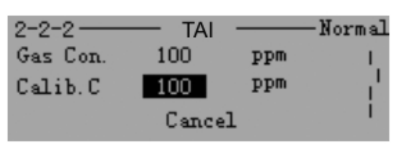


4.7.2.2 CALIBRATION PREVIEW (PREVIEW)

The second selection available from the Offline Calibration Menu is the Calibration Preview screen. This menu is used to preview the span gas concentration or set the calibration gas concentration of your span gas and span calibrate the instrument.

Note: The Purge Compensation Menu (Pur. Gas)) is used to compensate for any measured gas component that is contained in the purge gas. See Section 4.7.3.2.

Selecting Preview from the Offline Calibration (Calib.) menu calls up the Calibration Preview screen as shown below.



Make sure span gas is flowing to the analyzer.

In previewing the calibration information, make sure Gas Conc. matches the Calib. C. value. If so, the span gas concentration is correct and the instrument is properly span calibrated. Press “Cancel” to return to the previous menu or “ESC” to return to the measurement screen.

If Gas Conc. value does not match with the Calib. C. value, the instrument needs to be recalibrated. This is accomplished by:

- Inputting the known span gas concentration of your span gas. (If required).
- Initializing the calibration operation.

To calibrate the analyzer, follow the procedure below:

1. If required, input the correct value of your span gas to “Calib. C.” Use the “</>”keys to move the cursor to “Calib. C.”
2. Press “SET” to bring up the numeric keyboard.
3. Use “</>” to adjust the concentration value to match your span gas. Then press “OK” to accept the value and close the keyboard.
4. Press “ACCEPT” to initiate the span calibration or “CANCEL” to abort the calibration operation.

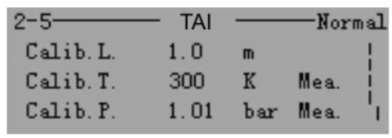
Note: Since LGA-4000 will not drift a lot within the recommended calibration cycle, “CANCEL” is strongly recommended instead of “ACCEPT” especially if there exits a large difference between the measured concentration and the real gas concentration. Please check the “calibration parameters menu” to make sure that the calibration system is properly sealed, and the correct span gas is flowing to the analyzer.

Note: *Accuracy of the analysis system is largely dependant on calibration accuracy, and it is crucial to conduct it carefully. Please make a backup of the calibration parameters (see Section 4.7.7.7 Parameter Backup). DO NOT Accept the calibration if anything abnormal occurs.*

Once the calibration operation initiates, a progress bar will appear onscreen. When the calibration is complete, the Calibration Preview screen will reappear. Press ESC to return to the measurement screen.

4.7.2.3 Calibration Path Length, Temperature and Pressure

The third, fourth, and fifth selections from within the Offline Calibration Menu are Calibration Path Length (Calib. L), Calibration Temperature (Calib. T.), and Calibration Pressure (Calib. P.). These are set in the same way as online measurement selections. See Section 4.7.1.

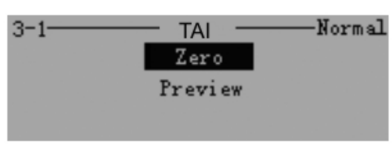


Calibration accuracy is directly related to its parameters. Make sure all parameters are carefully set to ensure measurement accuracy.

4.7.3 Purge Compensation (Pur. Gas)

When the purge gas contains a fraction of the measured gas, the purge gas will influence the measurement result. To solve this problem, the LGA-4000 integrates a purge compensation module that compensates the interference automatically.

After a period of continuous measurement the compensation module will drift, therefore a periodic calibration of the module is required. The Purge Compensation menu is the third menu within the Main Menu.



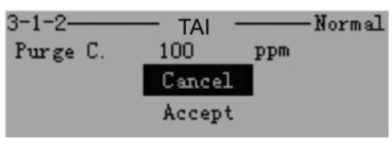
From this menu, the following operations can be performed:

- Adjust Zero (Ad. Zero): Fill the calibration tube with zero gas (such as high purity nitrogen) containing 0% of the gas under test, and perform the zeroing operation.
- Calibration Preview (Preview): Calibrate the purge compensation module. Fill the calibration tube with standard gas (such as high purity nitrogen) with a known content of measured gas, and perform the calibration operation.

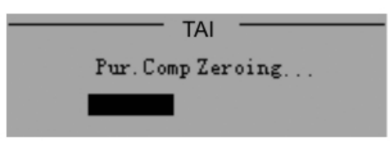
Note: Adjust zero before calibration.

4.7.3.1 ADJUST ZERO (AD. ZERO) PURGE COMPENSATION

1. Enter the Purge Compensation menu.
2. With the cursor on "Zero" press "SET" to enter the zeroing menu.



3. Move the cursor to "Accept" and press "SET" to start the zero operation. A screen showing the zero operation progress will appear.

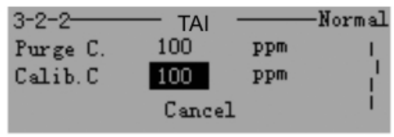


When the purge compensation zero process is complete the display will revert back to the Purge Compensation menu.

4.7.3.2 CALIBRATION PREVIEW (PREVIEW) PURGE COMPENSATION

The second selection available from the Purge Compensation Menu is the Calibration Preview screen. This menu is used to preview the measured species concentration in the purge gas or set the concentration of your purge gas to the known value of the measured species that is contained in the purge gas.

1. If not already there enter the Purge Compensation menu.
2. With the cursor on “Preview” press “SET” to enter the calibration menu.



Make sure the purge gas is flowing through the analyzer.

In previewing the calibration information, make sure Purge C. matches the Calib. C. value. If so, the purge compensation module is correctly set. Press “Cancel” to return to the previous menu or “ESC” to return to the measurement screen.

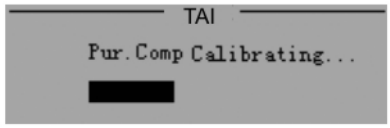
If Purge C. value does not match with the Calib. C. value, the compensation module needs to be recalibrated. This is accomplished by:

- Inputting the purge gas with a known concentration of measured gas species through the instrument.
- Initializing the purge compensation calibration operation.

To calibrate the compensation module, follow the procedure below:

1. If required, input the correct value of the known concentration of measured gas species in the purge gas to “Calib. C.” Use the “</>”keys to move the cursor to “Calib. C.”
2. Press “SET” to bring up the numeric keyboard.
3. Use “</>” to adjust the concentration value to match your purge gas. Then press “OK” to accept the value and close the keyboard.
4. Press “ACCEPT” to initiate the span calibration or “CANCEL” to abort the calibration operation.

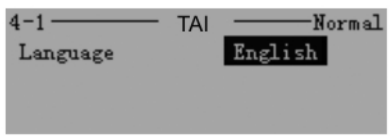
A new screen appears indicating the purge compensation calibration progress.



When the operation is complete, the screen will revert back to the Purge Compensation menu. Press ESC to go to the measurement screen.

4.7.4 Language

The Language menu is a submenu under the Main Menu. Users can shift from Chinese to English language from this menu.



1. Enter the Language menu and press “SET”
2. Use “</>”, to highlight the desired language then press “SET”. After the selection, all menus are in the language selected.
3. Press “ESC” to return to the Main Menu.

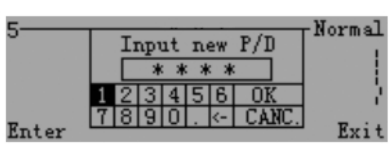
4.7.5 Password Modify

Password Modify (P/W Modi.) is a submenu under the Main Menu. This menu is used to set and/or modify a security password.

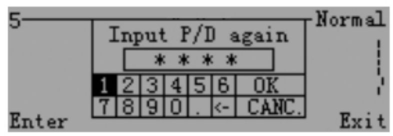
Passwords are 4 digit entries of numbers 0-9 and “.”.

To set the password:

1. Move the cursor to “P/W Modi. and press “SET”.



2. When the numeric keyboard appears, use the “</>” keys to key in the sequence of digits and “.”.
3. Select “OK” when the password is entered or choose “CANC.” to abort the entry and start over.
4. Once the password is entered, a second screen will appear prompting you to reenter the password.



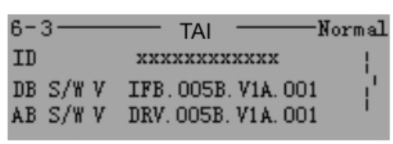
5. If reentry is correct, the system will save the password and open the Main Menu. Otherwise, the password reentry screen will reappear prompting for reentry of the new password again.

4.7.6 Software Update (Update)

Software for the analysis system can be updated via GPRS, Bluetooth, RS485 and other protocols from the Software Update (Update) menu.

The Update screen displays the following information:

- Instrument ID (ID)
- PC board software version (DB S/W V)
- Analog board software version (AB S/W V)



To update the software:

1. From the Main Menu, move the cursor to “Update” and press “SET”.
2. Use the “>” key to scroll down to “Accept”.

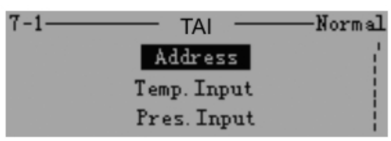
3. Press “SET” when the cursor is on “Accept” to start the update.

Note: You must have a digital connection to a GPRS, Bluetooth, RS485 or other supported protocol for obtaining software updates from this menu. Contact the factory for other supported technologies.

4. Press “Cancel” if you want to return to the existing version with no change rather than updating.

4.7.7 Accessorial Setting

The last submenu of the Main Menu is Accessorial Setting submenu.



From this submenu there are eight instrument parameters and tools available to set or use in tailoring the instrument to your process. They are:

- Instrument Address
- Temperature Input
- Pressure Input
- Concentration Output 1
- Concentration Output 2
- Measurement Range

- Data Backup
- Parameter Restore

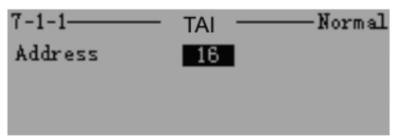
Use the “</> keys to scroll through the available options and press “SET” to enter the desired submenu.

4.7.7.1 ADDRESS

The Instrument Address menu is used to set the external communication address of the instrument. Users can choose any number other than 127 and 128 from 1 to 255 as the address. The recommended address is <32.

To set the instrument address:

1. Enter the Accessorial Setting submenu and place the cursor on “Address”. Press “SET” to enter the Address submenu.



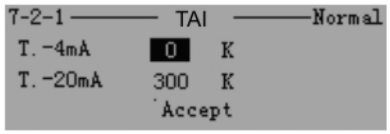
2. With the cursor on the current address press “SET”. The numeric keyboard will appear allowing you to edit and change the address number.
3. Use the “</>”keys to change the address then press “OK”. This will return you to the Address submenu where you can check the number for the proper address.
4. Press “ESC” to return to the Accessorial submenu.

4.7.7.2 TEMPERATURE INPUT

The Temperature Input screen is used to input the temperature relating to the 4mA and 20mA output respectively. The temperature corresponding to 4mA must be lower than that of 20mA, otherwise an “error” will appear.

To set the temperature:

1. Enter the Accessorial Setting submenu and scroll the cursor to “Temperature Input”. Press “SET” to enter the Temperature Input submenu.



2. With the cursor on the temperature relating to the 4mA point, press “SET” to bring up the numeric keyboard.
3. Use the “</>” keys to enter the temperature corresponding to a 4mA output then select “OK”. The Temperature Input screen reappears with the new temperature value for the 4mA output.
4. Use the “>” key to move the cursor to the 20mA temperature and press “SET” to bring up the numeric keyboard again.
5. Use the “</>” keys to enter the temperature corresponding to the 20mA output then select “OK”. The Temperature Input screen reappears with the new temperature value for the 20mA output.
6. Move the cursor with the “</>” keys to “Accept” and press “SET” to save the new temperature input values.

4.7.7.3 PRESSURE INPUT

The Pressure Input screen is used to input the pressure relating to the 4mA and 20mA output respectively. The pressure corresponding to 4mA must be lower than that of 20mA, otherwise an “error” will appear.

To set the pressures:

1. Enter the Accessorial Setting submenu and scroll the cursor to “Pressure Input”. Press “SET” to enter the Pressure Input submenu.

2. With the cursor on the pressure relating to the 4mA point, press “SET” to bring up the numeric keyboard.
3. Use the “</>” keys to enter the pressure corresponding to a 4mA output then select “OK”. The Pressure Input screen reappears with the new pressure value for the 4mA output.
4. Use the “>” key to move the cursor to the 20mA pressure and press “SET” to bring up the numeric keyboard again.
5. Use the “</>” keys to enter the pressure corresponding to the 20mA output then select “OK”. The Pressure Input screen reappears with the new pressure value for the 20mA output.
6. Move the cursor with the “</>” keys to “Accept” and press “SET” to save the new pressure input values.

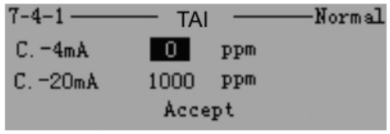
4.7.7.4 Concentration Output

The Concentration Output screens are used to input the concentration relating to the 4mA and 20mA output respectively for channel 1 (Concentration Output 1) and channel 2 (Concentration Output 2). The concentration corresponding to 4mA must be lower than that of 20mA, otherwise an “error” will appear.

The procedure for entering or changing the concentration output for channel 1 and channel 2 are identical so use the following procedure for either submenu Concentration Output 1 or Concentration Output 2 depending on which channel you desire to set.

To set the concentration:

1. Enter the Accessorial Setting submenu and scroll the cursor to “Concentration Output 1 (or 2)”. Press “SET” to enter the Concentration Output submenu.



2. With the cursor on the concentration relating to the 4mA point, press “SET” to bring up the numeric keyboard.
3. Use the “</>” keys to enter the concentration in ppm corresponding to a 4mA output then select “OK”. The Concentration Output screen reappears with the new concentration value for the 4mA output.
4. Use the “>” key to move the cursor to the 20mA concentration and press “SET” to bring up the numeric keyboard again.
5. Use the “</>” keys to enter the concentration in ppm corresponding to the 20mA output then select “OK”. The Concentration Output screen reappears with the new concentration value for the 20mA output.
6. Move the cursor with the “</>” keys to “Accept” and press “SET” to save the new concentration output values.

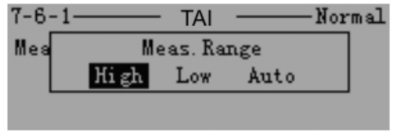
Repeat the above procedure to set the concentration output for the other channel.

4.7.7.5 MEASUREMENT RANGE

The Measurement Range sub menu is used to set the analysis range for the instrument. The analyzer has two ranges High and Low plus the option of operating in autoranging mode. Each measured species has its own fixed Low and High measurement range as shown in Table 4-1.

To enter the Measurement Range submenu:

1. Enter the Accessorial Setting submenu and scroll the cursor to “Measurement Range”. Press “SET” to enter the Measurement Range submenu.



2. Use the “</>” keys to move to the desired measurement range and press “SET” to set the analyzer to that fixed analysis range. The analyzer will accept the input and return to the previous screen.

Note: If you select “Auto” the analyzer will automatically switch between low and high ranges as the need arises.

Table 4-1: Analysis Range for Measured Gas Species

Gases	Threshold	Measurement Range
O_2	0.01%Vol.	0-1% Vol., 0-100% Vol.
HCL	0.01 ppm	0-7 ppm, 0-8000 ppm
HF	0.01 ppm	0-1 ppm, 0-10000 ppm
NH_3	0.1 ppm	0-10 ppm, 0-1% vol.
CO	40 ppm	0-8000 ppm, 0-100% Vol.
H_2O	0.03 ppm	0-3 ppm 0-70% Vol.
H_2S	2 ppm	0-200 ppm, 0-30% Vol.
CH_4	10 ppm	0-200 ppm, 0-10% Vol.
HCN	0.2 ppm	0-20 ppm, 0-1% vol.
CO_2	20 ppm	0-2000 ppm 0-100% vol.

C_2H_2	0.1 ppm	0-10 ppm 0-70% vol.
C_2H_4	1.0 ppm	0-100 ppm 0-70% vol.

4.7.7.6 Data Backup

This menu is used to make a backup of the instrument settings. It is used in conjunction with the Parameter Restore (Para. Restore) submenu described in Section 4.7.7.7.

To make a backup copy of your current instrument settings (highly recommended):

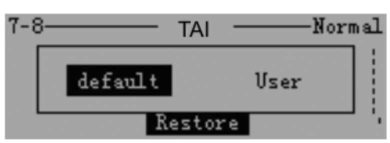
1. Enter the Accessorial Setting submenu and scroll the cursor to “Data Backup”.
2. Press “SET” to create a backup copy of your instrument settings.

4.7.7.7 Parameter Restore (Para. Restore)

This menu restores the instrument settings from the last backup copy (see Section 4.7.7.6) saved. There is also an option to restore the instrument to the original factory default settings.

To restore the instrument to a previously saved configuration or return to the default setup:

1. Enter the Accessorial Setting submenu and scroll the cursor to “Para. Restore”. Press “SET” to enter the Parameter Restore submenu.



2. Use the “</>” keys to select the desired option. User restores to the last saved backup configuration. Default restores to the original factory configuration.

3. Press “SET” to restore to the desired configuration.

4.8 Alarms

4.8.1 Alarm Indicators

The system generates an error or warning whenever it encounters an abnormal or faulty condition. When this occurs, the system displays a large alarm icon on the Main Menu and a small one on upper right of the screen saver as well as on other menus other menus.

⚠ is used to indicate a warning or concentration alarm.

⊗ is used for an error.

Figure 4-5 shows the warning icon as it appears on the Main Menu. The Screen Saver uses a smaller version. Figure 4-6 shows an Error indication as it appears on the Screen Saver. On other menus the same but smaller alarm symbol is used and usually appears in the upper right corner of the screen. Figure 4-7 shows an Alarm indicator as it would appear on the Main Setting menu.

Additional alarm information is covered in Section 5.

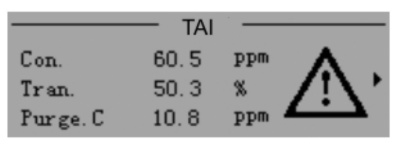


Figure 4-5: Warning Alarm as it Appears on Main Menu

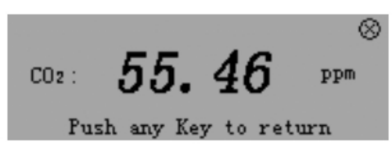


Figure 4-6: Error Indication as it Appears on the Screen Saver

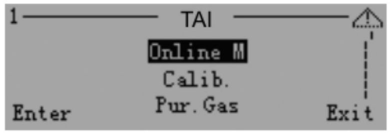


Figure 4-7: Alarm Indication on Main Setting Menu

4.8.2 Alarm Code Menu

When Alarm occurs on the Main Menu, press “>” to enter the alarm code menu to determine the exact nature of the alarm. The Alarm Code Menu is shown in Figure 4-8. This screen lists a code indicating the particular alarm or error that has occurred.

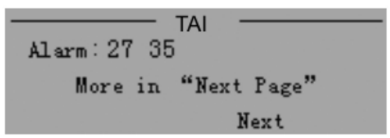


Figure 4-8: Alarm Code Menu

It additional information regarding the exact nature of the alarm is required, use “</>” keys to call up a description of each alarm. See Figure 4-9.

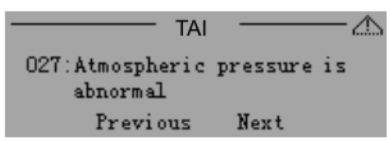


Figure 4-9: Alarm Code Description

Alarm Messages

There are 3 types of Alarms installed in the LGA-4000. They include a 3-channel relay alarm, a 4-20mA output alarm, and LCD display of alarm information.

5.1 Relay Alarm

The 3-Channel relay in the LGA-4000 is set up as follows:

Relay 1—warning alarm relay

Relay 2—error alarm relay

Relay 3—concentration alarm relay

The concentration alarm relay is triggered when the measured gas concentration has exceeded the high or low limits set by the user. When this occurs, the relay opens indicating that the current concentration is out of the set range.

The warning alarm and error alarm when triggered indicate that the system working status is abnormal (warning status in normal mode and system error).

Table 5.1 shows the relay and output state for various operational modes of the LGA-4000.

5.2 4-20mA Analog Output

When the system status is normal, the 4-20mA analog output represents the measured gas concentration. In general, 4-20mA corresponds to the user-defined measurement range. 4mA corresponds to the minimum value of the user-defined measurement range and 20mA corresponds to the maximum. When the system encounters an error and enters error mode, the output of the 4-20mA port is 2mA.

CAUTION: 2MA DOES NOT REPRESENT MEASURED GAS CONCENTRATION. IT ONLY SHOWS THAT THE ANALYZER HAS ISSUED AN ERROR ALARM.

Table 5.1 Relays and Output Status for Operation Modes

System Working Status		LCD Alarm Icon (Graphics Mode)	Relay			4-20mA Output
			Warning Alarm (Relay_1)	**Error Alarm (Relay_2)**	**Concentration Alarm (Relay_3)**	
Power-off		No	Open = Alarm	Open = Alarm	Open = Alarm	0mA
Start-up Mode		No	Closed = No Alarm	Closed = No Alarm	Closed = No Alarm	0mA
Normal Mode	**Normal Status**	Normal	Closed = No Alarm	Closed = No Alarm	Depending on gas concentration	4-20mA
	Warning Status	⚠	Open = Alarm	Closed = No Alarm	Depending on gas concentration	4-20mA
Error Mode		⊗	Open = Alarm	Open = Alarm	Closed = No Alarm	2mA

5.3 LCD Alarm Message Display

When the LGA-4000 enters an alarm condition an alarm message is displayed on the LCD screen. Detailed descriptions and solutions of these messages are listed in Table5.2.

.

Table 5.2: LCD Display Alarm Messages

Alarm Code on LCD	Possible Cause of the alarm	Relay Status a. Warning Alarm b. Error Alarm c. Conc. Alarm (O=Open C=Closed)	4-20mA Output	Trouble shooting
001 **002** **003** **011** **012** **013** **017** **018** **025** **026** **58**	LGA-4000 has internal system error	a = O b = O c = C	2mA	Write down the alarm code; power off the system; reboot the system in an hour; If the same alarm persists, contact customer support center.
005/006	The temperature of the Transmitter unit is too high/low.	a = O b = O c = C	2mA	Power off the system; check whether the environment temperature inside/outside of the analyzer is abnormal; reboot the system after making sure that the temperature is normal. If the same alarm persists, contact customer support center.
008/009	The laser temperature is too high/low.	a = O b = O c = C	2mA	Power off the system; reboot the system in an hour; If the same alarm persists, contact the customer support center.

Alarm Code on LCD	Possible Cause of the alarm	Relay Status a. Warning Alarm b. Error Alarm c. Conc. Alarm (O=Open C=Closed)	4-20mA Output	Trouble shooting
010	Clock readout failure	a = O b = O c = X X means it depends on gas concentration	2mA	Power off the system and reboot. If the same alarm persists, contact the customer support center.
020	Background radiation is too strong during system self test.	a=O b=O c=C	2mA	Power off the system; reboot the system in an hour; If the same alarm persists, contact the customer support center.
021/022	Temperature of the diode laser is too high/higher than the stored temperature	a=O b=O c=C	2mA	Power off the system; reboot the system in an hour; If the same alarm persists, contact the customer support center.
027	Abnormal atmospheric pressure measurement	a = O b = C c = X X means it depends on gas concentration	4-20mA, the exact number is from calculation	Use 1.01Bar as the atmospheric pressure to calculate the concentration; check the ambient pressure *Note: In this situation, the calculated concentration may be inaccurate.*
031	The pressure of the gas environment under test exceeds the LGA-4000 application limit.	a = O b = C c = X X means it depends on gas concentration	4-20mA, the exact number is from calculation.	Use 300K as the gas temperature to calculate the concentration; check the pressure of the tested gas *Note: In this situation, the calculated concentration may be inaccurate.*

Alarm Code on LCD	Possible Cause of the alarm	Relay Status a. Warning Alarm b. Error Alarm c. Conc. Alarm (O=Open C=Closed)	4-20mA Output	Trouble shooting
035	The temperature of the gas environment under test exceeds the LGA-4000 application limit.	a = O b = C c = X X means it depends on gas concentration	4-20mA, the exact number is from calculation.	Use 1.01Bar as the atmospheric pressure to calculate the concentration; check the ambient temperature. *Note: In this situation, the calculated concentration may be inaccurate.*
038	Purging Concentration is out of the range	a = O b = C c = X X means it depends on gas concentration X	4-20mA, the exact number is from calculation.	Use 0% as the purging concentration to calculate the concentration; check the content of the tested gas in the purging gas *Note: In this situation, the calculated concentration may be inaccurate.*
43	LGA-4000 EEPROM fault	a = O b = O c =O	2mA	Power off the system; contact customer support center.
45	During analysis, the laser power is too high or the background light is too strong	a = O b = C c = X	4-20mA, the exact number is from calculation.	Reboot the system; If the same alarm persists, and there is no strong background light in the gas flow pipe under test, contact the customer support center.
48	The measured gas concen-tration exceeds LGA-4000 upper limit for 1 minute.	a = O b = C c = X	4-20mA, keep the last measured value	If the same alarm persists, and the gas flow is not abnormal, contact the customer support center.

Alarm Code on LCD	Possible Cause of the alarm	Relay Status a. Warning Alarm b. Error Alarm c. Conc. Alarm (O=Open C=Closed)	4-20mA Output	Trouble shooting
059/060	Low transmittance due to contamination on the optical window or the dust density in the environment under test exceeds normal range.	a = O b = C c = X	4-20mA	Power off the system; clean the optical windows (follow the instructions in Users' Manual); If the same alarm still persists, contact the customer support center.
061/062	Temperature of the transmitter unit and the receiver unit is too high/low	a = O b = O c = X	2mA	Power off the system; check carefully the temperature inside/outside the receiver unit; reboot the system if the temperature is normal. If the same alarm still persists, contact customer service center.
063	Rate of the power supply is too low	a = O b = O c = X	2mA	Power off the system; check carefully the power supply; reboot the system if the rate is normal. If the same alarm still persists, contact our customer service center.
99	LGA-4000 internal communication error alarm.	a = O b = O c =C	2mA	Power off the system; reboot the system in an hour; If the same alarm persists, contact the customer support center.
201	Level 1 concen-tration alarm (high)	a = O b = O c = X	4-20mA, the exact number is from calculation	Normal concentration alarm.

Alarm Code on LCD	Possible Cause of the alarm	Relay Status a. Warning Alarm b. Error Alarm c. Conc. Alarm (O=Open C=Closed)	4-20mA Output	Trouble shooting
202	Level 1 concen-tration alarm (low)	a = O b = O c = X	4-20mA, the exact number is from calculation	Normal concentration alarm.
205	Level 2 concen-tration alarm (high)	a = O b = O c = X	4-20mA, the exact number is from calculation	Normal concentration alarm.
206	Level 2 concen-tration alarm (low)	a = O b = O c = X	4-20mA, the exact number is from calculation	Normal concentration alarm.

Maintenance and Calibration

The LGA-4000 Laser Gas Analyzer needs to be maintained and calibrated periodically to ensure it is working properly.

6.1 Maintenance

There are no user serviceable parts within the LGA-4000. Daily preventive maintenance is limited to:

- Checking and adjusting the purge gas flow
- Visually inspecting and cleaning the optical devices
- Optimizing the optical transmission.

The LGA-4000 Laser Gas Analyzer incorporates a purging system to protect the optical parts in the transmitter unit and the receiver unit from contamination by dust, water vapor, and process gas deposition. Maintaining an appropriate purge gas flow rate is a key factor in its ability to keep the components functioning. However, dust and other pollutants in the environment still could contaminate the optical parts during extended operation of the system which would result in lower the transmittance between the transmitter and receiver as well as influence the overall performance of the system. For this reason it is important to clean the optical parts periodically. Drift in the optical transmission alignment may also occur after a period of time, and needs to be re-adjusted and optimized periodically.

The LGA-4000 uses specially designed signal processing circuits. As long as signal voltage from the sensor is no less than 1% of its normal value, the system measurement and analysis performance is not affected. It greatly reduces the demand of cleaning the optical parts and re-adjusting the optical transmission alignment.

In addition, visually inspect for leaks, probe corrosion and ensure that all joints are secure during maintenance.

6.1.1 Clean the Optical Parts

For most applications, the time interval to do optical parts cleaning usually exceeds 3 months. Even for highly dusty applications, with proper purging, the optical parts are kept clean for a relatively long time. TAI recommends cleaning the system optical parts once every two or three months to ensure that the system will run continuously and dependably with minimum downtime. If the purge system malfunctions, check the optical parts for contamination.

The optical transmission information is shown on LCD screen. The transmittance decreases when the optical parts become dirty or the optical transmission alignment between the transmitter and receiver is off from the optimal position. The transmittance information thus can be used as an indicator to determine whether the optical parts need cleaning or adjustments to the optical transmission alignment are needed (see Section 6.1.2). If there is no significant decline in transmittance, you can prolong the maintenance interval. When the transmittance does drop, shorten the maintenance interval.

In addition, the warning alarm relay triggers when the transmittance is lower than 3%. The corresponding alarm message appears on the LCD front panel (please refer to Table 5.2 for detailed alarm information) to remind the user to maintain the system.

Use the following procedure to clean the optical parts:

CAUTION: **LASER RADIATION CAN CAUSE DAMAGE TO THE EYES. POWER MUST BE DISCONNECTED DURING SYSTEM MAINTENANCE.**

CAUTION: **DO NOT REMOVE THE TRANSMITTER OR RECEIVER UNITS WHEN THERE IS GAS FLOWING IN THE ENVIRONMENT UNDER TEST WITHOUT FIRST CLOSING THE VALVE BETWEEN THE UNITS AND THE PROCESS FLOW.**

1. Turn off the power supply to make sure that the transmitter unit does not emit during the maintenance process.
2. Loosen the mounting nut and remove both the transmitter unit and the receiver unit from the instrument flanges. Make sure the

cable connection between the transmitter unit, the receiver unit and the central processing unit are not affected.

3. Check the contamination of the optical parts and look for possible damage (such as cracks). If there is any damage to the optical part, they must be replaced (Please contact TAI customer support center).
4. Clean the optical parts with a mixture of alcohol and ether, then dry with clean compressed air.
5. If the optical parts cannot be cleaned completely, they should be replaced . (Please contact TAI customer support center).
6. Reinstall the transmitter and receiver units, and turn on the power supply.

After initialization and self test, if the transmittance shown on LCD is still low (lower than 80%), optimize the optical transmission alignment according to instructions in section 6.1.2.

6.1.2 Optimize the Optical Transmission Alignment

For optimum analysis TAI recommends that you readjust and optimize the optical transmission alignment twice a year. Refer to Section 3.7 for the specific optimization procedure and steps.

The LGA-4000 automatically monitors the working conditions of all key units. The system will prompt when specific unplanned maintenance is needed. The above maintenance procedures are for preventive purposes. If other system malfunctions occur, please contact our customer support center immediately.

6.2. Calibration

All LGA-4000 analyzers are calibrated at the factory and do not need calibration the first time they are used. However, with time, system parameters may drift due to gradual aging of the laser device and electronic parts in the system. This will affect measurement accuracy. Therefore, periodic recalibration is necessary. Compared to the conventional analysis systems such as the NDIR systems, the LGA-4000 has a long calibration interval (over 3 months) due to its advanced measurement principles and special low drift design.

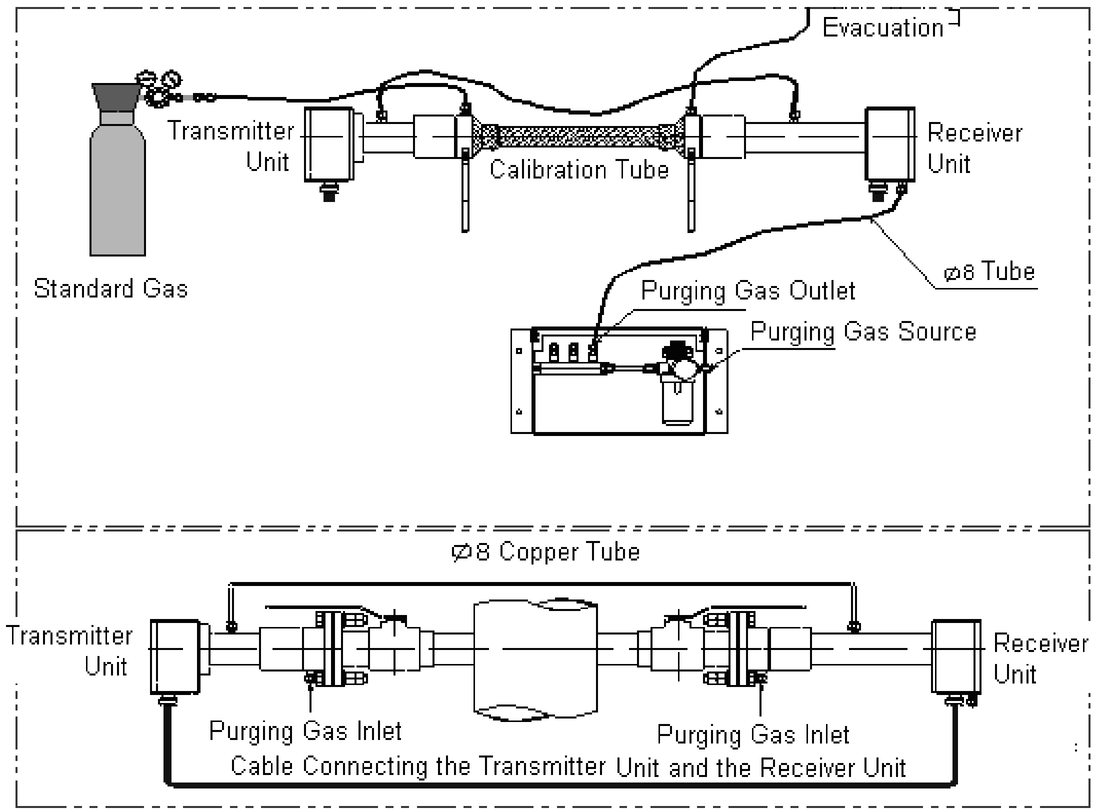


Figure 6.1 Schematic of the Calibration Setup

Always bear in mind that the measurement accuracy of the system is determined by the accuracy of its calibration. With this in mind, determine first if the system needs calibration. When it is indeed necessary, make sure it is performed correctly. We suggest that you use the calibration tube that comes with the system from TAI. Figure 6.1 is the schematic of the calibration setup. The calibration is performed either by operating the keyboard of the LCD front panel on the central processing unit or through a PC connected to the unit through the RS485 port.

The concentration of the calibration gas depends on both the system's measurement range and the environment temperature. If the concentration is too high, it can saturate the measurement signal. If the concentration is too low, the calibration accuracy would be affected because the calibration tube and the connection tubes absorb some of the gas, and the background noise would be large with respect to the signal.

Calibration gas should be a mixture of nitrogen and the gas under test, and the concentration of the gas under test is set according to the calibration requirement.

When calibrating some highly absorptive gases (such as H_2O, HCl, HF and NH_3), especially if the measurement range of the system is small, special care should be taken as the calibration tube and the connection tubes could absorb a significant amount of the gas and severely affect the calibration accuracy. When calibrating these gas species, it is strongly recommended to:

- Use short tubes for connection, especially those used to connect the standard gas container to the calibration tube.
- Make sure calibration devices and connection tubes are dry. Purge them with dry clean nitrogen a few times before injecting the standard calibration gas.
- Before starting the calibration process, purge the calibration tube a few times with the standard calibration gas.
- Use relatively large flow rate, such as 5 L/min.
- Connect the calibration system with Teflon tubes.
- Wait till the measured gas concentration value is stable.

Observe whether the measured gas concentration value changes much when the flow rate is increased. If it doesn't, then the gas absorption by the calibration tube and the connection tubes are negligible.

6.2.1 Calibration Procedure

To calibrate the system, follow the procedure listed below:

1. Turn off the system power supply.

CAUTION: DO NOT REMOVE THE TRANSMITTER OR RECEIVER UNITS WITH GAS FLOWING IN THE ENVIRONMENT UNDER TEST WITHOUT FIRST CLOSING THE VALVE BETWEEN THE UNITS AND THE PROCESS FLOW.

2. Loosen the mounting nut and take off the transmitter unit and the receiver unit (Figure 6.2). Check the optical parts for cracks, dust or other contaminants. If damage or contamination is evident refer to section 6.1.1 to clean and maintain the optical parts.

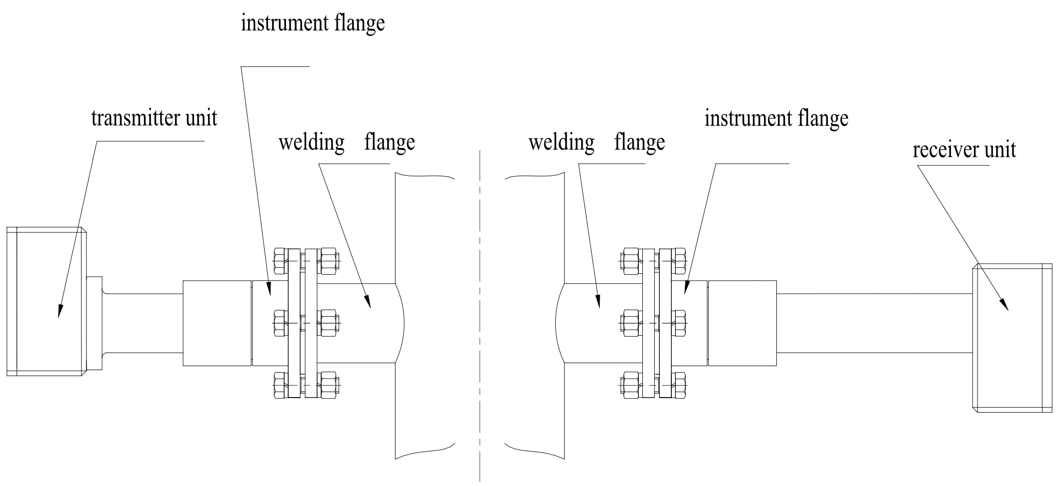


Figure 6.2 Removing the Transmitter Receiver Units

3. Mount the transmitter and receiver units to the flanges at the each end of the calibration devices, then and fasten the locknut (Figure 6.3)

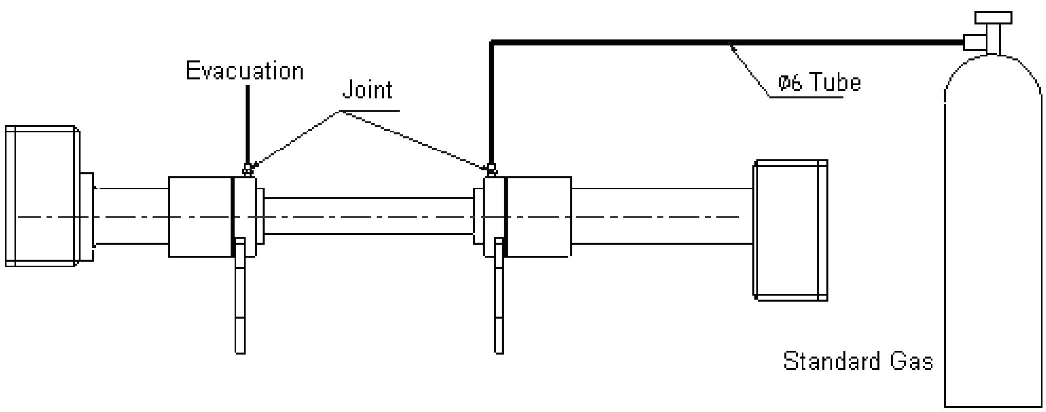


Figure 6.3 Schematic for Calibration Gas Transport Tubes

4. Before starting the calibration, turn on the system power and wait for at least 15 minutes.

Note: The instrument and electronics must be thermally stable. If the temperature of the sample site (or where the receiver and transmitter and calibration tube are located) fluctuates, *the stabilization period could be longer than one hour.*

5. Set the optical path length of the calibration tube and the calibration gas concentration, temperature and pressure via the front panel. For increased accuracy, the temperature and pressure of the calibration gas should be measured directly with temperature and pressure sensors.
6. Introduce the standard gas (such as pure nitrogen) into the calibration system; wait for a while until the gas concentration is stabilized in the calibration tube, and then run the zeroing program from the system front panel. This step can be skipped due to LGA-4000's tiny zero drift;
7. Switch from zero gas to span gas (standard gas with a concentration that is recommended by TAI). Once again, wait until the span gas concentration has stabilized then run the calibration program from the front panel.
8. Remove the transmitter and the receiver units from the calibration tube and remount them onto the instrument flanges.
9. Reset the optical path length, environment temperature and environment pressure parameters for the environment under test.

CAUTION: **RESETTING THE OPTICAL PATH LENGTH IS NECESSARY. WITHOUT CORRECT PARAMETERS, THE SYSTEM CANNOT ANALYZE THE GAS CONCENTRATION CORRECTLY.**

CAUTION: **DO NOT CALIBRATE THE SYSTEM WHEN THERE IS AN ERROR OR WARNING ALARM MESSAGE ON LCD.**

CAUTION: **DO NOT CALIBRATE WHEN THERE IS GAS FLOW IN THE ENVIRONMENT UNDER TEST WITHOUT FIRST CLOSING THE ISOLATION VALVES. THE PROCESS GAS COULD ESCAPE INTO THE ROOM OR AIR COULD ENTER THE PROCESS PIPE.**

Extended Communication Functions

The demand for networked, intelligent, and automated analysis systems is increasing. In addition to advanced remote data communication capabilities, users also want the systems to be equipped with remote communications and system management functions such as wireless data transmission, capability for setting system parameters and upgrading system software remotely through wireless networks. To meet our customers' needs, the LGA-4000 Laser Gas Analyzer provides a GPRS based wireless remote data communications interface as a supplement to their 4-20mA output port and RS485 local communication port.

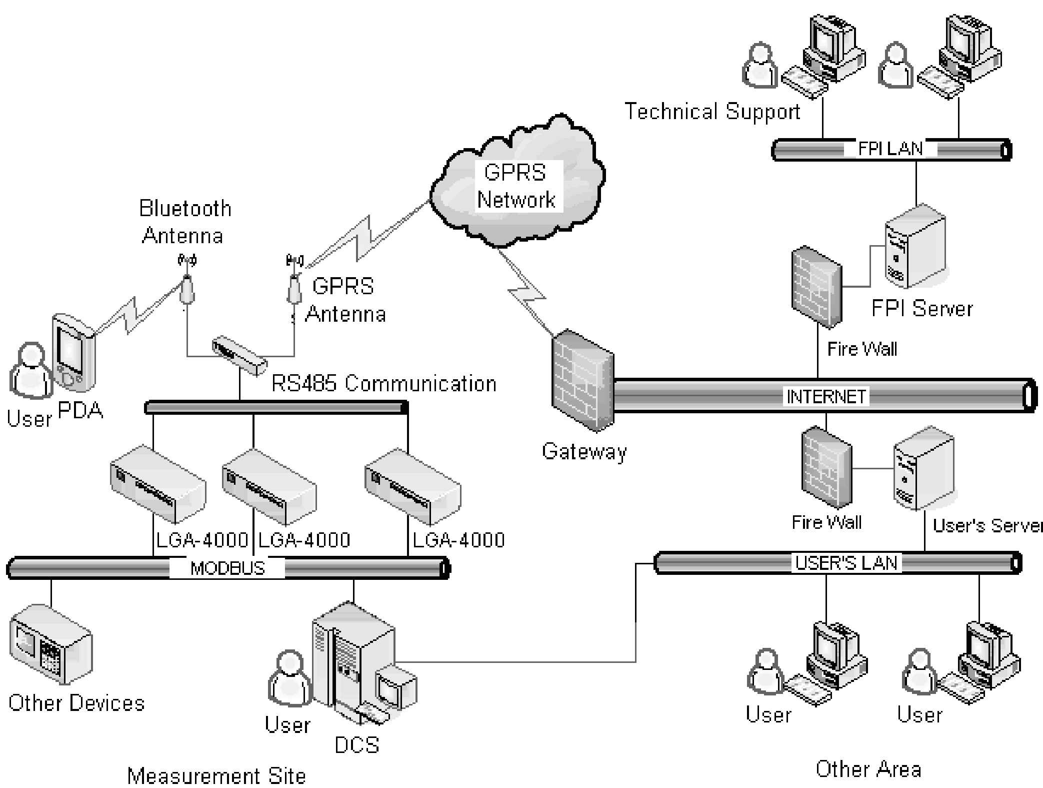


Figure 7.1 LGA-4000 Digital Network

The main functions of this implementation are:

- **Remote data communications:** Data include the concentration, pressure, temperature, etc. of the gas under test.
- **Remote query and setting of system parameters:** Enables quick data analysis and remote system diagnosis. This greatly improves the turn-around time as well as the accuracy of after-sales technical support and services.
- **Wireless system software updating:** New versions of the system software and custom-made software can be uploaded into the system remotely through GPRS wireless networks.
- **Centralized monitoring of multiple measurement points:** Using one single service program to collect data wirelessly from multiple measurement points.

Appendix

A.1 Specifications

Technical Features	Optical path length (OPL)	≤ 15m
	Response time	< 1s
	Linear accuracy	≤ ± 1% FS
	Span drift	≤ ± 1% FS (within maintenance interval)
	Zero drift	Negligible
	Warm-up time	< 1hour
	Maintenance interval	< 4 times/year (no replacement parts)
	Calibration interval	< 2 times/year
Input & Output Signal	Analog output	2-channel 4~20mA current loop, 500Ω Max, isolated
	Digital output	RS485/RS232/Bluetooth/GPRS
	Relay output	3-Channel (24V, 1A)
	Analog Input	2-channel 4-20mA with temperature, pressure compensation
Operation conditions	Environment temperature	-30ºC—60º C
	Protection class	Transmitter/ Receiver: IP65
	Power supply	24VDC
	Purging gas	0.38 MPa N_2, clean instrument air etc.
	Explosion Proof	(Option) consult factory

Installation	Mounting method	Use DN50/PN2.5 flanges to install transmitter and receiver
	Installation	In-situ or bypass

A.2 Recommended Spare Parts List

Qty.	Part Number	Description

A minimum charge is applicable to spare parts orders.

Note: Orders for replacement parts should include the part number (if available) and the model and serial number of the instrument for which the parts are intended.

Orders should be sent to:

TELEDYNE Analytical Instruments

16830 Chestnut Street
City of Industry, CA 91749-1580

Phone (626) 934-1500, Fax (626) 961-2538

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

A.3 Reference Drawings

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