User Manual | ICOS
GLA431 Enhanced Performance Benchtop Liquid Water Isotopic Analyzer
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Disclaimer
This document contains product specifications and performance statements that may be in conflict with other ABB published literature, such as product flyers and product catalogs. All specifications, product characteristics, and performance statements included in this document are suggested specifications only. In case of conflict between product characteristics in this document and specifications in the official ABB product catalogs, the latter takes precedence.

ABB reserves the right to make changes to the specifications of all equipment and software, and to the contents of this document, without obligation to notify any person or organization of such changes. Every effort has been made to ensure that the information contained in this document is current and accurate. Please contact ABB-LGR if you find any error in this document, so we can make appropriate corrections.

Cybersecurity
This product is designed to be connected to and to communicate information and data via a network interface. It is your sole responsibility to provide and continuously ensure a secure connection between the product and your network or any other network (as the case may be). You shall establish and maintain any appropriate measures (such as, but not limited to, the installation of firewalls, application of authentication measures, encryption of data, etc.) to protect the product, the network, its system and the interface against any kind of security breaches, unauthorized access, interference, intrusion, leakage and/or theft of data or information. ABB and its affiliates are not liable for damages and/or losses related to such security breaches, any unauthorized access, interference, intrusion, leakage and/or theft of data or information.

Patent
The analyzer technology is protected by patents:
- 7,468,797
- 6,839,140
- 6,795,190
- 6,694,067

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Safety

The following pages provide important safety precautions.

Class of Laser Equipment

The analyzer is a Class 1 laser instrument when the case cover is closed for normal operation, and the lock is installed.

Certification

The analyzer certifications are listed in Table 1.

Table 1: Safety Certifications

<table>
<thead>
<tr>
<th>Symbols</th>
<th>Standards Tested and Met</th>
</tr>
</thead>
<tbody>
<tr>
<td>CE</td>
<td>2004/108/EU (EMC), EN61326-1</td>
</tr>
<tr>
<td>FDA</td>
<td>Title 21 Code of Federal Regulations, chapter 1, sub-chapter J</td>
</tr>
</tbody>
</table>

WEEE Directive

The analyzer 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.
Labels

The following labels are at specific locations on or in the analyzer to identify hazardous areas. (Figure 1)

![Radiation Labels](image)

*Figure 1: Radiation Labels*

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.

Operator Safety

When the case cover is closed and locked into position, the analyzer runs safely, without risk to the operator. Modifying the analyzer to operate with the case cover open can injure personnel.

---

**WARNING!**

Bypassing the analyzer interlock switch to open the case cover during analyzer operations can cause serious bodily injury. Even though the analyzer provides a second layer of protection, such as a laser cover to prevent the user from the invisible laser beam or any secondary reflection from the laser on a reflective surface, it is not recommended to modify the analyzer to operate in an unsafe condition.

---

Electrical Hazards

The analyzer poses no electrical hazards. The analyzer components operate at $\leq 6.8$ V DC.
Laser Hazards

The analyzer is a Class 1 laser product that complies with:

- 21 CFR 1040.10 and 1040.11
- EN 60825-1:2014

The laser is classified as a Class IIIb when exposed.

Only trained service personnel are authorized to open the housing or service the laser.

**WARNING**

Using this analyzer in a manner not specified by ABB-LGR may result in damage to the analyzer and render it unsafe to operate.

Only authorized persons may open the analyzer cover or perform internal maintenance. Contact ABB-LGR for maintenance instructions and maintenance kits. Make sure the analyzer is unplugged before working with the internal components. Failure to do so may result in damage to the analyzer and electric shock.

**WARNING**

Safety Provisions for a Chemical Spill

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.

If a spill occurs:

- 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.
Text Formats and Warning Icons

Text Formats

This section describes text formats and warning icons used in this manual.

- *Italicized* text is used for emphasis in text and also to emphasize the names of screens or text fields.
- **Bold** text is used to show text that you type in fields and also button choices that you enter.

Warning Icons

Table 2 shows and describes the warning icons used in this manual.

*Table 2: Warning Icon Descriptions*

<table>
<thead>
<tr>
<th>Icon</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>![NOTE]</td>
<td>Emphasizes facts and conditions important to analyzer operation.</td>
</tr>
<tr>
<td>![WARNING!]</td>
<td><strong>General Warning Icon</strong>: gives general safety information that must be followed to avoid hazardous conditions.</td>
</tr>
<tr>
<td>![WARNING!]</td>
<td><strong>Electrical Warning Icon</strong>: warns of potential electrical shock hazard.</td>
</tr>
<tr>
<td>![WARNING!]</td>
<td><strong>Laser Warning Icon</strong>: warns of potential laser hazard.</td>
</tr>
</tbody>
</table>


Transportation and Storage of Boxed Analyzers

When transporting and storing boxed analyzers:

- Analyzers may be shipped in non-pressurized aircraft.
- Analyzers are fragile: Do not drop or smash boxed analyzers.
- Do not store analyzers outside in wet weather.
- Do not stack boxes more than five high.
- Analyzers may be safely stored at temperatures between -20°C and +60°C.

Save the original shipping materials to use when returning the analyzer to ABB-LGR if factory service or repair is needed.

Table 3 lists and describes the safety icons on ABB-LGR shipping boxes. Follow these instructions when transporting and storing boxed analyzers.

### Table 3: Transportation and Storage Icon Descriptions

<table>
<thead>
<tr>
<th>Icon</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="rain" alt="Icon" /></td>
<td>Store your analyzer in a sheltered, dry area. Do not let the box get wet.</td>
</tr>
<tr>
<td><img src="arrows-up" alt="Icon" /></td>
<td>Transport and store the analyzer box with the arrows on the box pointing up.</td>
</tr>
<tr>
<td><img src="fragile" alt="Icon" /></td>
<td>The analyzer is fragile. Transport carefully. Do not drop the box.</td>
</tr>
</tbody>
</table>

Positioning the analyzer

Positioning the analyzer is a two-person task. With one person on each side, lift the analyzer out of the box and onto a flat surface. Leave four inches of free space on each side of the analyzer for proper ventilation.
Warranty

Each ABB-LGR analyzer is warranted by ABB-LGR to be free from defects in material and workmanship. However, our sole obligation under this warranty shall be to repair or replace any part of the analyzer, which our examination discloses to have been defective in material or workmanship without charge and only under the following conditions:

1. The defects are called to the attention of ABB-LGR in writing within one year after the shipping date of the analyzer.
2. The analyzer has not been maintained, repaired or altered by anyone who was not approved by ABB-LGR.
3. The analyzer was used in the normal, proper, and ordinary manner and has not been abused, altered, misused, neglected, involved in an accident or damaged by an act of God or other casualty.
4. The purchaser (whether a distributor or direct customer of ABB-LGR, or a distributor’s customer), packs and ships or delivers the analyzer to ABB-LGR’s main office within 30 days after ABB-LGR has received written notice of the defect. Unless other arrangements have been made in writing, transportation to ABB-LGR is at customer’s expense.
5. No-charge repair parts may be sent at ABB-LGR’s sole discretion to the purchaser for installation by purchaser.
6. ABB-LGR’s liability is limited to repair or replace any part of the analyzer free of charge if ABB-LGR’s examination discloses the part to be defective.

The laws of some locations may not allow the exclusion or limitation on implied warranties or on incidental or consequential damages, so the limitations herein may not apply directly. This warranty gives you specific legal rights, and you may already have other rights, which vary from location to location. All warranties that apply, whether included by this contract or by law, are limited to the time period of this warranty, which is a twelve-month period commencing from the analyzer customer ship date or eighteen months from the date of shipment to an ABB-LGR authorized distributor, whichever is earlier.

Further information concerning this warranty may be obtained by writing or telephoning the Warranty Manager at ABB-LGR Customer Service.

ABB-LGR provides direct assistance in the use and application of all of its analyzers through email, telephone, and if necessary, in person.

Please contact icos.support@ca.abb.com and your local sales representative for more details.
Warranty Returns
If your product is defective, you may return it during its designated warranty period for a prompt exchange or repair. To return a product, please contact your local sales representative and ABB service support to request a Return Material Authorization (RMA) number. Requests for refunds and exchanges cannot be processed without a valid RMA number.

Please have the following information available when requesting an RMA number:
• Part Number
• Serial Number (Located on the back panel of the analyzer)
• Description of the Problem

The company-issued RMA number must be prominently displayed on the return package.

No returns will be accepted collect or C.O.D. On all warranty returns, ABB-LGR will pay the shipping charges on the return of the merchandise to the customer.

Customer Support
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:

ABB Inc. Measurement & Analytics
3400, rue Pierre-Ardouin
Quebec, (Quebec) G1P 0B2 Canada

Tel: 1 800 858 3847 (North America)
Tel: +1 418 877 2944 (Worldwide)
Fax: +1 418 877 2834
Technical Support: Icos.support@ca.abb.com

Please contact icos.support@ca.abb.com and your local sales representative for more details.

---

Please provide the serial number or sales order number of the analyzer.
Analyzer Overview

The ABB-LGR GLA431 Liquid Water Series are Enhanced Performance Benchtop Gas analyzers. The Triple Liquid Water analyzer (GLA431-TLWIA) measures $^{18}\text{O}/^{16}\text{O}$, $^{17}\text{O}/^{16}\text{O}$, and D/H in liquid water samples with high accuracy. The Liquid Water Isotopic EP Benchtop analyzer (GLA431-LWIA) measures $^{18}\text{O}/^{16}\text{O}$ and D/H. An autoinjector enables long-term liquid water isotope monitoring studies without user intervention. Due to its rugged packaging, this analyzer is ideal for a wide variety of hydrological, analytical, and biological science applications that involve measurements of fresh water or sea water.

The measurement strategy is based on high-resolution laser absorption spectroscopy. As a result, the GLA431 Liquid Water Series analyzers provide accurate isotope ratio measurements over an extraordinarily wide range of delta values (from highly depleted to highly enriched).

For applications requiring unattended, long-term, operation, the GLA431 Liquid Water Series analyzer’s internal computer controls water injection cycles and stores all measurement data on its internal storage for later analysis. All data stored on the internal storage can be accessed directly through a USB connection, or remotely over the Ethernet.

---

This analyzer is a Class 1 laser product.
Performance Specifications

Ambient Humidity
  • 0% to 100%

Operating Temperature
  • 0 - 45°C

Throughput
  • 800 injections per day

Sample Volume
  • 1μL per injection

Maximum Altitude
  • 6,000 Feet

Power Requirements
  • 115/230 VAC, 50/60hz
  • 180 watts (total, including ACC DP4H pump)

Fuse Ratings
  • 250 VAC
  • 10 Amps

Cable Plugs and Voltage for EC Countries
  • See page 220.

---

Always use the power supply cord provided by ABB-LGR. See page 220 for a description of power cords for a specific country.
Standard Components

This section describes the analyzer components. Verify that each of the system components has arrived before installation.

GLA431 Liquid Water Series Analyzer
- Analyzer power cord
- User guide (this document)
- USB flash drive

External Pump Kit
- External pump (ACC-DP4H)
- Pump Power Cord
- \( \frac{1}{2} \)” Teflon connection tube

Starter Supplies Kit
- Syringe (1.2 \( \mu \)L capacity) (3)
- Centering needle (1)
- Septum puller (1)
- Set of working standards (5 Vials - Standards 1–5)
- 2mL vials (1 pack of 100)
- Screw thread caps with attached septa (1 box of 100)
- Septa (1 box of 50)
- Pair of thermal gloves (2 - 1 large, 1 small)
- Dry air (1 can)
- Allen keys (2)
- 7/16” wrench (2)
- 9/16” wrench (1)
- 7/8” wrench (1)
- Drierite\textsuperscript{®} laboratory gas drying unit (1)
Optional Components

PAL3 LSI Autoinjector Kit (ACC-AUTOINJECT)
- Autoinjector
- Autoinjector power supply
- Control panel with Display
- Cables
- Nylon screws (8)
- Vial trays (3)
- Injection block alignment tool (1)
- Spare injection block with septum and cap (1)
- TP-Link 5-port Fast Ethernet Switch
- GL-MT300N-V2 Mini Smart Router
- Syringe alignment tool

---

**WARNING**

This analyzer has been CE certified using data cables three meters long or less. Connecting the analyzer using longer data-cables is not recommended.

---

If you have not received all of these components, contact ABB-LGR at icos.support@ca.abb.com.
Figure 2 shows the front of the analyzer.

![Figure 2: Front Panel](image)

Figure 3 shows the back of the analyzer with connections.

![Figure 3: Back Panel](image)
Power Connections
Figure 4 shows the power connections on the back panel, and Table 4 describes the connections.

![Figure 4: Power Connections and AC Voltage Selection Switch](image)

Table 4: Power Connections and AC Voltage Selection Switch Description

<table>
<thead>
<tr>
<th>Connector</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC Voltage Selection</td>
<td>Toggles the input voltage to the analyzer’s power supply between 115 VAC and 230 VAC, determined by the country where the analyzer is used. Setting an incorrect voltage may damage the analyzer. When changing the supply voltage verify that both the: • Analyzer is powered off or not connected to power. • AC voltage selection on the analyzer matches the AC voltage being supplied from your power supply.</td>
</tr>
<tr>
<td>AC Power In</td>
<td>Connects the analyzer to the power supply</td>
</tr>
<tr>
<td>EXT. Pump Power</td>
<td>Provides power to an external pump when operating the analyzer</td>
</tr>
</tbody>
</table>

---

**NOTE**
If you require a different power source, please contact ABB-LGR.
Data Interface Connection Ports

This section describes the data interface connections as shown in Figure 5. These connections vary from analyzer to analyzer depending on the ordered configuration.

- Ethernet port – Connects the analyzer to a local area network (LAN), communicates with the PAL3 autoinjector, and allows access to the data directory using an external computer.
- USB ports – Used for transferring data to a USB memory device, or to connect a USB keyboard and mouse.
- Serial port (9 pin D-sub) – Not applicable.
- Video port (15 pin D-sub) – Connects an external monitor to the analyzer.
- ACC-Autoinject-P – To the ACC-Autoinject-P mini-autoinjector

Figure 5: Data Interface Connection Ports
Plumbing Diagram

When flushing dry air into the cavity, valve #2 is closed and valve #1 is open.

When the analyzer is pumping down, valve #1 is closed and valve #2 is open.

When the analyzer is measuring a sample, the cavity is pumped down and stable at ≈1 Torr, and both valves are closed.

Figure 6 shows the plumbing diagram for the GLA431 Liquid Water Series analyzer.
Inlet/Outlet Connections
The inlet and outlet ports are located on the back panel of the analyzer. (Figure 3) These ports are shown in detail in Figure 7.

The unit ships with inlets and outlets capped for protection. The connections use Swagelok fittings ISO thread size 1/4” and 1/2”. (Figure 7)

*Figure 7: Inlet/Outlet*
Warning Labels and Descriptions

This section describes the warning labels shown on the analyzer.
- Table 5 gives a description of the warning labels.
- Figure 8 shows the location of the labels on the analyzer.

### Table 5: Warning Labels and Descriptions

<table>
<thead>
<tr>
<th>Label</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="CAUTION Label" /></td>
<td>The laser is rated Class 3 (invisible laser radiation) when the housing is open. Only trained maintenance personnel may open the analyzer housing.</td>
</tr>
<tr>
<td><img src="image2" alt="DANGER Label" /></td>
<td>General laser warning label.</td>
</tr>
</tbody>
</table>

![Figure 8: Warning Label Locations](image3)
Specifications
This section provides the weight and dimensions of the analyzer. (Figure 9)

External Dimensions
11” H x 38” W x 22” D

Weight
40 kg

Figure 9: Front Panel Dimensions
Analyzer Setup

Connect the Power Cords
1. Connect the analyzer’s power cord from the AC power port on the back panel to a grounded outlet of your power supply. (Figure 4)
2. Connect the external pump’s power cord to the EXT. PUMP POWER port on the back panel of the analyzer. (Figure 4)

Connect the Analyzer Inlet/Outlet Connections
1. Connect the transfer tube to the analyzer:
   a. Connect the 1/8” Teflon tube with the attached 10 m screen filter from the TO SEPTUM port on the back of the analyzer (Figure 7) to the 1/4” fitting on the autoinjector septum arm. (Figure 175)

   ![NOTE]
   Always vent the analyzer cavity before changing the septum to prevent contamination of the cavity.

2. Connect the Drierite® laboratory drying unit:
   a. Remove the plastic plug from the bottom of the drying unit. (Figure 10)
   b. Connect the drying unit to the 1/4” Swagelok port, labeled DRY GAS INLET 0-5 PSIG, on the back of the analyzer using the provided 1/4” Teflon tubing. (Figure 7)
   c. Tighten the connection to 1/4 - 1/2 turn past finger-tight, leaving a gap of < 3.5 mm. (Figure 12)

![Figure 10: Drierite® Laboratory Gas Drying Unit]
When using dry gas from a cylinder or a house dry gas system, make sure that the inlet pressure is between 0-5 psig.

3. Connect the External Pump:
   a. Connect the External Pump’s 6’ x ½” Teflon tubing with Swagelok fittings from the external pump to the TO EXT PUMP port on the back panel of the analyzer. (Figure 7)
   b. The exhaust port is located on the pump. It can either be connected to the provided muffler (Figure 11) to expel exhaust into the room air, or the exhaust can be routed to the facility ventilation system.

*Figure 11: Exhaust Muffler*
Attach and Tighten the Swagelok Connectors
1. Tighten the Swagelok connections to between 1/4 and 1/2 turn past finger tight. Leave a gap of at least 3.5 mm as shown in Figure 12.
2. Table 6 lists the Swagelok fitting sizes and recommended wrench sizes.

![Figure 12: Swagelok Connection Gap](image)

<table>
<thead>
<tr>
<th>Table 6: Recommended Wrench Sizes for Swagelok Fittings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swagelok Fitting Size</td>
</tr>
<tr>
<td>------------------------</td>
</tr>
<tr>
<td>1/8&quot;</td>
</tr>
<tr>
<td>1/4&quot;</td>
</tr>
<tr>
<td>1/2&quot;</td>
</tr>
</tbody>
</table>

Connect the Data Interface Connections
1. See Figure 5 for a detailed description of the connections.
The PAL3 LSI Autoinjector

The PAL3 autoinjector allows a throughput of 800 injections per day. It communicates with the analyzer through a local network communication.

The PAL3 LSI User Manual contains additional diagrams, configuration data, and function control data to assist you when using the autoinjector with the analyzer. For additional information, including the latest documentation, visit http://www.palsystem.com/, or refer to CTC’s PAL3 User Manual Edition 9.1 pdf, which is included with the autoinjector.

Figure 13 shows a front view of the autoinjector.

Figure 13: PAL LSI autoinjector (Front View)
Unpack the Autoinjector

The PAL3 autoinjector is shipped in a box separate from the analyzer. It contains the PALbase, PAL arm, PALterminal, power supply, attached tray holder, attached injector port, trays, safety shield and provided accessories. The vertical arm is removed for protection and must be installed.

To unpack the PAL3 autoinjector:
1. Remove the top layers of foam and accessories from the box and set aside.
2. Having two people lift, carefully remove the autoinjector base and set onto a bench.

---

**WARNING**

Positioning the PAL3 is a two-person task. With one person on each side, safely lift the autoinjector out of the box and onto a flat surface.
Assemble the Autoinjector

To assemble the autoinjector:

1. Install the PALhead (vertical arm).
   a. Using the provided T-25 screwdriver, unscrew the 2 screws on the back side of the autoinjector. Save these screws! (Figure 14)
      i. The top screws removes the cover.
      ii. The lower screw unlocks the transport locking device.

   b. Set the cover aside.
   c. Remove the Transport Locking Device (black polymer circle). (Figure 15)
      i. Save the Transport Locking Device in the event that the autoinjector needs to be relocated.

Figure 14: Remove screws

Figure 15: Transport Locking Device
d. Lift the vertical arm onto the Y-axis by setting the arm on the two locating pins. (Figure 16)

---

**NOTE**

Have a second person hold the arm in place while the screws are being inserted.

---

*Figure 16: Locate pins on Y-axis and holes on vertical arm*

---

e. Use the provided T-25 screwdriver to tighten the vertical arm into place. Figure 17 shows the 2 screw holes.

*Figure 17: Tighten the vertical arm into place*

---

f. Press the ribbon cable from the vertical arm into the slot on the Y-axis. Set the protective metal cover over the ribbon cable and tighten with the 3rd screw.
g. Re-attach the cover, using the original screw. (Figure 18)

2. Install the Safety Guard.
   a. Install the provided safety guard brackets onto both sides of the autoinjector. The brackets are installed underneath the side covers of the x-axis, using the two holes at the REAR side. (Figure 19)
b. Attach the safety guard to both brackets. Carefully hold the safety guard in the proper position as you screw it into the brackets. Alternate screwing the safety guard into the left and right side until it is secure. (Figure 20)

For safety reasons, it is mandatory to install the Safety Guard to the PAL3 autoinjector. The Safety Guard marks the working boundary of the autoinjector and prevents the user from reaching into the running system.

3. Attach the display screen.
   a. Attach the metal display screen holder, underneath the side covers of the x-axis, using the 2 holes at the FRONT side. (Figure 21)
The keypad and holder can be installed on either side of the autoinjector.

b. Insert the display screen into the holder. (Figure 22)

![Figure 22: Display Screen mounted in holder](image)

4. Attach the cables to the back panel of the autoinjector:
   Figure 23 shows the back panel of the autoinjector.

![Figure 23: Autoinjector (Back Panel)](image)
a. Connect the black cord from the POWER port to the autoinjector power supply. (Figure 23 and Figure 24)

![Figure 24: Electrical Connections to PALrobot](image)

b. Connect the grey display screen cord to the TERMINAL port. (Figure 23 and Figure 24)

5. Connect the 5- port TP-Link Ethernet switch:
   a. Attach the power cord to the Ethernet switch and plug into your local power source.
   b. Connect one of the 3 Ethernet cables from the back panel of the PAL3 autoinjector (Figure 23) to any port on the switch. (Figure 25)

![Figure 25: TP Link Switch](image)

c. Connect an Ethernet cable from the back panel of the analyzer (Figure 3) to any port on the switch. (Figure 25)

d. Connect an Ethernet cable from the Ethernet switch to your local network. If no local area network (LAN) is available, refer to Appendix D: Wireless Router Setup for Liquid Water/PAL3 Autoinjector Compatibility on page 148 for wireless router setup and instructions.
The Dynamic Host Configuration Protocol (DHCP) is enabled on the PAL3 autoinjector to automatically assign an IP address to the autoinjector. To enter a unique static IP address, see Enter a Unique Static IP Address on page 179.

6. Place the three vial trays into the tray holder. (Figure 13)
7. Place the injector block alignment tool onto the septum cap of the injector block. (Figure 40)
8. Connect the circular three pin DIN connector from the autoinjector heater block (Figure 175) to the TO SEPTUM HEATER port on the back panel of the analyzer. (Figure 3)

The injector block is heated to ≈100 °C!
Use heat resistant gloves whenever you handle the injector block.

9. Connect the 1/8" Teflon tube with the attached 10µm screen filter from the autoinjector septum to the TO SEPTUM port on the back of the analyzer. (Figure 3)

Refer to Connect the Analyzer Inlet/Outlet Connections on page 25 for attaching the transfer tubing from the autoinjector to the analyzer.

10. Turn the autoinjector on by pressing the POWER ON switch on the power supply.
11. Store the cardboard box and the custom packing material carefully to reuse if the autoinjector is transported to a new location.
Figure 26 shows the Septum/Autoinjector connections on the analyzer.

Install the Septum

See *Routine Maintenance of the Septum, Sample Transfer Line, and Injector block* on page 115.
Function Keys

The button functions are as follows:

- **Menu Button A (Options):** Options for a particular menu are assigned to the corresponding function key on the left side.
- **Menu Button B (Default Action):** Reserved for default actions, such as Save, Next, OK, etc.
- **Back Button:** Return to the previous menu
- **Stop Button:** Aborts the ongoing activity

Figure 27 shows the autoinjector keypad and lists its features.

![Autoinjector Keypad Terminal](image)

*Figure 27: Autoinjector Keypad Terminal*
Adjust Software Settings

**NOTE**

The autoinjector software is pre-installed. Do NOT change the parameters unless the autoinjector software is not functioning properly.

This section details each step:
- Check the tray holder reference position
- Check the position of the three trays
- Check the position of the injection block
- Check the needle penetration depth of the vials

**Check the tray holder reference position**

1. Enter the sequence of commands, using the keypad dial wheel and center button as shown in Figure 27.

   To check the tray holder reference position:
   a. Scroll to *Tray Holder 1*. (Figure 28)

   ![Figure 28: Tray Holder 1](image)

   b. Press *Enter*
   c. Press *Options (Button A)*
d. Scroll to Check Teaching. (Figure 29)

![Image of Check Teaching]

**Figure 29: Check Teaching**

i. This confirms the x, y and z axes
ii. Press Enter
iii. The autoinjector will beep and the arm will move to the Teach point.
This disk is referred to as a Lunette. (Figure 30)

![Image of Lunette]

**Figure 30: The vertical arm moves to the teach point**
iv. Verify that the needle guide is centered on the lunette. (Figure 31)

![Figure 31: Needle guide is centered on the lunette](image)

v. Press **Next (Button B)**

vi. Press **OK (Button B)** to move the PALhead back to the *Home* position

![Figure 32: Move PALhead to home position](image)

vii. To return to the *Home* screen, press the **Back** button.
Check the position of the three vial trays

The vial tray parameters are pre-set, using the provided vials and caps. If you use a different style vial and cap, the parameters may need to be reset. Refer to Appendix: The PAL3 LSI Autoinjector on page 171 for details on how to teach vial positions.

To check the position of the vial trays:

1. Place 3 trays onto the tray holder. (Figure 33)
   The tray holder is labeled #1, #2 and #3 for each tray.

   ![Figure 33: 3 trays on the tray holder](image)

2. Place 3 vials with caps in positions 1, 46 and 54 of each tray. (Figure 34)

   ![Figure 34: Positions 1, 46, and 54](image)
3. Enter the sequence of commands using the keypad dial wheel and center button as shown in Figure 27.
   a. On the Home Screen, scroll to Tray Holder 1. Press Enter. (Figure 35)

   ![Figure 35: Tray Holder 1](image)

   b. Scroll to Slot 1. (Figure 36)

   ![Figure 36: Slot 1](image)

   c. Press Enter
d. Select Rack 1. Enter. (Figure 37)

![Figure 37: Rack 1](image)

e. Press Options (Button A)
f. Scroll to Check Teaching. This will confirm the x, y and z-axes. (Figure 38)

![Figure 38: Check Teaching](image)
g. Press Enter.

h. Press Check (Button B). The arm will move to Vial #1 in Tray #1.

i. Confirm that the needle is centered over the vial.

---

NOTE

The needle guide must be centered over the vial in position 1 to prevent syringe breakage.

---

j. Press Next (Button B) to prepare the module for checking the next vial position.

k. Press Check (Button B). The arm will move to Vial #46 in Tray #1.

l. Confirm that the needle is centered over the vial.

m. Press Next (Button B) to prepare the module for checking the next vial position.

n. Press Check (Button B). The arm will move to Vial #54 in Tray #1.

o. Confirm that the needle is centered over the vial.

p. Press Next (Button B)

q. Press OK to move the PALhead back to Home position (Button B). (Figure 39)

---

Figure 39: Move PALhead back to Home

r. Press Back 2 times to return to the Tray Holder 1 folder.

s. Scroll to Slot 2 and press ENTER.

t. Repeat steps d through q to define Tray 2 positions.

u. Press Back 2 times to return to the Tray Holder 1 folder.

v. Scroll to Slot 3 and press ENTER.

w. Repeat steps d through q to define Tray 3 positions.
Check the Position of the Injection Port

1. Place the provided Syringe Alignment Tool onto the septum cap. (Figure 40)

NOTE

This tool remains on the septum cap during injections to guide the syringe into the proper location.

2. Enter the sequence of commands using the keypad dial wheel and center button as shown in Figure 27.
3. On the Main Menu, scroll to Injector LC 1. (Figure 41)

![Select Injector LC 1](image)

**Figure 41: Injector LC 1**

- a. Press Enter
- b. Press Options (Button A)
- c. Scroll to “Check Teaching”. (Figure 42)
  - i. This will confirm the x, y and z-axes.

![Check Teaching](image)

**Figure 42: Check Teaching**

d. Press Enter

e. Press Check (Button B)
f. The arm will move to the teach point (TP) of the heated injector block. (Figure 43)
g. Confirm that the black conical syringe guide sits securely within the syringe alignment tool. (Figure 43)

![Figure 43: Syringe Guide](image)

h. Press **Next (Button B)**
i. Press **OK (Button B)** to move the PALhead back to the home position.
Check the Needle Penetration Depth

This step needs to be performed anytime that a new vial type or vial insert is used. Switching vial types can result in syringe breakage.

1. Remove trays #2 and #3 from the Tray Holder. (Figure 33)
2. Put a vial without a cap into Vial Position #52. There is a cut-out in the tray that will allow you to see the vial.
   a. If you are using inserts, place a vial insert into the vial.
3. Insert a syringe into the syringe holder. Refer to the Install the Syringe section on page 53.
4. Enter the sequence of commands using the autoinjector keypad dial wheel and center button. (Figure 27)
   a. Press A and B Menu Buttons simultaneously to change Access Level.
   b. Scroll to Extended User Level.
      Note: The Extended User Level allows certain parameters to be adjusted, such as X, Y and Z axes and position teaching.
   c. Press Enter
d. On the Home Screen, scroll to Tray Holder 1. Press Enter. (Figure 44)

![Figure 44: Tray Holder 1](image)

![Select Tray Holder 1](image)

e. Scroll to Slot 1. (Figure 45)

![Figure 45: Slot 1](image)

![Select Slot 1](image)

f. Press Enter.
g. Select Rack 1. (Figure 46)

![Figure 46: Rack 1]

h. Press **Options** (Button A)

i. Scroll to **Check Needle Penetration**. (Figure 47)

![Figure 47: Check Needle Penetration]

j. Press **Enter**.

k. The autoinjector arm will move the syringe above the vial, but will remain at 0 mm.
I. Carefully, turn the dial to insert the needle in millimeter increments until the desired depth has been reached. The user will add this value to the analyzer software in the following steps. Example: 32mm is an appropriate setting for the provided vials.

---

**NOTE**

**Caution:** Do NOT touch the tip of the needle to the base of the vial to prevent the syringe from breaking.

---

m. On the liquid water analyzer, enter **Setup** mode:
   i. Click the **Setup** button on the **User Interface Control Bar**. (Figure 48)

![Figure 48: User Interface Control Bar](image)

n. Select the **Autoinjector** tab at the top of the screen. (Figure 49)

![Figure 49: Autoinjector Tab](image)

o. Enter the desired **Penetration Depth [mm]** value that was determined by the autoinjector. (Figure 49)
Install the Syringe

Manual priming is recommended for 1.2 µL Hamilton syringes before installation.

**Priming the syringe:**
Actuate the syringe in deionized water, or NMP syringe lubricant (1-Methyl-2-pyrrolidinone, Sigma Aldrich).
- If syringe lubricant is used, refer to *Caring for Syringes* on page 127 for proper use.
- Make sure that the syringe has some resistance when manually actuated.

**Installing the syringe:**
1. Scroll to *LS1 1.2uL; NL: 57mm*
2. Press **Enter**
3. Press **Options (Button A)**
4. Select *Change Syringe*
5. Press **Enter**
6. Press **Move (Button B)**
   a. The injector arm will move to the change syringe position.
7. To install the syringe:
   a. Remove the black polymer *Bayonet Nut* by twisting counter-clockwise and lifting upward. (Figure 50)

**Figure 50: Remove the Bayonet Nut**
b. Slide the flat side of the syringe into the groove of the upper section of the holder. Position the tip of the needle into the upper and lower needle guide by slowly lowering the syringe. Then, place the syringe flange into the holder. (Figure 51)

![Figure 51: Insert the Syringe into the Adapter](image)


c. Place the Bayonet Nut over the syringe plunger and into the grooved upper section of the Syringe Adapter. To keep the syringe in its precise position, secure the black polymer Bayonet Nut by twisting clockwise until it clicks into place. (Figure 52)

![Figure 52: Secure the syringe with the Bayonet Nut](image)
d. Push the Plunger Coupling Adapter towards the Syringe Plunger Adapter so that it touches the coupling device. The Plunger Coupling Adapter should connect with the Syringe Plunger. (Figure 53)

8. To remove the syringe:
   a. Pull the Plunger Coupling Adapter in an upward position so that the Syringe Plunger Adaptor can be ejected.
   b. Raise the Releasing Holding Pin of the coupling device. The Ejector is equipped with a spring that causes the Syringe Plunger Adapter to release.
   c. To release the syringe, twist the black polymer Bayonet Nut clockwise. (Figure 54)
d. Slowly remove the syringe from the *Syringe Adapter* by lifting it upwards. (Figure 55)

![Image of Syringe Adapter](image)

*Figure 55: Lift the syringe out of the Syringe Adapter*

9. Press **Next (Button B)**
10. Press **Back** to go to the *Main Menu*
Pair the Autoinjector with the GLA431 Liquid Water Series Analyzer

The PAL3 autoinjector communicates with the analyzer through the provided 5-port Ethernet Switch. (Figure 25)

To pair the PAL3 autoinjector with the analyzer:

1. Within the analyzer’s Setup menu, click on the Find auto injector(s) tab. (Figure 56)

![Autoinjector tab on Setup Menu](image)

2. The IP address of the autoinjector will appear on the screen
   a. For details on how to locate the IP address of the autoinjector, refer to page 178.

![IP Address Example](image)
Prepare Samples for Analysis

To prepare water samples:
1. If the sample contains visible particulates, filter the sample using very fine filter paper (Advantec MFS® grade No. 235 or similar).
   a. Samples that contain high concentrations of contaminants (for example, volatile organics or proteins) may require additional sample preparation.
2. Fill the provided 2 mL sample vial with 0.5 – 1.5 mL water sample or standard using a disposable pipette (glass or polyethylene).
   a. Use each pipette for a single water sample to avoid cross-contamination between samples.
   b. Do NOT overfill the vial as this results in abnormally high-injected volumes.
   c. If vial inserts are used for low volume samples, adjust the needle penetration depth accordingly (as detailed in the PAL LSI User Manual) to avoid needle breakage.
3. Immediately after taking the sample, cap the vial, using the provided vial caps.
4. Dispose of the pipette tip.
5. Repeat steps 1 through 4 for each sample or standard.

- The Liquid Water Isotopic analyzers are designed to measure isotope ratios in clean waters with salinities ranging from 0-4 g/L.
- Salty or dirty samples (i.e: brines and turbid waters) can damage the syringe and leave residue in the injector block and sample transfer line, which will affect future measurements. Frequent cleaning of the injector block may be required.
- If saline samples are measured, they must be alternated with freshwater samples/standards to prevent excessive salt deposition in the syringe.
Prepare Biological Samples for Analysis

This procedure applies to sample preparation and measurement of plasma, urine and saliva samples for deuterium and $^{18}$O content versus known standards on the TLWIA. The proteins in plasma and saliva samples must be precipitated by zinc sulfate. Urine samples do not require protein precipitation. The deuterium and $^{18}$O content of unknown samples shall be determined using a calibration curve.

To prepare plasma or saliva samples for analysis:

1. Label the appropriate number of microcentrifuge tubes for the number of samples to be prepared (Microcentrifuge tube, disposable, conical, 1.5 mL, VWR, catalog number 20170-038 or equivalent)
2. Add 200 µL each plasma or saliva, as well as any controls to be run that are plasma or saliva-based, to the corresponding microcentrifuge tube. A volume of 30-250 µL of plasma or saliva is acceptable for preparation.
3. Add approximately 5 mg of zinc sulfate monohydrate to each sample, and cap the tube (Zinc sulfate monohydrate, Sigma-Aldrich, catalog # 307491 or equivalent.)
4. Vortex the tubes for 15 seconds, using Vortex mixer (Vortex-Genie or equivalent)
5. Place the microcentrifuge tubes in the centrifuge (Helena Laboratories, model 7040, serial number 028530301 or equivalent)
6. Centrifuge at 8,000 rpm for 10 minutes.
7. Place a glass insert into each LC-PAL autoinjector vial (Clear glass flanged insert, mandrel point, <300 µL, Advantage Molding Products catalog number #100149 or equivalent)
8. Transfer 10 µL (minimum) to 75 µL (maximum) supernatant of plasma or saliva to an autoinjector vial.
   a. Check that no small air bubbles have formed in the conical insert. If bubbles are present, remove them by tapping the vial on a bench top until the air bubble is removed.

To prepare urine samples for analysis:

1. If the sample contains visible particulates, filter the sample using very fine filter paper (Advantec MFS® grade No. 235 or similar).
2. Place a glass insert into each LC-PAL autoinjector vial (Clear glass flanged insert, mandrel point, <300 µL, Advantage Molding Products catalog number #100149 or equivalent)
3. Transfer 10 µL (minimum) to 75 µL (maximum) supernatant of urine without dilution to an autoinjector vial.
   a. Check that no small air bubbles have formed in the conical insert. If bubbles are present, remove them by tapping the vial on a bench top until the air bubble is removed.
Initialize and Run the Analyzer

To initialize the analyzer:

1. Press the power switch located on the front of the external pump to the **ON** position.
2. Press the power switch located on the Autoinjector power supply to the **ON** position.
3. Press the power switch on the front of the analyzer to the **ON** position. (0 = OFF / - = ON)
4. The internal computer initializes, and a screen (Figure 58) displays as the program loads.

![Figure 58: Start-up Screen in Busy Mode](image)

5. The **Launch Service** screen displays after initialization. (Figure 60)
6. Click on the *(T)LWIA* button to manually launch the analyzer. (Figure 60)
   a. If you do not make a selection within 120-seconds, the analyzer automatically defaults to the **Configuration** display. (Figure 64)
7. Click on the maintenance **SERVICE** button (Figure 60) if you need more time or need to choose a maintenance setting. (Figure 61)
File System Integrity Check
Once a month, the analyzer automatically performs a file system integrity check following initialization. Figure 59 shows the screen you see while the integrity check runs. The integrity check runs for one to two minutes before launching the analyzer’s control software.

---

**WARNING**

Do not turn off the computer while the integrity check is running.

---

![File System Integrity Check Screen](image)

*Figure 59: File System Integrity Check Screen*

---

Thermal Stabilization

Run the analyzer for four hours before collecting data. This allows the internal temperature to stabilize. The exact final cell temperature will be analyzer specific (≈45°C).
The Launch Service Screen

The *Launch Service* screen displays when initialization is complete. From this interface, you can:

- Bypass the auto launch countdown by clicking **TLWIA**.
- Open the auto launch window by clicking **Service**.
- Turn off the analyzer by clicking **Shutdown**.

Figure 60 shows the *Launch Service* screen.
The Auto Launch Screen

The Auto Launch and Maintenance settings are available when you click the Service button on the Launch Service screen. From this interface, you can:

- Change the auto launch delay timing.
- Transfer files from the internal hard drive to an external storage device connected via USB by clicking Files.
- Restore the analyzer’s factory settings by clicking Restore.

Figure 61 shows the Auto Launch screen.
Main Panel
After the software launches, the Main Panel is displayed. (Figure 62)

This panel contains the User Interface Control Bar (Figure 63) and the Configuration Display. (Figure 64)

User Interface Control Bar
Use the control bar to operate the analyzer.

- To select the 3 display screens
- Displays analyzer details
- To access additional service menus
- To shut down the analyzer
- Not applicable
- For file transfer to external device

Figure 63: User Interface Control Bar
Display – Toggles through the three Main Panel display formats:

- **Configuration Display** – Default display. Displays configuration settings and available controls to set up analyses. (Figure 64)
- **Spectrum Display** – Displays the raw and fitted spectral scans for both lasers. Analyzers may be equipped with 1 or 2 lasers. (Figure 70 and Figure 71)
- **Run Display** – Shows the sequence of measurements. (Figure 69)

Rate – Not applicable

Parameter Window – Displays the:

- Time – Current time
- Data File – Current filename to log data
- Gas Temperature – Temperature in Cell (Celsius - °C)
- Gas Pressure – Pressure in Cell (Torr)
- Laser A τ – Laser A ring-down time (micro-seconds - µs)
- Laser B τ – Laser B ring-down time (micro-seconds - µs)
  - Only applicable for two laser systems
- Rate – Sampling Frequency
- Disk Space – Remaining hard-drive space

Files – Allows easy transfer of files onto USB storage devices.

Setup – Accesses additional configuration and service menus.

Exit – Exits the application and shuts down the analyzer. Note: the analyzer will perform a 3-minute venting cycle before shutdown.
Main Panel Display Screens

Configuration Display

The configuration display appears when the analyzer is first turned on or rebooted. It is used to:

- Set up the analyzer’s sampling parameters
- Configure and make measurement runs
- Save new configurations
- Load saved configurations in the default or LIMS format

This section explains how to use the interface. It consists of the:

- Tray Population pane
- Samples to Measure pane
- Standards to Measure pane

The Example Run Configurations section on page 98 shows example configurations created by ABB-LGR that you can use as a starting point to build your own custom configurations.

Figure 64: Configuration Display
Tray Population
The Tray Population Pane contains information about the samples and standards to measure. Use this pane to:

- Assign custom names
- Assign trays and positions within the tray
- Add comments for each sample or standard

Click on the Available Samples or Available Standards tabs to add a new entry as a sample or standard, or to see existing samples and standards. (Figure 65)
Table 7 explains how to use the Tray Population pane.

**Table 7: Using the Tray Population Pane**

<table>
<thead>
<tr>
<th>Task</th>
<th>Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Add samples to population.</td>
<td>1. Select the <em>Available Samples</em> tab.</td>
</tr>
<tr>
<td></td>
<td>2. Click the <strong>Add Item</strong> icon</td>
</tr>
<tr>
<td></td>
<td>3. Enter a custom:</td>
</tr>
<tr>
<td></td>
<td>• Name</td>
</tr>
<tr>
<td></td>
<td>• Tray position</td>
</tr>
<tr>
<td></td>
<td>• Vial position</td>
</tr>
<tr>
<td></td>
<td>• Comment (optional)</td>
</tr>
<tr>
<td>Add standards to population.</td>
<td>1. Select the <em>Available Standards</em> tab.</td>
</tr>
<tr>
<td></td>
<td>2. Click <strong>Add Item</strong> icon</td>
</tr>
<tr>
<td></td>
<td>3. Enter a custom:</td>
</tr>
<tr>
<td></td>
<td>• Name</td>
</tr>
<tr>
<td></td>
<td>• Tray position</td>
</tr>
<tr>
<td></td>
<td>• Vial position</td>
</tr>
<tr>
<td></td>
<td>• Comment (optional)</td>
</tr>
<tr>
<td>Change default tray for adding new items to</td>
<td>Choose a different tray number from the <em>Put New Vials in Tray</em> selection.</td>
</tr>
<tr>
<td>tray population.</td>
<td>Subsequently added items default to this new tray selection.</td>
</tr>
<tr>
<td>Remove items from tray population.</td>
<td>1. Select the item.</td>
</tr>
<tr>
<td></td>
<td>2. Click the <strong>Remove Item</strong> icon</td>
</tr>
</tbody>
</table>
Samples To Measure
The Samples To Measure pane lists the items you select as samples for the measurement run. (Figure 66)

![Samples To Measure](image)

*Figure 66: Samples To Measure*

Table 8 describes how to use this pane.

**Table 8: Using the Samples To Measure Pane**

<table>
<thead>
<tr>
<th>Task</th>
<th>Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Add item to Samples to Measure</td>
<td><strong>1.</strong> Select an item from the Available Samples in the Tray Population pane. <strong>2.</strong> Click the upper green arrow icon. To add multiple measurement sets for selected samples, use the spinner control below the green arrow button.</td>
</tr>
<tr>
<td>Remove Items from Samples to Measure</td>
<td><strong>1.</strong> Select the item. <strong>2.</strong> Click the Remove Item icon.</td>
</tr>
<tr>
<td>Prep Inj/Vial: Preparatory Injections for each item in the Samples to Measure and Standards to Measure lists</td>
<td>These injections help to mitigate memory effects. The injections are not measured and therefore do not contribute to the final measured values of a sample or standard. The number you choose depends on the type of samples and standards being measured. Refer to Injection Pattern Conventions on page 102 for details.</td>
</tr>
<tr>
<td>Measured Inj/Vial</td>
<td>Each injection contributes to the final measured values of a sample or standard. The number you choose depends on the type of samples and standards being measured.</td>
</tr>
</tbody>
</table>
Standards To Measure
The Standards to Measure pane lists items to characterize as standards for the measurement run. (Figure 67)

![Image of Standards To Measure pane]

**Figure 67: Standards To Measure**

Table 9 explains how to use this pane.

**Table 9: Using the Standards To Measure pane**

<table>
<thead>
<tr>
<th>Task</th>
<th>Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Add an item to the <strong>Standards to Measure</strong> list.</td>
<td>1. Select an item from the <strong>Available Standards</strong> in the <strong>Tray Population</strong> pane.</td>
</tr>
<tr>
<td></td>
<td>2. Click the lower green arrow.</td>
</tr>
<tr>
<td>Add multiple injection sets for selected standards.</td>
<td>To add multiple injection sets for selected standards, use the spinner control below the green arrow button.</td>
</tr>
<tr>
<td>Remove Items from <strong>Standards to Measure</strong>.</td>
<td>1. Select the item</td>
</tr>
<tr>
<td></td>
<td>2. Click the <strong>Remove Item icon</strong>.</td>
</tr>
<tr>
<td>Start with</td>
<td>Begins the measurement run with either a standard or sample set.</td>
</tr>
<tr>
<td>Run After x samples</td>
<td>Set the interleave interval to determine the frequency with which standards will be interleaved with samples.</td>
</tr>
<tr>
<td>Standard Interleave Type</td>
<td>The drop down selection box lets you select between running one standard per sample set, or running a whole standard group per sample set.</td>
</tr>
<tr>
<td>Complete standard set at beginning and end</td>
<td>The run begins with a complete standard set before measuring samples and also ends with the complete standard set. By bracketing the measurement run with standards you can use a spline fit in the analysis.</td>
</tr>
</tbody>
</table>
Additional Run Configuration Actions

Use the four highlighted buttons shown in Figure 68 to import, load, save, or set run configurations.

![Figure 68: Additional Run Configuration Button Controls](image)

Table 10 explains how to use these buttons.

**Table 10: Using Additional Run Configuration Buttons**

<table>
<thead>
<tr>
<th>Task</th>
<th>Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>LIMS Import</td>
<td>Use this pane to import injection lists that have been exported from LIMS databases or Excel spreadsheets. The file dialog used to select the *.csv to be loaded is accessed by clicking the <strong>LIMS Import</strong> button on the <strong>Configuration Display</strong>.</td>
</tr>
</tbody>
</table>
| Load Cfg   | Load a saved configuration file:  
  1. Click **Load Cfg**.  
  2. Navigate to the saved location of your configuration file.  
  3. Click **Open**. |
| Save Cfg   | To save the current configuration, click **Save Cfg**. The configuration file is saved as an ASCII text file (.vial file extension). This file contains all the parameters from the **Configuration display** and the autoinjector settings within the **Setup Menu**. (Figure 82) |
| Make Run   | Use this button to set the run configuration (shown in the Run Display) from the current settings. Click **Make Run** to set the run configuration. |
Run Display

Click the Display button on the User Interface Control Bar to switch to the Run Display. (Figure 69)

The Run Display shows the sequence of injections that were populated in the Configuration Display. (Figure 64)

![Run Display Image]

Table 11 describes the columns within the Run Display.

**Table 11: Run Display Column Fields and Descriptions**

<table>
<thead>
<tr>
<th>Column Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td>Sample/Standard name</td>
</tr>
<tr>
<td>S/N</td>
<td>Serial number</td>
</tr>
<tr>
<td>Tray</td>
<td>Tray number (1-4)</td>
</tr>
<tr>
<td>Pos</td>
<td>Position of the vial within the tray (1-54)</td>
</tr>
<tr>
<td>Comment</td>
<td>Optional comment added to a sample/standard</td>
</tr>
<tr>
<td>Flag</td>
<td>Performance flags for each injection</td>
</tr>
<tr>
<td>H2O_N/cm3</td>
<td>Water number density (H$_2$O$_N$/cm$^3$)</td>
</tr>
<tr>
<td>Raw delta D</td>
<td>Uncorrected raw delta D values</td>
</tr>
<tr>
<td>Raw delta 18O</td>
<td>Uncorrected raw delta $^{18}$O values</td>
</tr>
<tr>
<td>Raw delta 17O</td>
<td>Uncorrected raw delta $^{17}$O values</td>
</tr>
</tbody>
</table>
Within this screen, you can start and stop a configured run. To start a run:

1. Click the **Start** button.
   a. The analyzer goes through a flush cycle, filling the measurement cavity with dry air and then purging for approximately one minute to remove residual water.

2. The autoinjector vertical arm moves to the first vial position and transfers $\approx 1\mu L$ of water into the injection port.

3. The needle remains in the port for 20 seconds, withdraws, and holds for 3 seconds to assure complete sample evaporation.

4. The analyzer records 30 measurements of the injection.
   a. Note: the final value displayed within the raw delta D, raw delta 18O, and raw delta 17O columns is the last measurement, NOT an average of the 30 measurements.

5. Once the measurement is complete, a performance flag is displayed, indicating the status of each injection.
   a. Refer to *Troubleshooting Injection Performance Flags* on page 131 for details.

6. The data is logged to the current log file when the run is complete or when you click **Stop**. (Figure 69)

---

**NOTE**

The *Raw delta D*, *Raw delta 18O*, and *Raw delta 17O* values displayed on the Run Display are uncorrected raw values for the isotope ratios. For instructions on how to analyze the recorded data and obtain corrected isotope ratios, see *Data Analysis* on page 112.

---

The user can stop or pause a run that is in progress:

- To stop a run, click the **Stop** button. (Figure 69)
  - Note: You must return to the *Configuration Display* and click **Make Run** to restart the run. (Figure 68)

- To pause a run, click **Pause**. (Figure 69)
  - To resume after a pause, click **Next**.

---

**NOTE**

When selecting Stop or Pause, the current injection will be completed before pausing or stopping the run.
Spectrum Display

Click the **Display** button on the *User Interface Control Bar* to switch to **Spectrum Display**.

Figure 70 and Figure 71 show the **Spectrum Display** for the GLA431-TLWIA.

The top plot shows the voltage from the photo-detector as the laser scans across the three main isotopomers of H₂O absorption features (near 1.38 microns).

- For example, Figure 70 shows the optical absorption fraction due to H₂¹⁸O, H₂¹⁶O and HOD in black, and the spectral fit resulting from signal analysis in blue.
  - The peak at ~ 4.0 GHz is due to H₂¹⁸O
  - The peak at ~ 1.0 GHz is due to H₂¹⁶O
  - The peak at ~ 6.0 GHz is due to HOD

The bottom plot shows the corresponding optical absorption displayed as black circles, and the peak fit resulting from signal analysis as a blue line.

The **Triple Liquid Water Isotopic Analyzer** is a dual-laser system. The **drop-down selector** in the lower right portion of the **Spectrum Display** lets you toggle between the two lasers:

- Laser A (also referred to as laser A) displays the H₂¹⁸O, H₂¹⁶O, and HOD peaks. (Figure 70)
- Laser B (also referred to as laser B) displays the H₂¹⁷O and H₂¹⁶O peaks. (Figure 71)

---

**Figure 70: Spectrum Display for Laser A (GLA431-TLWIA and GLA431-LWIA)**
For Laser A (Figure 70), the transmission spectrum (top panel) should have a maximum of 0.3-6.0 Volts and show three marked dips due to water absorption features. The absorption spectrum (bottom panel) should show absorption on the order of 5% to 60%. The large, central peak near -1.0 GHz should be roughly centered in the shaded grey box.

For Laser B (Figure 71), the transmission spectrum (top panel) should have a maximum of 0.3-6.0 Volts and show three marked dips due to water absorption features. The absorption spectrum (bottom panel) should show absorption on the order of 5% to 60%. The peak near -3.0 GHz should be roughly centered in the shaded grey box.
File Transfer Menu

Use the File Transfer menu to access data collected by the analyzer.

- Each time the analyzer is re-started, three files are created (f, l and s) with the most recent file name displayed in the form: tlwia_2020-12-29_f0001.txt, where the:
  - First characters represent the analyzer model (Example: tlwia)
  - Next 10 characters represent the date (yyyy-mm-dd)
  - A letter indicating each file type:
    - f – standard data file
    - l – long format data file
    - s – spectra data file
  - Last four numbers are a serial number.
    - The serial number counts upward to provide up to 10,000 unique file names each day.

If the analyzer is left in continuous operation, a new data file will automatically be created every 24 hours to keep data file sizes manageable.

Figure 72 shows a standard data file for the GLA431-TLWIA.

<table>
<thead>
<tr>
<th>Time, Injection No.</th>
<th>Vial Name</th>
<th>Vial 2/3</th>
<th>Trap Flow</th>
<th>[S(18O)]_2H</th>
<th>[S(18O)]_2H, 1D</th>
<th>SR, 1D</th>
</tr>
</thead>
<tbody>
<tr>
<td>06/15/2015 14:50:00.00</td>
<td>1</td>
<td>LBRC, LBRC, LBRC</td>
<td>1.4</td>
<td>2.0965e+16, 2.0513e+13</td>
<td>1.2856e+04</td>
<td>1.2856e+04</td>
</tr>
<tr>
<td>06/15/2015 14:51:57.00</td>
<td>1</td>
<td>LBRC, LBRC, LBRC</td>
<td>1.4</td>
<td>2.0965e+16, 2.0513e+13</td>
<td>1.2856e+04</td>
<td>1.2856e+04</td>
</tr>
<tr>
<td>06/15/2015 14:53:53.00</td>
<td>1</td>
<td>LBRC, LBRC, LBRC</td>
<td>1.4</td>
<td>2.0965e+16, 2.0513e+13</td>
<td>1.2856e+04</td>
<td>1.2856e+04</td>
</tr>
<tr>
<td>06/15/2015 14:55:06.00</td>
<td>1</td>
<td>LBRC, LBRC, LBRC</td>
<td>1.4</td>
<td>2.0965e+16, 2.0513e+13</td>
<td>1.2856e+04</td>
<td>1.2856e+04</td>
</tr>
<tr>
<td>06/15/2015 14:56:40.00</td>
<td>1</td>
<td>LBRC, LBRC, LBRC</td>
<td>1.4</td>
<td>2.0965e+16, 2.0513e+13</td>
<td>1.2856e+04</td>
<td>1.2856e+04</td>
</tr>
<tr>
<td>06/15/2015 15:00:16.00</td>
<td>1</td>
<td>LBRC, LBRC, LBRC</td>
<td>1.4</td>
<td>2.0965e+16, 2.0513e+13</td>
<td>1.2856e+04</td>
<td>1.2856e+04</td>
</tr>
<tr>
<td>06/15/2015 15:01:09.00</td>
<td>1</td>
<td>LBRC, LBRC, LBRC</td>
<td>1.4</td>
<td>2.0965e+16, 2.0513e+13</td>
<td>1.2856e+04</td>
<td>1.2856e+04</td>
</tr>
<tr>
<td>06/15/2015 15:02:51.00</td>
<td>1</td>
<td>LBRC, LBRC, LBRC</td>
<td>1.4</td>
<td>2.0965e+16, 2.0513e+13</td>
<td>1.2856e+04</td>
<td>1.2856e+04</td>
</tr>
</tbody>
</table>

Figure 72: Triple Liquid Water Isotopic Analyzer Data File
File Type Details

The following data files show examples for the GLA431-TLWIA.

Standard Data File:
t_lwiaDDMMYYYY_fxxxx.txt
This file is used for data processing. Table 12 lists and describes the standard data file columns.

Long Format Data File:
t_lwiaDDMMYYYY_lxxxx.txt
This file is for diagnostic purposes and may be requested by ABB-LGR to diagnose an issue.

Spectra Data File:
t_lwiaDDMMYYYY_sxxxx.txt
This file is for diagnostic purposes and may be requested by ABB-LGR to diagnose an issue. It is not needed for regular data analysis.

Library Information Management System (LIMS):
t_lwiaDDMMYYYY_xxxx_LIMS.csv
This file contains data in LIMS format.
- LIMS is a Microsoft Access database program for managing samples, analyses, reports, and other data in a stable isotope laboratory.
- For more information about the Laboratory Information Management System (LIMS), visit the website: http://water.usgs.gov/software/LIMS/.

Data files also contain:
- Columns labeled with suffix_sd. These columns contain the measured standard deviation for the column without the _sd suffix.
- Encoded analyzer settings, which are recorded for diagnostic or troubleshooting purposes.
Table 12 describes the standard data file columns.

**Table 12: Standard Data File Column Names and Descriptions**

<table>
<thead>
<tr>
<th>Column Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time</td>
<td>Timestamp of recorded injection</td>
</tr>
<tr>
<td>Injection No.</td>
<td>Injection number</td>
</tr>
<tr>
<td>Vial Name</td>
<td>Sample name</td>
</tr>
<tr>
<td>Vial S/N</td>
<td>Sample serial number</td>
</tr>
<tr>
<td>Tray-Pos</td>
<td>Tray number and position of the vial within the tray</td>
</tr>
<tr>
<td>[H2Oa]_ND</td>
<td>Water number density (H2O_N/cm3)</td>
</tr>
<tr>
<td>DHr</td>
<td>Raw D/H atomic ratio for each injection</td>
</tr>
<tr>
<td>O18O16r</td>
<td>Raw molecular ratio of H$<em>{2}^{18}$O/H$</em>{2}^{16}$O</td>
</tr>
<tr>
<td>O17O16r</td>
<td>Raw molecular ratio of H$<em>{2}^{17}$O/H$</em>{2}^{16}$O (only applicable for 2 laser systems)</td>
</tr>
<tr>
<td>Raw_D_del</td>
<td>RAW $\delta$ D for each injection</td>
</tr>
<tr>
<td>Raw_O18_del</td>
<td>RAW $\delta$ 18O for each injection</td>
</tr>
<tr>
<td>Raw_O17_del</td>
<td>RAW $\delta$ 17O for each injection (only applicable for 2 laser systems)</td>
</tr>
<tr>
<td>WideBandM</td>
<td>Spectral Interference Metric (interpreted by the Post-Processor)</td>
</tr>
<tr>
<td>NarrowBandM</td>
<td>Spectral Interference Metric (interpreted by the Post-Processor)</td>
</tr>
<tr>
<td>GasP_tor</td>
<td>Cavity Pressure (Torr)</td>
</tr>
<tr>
<td>GasT_C</td>
<td>Cavity Temperature (Celsius° C)</td>
</tr>
<tr>
<td>RD0_us</td>
<td>Ringdown time (in microseconds) of laser A</td>
</tr>
<tr>
<td>RD1_us</td>
<td>Ringdown time (in microseconds) of laser B (only applicable for 2 laser systems)</td>
</tr>
<tr>
<td>Flag</td>
<td>Injection performance flags for current run</td>
</tr>
</tbody>
</table>
Transfer Data Files

To transfer data files from the analyzer hard drive to a USB storage device:

1. Click the Files button on the User Interface Control Bar (Figure 63) to access the File Transfer Menu. (Figure 73)
2. Insert a USB storage device into the USB port on the back panel of the analyzer.
3. Click on the Mount USB button. (Figure 73)
4. Transfer data files from the analyzer hard drive to a USB storage device by dragging and dropping the files from the hard drive pane to the USB device pane. Use the left mouse button to highlight one or multiple files in the window.

The directory windows default to the local hard drive on the left screen and the USB memory device on the right.

Navigate through folders, create new folders, and delete files and folders.

![Figure 73: File Transfer Menu: Local Hard Drive (left pane) and USB Flash Drive (right pane)](image)

**NOTE**

USB drives should be no larger than 8GB. They must be FAT32 formatted.
When you have finished transferring files:

5. Click the **Unmount USB** button. (Figure 73)
   Wait for the *Safe to Remove USB Memory Device* message before removing the USB memory device.

6. Click **Close** to exit the *File Transfer Menu*. (Figure 73)

---

**NOTE**

Removing the USB memory device before seeing the *Safe to Remove* pop-up message may result in loss of data.
Types of directories in the local hard drive

The analyzer hard drive contains two types of directories:

- Daily Directory
- Archive Directory

**Daily Directory**
The local hard drive (Figure 73) creates a daily folder containing new data files for each day that the analyzer operates.

To access the data files for a specific date, double-click the folder. Three unique files are created each time the **Start** button is pressed on the **Run Display**. (Figure 69) Refer to **File Type Details** on page 77 for information on each file type.

Each file is a single zipped .txt file, using the following convention: (Figure 74)

- (t)lwia_YYYY-MM-DD_f0000.txt.zip
- (t)lwia_YYYY-MM-DD_l0000.txt.zip
- (t)lwia_YYYY-MM-DD_s0000.txt.zip

Figure 74 shows Examples of files in the daily directory for the GLA431-TLWIA.

![Figure 74: Daily Directory (GLA431-TLWIA)](image)
Archive Directory
The local hard drive (Figure 73) creates an archived folder containing zipped files organized by date. (Figure 75)

To access the archived files, double-click the Archive folder. (Figure 73)

Each file is a single zipped .txt file, using the following convention: YYYY-MM-DD.zip. Each zipped file contains the data files for the day that the analyzer operated.

An example of files in the archive directory is shown in Figure 75.

Figure 75: Archive Directory
File Transfer Error Screen

The *File Transfer Error screen* (Figure 76) displays when:

- The USB Key does not have enough storage space.
- The device is not recognized.

Try again with a correctly inserted USB device.

![Copy operation was aborted or failed due to a full USB key.](image)

*Figure 76: File Transfer Error*
Setup Menu

The Setup menu allows access to additional configurations and services.

To enter Setup mode:

1. Click the Setup button on the User Interface Control Bar. (Figure 78)

2. The default Time/Files screen is displayed. (Figure 78)
The Setup menu has function tabs at the top of the screen that allows you to configure the analyzer mode and settings. (Figure 78) These tabs let you:

- Manage file saving settings
- Adjust LIMS State
- Adjust the current time/date settings
- Adjust autoinjector settings
- Enable the laser offset adjustment
- Perform routine septum changes

Use these function tabs to make adjustments to the analyzer and its operation.

**Time/Files Tab**

The Time/Files menu allows you to adjust the time zone, manually set the clock, and adjust the format of data files.

![Time/Files Menu](image)

*Figure 79: Functions of the Time/Files Menu*
Local Time Zone
The Local Time Zone menu lets you adjust the current local time zone by selecting an option from the drop-down selection box.

Clock
The Clock menu lets you manually adjust the current time and date settings.

File Output
The File Output menu lets you adjust the timestamp format of the data files. The available timestamp formats are shown in Table 13.

New file creation intervals (when running continuously) can be set by adjusting the value in the Output Interval [minutes] spinner control box.

Table 13: Available Time Stamp Formats

<table>
<thead>
<tr>
<th>Time Stamp Name</th>
<th>Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absolute Local American</td>
<td>mm/dd/yyyy, hh:mm:ss.sss</td>
</tr>
<tr>
<td>Absolute Local European</td>
<td>dd/mm/yyyy, hh:mm:ss.sss</td>
</tr>
<tr>
<td>Absolute GMT American</td>
<td>mm/dd/yyyy, hh:mm:ss.sss</td>
</tr>
<tr>
<td>Absolute GMT European</td>
<td>dd/mm/yyyy, hh:mm:ss.sss</td>
</tr>
<tr>
<td>Relative Seconds After Power On</td>
<td>sssssss.sss</td>
</tr>
<tr>
<td>Relative Seconds in Hours, Minutes, Seconds</td>
<td>hh:mm:ss.sss</td>
</tr>
</tbody>
</table>
LIMS State
LIMS (Library Information Management System) users can designate a unique ID for the Liquid Water Isotopic Analyzers. This ID can be changed upon receipt of the analyzer if the current ID is already in use in their laboratory. (Figure 79)

Each LIMS run will be designated with an analysis number, which follows the Instrument ID. For example (L-14), where L is the Instrument ID, and 14 is the Analysis Number.

- Note: The Next Analysis Number box only needs to be updated if the analyzer has received a new hard drive or has been serviced.

The Instrument ID and Analysis Number appear in the Vial S/N column of the standard data file (f file). (Figure 80)

<table>
<thead>
<tr>
<th>Time, Injection No., Vial Name, Vial S/N</th>
</tr>
</thead>
<tbody>
<tr>
<td>07/20/2016 10:36:20.259, 1, LGR3C, L-14,</td>
</tr>
<tr>
<td>07/20/2016 10:40:00.923, 2, LGR3C, L-14,</td>
</tr>
<tr>
<td>07/20/2016 10:41:42.636, 3, LGR3C, L-14,</td>
</tr>
<tr>
<td>07/20/2016 10:43:23.299, 4, LGR3C, L-14,</td>
</tr>
<tr>
<td>07/20/2016 10:45:03.964, 5, LGR3C, L-14,</td>
</tr>
<tr>
<td>07/20/2016 10:46:45.575, 6, LGR3C, L-14,</td>
</tr>
<tr>
<td>07/20/2016 10:48:23.194, 7, LGR3C, L-14,</td>
</tr>
<tr>
<td>07/20/2016 10:50:00.711, 8, LGR3C, L-14,</td>
</tr>
<tr>
<td>07/20/2016 10:51:38.230, 9, LGR3C, L-14,</td>
</tr>
<tr>
<td>07/20/2016 10:53:15.746, 10, LGR3C, L-14,</td>
</tr>
<tr>
<td>07/20/2016 10:54:53.266, 11, LGR3C, L-14,</td>
</tr>
<tr>
<td>07/20/2016 10:56:30.795, 12, LGR3C, L-14,</td>
</tr>
<tr>
<td>07/20/2016 10:56:09.351, 13, LGR3C, L-14,</td>
</tr>
</tbody>
</table>

Figure 80: LIMS Data File

For additional information, visit:
http://www-naweb.iaea.org/napc/ih/IHS_resources_sampling.html#lims
To change the Instrument ID:
1. Click the **Instrument ID** drop-down box to select an analyzer specific ID. (Figure 81)
a. Click on the designated letter. The options within the box are alphabetical: A-Z
2. Click **Save Changes**.

![Figure 81: LIMS ID](image)

**About**
The *About* section displays analyzer specific information, such as the:
- Build Date of the current software
- Version of the code
- IP Address
- Serial Number of the analyzer
Autoinjector

Use the autoinjector tab to make adjustments to the autoinjector settings. For optimal performance, ABB-LGR recommends the default settings shown below. (Figure 82)

Autoinjector tab

The options within the autoinjector tab are as follows:

- Prep Fill Settings
- Prep Injection Settings
- Measure Fill Settings
- Measure Injection Settings
- Flush Settings
- Auto/Manual Injection
- Syringe Idle Position

Figure 82: Autoinjector Settings Menu
The following tables provide a description of the options within the autoinjector tab.

**Prep Fill Settings**

*Table 14: Prep Fill Settings*

<table>
<thead>
<tr>
<th>Dialog Item</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample Volume (nL)</td>
<td>The injected volume for samples and standards</td>
</tr>
<tr>
<td>Fill Speed (nL/s)</td>
<td>The rate the syringe is filled</td>
</tr>
<tr>
<td>Eject Speed (nL/s)</td>
<td>The rate the syringe is withdrawn from the vial</td>
</tr>
<tr>
<td>Pull-Up Delay (ms)</td>
<td>The time between filling and ejecting</td>
</tr>
<tr>
<td>Fill Strokes</td>
<td>The number of strokes used to fill the syringe:</td>
</tr>
<tr>
<td></td>
<td>• Using multiple strokes minimizes the amount of air that enters the syringe.</td>
</tr>
<tr>
<td>Penetration Depth (mm)</td>
<td>Syringe depth within the vial</td>
</tr>
<tr>
<td>Penetration Speed (mm/s)</td>
<td>Syringe speed into the vial</td>
</tr>
</tbody>
</table>

**Prep Injection Settings**

*Table 15: Prep Injection Settings*

<table>
<thead>
<tr>
<th>Dialog Item</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Injection Speed (nL/s)</td>
<td>The rate the sample is injected into the analyzer</td>
</tr>
<tr>
<td>Eject Speed (nL/s)</td>
<td>The rate the syringe is removed from the injector block.</td>
</tr>
<tr>
<td>Pre-Fill Delay (ms)</td>
<td>The delay prior to injecting the sample</td>
</tr>
<tr>
<td>Post-Fill Delay (ms)</td>
<td>The duration the syringe is held in the injector block:</td>
</tr>
<tr>
<td></td>
<td>• This delay assures that the sample is completely transferred into the analyzer.</td>
</tr>
<tr>
<td>Penetration Depth (mm)</td>
<td>Syringe depth within the injector block</td>
</tr>
<tr>
<td>Penetration Speed (mm/s)</td>
<td>Syringe speed into the injector block</td>
</tr>
<tr>
<td>Post Withdrawal Delay (ms)</td>
<td>The delay between the syringe being removed and when the measurement begins:</td>
</tr>
<tr>
<td></td>
<td>• This delay allows the system to adjust to the rapid syringe removal.</td>
</tr>
</tbody>
</table>
Measure Fill Settings

Table 16: Measure Fill Settings

<table>
<thead>
<tr>
<th>Dialog Item</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample Volume (nL)</td>
<td>The injected volume for samples and standards</td>
</tr>
<tr>
<td>Fill Speed (nL/s)</td>
<td>The rate the syringe is filled</td>
</tr>
<tr>
<td>Eject Speed (nL/s)</td>
<td>The rate the syringe is withdrawn from the vial</td>
</tr>
<tr>
<td>Pull up Delay (ms)</td>
<td>The time between filling and ejecting</td>
</tr>
<tr>
<td>Fill Strokes</td>
<td>The number of strokes used to fill the syringe:</td>
</tr>
<tr>
<td></td>
<td>• Using multiple strokes helps minimize the amount of air that enters the syringe.</td>
</tr>
<tr>
<td>Penetration Depth (mm)</td>
<td>Syringe depth within the vial</td>
</tr>
<tr>
<td>Penetration Speed (mm/s)</td>
<td>Syringe speed into the vial</td>
</tr>
</tbody>
</table>

Measure Injection Settings

Table 17: Measure Injection Settings

<table>
<thead>
<tr>
<th>Dialog Item</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Injection Speed (nL/s)</td>
<td>The rate the sample is injected into the analyzer</td>
</tr>
<tr>
<td>Eject Speed (nL/s)</td>
<td>The rate the syringe is removed from the injector block.</td>
</tr>
<tr>
<td>Pre-Fill Delay (ms)</td>
<td>The delay prior to injecting the sample</td>
</tr>
<tr>
<td>Post-Fill Delay (ms)</td>
<td>The duration the syringe is held in the injector block:</td>
</tr>
<tr>
<td></td>
<td>• This delay assures that the sample is completely transferred into the analyzer.</td>
</tr>
<tr>
<td>Penetration Depth (mm)</td>
<td>Syringe depth within the injector block</td>
</tr>
<tr>
<td>Penetration Speed (mm/s)</td>
<td>Syringe speed into the injector block</td>
</tr>
<tr>
<td>Post Withdrawal Delay (ms)</td>
<td>The delay between the syringe being removed and when the measurement begins:</td>
</tr>
<tr>
<td></td>
<td>• This delay allows the system to adjust to the rapid syringe removal.</td>
</tr>
</tbody>
</table>

Flush Settings

Table 18: Flush Settings

<table>
<thead>
<tr>
<th>Dialog Item</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Dry Flush (ms)</td>
<td>The initial flush time:</td>
</tr>
<tr>
<td></td>
<td>• This step removes residual water prior to filling with dry air.</td>
</tr>
<tr>
<td>Dry Air Fill (ms)</td>
<td>Purge fill time:</td>
</tr>
<tr>
<td></td>
<td>• Dry air is added to the cell.</td>
</tr>
<tr>
<td>Dry Air Pump-Out (ms)</td>
<td>The final pump-down time prior to the next injection</td>
</tr>
</tbody>
</table>
Syringe Idle Position

Table 19: Syringe Idle Position

<table>
<thead>
<tr>
<th>Dialog Item</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Syringe idle enable</td>
<td>This checkbox enables/disables the syringe idle feature. When enabled, at the end of a run, the syringe will move to a designated vial and hold 1.2uL of water to prevent the syringe from drying out.</td>
</tr>
<tr>
<td>Tray</td>
<td>Trays 1-3 can be selected for the idle position.</td>
</tr>
<tr>
<td>Position</td>
<td>Vials 1-54 can be selected for the idle position.</td>
</tr>
</tbody>
</table>

Find auto injector(s)
Pair the PAL3 autoinjector with the analyzer.
- The Triple Liquid Water Isotopic Analyzer looks for the IP address of all PAL3 autoinjectors that are connected to the same Ethernet switch.

Auto/Manual Injection
Choose manual or automated injection.
- Automated injection only works with the recommended PAL3 autoinjector.
Laser Adjust Tab

Use the Laser Adjust tab to manually adjust the laser’s wavelength to compensate for any cumulative drift. (Figure 83)

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.

Figure 83 shows the offset between absorption peaks and target lines for laser A (top plot) and laser B (bottom plot). Both lasers need adjustment.

*Figure 83: Absorption peaks off of target lines. Laser voltage adjustment needed.*
Manually Adjust the Laser Offset

1. Click the **Setup** button on the *User Interface Control Bar*. (Figure 77)
2. Select the **Laser Adjust** tab at the top of the screen. (Figure 83)
3. Select the **Disable Laser Frequency Lock** check box to allow manual control of the lasers.
4. Adjust the **Laser A Voltage** (top plot) using the arrow buttons to shift the peaks until they are centered on their respective target lines.
   a. Up Arrow: Peaks adjust to the right
   b. Down Arrow: Peaks adjust to the left
5. Adjust the **Laser B Voltage** (bottom plot) using the arrow buttons to shift the peaks until they are centered on their respective target lines. (Only applicable for 2 laser systems).
   a. Up Arrow: Peaks adjust to the right
   b. Down Arrow: Peaks adjust to the left
6. Deselect the **Disable Laser Frequency Lock** check box. The software resumes automatic tracking and control of the laser wavelength.
7. Click **Close** to exit the menu and return to the *Main Panel*.

Figure 84 shows the laser voltage adjusted so that the absorption peaks are centered on the target lines.
Septum Tab

The *Septum* tab (Figure 85) includes a step-by-step process to change the septum. The septum should be changed after ≈ 750-1000 injections. The screen has five fields showing the progress of each step. Follow the sequence correctly to prevent contamination of the cavity.

To change the septum:
1. Click the **START** button to *Initiate Septum Change*.
2. The analyzer vents the cavity, and the screen will display *Venting Cavity for 3 Minutes*. (Figure 104)
3. When the screen shows *User Septum Change*, remove the old septum and install a new one.

Refer to Routine Maintenance of the Septum, Sample Transfer Line and Injector Block on page 115 for details on how to change the septum.

4. Once the new septum has been installed, click **NEXT** to *Initiate Cavity Pump Out*.
5. When the cavity has finished pumping down, *Finish Septum Change* will be displayed.
6. Click **Close**.

Always vent the analyzer cavity before changing the septum to prevent contamination of the cavity. Teflon/Silicone/Teflon septa must be used to avoid sample fractionation and extend syringe lifetimes.

*Figure 85: Septum Change Menu*
Shutting Down the Analyzer

To shut down the analyzer:

1. Click the **Exit** button on the *User Interface Control Bar*. (Figure 86)

   ![Figure 86: User Interface Control Bar Exit Button](image)

2. A pop-up box appears on the *Main Panel* to verify that you want to shut down the analyzer to prevent accidental button presses from causing interruption in data acquisition. (Figure 87)

   ![Figure 87: Analyzer Shutdown Prompt](image)

3. Click the **OK** button. (Figure 87)

4. The analyzer will vent for 3 minutes, and the pop-up window will display the progress. (Figure 88)

   ![Figure 88: Venting the cavity](image)
5. When the “You may turn off the instrument” message displays (Figure 89), shut off power to the analyzer by pushing the OFF switch on the front of the analyzer. (Figure 2)

![Figure 89: Final Shutdown Screen](image)

Failure to wait for the power down command to display before shutting off power to the analyzer may result in file system instability.

---

**NOTE**
Example Run Configurations

This section describes several example run configurations to use as starting points to define more complex measurement sequences. These configurations are pre-installed on the analyzer.

The configurations are organized based on the samples’ expected δD range:

- **Standard Natural Range:** -150 ‰ ≤ δD ≤ 0 ‰
- **Full Natural Range:** -455 ‰ ≤ δD ≤ 0 ‰ (ex: SLAP2 to VSMOW2)
- **Enriched Range:** -455 ‰ ≤ δD ≤ 1000 ‰

Each range has the following example configurations:
- High Precision
- High Throughput

Loading Example Run Configurations

To load the pre-installed example run configurations:

1. Click **Load Cfg** on the **Configuration Display**. (Figure 68)
2. A pop-up window will appear defaulting to the `/home/lgr/data` folder. (Figure 90)

3. Click on the **Configuration Files** folder. (Figure 90)
4. Click on the **Examples** folder. (Figure 91)

![Click on the Examples folder](image)

*Figure 91: Click on the Examples Folder*

5. Within the **Examples** folder are 3 additional folders containing examples of: (Figure 92)
   a. Enriched example run configurations (**Enriched** folder)
   b. Full Natural Range example run configurations (**FullNaturalRange** folder)
   c. Standard Natural Range example run configurations (**StandardNaturalRange** folder)

![Run Configuration Examples](image)

*Figure 92: Run Configuration Examples*
6. Click one of the 3 folders to access the files. Files of type: (*.vials)
   a. The **Enriched** folder contains these run configurations:
      i. EnrichedHPExample.vials (high precision)
      ii. EnrichedHPSplineExample.vials (high precision optimized for spline)
      iii. EnrichedHTExample.vials (high throughput)
      iv. EnrichedHTSplineExample.vials (high throughput optimized for spline)
   b. The **Full Natural Range** folder contains these run configurations:
      i. FullNaturalRangeHPExample.vials (high precision)
      ii. FullNaturalRangeHPSplineExample.vials (high precision optimized for spline)
      iii. FullNaturalRangeHTExample.vials (high throughput)
      iv. FullNaturalRangeHTSplineExample.vials (high throughput optimized for spline)
   c. The **Standard Natural Range** folder contains these run configurations:
      i. HighPrecisionExample.vials (high precision)
      ii. HighPrecisionSplineExample.vials (high precision optimized for spline)
      iii. HighThroughputExample.vials (high throughput)
      iv. HighThroughputSplineExample.vials (high throughput optimized for spline)

7. Select the example run configuration you wish to run and click **Open**. (Figure 93)
8. The Configuration Display will be populated with the selected run configuration. (Figure 94)

9. Click on Make Run. (Figure 68)

10. Toggle the Display button (Figure 63) to access the Run Display. (Figure 69)

11. Press Start to begin the run. (Figure 69)
Injection Pattern Conventions

An interleaved run is defined as having standard and sample injection sets measured in alternating order.

Figure 95 shows an example of an interleaved data set with rotating standards in between samples.

- Each standard and sample injection group consists of 6 measurements: 2 injections that will be ignored, and 4 measured injections.
- The run begins with 1 standard injection group, followed by 4 sample injection groups. This pattern continues with 3 standards of different isotopic compositions.

<table>
<thead>
<tr>
<th>Standard 1</th>
<th>Ignored Injections</th>
<th>Measured Injections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample 1</td>
<td>1 2</td>
<td>Inj 3 Inj 4 Inj 5 Inj 6</td>
</tr>
<tr>
<td>Sample 2</td>
<td>1 2</td>
<td>Inj 3 Inj 4 Inj 5 Inj 6</td>
</tr>
<tr>
<td>Sample 3</td>
<td>1 2</td>
<td>Inj 3 Inj 4 Inj 5 Inj 6</td>
</tr>
<tr>
<td>Sample 4</td>
<td>1 2</td>
<td>Inj 3 Inj 4 Inj 5 Inj 6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Standard 2</th>
<th>Ignored Injections</th>
<th>Measured Injections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample 5</td>
<td>1 2</td>
<td>Inj 3 Inj 4 Inj 5 Inj 6</td>
</tr>
<tr>
<td>Sample 6</td>
<td>1 2</td>
<td>Inj 3 Inj 4 Inj 5 Inj 6</td>
</tr>
<tr>
<td>Sample 7</td>
<td>1 2</td>
<td>Inj 3 Inj 4 Inj 5 Inj 6</td>
</tr>
<tr>
<td>Sample 8</td>
<td>1 2</td>
<td>Inj 3 Inj 4 Inj 5 Inj 6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Standard 3</th>
<th>Ignored Injections</th>
<th>Measured Injections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample 9</td>
<td>1 2</td>
<td>Inj 3 Inj 4 Inj 5 Inj 6</td>
</tr>
<tr>
<td>Sample 10</td>
<td>1 2</td>
<td>Inj 3 Inj 4 Inj 5 Inj 6</td>
</tr>
<tr>
<td>Sample 11</td>
<td>1 2</td>
<td>Inj 3 Inj 4 Inj 5 Inj 6</td>
</tr>
<tr>
<td>Sample 12</td>
<td>1 2</td>
<td>Inj 3 Inj 4 Inj 5 Inj 6</td>
</tr>
</tbody>
</table>

*Figure 95: An interleaved data set with rotating standards in between samples*

The Post Analysis Software processes any number of interleaved samples.
Ignored Injections:

Ignored injections are the initial injections which will be excluded in the Post Analysis Software each time a standard or sample is changed to mitigate analyzer memory effects, regardless of any other issue with those injections. They function as normal injections, but the measured data will be excluded by the Post Analysis Software.

- For samples with similar isotopic ratios, running six injections for each sample/standard is recommended.
  - Injections 1-2 are ignored injections in the Post Analysis Software to mitigate memory effects.
  - Injections 3-6 will be used for processing.
- For a wider range of isotope ratios, increase the number of injections per sample/standards. For example, run 10 injections for each sample/standard.
  - Injections 1-6 are ignored injections in the Post Analysis Software to mitigate memory effects.
  - Injections 7-10 will be used for processing.

Preparatory injections (prep)

Prep injections also mitigate analyzer memory effects. They are set within the Samples To Measure pane on the Configuration Display. (Figure 66) The injections are not measured and therefore do not contribute to the final measured values of a sample or standard.

Prep injections are shorter than ignored injections. Once the sample/standard is injected into the septum port, the analyzer skips the measurement cycle and immediately begins the next injection.

In order to achieve the best injected volume stability, it is recommended to run ignored injections in between prep injections and measured injections. For example, when running Enriched samples:

- Run 12 injections for each sample/standard.
  - Injections 1-4 are prep injections
  - Injections 5-8 are ignored injections
  - Injections 9-12 will be used for processing.

Figure 96 through Figure 102 shows examples of injection patterns to help visualize the measurement sequence for each configuration.
Spline Fitting Run Configuration

When using any of the spline calibration functions in the Post Analysis Software, it is recommended to include in the TLWIA run configurations additional standard measurements at the beginning and end of the run. This setup allows the benefits of the spline calibration to extend to all samples in the run. Note that spline calibration will work without the full standard group at the beginning and end, but it will not correct for analyzer drift at the beginning and end of the run.

Figure 96 shows an example of a Spline-enabled TLWIA run configuration.
Injection Patterns for Standard Natural Range, Full Natural Range, and Enriched Samples

A measurement is defined as 6 injections of the same sample. High performance is defined as the average of 10 measurements of the same sample.

The length of time for a run is dependent on the user configuration and how often standards are used for referencing.

- In high throughput mode, using the recommended referencing interval, the user can measure approximately 80-90 unique samples per day.
- In high precision mode, the same sample is measured 10 times and averaged. The user can measure approximately 8-9 unique samples per day.

The follow figures show examples of recommended injection patterns, depending on the range of waters sampled:

- **Standard Natural Range**
  - High Precision (Figure 97)
  - High Precision optimized for Spline calibration (Figure 97)
  - High Throughput (Figure 98)
  - High Throughput optimized for Spline calibration (Figure 98)

- **Full Natural Range**
  - High Precision (Figure 99)
  - High Precision optimized for Spline calibration (Figure 99)
  - High Throughput (Figure 100)
  - High Throughput optimized for Spline calibration (Figure 100)

- **Enriched**
  - High Precision (Figure 101)
  - High Precision optimized for Spline calibration (Figure 101)
  - High Throughput (Figure 102)
  - High Throughput optimized for Spline calibration (Figure 102)
# Standard Natural Range

## Standard Natural Range High Precision Injection Patterns

<table>
<thead>
<tr>
<th>Standard 1</th>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Sample 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ignored Injections</td>
<td>Inj 1 Inj 2 Inj 3 Inj 4 Inj 5 Inj 6</td>
<td>Inj 1 Inj 2 Inj 3 Inj 4 Inj 5 Inj 6</td>
<td>Inj 1 Inj 2 Inj 3 Inj 4 Inj 5 Inj 6</td>
</tr>
<tr>
<td>Measured Injections</td>
<td>Inj 1 Inj 2 Inj 3 Inj 4 Inj 5 Inj 6</td>
<td>Inj 1 Inj 2 Inj 3 Inj 4 Inj 5 Inj 6</td>
<td>Inj 1 Inj 2 Inj 3 Inj 4 Inj 5 Inj 6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Standard 2</th>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Sample 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ignored Injections</td>
<td>Inj 1 Inj 2 Inj 3 Inj 4 Inj 5 Inj 6</td>
<td>Inj 1 Inj 2 Inj 3 Inj 4 Inj 5 Inj 6</td>
<td>Inj 1 Inj 2 Inj 3 Inj 4 Inj 5 Inj 6</td>
</tr>
<tr>
<td>Measured Injections</td>
<td>Inj 1 Inj 2 Inj 3 Inj 4 Inj 5 Inj 6</td>
<td>Inj 1 Inj 2 Inj 3 Inj 4 Inj 5 Inj 6</td>
<td>Inj 1 Inj 2 Inj 3 Inj 4 Inj 5 Inj 6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Standard 3</th>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Sample 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ignored Injections</td>
<td>Inj 1 Inj 2 Inj 3 Inj 4 Inj 5 Inj 6</td>
<td>Inj 1 Inj 2 Inj 3 Inj 4 Inj 5 Inj 6</td>
<td>Inj 1 Inj 2 Inj 3 Inj 4 Inj 5 Inj 6</td>
</tr>
<tr>
<td>Measured Injections</td>
<td>Inj 1 Inj 2 Inj 3 Inj 4 Inj 5 Inj 6</td>
<td>Inj 1 Inj 2 Inj 3 Inj 4 Inj 5 Inj 6</td>
<td>Inj 1 Inj 2 Inj 3 Inj 4 Inj 5 Inj 6</td>
</tr>
</tbody>
</table>

## Standard Natural Range High Precision Optimized for Spline

<table>
<thead>
<tr>
<th>Standard 1</th>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Sample 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ignored Injections</td>
<td>Inj 1 Inj 2 Inj 3 Inj 4 Inj 5 Inj 6</td>
<td>Inj 1 Inj 2 Inj 3 Inj 4 Inj 5 Inj 6</td>
<td>Inj 1 Inj 2 Inj 3 Inj 4 Inj 5 Inj 6</td>
</tr>
<tr>
<td>Measured Injections</td>
<td>Inj 1 Inj 2 Inj 3 Inj 4 Inj 5 Inj 6</td>
<td>Inj 1 Inj 2 Inj 3 Inj 4 Inj 5 Inj 6</td>
<td>Inj 1 Inj 2 Inj 3 Inj 4 Inj 5 Inj 6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Standard 2</th>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Sample 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ignored Injections</td>
<td>Inj 1 Inj 2 Inj 3 Inj 4 Inj 5 Inj 6</td>
<td>Inj 1 Inj 2 Inj 3 Inj 4 Inj 5 Inj 6</td>
<td>Inj 1 Inj 2 Inj 3 Inj 4 Inj 5 Inj 6</td>
</tr>
<tr>
<td>Measured Injections</td>
<td>Inj 1 Inj 2 Inj 3 Inj 4 Inj 5 Inj 6</td>
<td>Inj 1 Inj 2 Inj 3 Inj 4 Inj 5 Inj 6</td>
<td>Inj 1 Inj 2 Inj 3 Inj 4 Inj 5 Inj 6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Standard 3</th>
<th>Sample 1</th>
<th>Sample 2</th>
<th>Sample 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ignored Injections</td>
<td>Inj 1 Inj 2 Inj 3 Inj 4 Inj 5 Inj 6</td>
<td>Inj 1 Inj 2 Inj 3 Inj 4 Inj 5 Inj 6</td>
<td>Inj 1 Inj 2 Inj 3 Inj 4 Inj 5 Inj 6</td>
</tr>
<tr>
<td>Measured Injections</td>
<td>Inj 1 Inj 2 Inj 3 Inj 4 Inj 5 Inj 6</td>
<td>Inj 1 Inj 2 Inj 3 Inj 4 Inj 5 Inj 6</td>
<td>Inj 1 Inj 2 Inj 3 Inj 4 Inj 5 Inj 6</td>
</tr>
</tbody>
</table>

Figure 97: Standard Natural Range High Precision Injection Patterns
### Standard Natural Range High Throughput Injection Patterns

<table>
<thead>
<tr>
<th>Standard</th>
<th>Ignored Injections</th>
<th>Measured Injections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard 1</td>
<td>Inj. 1 Inj. 2</td>
<td>Inj. 3 Inj. 4 Inj. 5 Inj. 6</td>
</tr>
<tr>
<td>Sample 1</td>
<td>Inj. 1 Inj. 2</td>
<td>Inj. 3 Inj. 4 Inj. 5 Inj. 6</td>
</tr>
<tr>
<td>Sample 2</td>
<td>Inj. 1 Inj. 2</td>
<td>Inj. 3 Inj. 4 Inj. 5 Inj. 6</td>
</tr>
<tr>
<td>Sample 3</td>
<td>Inj. 1 Inj. 2</td>
<td>Inj. 3 Inj. 4 Inj. 5 Inj. 6</td>
</tr>
<tr>
<td>Sample 4</td>
<td>Inj. 1 Inj. 2</td>
<td>Inj. 3 Inj. 4 Inj. 5 Inj. 6</td>
</tr>
<tr>
<td>Standard 2</td>
<td>Inj. 1 Inj. 2</td>
<td>Inj. 3 Inj. 4 Inj. 5 Inj. 6</td>
</tr>
<tr>
<td>Sample 5</td>
<td>Inj. 1 Inj. 2</td>
<td>Inj. 3 Inj. 4 Inj. 5 Inj. 6</td>
</tr>
<tr>
<td>Sample 6</td>
<td>Inj. 1 Inj. 2</td>
<td>Inj. 3 Inj. 4 Inj. 5 Inj. 6</td>
</tr>
<tr>
<td>Sample 7</td>
<td>Inj. 1 Inj. 2</td>
<td>Inj. 3 Inj. 4 Inj. 5 Inj. 6</td>
</tr>
<tr>
<td>Sample 8</td>
<td>Inj. 1 Inj. 2</td>
<td>Inj. 3 Inj. 4 Inj. 5 Inj. 6</td>
</tr>
<tr>
<td>Standard 3</td>
<td>Inj. 1 Inj. 2</td>
<td>Inj. 3 Inj. 4 Inj. 5 Inj. 6</td>
</tr>
<tr>
<td>Sample 9</td>
<td>Inj. 1 Inj. 2</td>
<td>Inj. 3 Inj. 4 Inj. 5 Inj. 6</td>
</tr>
<tr>
<td>Sample 10</td>
<td>Inj. 1 Inj. 2</td>
<td>Inj. 3 Inj. 4 Inj. 5 Inj. 6</td>
</tr>
<tr>
<td>Sample 11</td>
<td>Inj. 1 Inj. 2</td>
<td>Inj. 3 Inj. 4 Inj. 5 Inj. 6</td>
</tr>
<tr>
<td>Sample 12</td>
<td>Inj. 1 Inj. 2</td>
<td>Inj. 3 Inj. 4 Inj. 5 Inj. 6</td>
</tr>
<tr>
<td>Standard 2</td>
<td>Sample 13</td>
<td>Inj. 1 Inj. 2 Inj. 3 Inj. 4 Inj. 5 Inj. 6</td>
</tr>
<tr>
<td>Sample 17</td>
<td>Inj. 1 Inj. 2</td>
<td>Inj. 3 Inj. 4 Inj. 5 Inj. 6</td>
</tr>
<tr>
<td>Sample 18</td>
<td>Inj. 1 Inj. 2</td>
<td>Inj. 3 Inj. 4 Inj. 5 Inj. 6</td>
</tr>
<tr>
<td>Sample 19</td>
<td>Inj. 1 Inj. 2</td>
<td>Inj. 3 Inj. 4 Inj. 5 Inj. 6</td>
</tr>
<tr>
<td>Sample 20</td>
<td>Inj. 1 Inj. 2</td>
<td>Inj. 3 Inj. 4 Inj. 5 Inj. 6</td>
</tr>
<tr>
<td>Standard 3</td>
<td>Sample 21</td>
<td>Inj. 1 Inj. 2 Inj. 3 Inj. 4 Inj. 5 Inj. 6</td>
</tr>
<tr>
<td>Sample 25</td>
<td>Inj. 1 Inj. 2</td>
<td>Inj. 3 Inj. 4 Inj. 5 Inj. 6</td>
</tr>
<tr>
<td>Sample 26</td>
<td>Inj. 1 Inj. 2</td>
<td>Inj. 3 Inj. 4 Inj. 5 Inj. 6</td>
</tr>
<tr>
<td>Sample 27</td>
<td>Inj. 1 Inj. 2</td>
<td>Inj. 3 Inj. 4 Inj. 5 Inj. 6</td>
</tr>
<tr>
<td>Sample 28</td>
<td>Inj. 1 Inj. 2</td>
<td>Inj. 3 Inj. 4 Inj. 5 Inj. 6</td>
</tr>
<tr>
<td>Standard 2</td>
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</tr>
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<td>Sample 31</td>
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<td>Sample 32</td>
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</tr>
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<td>Standard 3</td>
<td>Sample 33</td>
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</tr>
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<td>Sample 38</td>
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<td>Sample 39</td>
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<td>Sample 40</td>
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<td>Sample 46</td>
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<td>Inj. 3 Inj. 4 Inj. 5 Inj. 6</td>
</tr>
</tbody>
</table>

**Figure 98: Standard Natural Range High Throughput Injection Patterns**
**Full Natural Range**

Choose the appropriate standards for the full natural range.

**Example:**
- **Standard 1:** VSMOW2
- **Standard 2:** GISP
- **Standard 3:** SLAP2

---

### Full Natural Range High Precision Injection Patterns

**Full Natural Range High Precision**

<table>
<thead>
<tr>
<th>Prep or Ignored</th>
<th>Ignored Injections</th>
<th>Measured Injections</th>
</tr>
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<tbody>
<tr>
<td><strong>Standard 1</strong></td>
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<td></td>
</tr>
<tr>
<td>Sample 1</td>
<td>Y Y Y Y Y Y Y Y Y Y</td>
<td>Y Y Y Y Y Y Y Y Y</td>
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<td>Sample 2</td>
<td>Y Y Y Y Y Y Y Y Y Y</td>
<td>Y Y Y Y Y Y Y Y Y</td>
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<td></td>
<td></td>
</tr>
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<td>Y Y Y Y Y Y Y Y Y</td>
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<td>Sample 2</td>
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<td>Y Y Y Y Y Y Y Y Y</td>
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<td><strong>Standard 3</strong></td>
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<td>Sample 2</td>
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### Full Natural Range High Precision Optimized For Spline

<table>
<thead>
<tr>
<th>Prep or Ignored</th>
<th>Ignored Injections</th>
<th>Measured Injections</th>
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<tbody>
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<td><strong>Standard 1</strong></td>
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<td></td>
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<tr>
<td>Sample 1</td>
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<tr>
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*Figure 99: Full Natural Range High Precision Injection Patterns*
### Full Natural Range High Throughput Injection Patterns

#### Table: Full Natural Range High Throughput

<table>
<thead>
<tr>
<th>Prep or Ignored</th>
<th>Ignored Injections</th>
<th>Measured Injections</th>
</tr>
</thead>
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</tr>
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<td>Inj 1 Inj 2</td>
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<td>Sample 7</td>
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<td>Sample 8</td>
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<td>Inj 3 Inj 4 Inj 5</td>
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<tr>
<td>Sample 10</td>
<td>Inj 1 Inj 2</td>
<td>Inj 3 Inj 4 Inj 5</td>
</tr>
<tr>
<td>Sample 11</td>
<td>Inj 1 Inj 2</td>
<td>Inj 3 Inj 4 Inj 5</td>
</tr>
<tr>
<td>Sample 12</td>
<td>Inj 1 Inj 2</td>
<td>Inj 3 Inj 4 Inj 5</td>
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</tbody>
</table>

#### Table: Full Natural Range High Throughput Optimized For Spline

<table>
<thead>
<tr>
<th>Prep or Ignored</th>
<th>Ignored Injections</th>
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<tr>
<td>Standard 1</td>
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<td>Sample 1</td>
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<td>Sample 6</td>
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<td>Sample 8</td>
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<td>Sample 9</td>
<td>Inj 1 Inj 2</td>
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<td>Inj 1 Inj 2</td>
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</tr>
<tr>
<td>Sample 12</td>
<td>Inj 1 Inj 2</td>
<td>Inj 3 Inj 4 Inj 5</td>
</tr>
</tbody>
</table>

Figure 100: Full Natural Range High Throughput Injection Patterns
Enriched
Choose the appropriate standards for the enriched range.

Example:
- Standard 1: LGR5C
- Standard 2: ER2
- Standard 3: ER4

### High Precision Injection Pattern

#### Enriched High Precision

<table>
<thead>
<tr>
<th>Prep or Ignored</th>
<th>Ignored Injections</th>
<th>Measured Injections</th>
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<tr>
<td>Standard 1</td>
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<td>Inj 2</td>
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<td>Standard 1</td>
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<tr>
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<td>Inj 2</td>
</tr>
<tr>
<td>Standard 3</td>
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<td>Inj 2</td>
</tr>
<tr>
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<td>Inj 1</td>
<td>Inj 2</td>
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</table>

#### Enriched High Precision Optimized For Spline

<table>
<thead>
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<tr>
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<tr>
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<tr>
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<td>Inj 2</td>
</tr>
<tr>
<td>Sample 1</td>
<td>Inj 1</td>
<td>Inj 2</td>
</tr>
<tr>
<td>Standard 3</td>
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<td>Inj 2</td>
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<td>Inj 1</td>
<td>Inj 2</td>
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</table>

*Figure 101: Enriched High Precision Injection Patterns*
## High Throughput Injection Patterns

### Enriched High Throughput

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<th>Prep or Ignored</th>
<th>Ignored Injections</th>
<th>Measured Injections</th>
</tr>
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<td>Standard 1</td>
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<td>Inj 5 Inj 6 Inj 7 Inj 8</td>
</tr>
<tr>
<td>Sample 1</td>
<td>Inj 1 Inj 2 Inj 3 Inj 4</td>
<td>Inj 5 Inj 6 Inj 7 Inj 8</td>
</tr>
<tr>
<td>Standard 2</td>
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<td>Inj 5 Inj 6 Inj 7 Inj 8</td>
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<tr>
<td>Sample 2</td>
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<td>Inj 5 Inj 6 Inj 7 Inj 8</td>
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<tr>
<td>Standard 3</td>
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<td>Inj 5 Inj 6 Inj 7 Inj 8</td>
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<td>Inj 5 Inj 6 Inj 7 Inj 8</td>
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<tr>
<td>Standard 1</td>
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<td>Inj 5 Inj 6 Inj 7 Inj 8</td>
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### Enriched High Throughput Optimized For Spline

<table>
<thead>
<tr>
<th>Prep or Ignored</th>
<th>Ignored Injections</th>
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<td>Inj 5 Inj 6 Inj 7 Inj 8</td>
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</tr>
</tbody>
</table>

---

**Figure 102: Enriched High Throughput Injection Patterns**
Data Analysis

Use the provided Post Analysis Software for data analysis. (Figure 103) The software calculates adjustments to the measured values of $\delta D$, $\delta^{18}O$, and $\delta^{17}O$ (if applicable) based on the differences between known and measured values of water isotope standards, and it reports a processed value.

Functions of the post processor:

- Loads standard data files
- Performs all required standardization and processing steps
- Exports the processed data to easily readable text files
- Automatically checks for analyzer flags
- Recognizes and tracks customizable internal controls
- Provides optional data filters
- Allows many different graphical views of the data
- Fully configurable

To learn more about using the Post Analysis Software, refer to the Post Analysis Software manual.

Figure 103: Post Analysis Software
Maintenance

Daily Operation Checklist
Table 20 describes routine maintenance tasks that keep your analyzer operating smoothly.

Table 20: Maintenance Checklist

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Task</th>
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</thead>
<tbody>
<tr>
<td>Every 1-2 days</td>
<td>• Replace the septum as described on page 120.</td>
</tr>
<tr>
<td></td>
<td>• The syringe must be properly lubricated and cared for as described on page 127.</td>
</tr>
<tr>
<td></td>
<td>• On the Spectrum Display, verify that the spectrum is correct for each laser. The spectrum should appear as shown in Figure 70 and Figure 71. Become familiar with the normal appearance of the spectrum (the best way of diagnosing analyzer performance). Any deviations from normal could indicate a problem with the analyzer.</td>
</tr>
<tr>
<td></td>
<td>• Log the transmitted intensity displayed in the upper panel of the spectrum screen. Any decrease in transmitted intensity could be indicative of dirty mirrors.</td>
</tr>
<tr>
<td>Every 3-6 days</td>
<td>• Check the Laser Offset and adjust if necessary. (Figure 83)</td>
</tr>
<tr>
<td></td>
<td>• Clean the sample transfer line and filter assembly as described on page 117.</td>
</tr>
<tr>
<td>Every 2 weeks</td>
<td>• Inspect the Drierite® Laboratory Gas Drying Unit as described on page 128.</td>
</tr>
<tr>
<td>Every 1-2 months</td>
<td>• Clean the injector block as described on page 122.</td>
</tr>
</tbody>
</table>

It is recommended to run a diagnostic test on your LGR Working Standards every 6 months or when the volume of the vial decreases beyond half full to verify stability of the standards. To run a diagnostic test, refer to How To Perform an LGR Diagnostic Run on page 137.
Mirror Ring-Down Time and Maintenance
Measurement cell mirrors are protected from contamination by an external inlet filter. With continued use, the mirrors may gradually decline in reflectivity.

If a significant change occurs in the mirror ring-down time (for example, greater than 20% reduction), the precision of the measurements may be reduced.

Periodically note the ring-down time. If a significant reduction in ring-down time occurs:

- Request a mirror cleaning kit from ABB-LGR.
- If further maintenance is required, contact ABB-LGR for service.
  - Technical Support: icos.support@ca.abb.com

WARNING!
Only authorized persons may open the analyzer cover or perform internal maintenance. Make sure the analyzer is unplugged before working with the internal components. Failure to do so may result in damage to the analyzer and electric shock.
Routine Maintenance of the Septum, Sample Transfer Line and Injector Block

ALWAYS vent the cavity when cleaning the sample transfer line or injector block. Failure to do this may cause contamination of the cavity.

WARNING!

Vent the Analyzer Before Routine Maintenance

Before the septum can be changed or the transfer tube and injector block can be cleaned, the analyzer cavity must be vented.

Follow these steps to prepare the analyzer:

1. Click the Setup button on the User Interface Control Bar. (Figure 77)
2. Click the Septum tab at the top of the Setup menu. This screen has a status field for each step and will guide you through the septum change process. (Figure 104)
3. Click the START button to Initiate Septum Change. (Figure 85)
   - The in-progress step will be highlighted in red.
   - Wait until each step has reached 100% before proceeding to the next step.
4. The analyzer vents the cavity, and the screen will display Venting Cavity for 3 minutes while in progress.
   - The in-progress step will be highlighted in red.
   - The status bar counts from 0% to 100% as the analyzer vents to ambient atmospheric pressure. (Figure 104)

![Figure 104: Septum Change Initiated and Venting Cavity Status](image)
5. When the Venting Complete step reaches 100%, the screen will display Change Septum, Click NEXT when done. (Figure 105) Begin the cleaning process/septum change process. Refer to these sections for cleaning instructions:
   - Clean the Sample Transfer Line and the Attached Filter Assembly (Refer to Page 117)
   - Remove Septa Bits from the Injector Block (Refer to page 119)
   - Install the New Septum (Refer to page 120)

![Figure 105: Change Septum Prompt](image)

6. Once the components have been cleaned/changed, click NEXT to Initiate Cavity Pump Out. (Figure 105)

---

**WARNING**

Confirm that the sample transfer line, septum, and septum nut have been properly installed and tightened before pumping out the cavity. Failure to do so may cause air leakage and contamination to the cavity.

7. When the cavity has finished pumping down, Finish Septum Change will be displayed.
8. Click Close.
Clean the Sample Transfer Line and the Attached Filter Assembly

Small pieces of septa accumulate over time in the sample transfer line and injector block. ABB-LGR recommends that the sample transfer line and filter assembly be cleaned each time the septum is changed.

---

**WARNING**

Before the sample transfer tubing can be cleaned, the analyzer cavity must be vented. Refer to *Vent the Analyzer Before Routine Maintenance* on page 115 before proceeding with this procedure.

---

To clean the transfer line:

1. Detach the sample transfer line and filter assembly from the back of the analyzer. (Figure 106)

   ![Figure 106: Detach the Sample Transfer Line](image)

   Do NOT unscrew the smaller Swagelok fitting on the 10μ Screen Filter Assembly.

---

**WARNING**

Do NOT unscrew the smaller Swagelok connection between the filter assembly and transfer line.
2. Cap the **To Septum** fitting on the analyzer immediately, using the attached \( \frac{1}{4}'' \) Swagelok cap and finger-tighten firmly. This step is critical in preventing dust from entering the analyzer. Figure 107 shows the analyzer ports.

![TO SEPTUM: ¼” Swagelok fitting capped to prevent contamination.](image1)

*Figure 107: Cap the To Septum port to prevent contamination*

3. Remove transfer tube from heater block using 9/16” wrench at the \( \frac{1}{4}'' \) Swagelok connector.

4. Use the provided clean, dry air canister to puff a single pulse of air through the filter assembly and transfer line to remove small pieces of septa that may have accumulated in the sample transfer line. (Figure 108)

![Figure 108: Purge Filter Assembly and Transfer Line](image2)

*Figure 108: Purge Filter Assembly and Transfer Line*

---

**WARNING!**

Wear eye protection while using compressed air.
Remove Septa Bits from the Injector Block

Before cleaning the injector block, the analyzer cavity must be vented. Refer to *Vent the Analyzer Before Routine Maintenance* on page 115 before proceeding with this procedure.

**WARNING!**

The injector block is heated to ≈100 °C!

Use heat resistant gloves whenever you handle the injector block.

1. Unscrew the septum nut, using the provided heat resistant gloves.
2. Remove the septum from the septum nut, using the provided septum puller.
3. Remove the black septum support from the injector block, and carefully place it aside.
   a. To remove this support:
      i. Place the tip of the dry air canister in the lower port on the backside of the injector block.
      ii. Release a small amount of air into the block. The septum support pops out of the top port. (Figure 109)

   ![Figure 109: Septum Support Fitting](image)

4. Use the provided clean, dry air canister to release a single pulse of air through the top port of the block to remove small pieces of septa that have accumulated.

**WARNING!**

Wear eye protection while using compressed air.

5. Use the dry air canister to clear the opening of the black septum support.
6. Replace the septum support to the heated injector block.

**NOTE**

Salt deposits and small pieces of septa will accumulate over time in the injector block. After approximately 1–2 months of continuous use (15,000–20,000 injections), the injector block must be washed to remove these deposits. See *Clean the Injector Block* on page 122.
Replace the Septum

Before the septum can be replaced, the analyzer cavity must be vented. Refer to *Vent the Analyzer Before Routine Maintenance* on page 115 before proceeding with this procedure.

The septum must be changed every 750 to 1000 injections. To change the septum:

1. Slide the septum nut and new septum onto the provided blunt 22-gauge needle (*Hamilton AS* top style, or similar). (Figure 110)

![Figure 110: Blunt 22 Gauge Needle Figure (shown with new septum and septum nut)](image)

2. Verify that the black septum support is positioned inside the injector block. (Figure 111)

![Figure 111: Septum Support](image)

3. Using heat resistant gloves, place the needle fixture onto the injector block, through the septum support, and hand-tighten the septum nut firmly.

---

**WARNING!**

Failure to adequately hand-tighten the septum nut may cause air leakage and contamination during pump out.

---

4. Manually actuate the blunt 22-gauge needle five times to confirm that the septum is adequately pre-drilled.

5. Remove the needle fixture from the septum nut.
If the septum continuously shreds/deteriorates:
- Check the position of the septum injection port. Refer to page 47 for details.
- Check septum nut tightness.
  - The septum nut needs to be tight enough so that it is not leaking, but not so much that it begins to shred. Tighten it until you get resistance from the septum, and then turn \(\frac{1}{4}\) turn.
Clean the Injector Block

Salt deposits and small pieces of septa accumulate over time in the injector block. After approximately 1–2 months of continuous use (15000–20000 injections), clean the injector block to remove deposits.

Before the septum can be replaced, the analyzer cavity must be vented. Refer to *Vent the Analyzer Before Routine Maintenance* on page 115 before proceeding with this procedure.

To remove the injector block from the autoinjector

1. Unplug the septum heater (black and green cable) from the analyzer back panel.
2. Remove the blue cover from the injector block.

---

3. Allow sufficient time for the injector block to cool off.
4. Remove the transfer tube from the injector block by disconnecting the 1/4" Swagelok connection, using the provided 9/16" wrench.
5. With your hand on the base of the injector block, remove the 8 nylon screws and 4 insulating nylon spacers, using the provided 9/64" Allen key.
6. Carefully remove the injector block from the support arms.
7. Turn the injector block on its side and remove the heating element by removing the 4 screws with the provided 3/32" Allen key.
8. Unscrew the septum nut from the top of the injector block and remove the used septum from the nut with the provided septum puller.
9. Remove the black septum support from the injector block, and carefully place it aside.
   a. To remove this support:
      i. Place the tip of the dry air canister in the lower port on the backside of the injector block.
      ii. Release a small amount of air into the block. The septum support pops out of the top port. (Figure 109)
To clean the injector block

1. Soak the injector block in an ultrasonic bath of deliming solution (35% phosphoric acid) diluted 1:1 for 1 hour (Nyco brand Low Foam Delimer, Product # NL352, recommended).

**WARNING**

Deliming solution is caustic. Avoid bodily contact.

2. Thoroughly rinse the injector block with tap water.
3. Soak the injector block in an ultrasonic bath of mild detergent solution (ex: ultrasonic detergent or mild dishwashing detergent) for 1 hour.
4. Thoroughly rinse the injector block with tap water.
5. Soak the injector block in an ultrasonic bath of clean water for 1 hour.
6. Thoroughly rinse the injector block with clean water.
7. Soak the injector block in an ultrasonic bath of deionized water for 1 hour.
8. Using the provided dry air canister, repeatedly pulse dry air through the injector block to remove all residual water.
To re-install the injector block

1. Tighten the end of the sample transfer tube that does NOT have the filter assembly onto the injector block.
   a. Finger-tighten the 1/4” Swagelok connection firmly.
   b. Use the provided 9/16” wrench to further tighten by 1/4 to 1/2 turn. (Figure 12)

2. Mount the heating element on the injector block using the four screws and the provided 3/32” Allen key.
   a. Verify that the black and green wires from the heater block are facing the back of the injector block (the same side as the transfer tube).

3. Mount the injector block between the support arms.
   a. Hold the injector block between the support arms with the insulating nylon spacers between the injector block and the support arm.
   b. Use the black nylon screws to attach the injector block to the support arms.

---

**WARNING**

Do not over-tighten the nylon screws.

---

4. Slide the blue cover over the injection block.
5. Replace the septum as described in Replace the Septum on page 120.
6. Remove the ¼” Swagelok cap from the analyzer back panel and immediately replace the filter assembly end of the sample transfer tube onto the TO SEPTUM port on the analyzer back panel. (Figure 7)
7. Plug the heater cable into the analyzer back panel. (Figure 26)
8. Check the position of the septum injection port as described on page 47.
9. Heat the injector block to 100°C for ≈1 hour.

---

**WARNING**

Confirm that the sample transfer line, septum, and septum nut have been properly installed before pumping down the cavity. Failure to do so may cause air leakage and contamination to the cavity. Refer to Initiate Cavity Pump Out on page 125 to continue.

---

ABB-LGR recommends using an additional injection block to minimize down time from cleaning.
Initiate Cavity Pump Out

1. When the routine maintenance is complete, click **NEXT** to initiate the cavity pump out. (Figure 112)

*Figure 112: Septum Install Complete*

---

**WARNING**

The filter assembly, sample line, and injector block MUST be attached before clicking **NEXT**. Failure to do so may contaminate the cavity.
2. The cavity will pump out for one minute. (Figure 113)

![Figure 113: Analyzer pumps out cavity](image)

3. The indicator box displays *Septum Ready* when the process is complete. (Figure 114)

![Figure 114: Septum Ready](image)

4. Click the **Close** button to return to the *Main panels*. (Figure 114)
Caring for Syringes

Examine the syringes before each run. Salts and septum bits can deposit inside the syringe over time and impede its performance. Regular inspection and cleaning of the syringe will extend syringe lifetime and performance.

Clean and Lubricate the Syringe
1. Remove the syringe from the autoinjector as described on page 55.
2. Prepare a vial of NMP syringe lubricant: (1-Methyl-2-pyrrolidinone, Sigma Aldrich)
   a. Pipette 1mL into a clean 2mL provided vial.
   b. Use a punctured cap from a previously injected clean water sample so that the needle of the syringe can easily slide through the pre-punctured hole of the cap.
3. Insert the tip of the needle into the vial of NMP lubricant, and allow the needle to soak for several minutes.
4. Hold the barrel of the syringe firmly in one hand while rotating the plunger with the other hand. The plunger should rotate freely.
5. Carefully actuate the plunger over its normal range several times to rinse the interior of the needle and remove any salt build-up or septum residue. Continue actuating the syringe until it moves freely.
6. Actuate the plunger in clean, deionized water to rinse the NMP Syringe Lubricant from the needle.
7. Re-insert the syringe into the autoinjector as described in the Installing the Syringe section on page 53.

If the Syringe is Stuck and Difficult to Actuate
1. Remove the syringe from the autoinjector as described on page 55.
2. Soak the syringe in NMP syringe lubricant, (1-Methyl-2-pyrrolidinone, Sigma Aldrich), for 30 minutes to loosen residue.
3. Continue to actuate the plunger while slowly rotating the syringe body around the plunger.
4. Confirm that the syringe has some resistance when manually actuated.
5. Actuate the plunger in clean, deionized water to rinse the NMP Syringe Lubricant from the needle.
6. Re-insert the syringe into the autoinjector as described in the Installing the Syringe section on page 53.

- If the syringe will not be used for an extended period (several days) clean it as described above and store it in its original box.
- Dispose of old syringes in a proper sharps disposal bin.
Maintain the Drierite® Laboratory Drying Unit

Dry air is used to flush the measurement cell. The lifetime of the provided Drierite® laboratory drying unit is determined by ambient humidity levels; therefore, the desiccant may need to be regenerated or replaced more frequently in humid areas.

After approximately two weeks of continuous use (7,000 – 10,000 injections), verify that the Drierite® laboratory drying unit is functioning properly.

![Figure 115: Drierite® Laboratory Drying Unit](image)

To inspect and regenerate the Drierite® laboratory drying unit:

1. Examine the unit for color changes. (Figure 115)
   - Active desiccant = blue
   - Exhausted desiccant = pink

2. If the active desiccant region (blue) measures at least 1”, no action is necessary.
3. If the blue region is less than 1", regenerate or replace the desiccant.
   a. Remove the top of the column, using the provided wrenches. Carefully set aside the lid, metal spring, metal plate, and felt filter.
   b. Spread the granules in a layer one granule deep and heat for 1 hour at 210 °C (425 °F).
   c. Place the regenerated material back into the column and seal while hot.
   d. If replacing the desiccant, rather than regenerating, the Drierite® laboratory drying unit requires 1.25lbs of 8 mesh replacement indicating Drierite.

---

**NOTE**

The color of the desiccant may become less distinct on successive regenerations due to the migration of the indicator into the interior of the granule and sublimation of the indicator. This does not affect the drying performance.
Replace the Power Inlet Fuse
If the fuse on the power inlet blows or is otherwise damaged, the analyzer shuts down. To replace the fuse:

1. Unplug the analyzer.
2. On the back panel of the analyzer, locate the fuse above the power inlet. (Figure 116)

3. Use a flathead screwdriver to remove the fuse.
   a. Insert the head of the screwdriver into the slot below the fuse. (Figure 117)
   b. Push down on the screwdriver handle to remove the fuse holder from the power inlet.
   c. Remove the fuse from the fuse holder. (Figure 118)

4. Insert a new fuse into the fuse holder.
5. Re-insert the holder into the power inlet. Push it in until you hear a click.
6. Plug the power cord into the back panel of the analyzer.
7. Resume analyzer operation.
Troubleshooting Guide

The GLA431 Series Liquid Water Isotope analyzers should provide accurate isotope ratios.

- **High throughput mode:**
  - $\delta^1$H to within ± 0.4‰ (400 per meg)
  - $\delta^{18}$O to within ± 0.1‰ (100 per meg)
  - $\delta^{17}$O to within ± 0.1‰ (100 per meg)
  - Only applicable for the GLA431-TLWIA

- **High precision mode**
  - $\delta^1$H to within ± 0.2‰ (200 per meg)
  - $\delta^{18}$O to within ± 0.03‰ (30 per meg)
  - $\delta^{17}$O to within ± 0.03‰ (30 per meg)
  - Only applicable for the GLA431-TLWIA

If the analyzer is not achieving this performance, use this section for troubleshooting tips.

Troubleshooting Injection Performance Flags

The analyzer automatically examines the data while measuring to alert the user of possible problems with individual injections.

The *Flag* column on the *Run Display* (Figure 69) and the *Error code* column in the output text file (Figure 72), contain a four-letter code indicating the performance of individual injections. Table 21 describes the injection performance flags and the following sections provide solutions for abnormal results.

---

**NOTE**

Occasionally, an injection shows an error flag due to incomplete evaporation of the water before the measurement begins. This is often caused by a small piece of septum becoming lodged in the syringe and usually corrects itself after one or two subsequent injections.
<table>
<thead>
<tr>
<th>Flag</th>
<th>Description and Suggested Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>norm</td>
<td>The analyzer is operating within normal parameters. No action is required.</td>
</tr>
<tr>
<td>prep</td>
<td>A preparatory injection is in progress. No action is required.</td>
</tr>
</tbody>
</table>
| temp | The temperature of the water vapor is changing too rapidly during a single measurement. The temperature of the water vapor inside the measurement cell should not change at a rate faster than 0.3 °C / hour and show minimal oscillation during the run. This typically corresponds to a lab temperature change of less than 2 – 3 °C / hour.  
  • If this temperature specification is exceeded, place the analyzer in a more temperate environment (such as away from windows, doors, and air conditioning vents). |
| dens | The water number density inside the measurement cell is not stable during a measurement. See the solutions listed in:  
  • Confirmation of Measured Spectrum on page 133  
  • Confirmation of Injected Volume on page 136 |
| pres | The pressure within the measurement cell is rising during a measurement.  
  • Check that the septum is properly installed.  
  • Check that the transfer tube is securely attached to the back of the analyzer.  
  • Check that the transfer tube is securely attached to the injector block.  
  • Clean the injector block as described in Routine Maintenance of the Septum, Sample Transfer Line and Injector Block on page 115. |
| 2hsd | The $^2$H/$^1$H ratio is excessively noisy. See the solutions listed in:  
  • Confirmation of Measured Spectrum on page 133  
  • Confirmation of Injected Volume on page 136  
  • Confirmation of Measured Isotope Ratios on page 136 |
| 17sd | The $^{17}$O/$^{16}$O ratio is excessively noisy. (Only applicable for 2 laser systems). See the solutions listed in:  
  • Confirmation of Measured Spectrum on page 133  
  • Confirmation of Injected Volume on page 136  
  • Confirmation of Measured Isotope Ratios on page 136 |
| 18sd | The $^{18}$O/$^{16}$O ratio is excessively noisy. See the solutions listed in:  
  • Confirmation of Measured Spectrum on page 133  
  • Confirmation of Injected Volume on page 136  
  • Confirmation of Measured Isotope Ratios on page 136 |
| vial | There is no vial at the indicated tray position.  
  • Confirm that the tray positions in the Samples to Measure (Figure 66), and Standards to Measure (Figure 67) panes on the Configuration Display (Figure 64) correspond to the actual tray positions of the samples and standards. |
Confirmation of Measured Spectrum

The Spectrum Display should look similar to the spectra shown in Figure 119 and Figure 120.

**Figure 119: Confirmation of Spectrum Display, Laser A**

**Figure 120: Confirmation of Spectrum Display, Laser B**
After an injection, the *Transmitted Intensity* (top plot) should show a maximum transmission signal of 0.3 – 6.0 Volts and three marked dips due to water absorption features. (Figure 119)

The *Absorption* plot should show three absorption peaks ranging from 5% – 60%. The large, central peak near -1.0 GHz should be roughly centered in the shaded grey box. (Figure 119)

Troubleshooting tips:
- If the transmission signal is in an acceptable range, but does not show any absorption features, confirm that water is being introduced into the cavity. Potential issues include:
  - Broken syringe
  - Clogged transfer line
  - Empty vial
- If the spectrum is present, but does not look like the figures above, adjust the Laser Offset to locate the correct peaks. Refer to *Laser Adjust Tab* on page 93 for details.
- If the transmission signal is < 0.3 Volts, follow steps described in the *Contact ABB-LGR* section on page 138 before contacting ABB-LGR for further assistance.
- High number of *Pres* flags: Over time, small bits of septa can accumulate in the block, resulting in incomplete evaporation of the water before the measurement begins. The heated block may require cleaning. Different levels of cleaning may be necessary depending on the type of samples and amount of injections that have been introduced to the block. Start with Level 1 and if the issue persists, continue with the next levels until the analyzer is performing correctly.

---

**NOTE**

Before performing these levels, refer to *Vent the Analyzer Before Routine Maintenance* section on page 115. The analyzer cavity must be vented to avoid contamination to the cavity.

- **Level 1:**
  - Using the provided dry air canister, repeatedly pulse dry air through the injector block to remove small bits of septa.
- **Level 2:**
  - Follow the steps in the *To remove the injector block from the autoinjector* section on page 122 of this manual.
  - Soak the injector block in an ultrasonic bath of clean water for 1 hour.
  - Thoroughly rinse the injector block with deionized water.
  - Using the provided dry air canister, repeatedly pulse dry air through the injector block to remove all residual water.
- **Level 3:**
  - Follow the steps in the *To remove the injector block from the autoinjector* section on page 122 of this manual.
  - Soak the injector block in an ultrasonic bath of mild detergent solution (ex: ultrasonic detergent or mild dishwashing detergent) for 1 hour.
- Soak the injector block in an ultrasonic bath of clean water for 1 hour.
- Replace clean water and repeat for 1 hour.
- Thoroughly rinse the injector block with deionized water.
- Using the provided dry air canister, repeatedly pulse dry air through the injector block to remove all residual water.

  o Level 4:
    - Follow the steps in the To remove the injector block from the autoinjector section on page 122 of this manual.
    - Soak the injector block in an ultrasonic bath of deliming solution (35% phosphoric acid) diluted 1:1 for 1 hour (Nyco brand Low Foam Delimer, Product # NL352, recommended).
    - Soak the injector block in an ultrasonic bath of mild detergent solution (ex: ultrasonic detergent or mild dishwashing detergent) for 1 hour.
    - Soak the injector block in an ultrasonic bath of clean water for 1 hour.
    - Replace clean water and repeat for 1 hour.
    - Thoroughly rinse the injector block with deionized water.
    - Using the provided dry air canister, repeatedly pulse dry air through the injector block to remove all residual water.
Confirmation of Injected Volume
The number density (molecules/cm$^3$) of water molecules inside the cavity during each measurement typically ranges from $2 - 5 \times 10^{16}$ molecules/cm$^3$. Over the entire run, the injected density should fluctuate < ± 4% (rms fluctuation).

If the water number density fluctuates or exceeds these bounds:

• Confirm that the tests involve filtered freshwater samples.
  • Confirm that the sample and standard vials are filled between 0.5 - 1.5 ml of water.
    o Overfilling can result in abnormally high-injected volumes.

• Replace or clean the syringe and confirm that it can be smoothly manually actuated. Many injected volume problems have been attributed to defective or worn syringes. See Caring For Syringes on page 127.

• Clean or replace the transfer line to remove any septum pieces and sediment, as described in Clean the Sample Transfer Line and the Attached Filter Assembly on page 117.

• Replace the septum, as described in Replace The Septum on page 120. Proper centering is critical to extending syringe lifetime and achieving reproducible injected volumes.

• Clean the injector block to remove accumulated septum bits and salt deposits, as described in Clean the Injector Block on page 122.

• If the injected volume continues to fluctuate or exceed bounds, follow steps described in Contact ABB-LGR on page 138 before contacting ABB-LGR for further assistance.

Confirmation of Measured Isotope Ratios
If both the Spectrum Display (Figure 119 and Figure 120) and Injected Volume look correct, but the measurement accuracy/precision is inadequate:

• The temperature of the water vapor inside the analyzer should not change at a rate faster than 0.3 °C / hour and show minimal oscillation during the run. This typically corresponds to a lab temperature change of less than 2 – 3 °C / hour. If this temperature specification is exceeded, place the analyzer in a more temperate environment (such as away from windows, doors, air conditioning vents, and so on).

• Confirm that the ABB-LGR measurement protocol is being implemented. Less frequent standardization may result in more inaccuracy due to analyzer drift. Refer to Example Run Configurations on page 98.

• The standard deviation of the measured D/H atomic ratio should be ~1000 times smaller than the measured D/H atomic ratio. The standard deviation of the measured $^{18}\text{O}/^{16}\text{O}$ atomic ratio should be ~3000 times smaller than the measured $^{18}\text{O}/^{16}\text{O}$ atomic ratios. If these standard deviations are exceeded, please follow the steps described in Contact ABB-LGR on page 138 before contacting ABB-LGR for further assistance.
How To Perform an LGR Diagnostic Run

The ABB-LGR customer service department uses the LGR Diagnostic run to troubleshoot performance issues with your analyzer. Running this test before contacting ABB-LGR will help you to receive a faster diagnosis.

ABB-LGR will use the Standard Data File and Long Format Data File for troubleshooting:

- **Standard Data File:** \((t)_{lwiaDDMMYYYY}_{fxxxx}.txt\)
  - This file is used for data processing.
- **Long Format Data File:** \((t)_{lwiaDDMMYYYY}_{lxxxx}.txt\)
  - This file is for diagnostic purposes

For details on file types, see *File Type Details* on page 77.

To Perform the LGR Diagnostic Run:

1. Pipette 1mL of LGR1, LGR2, LGR3 and LGR4 into 4 of the provided vials and cap.
2. Place the vials into **Tray 1** on the autoinjector.
   a. LGR1 into position 1
   b. LGR2 into position 2
   c. LGR3 into position 3
   d. LGR4 into position 4
3. Within the **Configuration Display**, click the **Load Cfg** button. (Figure 68)
4. Click the **Configuration Files** folder. (Figure 90)
5. Open the **Support** folder. (Figure 121)

*Figure 121: Click on the Support folder*
6. Select `LGRDiagnostic.vials` and click OPEN. (Figure 122)

![Select LGRDiagnostic.vials](image)

**Figure 122: Select the LGRDiagnostic.vials file**

7. Within the *Configuration Display*, click on the Make Run button. (Figure 68)
8. Toggle the Display button on the *User Interface Control Bar* (Figure 63) to switch to the Run Display. (Figure 69)
9. Click Start.
   a. The test is ~12 hours long.
10. When the test is complete, send the Standard Data File (F file) and the Long Format Data File (L file) to ABB-LGR.

**Contact ABB-LGR**

Before contacting ABB-LGR to help troubleshoot an issue with the analyzer, prepare the following information to send to the customer service department:

- Record the analyzer’s serial number (located on the back panel).
- Take screenshots of both display spectrums.
- Perform an LGR Diagnostic Run.
- Save all data files created during the run, including:
  - Test results
  - Data files
  - Screenshots
Appendix A: Injected Volume Correction

Measured delta values can have a dependence on the water concentration in the analyzer. When a user measures this dependence, the Post Analysis Software can correct the measured delta values for small variations in the water concentration due to syringe instability.

This mathematical injected volume correction is similar to that described by Lis et al. (Analytical Chemistry, 2008) This type of correction is commonly called a linearity correction in IRMS data reductions.

Each analyzer has unique parameters; therefore, the user must measure the dependence for each analyzer.

Newer analyzers ship with a built-in run configuration on the analyzer to assist with this process.

Measure reference water and calculate:

1. Measure a single isotopic reference water on the Liquid Water Isotopic Analyzer at varying injected volumes between 600 nL and 1200 nL.
   a. Pipette 1mL of LGR3 standard into the provided vial and cap.
   b. Place the vial into Tray 1, Position 1 on the autoinjector.
   c. On the Configuration Display, click the LIAMS Import button. (Figure 123)

![Figure 123: LIAMS Import button](image)
d. A pop-up window will appear. Single click on the correct \texttt{InjVolCorr.lims\_LGR3.csv} file that corresponds with your water standard and press \textbf{Open} to load the injected volume configuration. (Figure 124)
   
   i. For the LGR3D standards, select the \texttt{InjVolCorr.lims\_LGR3D.csv} file
   
   ii. For the LGR3D standards, select the \texttt{InjVolCorr.lims\_LGR3D.csv} file

---

**NOTE**

The water standard bottles will be labeled either LGR3D or LGR3E

---

![Figure 124: InjVolCorr.lims.csv File](image1)

---

e. A pop up window will indicate that the run creation was successful. Press \textbf{OK}. (Figure 125)

   i. Note: The Configuration Display fields will not display details of the loaded configuration.

![Figure 125: Run creation successful window](image2)
f. Click **Display** on the **User Interface Control Bar** (Figure 123) to cycle to the Run Display.

**g.** The Run Display will be populated with the Injected Volume Correction run configuration. (Figure 126)

**h.** Press **Start**. (Figure 126)

![Figure 126: Run Display](image)

2. Transfer the standard data file to a computer. See Transfer Data Files on page 79 for details.
   a. Use the standard Data File (f file) for data processing:
      
      \[ t_{lwiaDDMYYYY_fxxx.txt} \quad \text{– Use the (f) file for data processing.} \]

3. Calculate the normalized water number density from the measured water number density (nmeas):

\[
N = (n_{meas} - n^*)/n^*, \quad \text{where } n^* = 3 \times 10^{16} \text{ molecules/cm}^3.
\]

The measured water number density is found in the H$_2$O_N/cm$^3$ or [H$_2$Oa]_ND column in the data file, depending on the version of your analyzer.
4. Plot the graphs:
   a. Measured isotope ratios (not delta values) of the isotopic reference water vs. normalized injected volumes
      i. Repeat for each isotope. The column name in the data file will vary depending on the version of your analyzer.
         1. D/H or DHr
         2. O18/O16 or O18O16r
         3. O17O16r (only applicable for 2 laser systems)
      ii. Figure 127 shows an example of the DHr isotope ratio vs the normalized injected volumes.

   ![Figure 127: Measured Isotope Ratio vs. Normalized Injected Volume](image)

5. Use a linear least-squares fit to determine the slope of the water concentration effect.
6. Check that the data fit to a line. If the data is not linear or the correlation coefficient is poor, it is recommended to rerun the test.
7. Enter the slopes into the Post Analysis Software.
   a. In some analyzers, the dependence on water concentration is very low. If dependence is not seen, enter a zero for the slope into the Post Analysis Software.

---

**NOTE**

See the Post Analysis Software User Manual for details.
Appendix B: About Gas Analyzers and Laser Absorption Spectroscopy

Conventional Laser Absorption Spectroscopy

For gas measurements based on conventional laser-absorption spectroscopy (Figure 128), a laser beam is directed through a sample, and the mixing ratio (or mole fraction) of a gas is determined from the measured absorption using Beer’s Law, which may be expressed:

\[
\frac{I_v}{I_0} = e^{-SLxP\Phi_v}
\]

Where:
- \( I_v \) is the transmitted intensity through the sample at frequency
- \( I_0 \) is the (reference) laser intensity prior to entering the cell
- \( S \) is the absorption line strength of the probed transition
- \( L \) is the optical path length of the laser beam through the sample
- \( \chi \) is the mole fraction
- \( P \) is the gas pressure
- \( \Phi \) is the line-shape function of the transition at frequency \( v \)

In this case,

\[
\int \phi(v) dv = 1
\]

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.

Figure 128: Typical Laser Absorption Spectroscopy Setup
Integration of the measured spectra with the measured values of:
- Gas temperature
- Gas pressure
- Path length
- Line strength of the probed transition

Enables you to determine the mole fraction directly from the relation:

\[ \chi = \frac{-1}{SLP} \int_{u} \ln \left( \frac{I_u}{I_o} \right) du \]

Use this equation to determine gas concentrations, even in hostile environments without using calibration gases or reference standards. These values are measured:
- Mixtures containing several species
- Flows at elevated temperatures and pressures
ABB-LGR’s Off-Axis Integrated-Cavity Output Spectroscopy (Off-Axis ICOS)

Off-Axis ICOS uses a high-finesse optical cavity as an absorption cell as shown in Figure 129. 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, they make thousands of passes before leaving the cell.

As a result, the effective optical path length may be several thousands of 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 spaced by 25 cm, the effective optical path length is 2500 meters.

![Figure 129: Schematic Diagram of an Off-Axis ICOS Analyzer](image)

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:
- The wavelength of the laser is turned over a selected absorption feature of the target species.
- 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
Appendix C: Accessing Data Using the Ethernet

Appendix B explains how to access the analyzer data directory as a Windows Share using an Ethernet connection on a local area network (LAN).

The data files stored on the internal hard disk drive of the analyzer can be accessed as a Windows Share over a Local Area Network (LAN) Ethernet connection. For this function to operate, the analyzer must:

- Be connected to a Local Area Network (LAN) via the RJ-45 Ethernet connection on the back panel of the analyzer.
- Receive a response to a DHCP (Dynamic Host Configuration Protocol) request when the analyzer is initialized.

If the analyzer does not receive a reply, the analyzer:

- Disables the Ethernet port.
- Does not attempt another DHCP request until the 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 data directory:

1. Click **Start > Run**, and enter the IP address of the analyzer:
   
   Example: `\192.168.100.29`

   Refer to the **Time/Files menu** (Figure 79) for the location of the analyzers’ IP address.

2. Click **OK**.

3. Within 10 to 60 seconds, the **Windows Share** directory displays the subdirectory **lgrdata**.

   Double-click on the **lgrdata** directory to see a listing of the data files stored on the internal hard drive of the analyzer.

   Open or transfer any of the data files, as you would with any Windows share drive.
Additional Notes

The analyzer shared data directory is in the LGR workgroup. If it is not visible, browse for it in the Windows Network Neighborhood by entering the IP address of the analyzer. Figure 79 shows the location of the IP address.

The current data file of the analyzer can be open while measurement is in progress without interrupting the analyzer operation. The current data file is updated after every fourth KB, so a new data file will appear empty until enough data is collected to be written to the disk.

If a Local Area Network (LAN) is not available, plug the analyzer into a standalone broadband router (example: Netgear Model RP614) to enable the analyzer to obtain a Dynamic Host Configuration Protocol (DHCP) address from the router when the analyzer is started. Then, plug any Windows computer into the same broadband router to access the data directory.

A crossover Ethernet cable will NOT allow an external computer to access the shared data directory, as the analyzer will not obtain a DHCP address on initialization and will shut down its Ethernet interface.

It is possible to access the shared analyzer data directory from operating systems other than Windows. The analyzer uses a Samba server to share the data directory, which could be accessed by any appropriate Samba client application.
Appendix D: Wireless Router Setup for Liquid Water / PAL3 Autoinjector Compatibility

The PAL3 autoinjector includes a GL-MT300N-V2 Mini Smart Router for use when the Local Area Network (LAN) is not available. When Wi-Fi is ON, the analyzer and PAL3 autoinjector will obtain a Dynamic Host Configuration Protocol (DHCP) address from the router. The user can plug any Windows computer into the same broadband router to access the data directory.

The router is pre-configured and assigns an IP address to its’ specific analyzer.

To use the wireless router:

1. Connect the 5-port TP-Link Ethernet switch:
   a. Attach the power cord to the Ethernet switch and plug into your local power source.
   b. Connect a provided Ethernet cable from the back panel of the Liquid Water Analyzer to any port on the 5-port switch. (Figure 130)

   ![Figure 130: 5-port TP-Link Ethernet Switch](image1)

2. Connect a provided Ethernet cable from the back panel of the PAL3 autoinjector to any port on the 5-port switch.
3. Connect the provided GL-MT300N-V2 Mini Smart Router:
   a. Connect the white cable from the Power port of the router to a USB port on the analyzer. (Figure below)
   b. Connect the provided Ethernet cable from the 5-port switch to the LAN port on the wireless router. (Figure below)

   ![Figure 131: GL-MT300N-V2 Mini Smart Router](image2)
The Dynamic Host Configuration Protocol (DHCP) is enabled on the PAL3 autoinjector to automatically assign an IP address.

4. Reboot the analyzer and autoinjector.
5. The analyzer IP address will be in the format 192.168.8.XXX, and will be displayed on the Time/Files screen. (Figure 133) To access this screen, press the Setup button on the User Interface Control Bar. (Figure 132)

6. The default Time/Files screen is displayed. (Figure 133)
7. Click on the **Autoinjector tab** at the top of the screen to access the Autoinjector settings menu. (Figure 134)

![Autoinjector tab]

**Figure 134: Autoinjector screen**

8. Click on the **Find auto injector(s) tab**. (Figure 134)

9. The IP address of the autoinjector will appear on the screen. Note: If there are multiple autoinjectors plugged into the 5-port switch, each unique IP address will be displayed. (Figure 135)

![IP Address example]

**Figure 135: IP Address example**
Connect to a Windows Computer

On your personal Windows computer:

1. Click on the network icon at the bottom right corner of the screen. (Figure 136)

   ![Wireless connection](image1)

   *Figure 136: Wireless connection*

2. From the list of wireless networks on the *Windows Wireless Networks* dialog-box (Figure 137) select the router. The name of the router is labeled on the front of the router. (example: SSID: GLMT300N-V2-3a4)

   ![Windows Wireless Networks dialog-box](image2)

   *Figure 137: Windows Wireless Networks dialog-box*

3. Press Connect. (Figure 138)

   ![Connect](image3)

   *Figure 138: Connect*
5. Type the password listed on the router into the Security key box: The password is **goodlife**. (Figure 139)

![Security key box](image)

*Figure 139: Security key box*

6. Press **OK**. (Figure 139)

**Wireless Control Using Remote Device**

For wireless control of the analyzer using a remote device, install the appropriate Virtual Network Client (VNC) software on your remote device. Refer to Appendix E: *Set Up Devices for Remove Access Using VNC Software* on page 162 for details on setting up devices for remote access using VNC software.
Reconfiguring the Wireless Router

If the router is to be used with a different analyzer, a new IP address will need to be assigned.

To setup the wireless router:

1. When the analyzer software is active, hover the mouse in the top, left corner of the screen and click on the icon.
2. A window will pop up. Select Web Browser. (Figure 140)
3. Mozilla Firefox will open. Type **192.168.8.1**. Press **ENTER**. (Figure 141)

![Mozilla Firefox screen](image1)

**Figure 141: Mozilla Firefox screen**

4. Type the password into the box: **Password: 123456789** (Figure 142)

![Enter password](image2)

**Figure 142: Enter password**
5. Click **Advanced Settings** in the top right corner. (Figure 143)

![Figure 143: Advanced settings](image)

6. Re-enter the password and click **Reset**. Password: **123456789** (Figure 144)

![Figure 144: Enter password](image)

7. Select the **Network** tab. (Figure 145)

![Figure 145: Network tab](image)
8. In the dropdown menu, select **DHCP and DNS**. (Figure 146)

![DHCP and DNS](image1.png)

*Figure 146: DHCP and DNS*

9. Scroll down to **Static Leases** to set up the MAC-Address and IPv4 address for the analyzer.
   a. Click **Add**. (Figure 147)

![Static Leases](image2.png)

*Figure 147: Static Leases*

b. Right click on the analyzer *home screen* to open a *Terminal Window*. Type: **ifconfig** and press **ENTER**. (Figure 148)

![Type ifconfig](image3.png)

*Figure 148: Type ifconfig in Terminal window*
c. The terminal window will display the MAC address of the analyzer. (Figure 149)

![Figure 149: MAC address](image)

---

d. Return to the Static Leases section in the Web Browser (Figure 150). Click on the Mac-Address drop-down selection box and choose the same address that is listed in the Terminal Window. (Figure 149)

![Figure 150: Static Leases](image)

e. Click on the IPv4-Address drop-down selection box (Figure 150) and choose the same address that is listed in the Terminal Window (Figure 149)

f. Click Save & Apply. (Figure 150)
10. Select the **Network** tab at the top of the web browser. (Figure 151) 
   a. Scroll to **Firewall** and press **ENTER**.

   ![Network tab](image1)

   **Figure 151: Network tab**

11. Set Port Forwards for VNC, SSH, MODBUS, and SMB:
   a. Click the **Port Forwards** tab at the top of the screen. (Figure 152)

   ![Select Port Forwards tab](image2)

   **Figure 152: Port Forwards**
b. Scroll to **New port forward** and set VNC: (Figure 153)
   i. Type Name: **VNC**
   ii. Set External port to **5900**
   iii. Set Internal port to **5900**
   iv. Select the **Internal IP address** drop down box and select the analyzer’s IP address.
   v. Press **Add**

![Figure 153: New port forward - VNC](image)


c. Set SSH: (Figure 154)
   i. Type Name: **SSH**
   ii. Set External port to **22**
   iii. Set Internal port to **22**
   iv. Select the **Internal IP address** drop down box and select the analyzer’s IP address.
   v. Press **Add**

![Figure 154: SSH](image)

d. Set MODBUS: (Figure 155)
   vi. Type Name: **MODBUS**
   vii. Set External port to **2222**
   viii. Set Internal port to **2222**
   ix. Select the **Internal IP address** drop down box and select the analyzer’s IP address.
   x. Press **Add**

![Figure 155: MODBUS](image)
e. Set SMB: (Figure 156)
   xi. Type Name: **SSH**
   xii. Set External port to **445**
   xiii. Set Internal port to **445**
   xiv. Select the **Internal IP address** drop down box and select the analyzer’s IP address.
   xv. Press **ADD**.

![Figure 156: SMB](image)

f. Click **Save and Apply**.
   xvi. Figure 157 shows all configured Port Forwards.

**Firewall - Port Forwards**
Port forwarding allows remote computers on the Internet to connect to a specific computer or service within the private LAN.

<table>
<thead>
<tr>
<th>Name</th>
<th>Match</th>
<th>Forward to</th>
<th>Enable</th>
</tr>
</thead>
<tbody>
<tr>
<td>VNC</td>
<td>IPv4-tcp</td>
<td>IP 192.168.6.237, port 5900 in lan</td>
<td><img src="image" alt="Checkmark" /></td>
</tr>
<tr>
<td></td>
<td>From any host in wan</td>
<td>Via any router IP at port 3900</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>IP 192.168.6.237, port 5900 in lan</td>
<td><img src="image" alt="Checkmark" /></td>
</tr>
<tr>
<td></td>
<td>From any host in wan</td>
<td>Via any router IP at port 3900</td>
<td></td>
</tr>
<tr>
<td>SSH</td>
<td>IPv4-tcp</td>
<td>IP 192.168.6.237, port 22 in lan</td>
<td><img src="image" alt="Checkmark" /></td>
</tr>
<tr>
<td></td>
<td>From any host in wan</td>
<td>Via any router IP at port 22</td>
<td></td>
</tr>
<tr>
<td>MODBUS</td>
<td>IPv4-udp, udo</td>
<td>IP 192.168.6.237, port 2222 in lan</td>
<td><img src="image" alt="Checkmark" /></td>
</tr>
<tr>
<td></td>
<td>From any host in wan</td>
<td>Via any router IP at port 2222</td>
<td></td>
</tr>
<tr>
<td>SMB</td>
<td>IPv4-tcp</td>
<td>IP 192.168.6.237, port 445 in lan</td>
<td><img src="image" alt="Checkmark" /></td>
</tr>
<tr>
<td></td>
<td>From any host in wan</td>
<td>Via any router IP at port 445</td>
<td></td>
</tr>
</tbody>
</table>

![Figure 157: Configured Port Forwards](image)
12. Re-type **192.168.8.1** and press **ENTER** to return to the *Main Window*. (Figure 158)

![Main Window](image)

*Figure 158: Main Window*

13. The SSID written on the router should match the SSID within *Settings*. (Figure 158)
14. The analyzer serial number should match the serial number located in *DEVICES* within settings. (Figure 158)
15. Refer to *Connect to a Windows Computer* on page 150 to access the analyzer.
Appendix E: Set Up Devices for Remote Access Using VNC Software

Listed below are three types of devices that can be connected to the analyzer through the wireless router to access information:

- Android OS based devices (smart phones and tablets)
- iOS based devices (smart phones, tablets, and laptops)
- Windows based devices (smart phones, tablets, and laptops)

Each of these devices uses Virtual Network Client (VNC) software to connect the analyzer through the router. Follow the instructions below to install and set up VNC software on the device you are connecting to the analyzer.

Set up VNC Software on Android Devices

1. On the Android device, go to Settings > WiFi > Connect to Wireless Network.
2. Connect to the wireless SSID network listed on the router sticker.
3. Select SSID.
4. Enter the wireless password printed on the router sticker. (Figure 139) Every router has a different, unique SSID number, and wireless password.
5. Select Connect.
6. Ensure that the IP address of the Android device is correct by holding your finger down on the network connection icon. The IP address of the Android device is either 192.168.100.100 or 192.168.100.101.
   a. Wireless devices can compete for dynamic addresses. If the 192.168.100.100 address does not connect, then use 192.168.100.101.
7. Record the IP address of the Android device because it will be necessary to refer to it in Step 0.
8. Install the VNC software by searching and installing from the Google Play store. Search for Android-vnc-viewer and install the application by tapping on the Install button. (Figure 159)

An Internet connection is required for this step.
Complete instructions for installing the Android-vnc-viewer can be found online at: http://code.google.com/p/android-vnc-viewer/wiki/Documentation

9. Open the VNC application on the Android device by selecting the VNC application icon. (Figure 160)

10. The Android VNC screen appears. (Figure 161)
11. In the *Address* field, enter the address of the analyzer (192.168.100.100 or 192.168.100.101).

The IP address of the analyzer will be whichever address the Android device is not. For example, if the IP address of the Android device that was displayed in Step 7 is 192.168.100.101, then the IP address of the analyzer will be 192.168.100.100.

12. In the Password field, enter *lgrvnc*.

13. Tap the **Connect** button to connect the Android device to the analyzer. The analyzer software interface screen displays on the device. The screen size is adjustable to fit the screen of the device. (Figure 162)

*Figure 162: Analyzer Software Interface Display with Size Adjustment for Android Devices*
Set up VNC Software on iOS Devices

1. On the iOS device, go to Settings > WiFi, then select the network from the list.
2. Connect to the wireless SSID network listed on the router sticker.
3. Select SSID.
4. The Enter Password screen appears. (Figure 163) In the Password field, enter the wireless password on the router sticker. (Figure 139)
5. Select Join.

![Figure 163: Router Connection Screen](image)

6. The Network Connections screen confirms that the iOS device is connected to the router.
7. Select the network to check the IP address (192.168.100.100 or 192.168.100.101) of the device as shown in Figure 164.
   a. Wireless devices can compete for dynamic addresses. If the 192.168.100.100 address does not connect, then use 192.168.100.101.
8. Record the IP address of the iOS device because it will be necessary to refer to it in Step 12.

![Figure 164: Device IP Address Confirmation Screen](image)
9. Install the VNC software by searching and installing it from the App store.
   a. *Mocha VNC Lite for iOS* is the software used in this example. (Figure 165)
   b. An Internet connection is required for this step.

---

**WARNING**

Complete instructions for installing *Mocha VNC Lite for iOS* can be found online at: http://www.mochasoft.dk/iphone_vnc_help2/help.htm.

---

**Figure 165: VNC Selection Screen**

10. Open the application and select **Configure**. (Figure 166)

**Figure 166: Mocha VNC Lite Configure (New) Screen**

11. The **Configure Screen** prompts you for the server IP address and password. (Figure 167)

**Figure 167: Mocha VNC Lite Configure Screen**
12. Enter the analyzer's address in the VNC server address field (192.168.100.100 or 192.168.100.101).

   The IP address of the analyzer will be whichever address the iOS device is not.

   For example, if the IP address of the iOS device that was displayed in Step 8 is 192.168.100.101, then the IP address of the analyzer will be 192.168.100.100.

13. In the VNC Password field, enter lgrvnc.

14. Select Connect.

   The Setup Configuration screen displays the IP address. (Figure 168)

   ![Figure 168: Setup Configurations Screen](image-url)
15. To connect the iOS device to the analyzer, tap the **IP Config** you set up. The analyzer software will display on the device. (Figure 169) The screen size is adjustable to fit the screen of the device.

*Figure 169: Analyzer Software Interface Screen (Size Adjustment for iOS Devices)*
Set up VNC Software on Windows Devices

1. On the Windows device, open Wireless Router options.

2. Locate the sticker on the router. (Figure 139)

3. Click on the Wireless Network Connections icon in the bottom left of the screen (Figure 170) to open the Windows Wireless Networks dialog-box. (Figure 170)

![Click on the Wireless Network Connections](image1)

*Figure 170: Wireless Connections Icon*

4. From the list of wireless networks on the Windows Wireless Networks dialog-box (Figure 137) select the router. The name of the router is labeled on the front of the router. (example: SSID: GLMT300N-V2-3a4)

![Select your wireless router](image2)

*Figure 171: Windows Wireless Networks dialog-box*

5. Press Connect. (Figure 138)

![Connect](image3)

*Figure 172: Connect*
7. Type the password listed on the router into the Security key box: The password is **goodlife**. (Figure 139)

![Security key box](image)

*Figure 173: Security key box*

8. Press **OK**. (Figure 139)

---

**NOTE**

Detailed instructions for installing Real VNC Viewer for Windows can be found online at: http://www.realvnc.com/products/vnc/documentation/5.0/guides/user/Chapter1.html

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10. Open the program by clicking the **Connect** button. (Figure 174)

![Real VNC Viewer Installation Screen](image)

*Figure 174: Real VNC Viewer Installation Screen*

11. Enter the analyzer’s address in the VNC server address field (**192.168.100.100** or **192.168.100.101**).

The IP address of the analyzer will be whichever address the Windows device is not. For example, if the IP address of the Windows device is **192.168.100.101**, then the IP address of the analyzer will be **192.168.100.100**.

Wireless devices can compete for dynamic addresses. If the **192.168.100.100** address does not connect, then use **192.168.100.101**.
Appendix F: The PAL3 LSI Autoinjector

The PAL3 LSI User Manual is provided with the autoinjector and provides diagrams, configuration data, and function control data to assist you when using the autoinjector with the analyzer.

For additional information, including the latest documentation, visit http://www.palsystem.com/.

Figure 175 shows a front view of the autoinjector.

*Figure 175: PAL LSI Autoinjector (Front View)*
Function Keys
The button functions are as follows:

- **Menu Button A (Options):** Options for a particular menu are assigned to the corresponding function key on the left side.
- **Menu Button B (Default Action):** Reserved for default actions, such as Save, Next, OK, etc.
- **Back Button:** Return to the previous menu
- **Stop Button:** Aborts the ongoing activity

Figure 176 shows the autoinjector keypad and lists its features.

*Figure 176: Autoinjector Keypad Terminal*
Set Regional Settings
To set the regional settings:

1. Press A and B Menu Buttons simultaneously to change Access Level
2. Scroll to Extended User Level
3. Press Enter
   Note: Steps 1-3 will allow the user to enter Service mode.
4. Press Options (Button A). (Figure 177)

   ![](image177.png)
   **Figure 177: Press Options (Button A)**

5. Scroll to Service. (Figure 178)

   ![](image178.png)
   **Figure 178: Scroll to Service**

6. Press Enter.
7. Scroll to Installation. (Figure 179)

8. Press Enter.
9. Scroll to Set Regional Settings. (Figure 180)

10. Press Enter.
11. Press **Language** and scroll to the language of your choice (example: *English*). (Figure 181)

![Figure 181: Select Language](image)

12. Press **Enter**.
13. Press **Region** and choose a region of your choice (example: *English (United States)*). (Figure 181)
14. Press **Enter**.
15. Press **Ok (Button B)**
Set Date and Time
To set the date and time:

1. Press **A and B Menu Buttons** simultaneously to change *Access Level*
2. Scroll to *Extended User Level*
3. Press **Enter**
   a. Note: Steps 1-3 will allow the user to enter *Service* mode.
4. Press **Options (Button A)**. (Figure 182)

![Figure 182: Press Options (Button A)](image1)

5. Scroll to *Service*. (Figure 183)

![Figure 183: Scroll to Service](image2)

6. Press **Enter**.
7. Scroll to *Installation*. (Figure 184)

![Figure 184: Installation](image)

8. Press **Enter**.

9. Scroll to *Set Date and Time*. (Figure 185)

![Figure 185: Set Date & Time](image)

10. Press **Enter**.
11. Scroll to *Time Zone*. (Figure 186)

![Figure 186: Time Zone](image)

12. Press Enter.
13. Scroll to *-8:00 Pacific Time (US & Canada)*. (Figure 186)
14. Press Enter
15. Press OK (Button B)

**Locate IP address**

To locate the IP address of the PAL3 autoinjector:

1. Press Options (Button A)
2. Press Enter
3. Scroll to *Setup Network*
4. The IP address is displayed on the screen. (ex: 172.25.34.130)
Enter a Unique Static IP Address
The Dynamic Host Configuration Protocol (DHCP) is enabled on the PAL3 autoinjector to automatically assign an IP address to the autoinjector. A unique static IP address can be set by de-selecting DHCP and manually entering an IP address.

If the autoinjector does not receive a DHCP response when the autoinjector is initialized, then you must go through the process to set up a static IP address so that it is reachable by the analyzer.

Once the autoinjector is able to obtain the DHCP response, or when a static IP address is entered by this process, then the analyzer can establish a connection to the autoinjector.

To change the IP address:

1. Press **A and B Menu Buttons** simultaneously to change Access Level
2. Scroll to **Extended User Level**
3. Press **Enter**
   - Note: Steps 1-3 will allow the user to enter Service mode.
4. Press **Options (Button A)**. (Figure 187)

![Press Options](image.png)

*Figure 187: Press Options (Button A)*
5. Scroll to Service. (Figure 188)

6. Press Enter.

7. Scroll to Installation. (Figure 189)

8. Press Enter.
9. Scroll to *Setup Network*. (Figure 190)  

![Figure 190: Setup Network](image)

10. Press *Enter*.  
11. Scroll to *DHCP*. (Figure 191)  

![Figure 191: Set the IP Address](image)
12. Press Enter to uncheck the box.

---

**NOTE**

When the DHCP box is checked, an IP address will be automatically assigned to the PAL3 autoinjector.

---

13. Scroll to *IP Address*. (Figure 191)
14. Press Enter
15. Set the IP address, the Subnet Mask, and the Default Gateway to values that are appropriate for your network by clicking on each box, scrolling through the numbers, and pressing Enter. (Figure 192)

![Setup Network](image)

*Figure 192: IP Address, Subnet Mask, & Default Gateway*

16. Press **OK (Button B)** to return to the *Setup Network* screen.
17. Press **OK (Button B)** to return to the *Installation* screen.
18. A message will display: *Processing*** Storing the Network settings may take up to 10 seconds.*
19. Press Enter.
20. Press the Back button 2x to return to the Home screen.
Firmware Version

1. On the Home screen, press Options (Button A). (Figure 193)

![Figure 193: Options](image1)

2. Scroll to About and press Enter. (Figure 194)

![Figure 194: About](image2)

3. Scroll to Product Version to see the latest version. (example: 2.4.1)
Adjust Location Settings

The autoinjector firmware is pre-installed. Do NOT change the parameters unless the autoinjector is not functioning properly.

This section details each step:

- Teach vial positions
- Teach the position of the injection block

To teach the autoinjector positions, you must be in Extended User mode.

The Extended User Level allows certain parameters to be adjusted, such as X, Y and Z axes and position teaching. It is recommended to keep the access level to 'User level' when not making changes to avoid accidental changes.

The PALrobot is always started in the 'User' access level. If the 'Extended User' mode is required, the user must change the access level.

Extended User Access Level

The Extended User Level allows certain parameters to be adjusted, such as X, Y and Z axes and position teaching.

To change the access level:
1. Press A and B Menu Buttons simultaneously to change Access Level.
2. Scroll to Extended User Level.
3. Press Enter.

It is recommended to keep the access level to 'User level' when not making changes to avoid accidental changes.

The PALrobot is always started in the 'User' access level. If the 'Extended User' mode is required, the user must change the access level.
Teach Vial Positions

If other trays and vials are used besides the ones provided, the tray positions may need to be re-taught.

1. Place 3 trays onto the tray holder. (Figure 195)
   The tray holder is labeled #1, #2 and #3 for each tray.

   ![Figure 195: 3 trays on the tray holder](image)

2. Place 3 vials with caps in positions 1, 46 and 54 of each tray. (Figure 196)

   ![Figure 196: Positions 1, 46, and 54](image)
3. Enter the sequence of commands using the keypad dial wheel and center button as shown in Figure 176.
   a. Press **A and B Menu Buttons** simultaneously to change **Access Level**
   b. Scroll to **Extended User Level**
   c. Press **Enter**
   d. On the **Home Screen**, scroll to **Tray Holder 1**. Press **Enter**. (Figure 197)

![Figure 197: Tray Holder 1](image)

   e. Scroll to **Slot 1**. (Figure 198)

![Figure 198: Slot 1](image)

   f. Press **Enter**
g. Select Rack 1. (Figure 199)

![Figure 199: Rack 1](image)

h. Press **Options (Button A)**
   i. Scroll to **Teach PALmodule**. This will define the x, y and z-axes. (Figure 200)

![Figure 200: Teach PALmodule](image)
j. Manually move the vertical arm to vial #1 in tray #1. (Figure 201)

k. Press Save (Button B)

l. Press Enter to fine tune adjustment of x, y or z position. (Figure 202)

The needle guide must be centered over the vial in position 1.
m. Press **Next (Button B)**

n. Manually move the vertical arm to vial #46 in tray #2. (Figure 203)

![Figure 203: 2nd Teach Point in Front Corner Left](image)

o. Press **Save (Button B)**

![Figure 204: Move vertical arm to vial #46](image)
p. Press Enter to fine tune adjustment of x, y or z position. (Figure 205)

$q. \text{ Press Next (Button B)}$

$r. \text{ Manually move the vertical arm to vial #54 in tray #1. (Figure 206)}$

$s. \text{ Press Save (Button B)}$
t. Press **Enter** to fine tune adjustments of x, y or z positions. (Figure 207)

![Figure 207: Fine tune adjustment](image)

u. Press **Next (Button B)**
v. Press **OK** to move the PALhead back to *Home* position (Button B). (Figure 208)

![Figure 208: Move PALhead back to Home](image)
w. Press **Back** 2 times to return to the *Tray Holder 1* folder
x. Scroll to *Slot 2* and press **Enter**
y. Repeat steps g through w to define Tray 2 positions
z. Press **Back** 2 times to return to the *Tray Holder 1* folder
aa. Scroll to *Slot 3* and press **Enter**
bb. Repeat steps g through w to define Tray 3 positions
Teach the Position of the Heated Injection Port

1. Unplug the power cord to the injector block and allow the block to cool to prevent injury.
2. Remove the protective blue cap from the heated injector block. (Figure 209)

![Figure 209: Remove the cap from the injector block](image)

3. Place the alignment tool on top of the septum cap. (Figure 210)

![Figure 210: Place alignment toll on septum cap](image)
4. Enter the sequence of commands using the keypad dial wheel and center button as shown in Figure 176.
5. Press **A and B Menu Buttons** simultaneously to change **Access Level**
6. Scroll to **Extended User Level**
7. Press **Enter**
8. On the **Main Menu**, scroll to **Injector LC 1**. (Figure 211)

![Figure 211: Injector LC 1](image)

9. Press **Enter**
10. Press **Options (Button A)**
11. Scroll to “**Teach PALmodule**”. (Figure 212)
   a. This will define the x, y and z-axes.

![Figure 212: Teach PALmodule](image)

12. Press **Enter**
13. Manually move the vertical arm to the heated injector block so that the conical syringe guide sits securely within the alignment tool. (Figure 213)

Figure 213: Syringe Guide

14. Press **Save (Button B)**

Figure 214: Move the head to the teach point
15. Press **Enter** to fine tune adjustment of x, y or z positions. Verify that the arm position is directly over the injector port.

![Figure 215: Fine tune adjustment](image)

16. Press **Next (Button B)**
17. Press **OK (Button B)** to move the PALhead back to the *Home* position. (Figure 216)

![Figure 216: Move the PALhead to Home position](image)
Changing to a different type of syringe

ABB-Los Gatos Research recommends using the provided 1.2uL Hamilton syringes. However, syringe types can be changed by following these steps:

Enter the sequence of commands using the keypad dial wheel and center button as shown in Figure 176.

1. Press **A and B Menu Buttons** simultaneously to change *Access Level*
2. Scroll to *Extended User Level*
3. Press **Enter**
4. Scroll to **LS1 1.2uL; NL: 57mm**
5. Press **Enter**
6. Scroll to *Syringe Type*
7. Press **Enter**
8. Scroll through the Syringe ID #'s and select the ID # located on the syringe box.
   a. For example, the provided Hamilton 1.2uL syringe's ID # is SF1_57_B_25P_COc.
Backup

To create a backup:
1. Insert the USB into the port on the back panel of the autoinjector. A USB icon will appear on the screen. (Figure 217)

2. Press Options (Button A)
3. Scroll to Maintenance and press Enter. (Figure 218)
4. Scroll to *Create Configuration Backup* and press **Enter**. (Figure 219)

5. Verify the *Serial Number* on the screen is the same as what is printed on the right side of the autoinjector arm. (Figure 220)
6. Press **Start (Button B)**. The configuration backup will begin. The screen displays the percentage of completion. (Figure 221)

![Figure 221: Completion %](image)

7. When complete, the screen will show the message “*The configuration backup has been created successfully*”. (Figure 222)

![Figure 222: Successful backup message](image)

8. Press **Exit**. (Figure 222)
Shutdown Process

To shutdown the autoinjector:
1. Press Options (Button A)
2. Scroll to Shutdown and press Enter. (Figure 223)
3. The “Are you sure you want to shut down?” prompt will appear on the screen. (Figure 224)
4. Scroll to Yes and press Enter. (Figure 224)
5. When the “Shutdown Completed!” message appears on the screen, switch the power button to OFF. (Figure 225)

Figure 225: Shutdown completed!
Error Messages

Pending Message (Blinking Envelope)
Pending Messages typically derive from a collision during the homing process. Check the homing path of all axes and reboot the system again.
If there is a blinking envelope at the top of the screen:
   1. Press Options (Button A)
   2. Scroll to Pending Message. (Figure 226)

   ![Figure 226: Pending Messages](image)

3. Press Enter
4. Follow instructions.

Y Drive 1 is not homed.
This message appears on the PAL3 display screen. It may be due to an improper shutdown. See page 200 for details on how to properly shut down/reboot the analyzer.

To re-home the Y position:
   1. Scroll to RobotArmLeft
   2. Press Enter
   3. Scroll to Y Drive 1
   4. Press Enter
   5. Press Options (Button A)
   6. Select Home PALdrive
   7. Press Enter
      a. The arm will move to the Y homing position.
   8. Press Back when complete.
X Drive 1 is not homed.
This message appears on the PAL3 display screen. It may be due to an improper shutdown. See page 200 for details on how to properly shut down/reboot the analyzer.

To re-home the X position:
1. Scroll to RobotArmLeft
2. Press Enter
3. Scroll to X Drive 1
4. Press Enter
5. Press Options (Button A)
6. Select Home PALdrive
7. Press Enter
   a. The arm will move to the X homing position.
8. Press Back when complete.

Error Network Connection
When the Error Network Connection message appears on the analyzer Run Screen, the autoinjector is not communicating with the analyzer. See page 57 for instructions on how to pair the autoinjector with the analyzer.

![Error Network Connection Message](image)

*Figure 227: Error Network Connection*
Error Penetration Depth
If the Error Execute [PenetrateObject] ActivityError!Runtime Error ‘General_Movement Timeout Occurred’ message appears on the analyzer Run Screen, the penetration speed is set too low. The PAL3 autoinjector times out if it takes too long to reach the penetration depth. (Figure 228)

To reset the penetration speed:
1. Enter Setup mode:
   a. Click the **Setup** button on the *User Interface Control Bar*. (Figure 229)
2. Select the **Autoinjector** tab at the top of the screen. (Figure 230)

![Autoinjector tab](image)

**Figure 230: Autoinjector tab**

3. Increase the Penetration speed in the **Prep Fill Settings** pane and the **Measure Fill Settings** pane. (Figure 230)
Appendix G: GLA431-IWA and GLA431-TIWA Setup

The (Triple) Isotopic Water EP Benchtop Analyzer is a combination of the (Triple) Liquid Water Isotope Analyzer (GLA431-TLWIA or GLA431-LWIA) and the (Triple) Water Vapor Isotope Analyzer (GLA431-TWVIA or GLA431-WVIA). This manual explains how to configure the (Triple) Isotopic Water Analyzer to operate in liquid water mode, water vapor mode, and the optional extended range water vapor mode.

Modes of operation:
- The Liquid Water Isotopic Analyzer measures discrete liquid injections.
- The Water Vapor Isotopic Analyzer measures a continuous flow of water vapor.
  - Standard Range: 4000 – 60,000ppm (non-condensing)
  - Optional Extended Range: 100 – 60,000ppm (non-condensing)

For each of these modes (T)LWIA, (T)WVIA or the optional (T)WVIA-Ext, you must:
- Physically configure the analyzer for the particular mode of operation.
- Launch the software package for the particular mode of operation.

This procedure describes the hardware and software setup for each configuration. See detailed operating instructions in:
- ABB GLA431 Liquid Water Series_User Manual_3KXG164001R4601_AA_08_2020
Standard Components of a GLA431-TIWA and GLA431-IWA

This section describes the analyzer components. Verify that each of the system components has arrived before installation.

GLA431-TIWA or GLA431-IWA
- Analyzer power cord
- User guides
  - ABB GLA431 Series_Liquid Water Isotopic User Manual
  - ABB GLA431 Series_Continuous Flow User Manual
- USB flash drive
- Serial port connection cable (null modem type)
- Exhaust Muffler

External Pump System
- External pump (ACC-DP4H)
- 1/2”x 6’ Teflon connection tube
- Pump power cord

Starter Supplies Kit
- Syringe (1.2 µL capacity) (3)
- Centering needle (1)
- Septum puller (1)
- Set of working standards (5 Vials - Standards 1-5)
- 2mL vials (1 pack of 100)
- Screw thread caps with attached septa (1 box of 100)
- Septa (1 box of 50)
- Pair of thermal gloves (2 - 1 large, 1 small)
- Dry air (1 can)
- Allen keys (2)
- 7/16” wrench (2)
- 9/16” wrench (1)
- 7/8” wrench (1)
- Drierite® laboratory gas drying unit (1)
Optional Components

PAL3 LSI Autoinjector Kit (ACC-AUTOINJECT)

- Autoinjector
- Autoinjector power supply
- Control panel with display
- Cables
  - See the GLA431-TLWI4A user manual for a list of cables and connections.
- Nylon screws (8)
- Vial trays (3)
- Spare injection block with septum and cap (1)
- TP-Link 5-port Fast Ethernet Switch
- GL-MT300N-V2 Mini Smart Router

⚠️ Note

The autoinjector setup is described in detail on page 28.

Water Vapor Isotope Standard Source (WVISS) – Standard range or Extended Range option

- WVISS hand pad
- Control signal cable
- BNC cables

⚠️ Note

The WVISS is described in detail in the Water Vapor Isotope Standard Source (WVISS) User Manual.

Multiport Inlet Unit (MIU)

- Power Cable
- 25-pin connection cable for control signal
- One 1\’\’ x 6\’ Teflon tube (connects the outlet port of the MIU to the inlet port of the analyzer)

⚠️ Warning

This analyzer has been CE certified using data cables three meters long or less. Connecting the analyzer using longer data-cables is not recommended.

If you have not received all of these components, contact ABB-LGR at icos.support@ca.abb.com.
Figure 231 shows the back of the analyzer with connections.

Figure 231: Back Panel
Plumbing Diagram

During Liquid Water operation, the cavity is flushed with dry air through the Dry Gas Inlet port (\(\frac{1}{4}\)" Swagelok) on the back panel of the analyzer. The cavity is then pumped out through the External Pump port (\(\frac{1}{2}\)" Swagelok). The sample is introduced to the To Septum port. The analyzer equilibrates and then begins sample measurement. The cavity is stable at approximately 1 Torr while measuring.

- When flushing dry air into the cavity, valve #2 is closed and valve #1 is open.
- When the analyzer is pumping down, valve #1 is closed and valve #2 is open.
- When the analyzer is measuring a sample, the cavity is stable at \(\approx 1\) Torr, and all valves are closed.

During Water Vapor operation, the internal pump draws gas through the Sample Inlet port (\(\frac{1}{4}\)" Swagelok) on the back panel of the analyzer, and the waste is exhausted through the Internal Pump Exhaust port (\(\frac{1}{4}\)" Swagelok). The inlet gas pressure range is 0 to 5 psig.
- Valves #3 and #8 are open during water vapor mode.

Figure 232 shows the plumbing diagram for the (Triple) Isotopic WaterAnalyzer.
1 Configure the Analyzer as a (T)LWIA

Connect the Analyzer as a (Triple) Liquid Water Isotope Analyzer

1. Connect the power cords:
   a. Connect the analyzer’s power cord from the AC power port on the back panel to a grounded outlet of your power supply. (Figure 4)
   b. Connect the external pump’s power cord to the EXT. PUMP POWER port on the back panel of the analyzer. (Figure 4)

2. Connect the Data Interface Connections:
   a. See Figure 5 for a detailed description of the connections.

3. Connect the transfer tube to the analyzer:
   a. Connect the 1/8” Teflon tube with the attached 10 m screen filter from the TO SEPTUM port on the back of the analyzer (Figure 7) to the 1/4” fitting on the autoinjector septum arm.

   **NOTE** Always vent the analyzer cavity before changing the septum to prevent contamination of the cavity.

4. Connect the Drierite® laboratory drying unit:
   a. Remove the plastic plug from the bottom of the drying unit. (Figure 233)
   b. Connect the drying unit to the 1/4” Swagelok port, labeled DRY GAS INLET 0-5 PSIG, on the back of the analyzer using the provided 1/4” Teflon tubing. (Figure 7)
   c. Tighten the connection to 1/4 - 1/2 turn past finger-tight, leaving a gap of < 3.5 mm. (Figure 11)

   **Figure 233: Drierite® Laboratory Gas Drying Unit**

   **NOTE** When using dry gas from a cylinder or a house dry gas system, make sure that the inlet pressure is between 0-5 psig.
5. Connect the External Pump:
   c. Connect the External Pump’s 6’ x ½” Teflon tubing with Swagelok fittings from the external pump to the TO EXT PUMP port on the back panel of the analyzer. (Figure 7)
   d. The exhaust port is located on the pump. It can either be connected to the provided muffler (Figure 234) to expel exhaust into the room air, or the exhaust can be routed to the facility ventilation system.

   ![Figure 234: Exhaust Muffler](image)

6. Connect the optional autoinjector.
   a. See the 28 for detailed instructions on connecting the autoinjector.
Inlet/Outlet Connections
The inlet and outlet ports are located on the back panel of the analyzer. (Figure 3) The TLWIA ports are highlighted in Figure 7.

The unit ships with inlets and outlets capped for protection. The connections use Swagelok fittings ISO thread size 1/4” and 1/2”.

![Figure 235: Inlet/Outlets for the TLWIA](image)

**NOTE**
Cap the **H2O VAPOR INLET** and **INTERNAL PUMP EXHAUST** ports when not in use.
2 Initialize and Select the Run Mode

To initialize the analyzer:

1. Press the power switch located on the front of the external pump to the ON position.
2. Press the power switch located on the autoinjector power supply to the ON position.
3. Press the power switch on the front of the analyzer to the ON position. (0 = OFF / - = ON)
4. The internal computer initializes, and a screen (Figure 236) displays as the program loads.

Figure 236: Start-up Screen in Busy Mode
5. The Launch Service screen displays after initialization. (Figure 237)
6. Select the button to manually launch the analyzer in the mode of choice. (Figure 237)
   a. If you do not make a selection within 120-seconds, the analyzer automatically defaults to (T)LWIA mode.

![Launch Service Screen to launch (T)LWIA mode](image)

7. Click on the maintenance SERVICE button (Figure 237) if you need more time or need to choose a maintenance setting. (Figure 61)
The Auto Launch Screen

The Auto Launch and Maintenance settings are available when you click the Service button on the Launch Service screen.

From this interface, you can:
- Select the mode for which the analyzer will default during start-up.
- Change the auto launch delay timing.
- Transfer files from the internal hard drive to an external storage device connected via USB by clicking Files.
- Restore the analyzer’s factory settings by clicking Restore.

Figure 238 shows the Auto Launch screen.

Figure 238: Auto Launch Screen for (T)LWIA mode

See the ABB GLA431 Continuous Flow Series User Manual for details on configuring and running the analyzer in (T)WVIA mode.
3  Configure the Analyzer as a (T)WVIA

Connect the Analyzer as a Water Vapor Isotope Analyzer

1. Connect the main power cable.
   a. Connect the analyzer power cord from the AC power port on the back panel to a grounded outlet of your power supply. (Figure 4)

2. Connect the Data Interface Connections:
   a. See Figure 5 for a detailed description of the connections.

3. Connect the Inlet/Outlet plumbing connections:
   a. Uncap the INLET port on the back panel of the analyzer.
   b. If applicable, connect a ¼” sample tube (not provided) from the INLET port to your sample source.
   c. Uncap the INTERNAL PUMP EXHAUST PORT on the back panel of the analyzer.
   d. Connect the provided exhaust muffler with Swagelok adaptor to the INTERNAL PUMP EXHAUST port to exhaust into the room air, or route to your facility ventilation system, using ¼” tubing. (Figure 239)

   ![Figure 239: Exhaust Muffler](image)

Connecting the Optional ACC-DP4H External Pump

The analyzer comes equipped with an internal pump. However, the optional ACC-DP4H External Pump provides fast flow-through times of <0.5 seconds.

To connect the external pump:

1. Connect the External pump’s power cord from the pump to the EXT. PUMP POWER port on the back panel of the analyzer. (Figure 4)

2. Connect the External Pump’s 6’ x ½” Teflon tubing with Swagelok fittings from the external pump to the TO EXT PUMP port on the back panel of the analyzer. (Figure 3)

3. The exhaust port is located on the pump. It can either be connected to the provided muffler to expel exhaust into the room air, or the exhaust can be routed to the facility ventilation system.
Water Vapor Isotope Inlet/Outlet Connections
The inlet and outlet ports are located on the back panel of the analyzer. (Figure 3) These ports are shown in detail in Figure 240.

The unit ships with inlets and outlets capped for protection. The connections use Swagelok fittings ISO thread size 1/4” and 1/2”.

Cap the TO EXTERNAL PUMP and DRY GAS INLET ports when not in use.

The (T)LWIA SEPTUM port must remain capped to prevent contamination to the cavity.
Set the Pressure Selection Switch for the Optional Extended Range Feature

For standard water vapor configuration, the pressure is controlled at 40 Torr. No adjustments are necessary.

For the optional Extended Range mode, the user must manually adjust the pressure switch to control the pressure at 80 Torr.

Figure 241 shows the pressure control switch that can be adjusted to 40 Torr or 80 Torr.

![Pressure Switch Settings](image)

*Figure 241: Pressure Switch Settings*
Appendix H: Cables

Table 22 describes the power cables shipped with your analyzer.

### Table 22: Power Cables

<table>
<thead>
<tr>
<th>Region</th>
<th>Cable Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Australia and New Zealand</strong></td>
<td><img src="image" alt="Cable Diagram" /></td>
</tr>
<tr>
<td></td>
<td>1. CORDAGE: SAA, 3 x 1.0mm, UNSHIELDED. CEE COLOR CODE, TEMP: RATING 70°C. RATING 250V 10A, JACKET COLOR: BLACK</td>
</tr>
<tr>
<td></td>
<td>2. PLUG: AS 3112/Australian</td>
</tr>
<tr>
<td></td>
<td>3. CONNECTOR: IEC 60320 C-13 APPROVALS: AUSTRALIA, NEW ZEALAND ROHS COMPLIANT</td>
</tr>
<tr>
<td><strong>United Kingdom</strong></td>
<td><img src="image" alt="Cable Diagram" /></td>
</tr>
<tr>
<td></td>
<td>1. CORDAGE: HOSVV-F, 3x1.0mm. CEE COLOR CODE, TEMP: RATING 70°C. RATING 250V, 10A, JACKET COLOR: BLACK</td>
</tr>
<tr>
<td></td>
<td>2. PLUG: UK PLUG BS1363A (SUPPLIED WITH 13A FUSE)</td>
</tr>
<tr>
<td></td>
<td>3. CONNECTOR: IEC 60320 C13 APPROVALS: UNITED KINGDOM, CE ROHS COMPLIANT</td>
</tr>
</tbody>
</table>
Europe

1. CORDAGE: H05VV-F, 3 x 1.0mm, UNSHIELDED,
CEE COLOR CODE, TEMP. RATING 80°C,
RATING: 250V 10A, JACKET COLOR: BLACK
2. PLUG: IEC 884/CEEP-VII
3. CONNECTOR: IEC 60320 C13
APPROVALS: CB, GERMANY, DENMARK, NORWAY, FINLAND,
BELGIUM, NETHERLANDS, SWEDEN, AUSTRIA,
ROHS COMPLIANT

United States

1. CORDAGE: SJT, 16AWG / 3C, UNSHIELDED,
CEE COLOR CODE, TEMP. RATING 60°C,
RATING: 125V 13A, JACKET COLOR: BLACK
2. PLUG: NEMA 5-15P
3. CONNECTOR: IEC 60320 C-13
APPROVALS: UL, cUL
ROHS COMPLIANT
—

ABB Measurement & Analytics

For your local ABB contact, visit:
abb.com/contacts

For more product information, visit:
abb.com/measurement

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