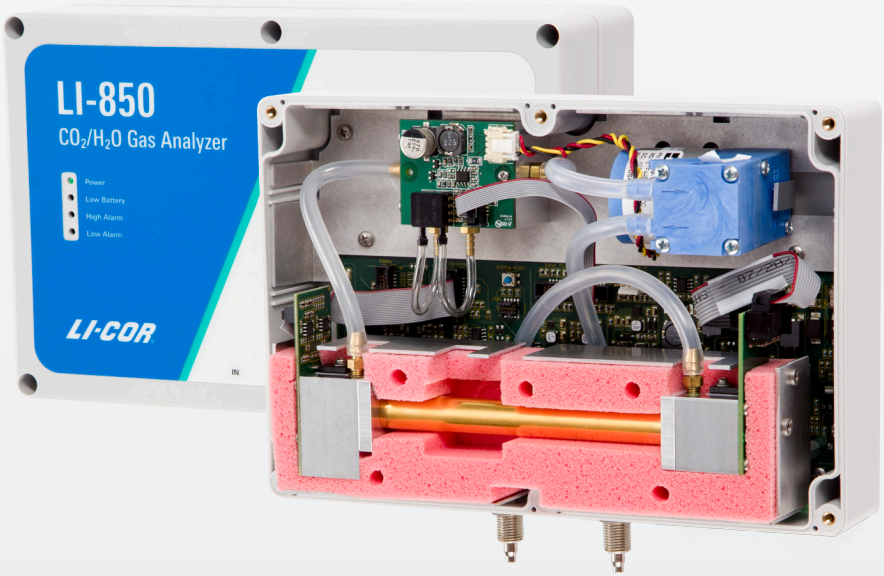
The LI-830 and LI-850 Integrator's Guide



LI-COR®

LI-830 and LI-850 Gas Analyzers

Integrator's Guide

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Printing History

Publication Number: 977-17191

Created on Monday, March 19, 2018

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Section 1.
Configuration grammar

The LI-830 and LI-850 can communicate with a computer or a system controller through a serial connection (either the RS-232 or USB output). The following discussion describes how to implement the communication protocol. To help facilitate this discussion, this document will rely exclusively on a terminal program to communicate with the gas analyzer. To use this document, download and install a terminal program on your computer. We give examples using TeraTerm for Windows and Serial for Mac, but nearly any terminal program will work.

About XML communications

The configuration grammar used to communicate with the analyzer is based upon the e**X**tensible **M**arkup **L**anguage (XML). XML relies on the use of tags to "Markup", or give structural rules to a set of data.

A tag is a descriptive identifier enclosed between a less than (<) and a greater than (>) symbol, used in part to describe a piece of data. For example, `<name>` is a tag that describes a person's name. Each tag must have a corresponding end tag, denoted by '/'. Extending the example above, the end tag of `<name>` is `</name>`.

Elements are the basic unit of XML content. An element consists of a start tag and an end tag, and everything in between. For example, consider the following element:

```
<name>george</name>.
```

In this example, `<name>` (start tag) and `</name>` (end tag) comprise the markup, and "george" comprises the data. Because XML is extensible, tags can be defined specifically for the data they are meant to describe.

Elements can also contain other elements other than data.

```
<name>
   <first>george</first>
   <last>smith</last>
</name>
```

In this example, the outermost element `<name>` encompasses two other elements that contain data. All elements combined make up the XML document.

The LI-830 and LI-850 communications are not case sensitive. So, your commands can be upper case, lower case, or a combination of upper and lower case if you are so inclined. The instruments do not interpret upper case commands as yelling, in the way that people often do.

Types of data

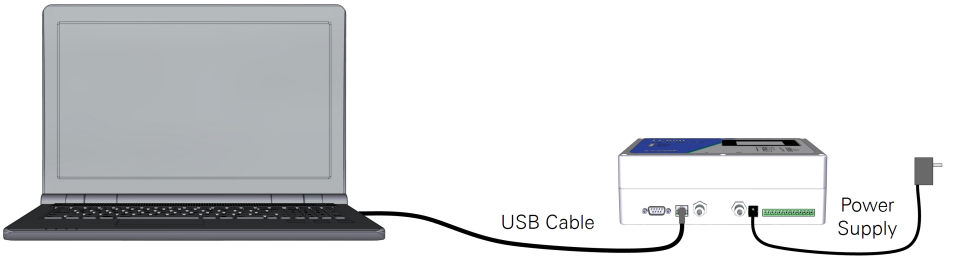
An element includes a start tag, end tag, and the data inside the tags. The data can take any of the forms described in *Table 1-1* below.

Table 1-1. The types of information sent in the XML grammar.

Value	Description	Example
{val | val |...}	The value will be a member of the specified set. In this document, the vertical bar (|) means "or".	2.5 | 5
{bool}	Boolean values.	TRUE | FALSE
{float}	Floating point values in decimal or exponential notation.	3.1415927
{int}	Integers.	25
{iso date}	Date in the International Organization for Standards (ISO) format: 4-digit year, 2-digit month, and 2-digit day.	2017-11-07
{string}	A sequence of characters	HGA-4234
'?'	The question mark, when sent in the XML, requests all values for that XML tag.	

Connecting over a terminal program

To connect with the analyzer, power it on and connect the USB cable between the analyzer and your computer. Or, connect to the board as described in *Circuit board connector* on page A-1.



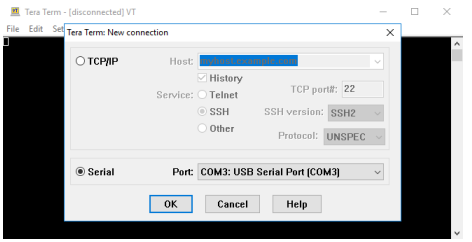
1 Launch the terminal program.

In this example, we use TeraTerm for Windows and Serial for Mac. In either case, you can select from the devices that are connected to the computer.

2 Connect with the instrument.

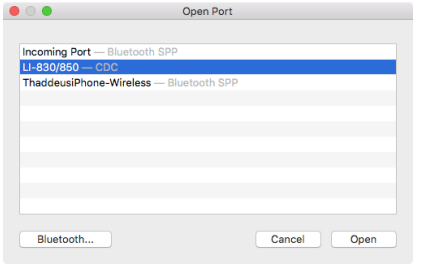
In **TeraTerm** on Windows:

Launch the **TeraTerm** app. Select **Serial**, select the port called **COM#: USB Serial Port (COM#)**, then click **OK**.



In **Serial** on Mac:

Launch the **Serial** app. It will open a window that lists all of the devices. Select LI-830/850 and click **Open**.



You may or may not see data stream into the terminal program immediately, depending on the current instrument configuration.

The default configuration for serial communication is given in *Details on the serial connection* on page A-3.

Sending a command

It can be a bit tricky to send commands if you're unfamiliar with terminal programs. Here are some tips that might help you get started:

> **Note:** The root tag for the LI-850 is `<li850>` and the root tag for the LI-830 is `<li830>`. We use `<li850>` throughout most of this document.

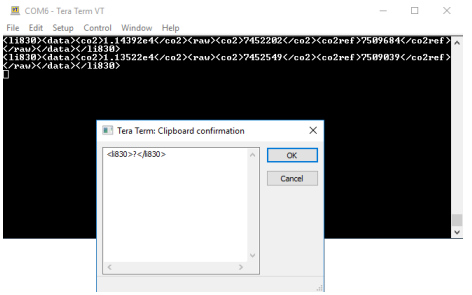
In **TeraTerm** on Windows:

Select the text below:

`<li850>?</li850>` or
`<li830>?</li830>`

and copy it to the clipboard (Ctrl + C).

In TeraTerm, click **Edit > Paste <CR>** to open a clipboard window, where you can edit the command.



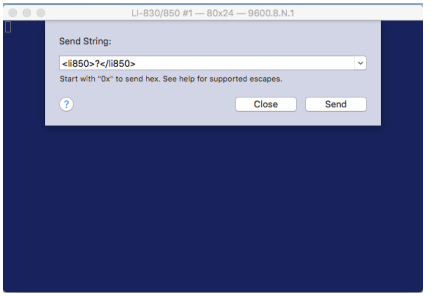
Click **OK** to submit the command.

In **Serial** on Mac:

Click **Terminal > Send String.**

Type (or copy and paste) the command into the interface.

`<li850>?</li850>` or
`<li830>?</li830>`



Click **Send** to submit the command.

The instrument will reply by returning the entire configuration as XML.

> **Note:** A simple way to write the commands is to copy the text from this document or type the command into a text editor and copy the text to your clipboard (select the text and press Ctrl+C). Then right-click in the terminal window and paste the command (or press Ctrl+V).

Reading data from the instrument

This section describes how to view measurements from the instrument in a terminal program.

Configuring the output rate

Copy the following command and paste it into the TeraTerm window:

```
<li850>
   <cfg>
      <outrate>1</outrate>
   </cfg>
</li850>
```

This will configure the instrument to send one measurement per second. The instrument will respond with a confirmation message (`<li850><ack->true</ack></li850>`) and by sending data once per second. You still may not see data however, depending on the instrument settings.

Enabling and disabling an output variable

To include the CO_2 reading among the data sent from the instrument, copy the following command and paste it into the TeraTerm window:

```
<li850>
   <rs232>
      <co2>true</co2>
   </rs232>
</li850>
```

This will configure the instrument to send the CO_2 measurement. After sending the command you will see the confirmation message and other variables in addition to CO_2, depending upon the instrument settings. The confirmation message is `<li850><ack>true</ack></li850>`.

To exclude the CO_2 reading from the data, send this command:

```
<li850>
   <rs232>
      <co2>false</co2>
   </rs232>
</li850>
```

CO_2 will no longer be returned. You will still see all the measurements that are configured as TRUE but not specified here.

Turning off all output variables except CO_2

Send this command to stop the instrument from sending all the measurements except CO_2 and to send CO_2 once per second:

```
<li850>
   <cfg>
      <outrate>1</outrate>
   </cfg>
   <rs232>
      <co2>true</co2>
      <flowrate>false</flowrate>
      <h2o>false</h2o>
      <celltemp>false</celltemp>
      <cellpres>false</cellpres>
      <ivolt>false</ivolt>
      <co2abs>false</co2abs>
      <h2oabs>false</h2oabs>
      <h2odewpoint>false</h2odewpoint>
      <raw>false</raw>
      <echo>false</echo>
      <strip>false</strip>
   </rs232>
</li850>
```

It may be evident by now that the TRUE command means do send; whereas the FALSE command means do not send. Also, here we included the command to configure the output rate to once per second.

Removing XML tags

So far we've been viewing data inside the XML tags. If you simply want to see the data *without* the enclosing XML tags, send this command:

```
<li850>
   <rs232>
      <strip>true</strip>
   </rs232>
</li850>
```

The instrument will respond with the confirmation message:

```
<li850><ack>true</ack></li850>
```

and by streaming space-delimited text rather than XML text. Send this command to return the data *with* XML tags:

```
<li850>
   <rs232>
      <strip>false</strip>
   </rs232>
</li850>
```

The instrument will respond with the confirmation message and by streaming data as XML text.

Reading the full dataset

Sending this command:

```
<li850>
   <data>?</data>
</li850>
```

instructs the analyzer to send the most recent set of data values according to the current configuration. You will only see data values that are set as `true` (see *Enabling and disabling an output variable* on page 1-5). In other words, you may see no data, some data, or all of the data.

Reading instrument settings

Previously we described how to configure the data that is sent over the serial port (RS-232 or USB). Here we describe how to read the current settings in the instrument. You may want to set the output rate (`<outrate>`) to 0 for these exercises.

The analyzer can be polled for individual sets of data by sending an XML document with a `?` in place of the set of elements requested. The element sets that can be requested include the data set, the current configuration, and the entire state of the instrument.

All settings

To receive the entire state of the instrument as an XML document (except the `<tech>` information), send this command:

```
<li850>?</li850>
```

The instrument will reply with the full configuration followed by the confirmation message.

Configuration settings

To receive all of the configuration information, send this command:

```
<li850>
   <cfg>?</cfg>
</li850>
```

The instrument will return the current configuration, including heater status, filter settings, DACs, and alarms, followed by the confirmation message. See *Configuration tags* on page 2-5 for the full description.

Zero and span settings

To receive the user-settable zero and span calibration settings, send:

```
<li850>
   <cal>?</cal>
</li850>
```

The instrument will return the current zero and span calibration information, including the dates of calibrations and the zero and span coefficients. See *Calibration tags* on page 2-9 for the full description.

Polynomial settings

To receive the coefficients for the calibration polynomial function, send:

```
<li850>
   <poly>?</poly>
</li850>
```

The instrument will return the factory-determined polynomial coefficients that are unique to your instrument. See *Polynomial tags* on page 2-10 for the full description.

Pump settings

To receive the pump settings, send:

```
<li850>
   <pump>?</pump>
</li850>
```

If the LI-COR pump is installed, the instrument will return all of the pump settings and the confirmation message. See *Pump tags* on page 2-8 for the full description.

Optical source hours of operation

To receive the hours of operation for the optical source, send:

```
<li850>
   <source>?</source>
</li850>
```

The instrument will return the number of hours on the source, followed by confirmation.

Serial number

To request the serial number of your instrument, send the following:

```
<li850>
   <serialnum>?</serialnum>
</li850>
```

The instrument will return the serial number of the instrument, followed by confirmation.

Software version

To request the software version, send:

```
<li850>
   <ver>?</ver>
</li850>
```

The instrument will return the software version number.

Applying instrument settings

Here we describe how to apply some settings. Earlier we described how to set the output rate. The output rate is a configuration:

```
<li850>
   <cfg>
      <outrate>1</outrate>
   </cfg>
</li850>
```

You can also configure the other settings. For example, sending this command:

```
<li850>
   <cfg>
      <heater>false</heater>
   </cfg>
</li850>
```

will turn the optical bench heater off and return a confirmation message. You normally don't want the heater off, so send this command to reenable it:

```
<li850>
   <cfg>
      <heater>true</heater>
   </cfg>
</li850>
```

Controlling the pump

For instruments that are equipped with a LI-COR-installed pump, the pump controls are in their own tag: `<pump>`. To enable the pump, send:

```
<li850>
   <pump>
      <enabled>true</enabled>
   </pump>
</li850>
```

The instrument will respond with a confirmation message.

To disable the pump, send:

```
<li850>
   <pump>
      <enabled>false</enabled>
   </pump>
</li850>
```

The instrument will respond with a confirmation message.

Calibrating the instrument

The analyzer CO_2 and H_2O (LI-850 only) zeros and spans can be performed using XML grammar. Just like when you calibrate with the software, be sure that a suitable calibration gas is flowing through the optical cell before changing a zero or span. See the instruction manual for details. To request the calibration information (optional), enter the following command:

```
<li850>
   <cal>?</cal>
</li850>
```

The instrument will respond with the current calibration information and a confirmation message: `<li850><ack>true</ack></li850>`. If the calibration cannot be performed, an error is returned: `<li850><error>text</error></li850>`.

1 Set the CO_2 zero.

With suitable CO_2-free air flowing through the analyzer cell:

A Send the command to initiate the zero. The date and concentration must be sent together.

```
<li850>
   <cal>
      <date>yyyy-mm-dd</date>
      <co2zero>true</co2zero>
   </cal>
</li850>
```

B Wait for the acknowledgment.

When the zero is set the instrument will return confirmation. If the operation fails the instrument will return an error message.

2 Set the primary CO_2 span.

Using a CO_2 span gas with a known concentration of CO_2 in air:

A Send the command to initiate the span.

```
<li850>
   <cal>
      <date>yyyy-mm-dd</date>
      <co2span>gas concentration</co2span>
   </cal>
</li850>
```

B Wait for the acknowledgment.

When the primary span is set the instrument will return confirmation. If the operation fails the instrument will return an error message.

3 Set the secondary CO_2 span (optional).

Using a CO_2 span gas with a known concentration of CO_2 in air (different from the concentration used to set the primary span):

A Send the XML command to initiate the second span.

```
<li850>
   <cal>
      <date>yyyy-mm-dd</date>
      <co2span2>gas concentration</co2span2>
   </cal>
</li850>
```

B Wait for the acknowledgment.

When the secondary span is set the instrument will return confirmation. If the operation fails the instrument will return an error message.

You can verify that all the calibrations were set by querying the instrument:

```
<li850>
   <cal>?</cal>
</li850>
```

The instrument will return the calibration settings and dates.

Configuring the alarms

The alarms can be set for either CO_2 or H_2O (in the LI-850). In either case, each alarm features a level and a deadband. The low alarm (`<low>`) is triggered when the reading drops below the setting. It is deactivated when the reading rises above the deadband setting (`<ldead>`). The high alarm (`<high>`) is triggered when the reading exceeds the setting. It is deactivated when the reading drops below the deadband setting (`<hdead>`).

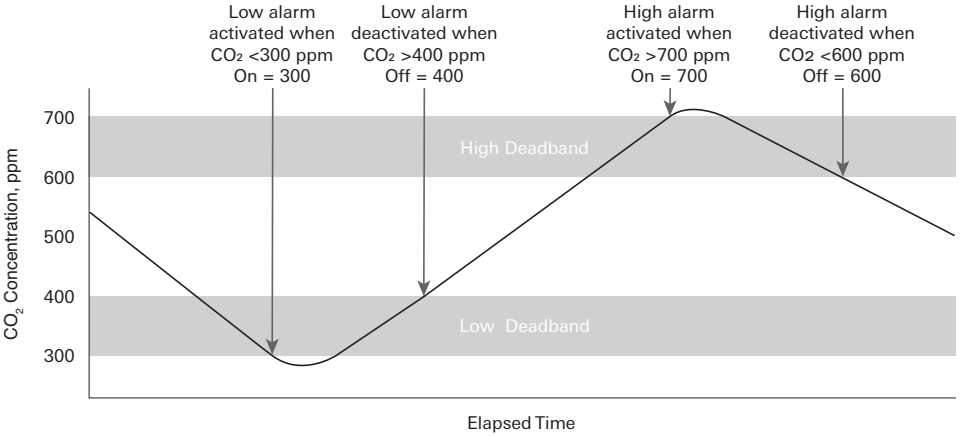


Figure 1-1. An alarm is triggered when a concentration exceeds a threshold. For example, the low alarm is triggered if the concentration drops below 300 ppm and is deactivated when the concentrations rises above 400 ppm. The high alarm is triggered if the CO_2 concentration exceeds 700 ppm. The alarm remains triggered until the concentration drops below 600 ppm.

Sending this command will configure the alarm on for CO_2 readings in the manner shown in *Figure 1-1* above.

```
<li850>
   <cfg>
      <alarms>
         <enabled>true</enabled>
         <source>co2</source>
         <low>300</low>
         <ldead>400</ldead>
         <high>700</high>
         <hdead>600</hdead>
      </alarms>
   </cfg>
</li850>
```

Configuring the analog outputs

The LI-830 and LI-850 can send two analog signals over analog output channels (either voltage or current). Analog signals are linear, single-ended outputs.

The voltage channels (pins 7 and 9) can be configured for ranges of 0 to 2.5 V or 0 to 5.0 V. The current channels (pins 11 and 13) are fixed to a range of 4 to 20 mA.

- `<d1>` configures **V Out 1** (pin 9) and **4-20 mA 1** (pin 13) on the terminal strip
- `<d2>` configures **V Out 2** (pin 7) and **4-20 mA 2** (pin 11) on the terminal strip

The data that can be sent as analog signals are:

XML variable	Data sent
co2	CO_2 concentration (ppm)
h2o	H_2O concentration (mmol mol^{-1}; LI-850 only)
h2odewpoint	H_2O dewpoint temperature (°C; LI-850 only)
cellpress	Pressure in the optical cell (kPa)
celltemp	Temperature in the optical cell (°C)
none	None

Sending the following command will configure the analog voltage output for a range of 0 to 5 V, and configure **V Out 1** (pin 9) to output 0 V when the instrument measures 200 ppm CO_2 and 5.0 V when the instrument measures 1000 ppm. This command will also configure the current output for **4-20 mA 2** (pin 11) will output 4 mA when the instrument measures 200 ppm and 20 mA when it measures 1000 ppm.

```
<li850>
   <cfg>
      <dacs>
         <range>5.0</range>
         <d1>co2</d1>
         <d1_0>200</d1_0>
         <d1_f>1000</d1_f>
      </dacs>
   </cfg>
</li850>
```

Section 2.
Element descriptions

In this section we break down each subset of the XML tags. We begin with the root-level tags and then describe the subordinate tags in greater detail.

Table 2-1. The root tag for all XML communication is `<li850>` or `<li830>`.

Root	Parent	Value	Definition
`<li850>` or `<li830>`	`<data>`	Float	See *Data tags* on the next page.
	`<auxdata>`	Float	See *Auxiliary data tags* on page 2-3.
	`<cfg>`	Various	See *Configuration tags* on page 2-5.
	`<pump>`	Various	Pump status. See *Pump tags* on page 2-8.
	`<source>`	Integer	Hours the source has operated. See *Source tag* on page 2-8.
	`<cal>`	Various	See *Calibration tags* on page 2-9.
	`<poly>`	Various	See *Polynomial tags* on page 2-10.
	`<rs232>`	True | False	See *RS-232 serial tags* on page 2-4.
	`<ver>`	String	Software version. See *Software version* on page 1-10.
	`<serialnum>`	String	Serial number. See *Serial number* on page 1-9.
	`<ack>`	True | False	Acknowledgment of a command.
	`<error>`	String	Error. Includes a message.
	`<tech>`	Various	Diagnostics. See *Tech tags* on page 2-11.

Sending this command will return the full configuration file and measured values that are configured to be sent over the serial connection.

```
<li850>?</li850>
```

The instrument will reply by sending the data and the confirmation message:

```
<li850><ack>true</ack></li850>
```

Data tags

The <data> tag contains all data values sent from the instrument. All of the elements within <data> are readable only. The <h2o>-related tags apply to the LI-850 only.

Table 2-2. Elements available in the <data> tag.

Root	Parent	Children	Values	R/W	Comments
<li850> or <li830>	<data>	<co2>	Float	R	CO_2 in ppm
		<co2abs>	Float	R	CO_2 absorption
		<h2o>	Float	R	H_2O in mmol/mol
		<h2odewpoint>	Float	R	H_2O in °C
		<h2oabs>	Float	R	H_2O absorption
		<celltemp>	Float	R	Cell temperature
		<cellpres>	Float	R	Cell pressure
		<ivolt>	Float	R	Input voltage
		<flowrate>	Integer	R	Measured flow rate
		<raw>	See *Raw data tags* on the facing page		

To query the data, send:

```
<li850>
   <data>?</data>
</li850>
```

If a data value is not returned, it is probably "turned off" in the serial data stream. See *RS-232 serial tags* on page 2-4 for more information.

Raw data tags

The raw detector counts can be retrieved by querying the parent <data> tag. The <h2o>-related tags apply to the LI-850 only. To see the raw detector counts, send:

```
<li850>
  <data>
    <raw>?</raw>
  </data>
</li850>
```

Table 2-3. Elements within the <raw> tag. These are raw detector readings.

Root	Parent	Parent	Children	Values	R/W
<li850> or <li830>	<data>	<raw>	<co2>	Integer	R
			<co2ref>	Integer	R
			<h2o>	Integer	R
			<h2oref>	Integer	R

To disable the raw data from the serial data stream, you have to modify the instructions under the <rs232> tag. So, send:

```
<li850>
  <rs232>
    <raw>false</raw>
  </rs232>
</li850>
```

Auxiliary data tags

The <auxdata> tag contains all auxiliary data values that can be retrieved from the instrument. All of the elements within the <auxdata> tag are readable only.

Table 2-4. These tags are under <auxdata>.

Root	Parent	Children	Values	R/W
<li850> or <li830>	<auxdata>	<pca>	Float	R
		<pha>	Float	R
		<psi>	Float	R
		<bb_eff>	Float	R

To query the auxdata, send:

```
<li850>
  <auxdata>?</auxdata>
</li850>
```

RS-232 serial tags

The <rs232> tag is where you set which values are output in <data>. **TRUE** means that the value will be sent; **FALSE** means it will not be sent. The <h2o>-related tags apply to the LI-850 only.

Table 2-5. Setting the <rs232> values will determine which values are output in <data>.

Root	Parent	Children	Values	R/W	Comments
<li850> or <li830>	<rs232>	<co2>	True | False	R/W	CO_2 in ppm
		<co2abs>	True | False	R/W	CO_2 absorption
		<h2o>	True | False	R/W	H_2O in mmol/mol
		<h2odewpoint>	True | False	R/W	H_2O dew point
		<h2oabs>	True | False	R/W	H_2O absorption
		<celltemp>	True | False	R/W	Cell temperature
		<cellpres>	True | False	R/W	Cell pressure
		<ivolt>	True | False	R/W	Input voltage
		<echo>	True | False	R/W	Echo commands sent
		<strip>	True | False	R/W	Strip XML
		<flowrate>	True | False	R/W	Flow rate

Sending this command will configure the output rate and the variables output over the serial connection.

```
<li850>
  <cfg>
    <outrate>1</outrate>
  </cfg>
  <rs232>
    <co2>true</co2>
    <co2abs>true</co2abs>
    <h2o>false</h2o>
    <h2odewpoint>false</h2odewpoint>
    <h2oabs>false</h2oabs>
    <celltemp>true</celltemp>
    <cellpres>true</cellpres>
    <ivolt>true</ivolt>
    <echo>false</echo>
    <strip>false</strip>
    <flowrate>false</flowrate>
  </rs232>
</li850>
```

Configuration tags

Configuration tags are used to apply settings to the instrument.

Table 2-6. Elements within the <cfg> tag.

Root	Parent	Children	Values	R/W	Comments
<li850> or <li830>	<cfg>	<outrate>	0.5 to 20	R/W	Output data every N seconds (0.5 second increments).
		<heater>	True | False	R/W	Turn heater on/off.
		<pcomp>	True | False	R/W	Pressure compensation on/off.
		<filter>	0 to 20	R/W	Set a 0 to 20 second filter for data logging.
		<bench>	14	R	Bench length (not used).
		<alarms>	Alarm settings. See *Alarm tags* on the next page.		
		<dacs>	DAC output settings. See *DAC tags* on page 2-7.		

Sending this command will set the output rate to 1 per second, turn the optical bench heater on, apply the pressure compensation, and turn off data filtering:

```
<li850>
  <cfg>
    <outrate>1</outrate>
    <heater>true</heater>
    <pcomp>true</pcomp>
    <filter>0</filter>
  </cfg>
</li850>
```

Alarm tags

Alarm tags configure the alarm states.

Root	Parent	Parent	Children	Values	R/W	Comments
<li850> or <li830>	<cfg>	<alarms>	<enabled>	True | False	R/W	Enable alarms
			<source>	co2 | h2o	R/W	Channel (CO_2, H_2O)
			<high>	Float	R/W	High alarm on at this value
			<hdead>	Float	R/W	High alarm off at this value
			<low>	Float	R/W	Low alarm on at this value
			<ldead>	Float	R/W	Low alarm off at this value

To configure the alarms, send:

```
<li850>
  <cfg>
    <alarms>
      <enabled>{bool}</enabled>
      <source>h2o | co2<source>
      <high>{float}</high>
      <hdead>{float}</hdead>
      <low>{float}</low>
      <ldead>{float}</ldead>
    </alarms>
  </cfg>
</li850>
```

DAC tags

DAC tags configure the analog outputs.

Root	Parent	Parent	Children	Values	R/W	Comments
<li850> or <li830>	<cfg>	<dacs>	<range>	2.5 | 5.0	R/W	Output voltage. 0 to 2.5V or 0 to 5.0V
			<d1>	Various	R/W	CO2 | H2O | H2ODEWPOINT | CELLPRES | CELLTEMP | NONE from DAC1
			<d1_0>	Float	R/W	Value where DAC1 outputs 0V
			<d1_f>	Float	R/W	Value where DAC1 outputs full scale
			<d2>	Various	R/W	CO2 | H2O | H2ODEWPOINT | CELLPRES | CELLTEMP | NONE from DAC2
			<d2_0>	Float	R/W	Value where DAC2 outputs 0V
			<d2_f>	Float	R/W	Value where DAC2 outputs full scale

To configure the DACs, send:

```
<li850>
  <cfg>
    <dacs>
      <range>{2.5|5.0}</range>
      <d1>{none|co2|h2o|h2odp|celltemp|cellpres}</d1>
      <d1_0>{float}</d1_0>
      <d1_f>{float}</d1_f>
      <d2>{none|co2|h2o|h2odp|celltemp|cellpres}</d2>
      <d2_0>{float}</d2_0>
      <d2_0>{float}</d2_f>
    </dacs>
  </cfg>
</li850>
```

Pump tags

Pump tags are used to control the LI-COR pump.

Table 2-7. Tags used to control the pump (if applicable).

Root	Parent	Children	Values	R/W	Comments
<li850> or <li830>	<pump>	<enabled>	True | False	R/W	Turns pump on/off
		<time>	Integer	R/W	Number of hours pump has run
		<status>	Integer	R/W	Pump and flow meter present? (0 = pump, 1 = flow meter, 2 = pump and flow meter, 3 = neither)

To enable the pump, send:

```
<li850>
  <pump>
    <enabled>true</enabled>
  </pump>
</li850>
```

To reset the pump hours (after replacing it, for example), send:

```
<li850>
  <pump>
    <hours>0</hours>
  </pump>
</li850>
```

Source tag

The source tag indicates the number of hours that the optical source has operated. This information is useful for diagnostic purposes.

Root	Parent	Children	Values	R/W	Comments
<li850> or <li830>	<source>	<time>	Integer	R/W	Number of hours of source operation

To read the source time, send:

```
<li850>
  <source>?</source>
</li850>
```

Calibration tags

Calibration tags are used to start a calibration or read calibration information. When calibrating, <date> must be paired with a <co2zero> or a <co2span>, or a <h2ozero> or <h2ospan>. The <h2o>-related tags apply to the LI-850 only.

Table 2-8. Tags used to calibrate the instrument.

Root	Parent	Children	Values	R/W	Comments
<li850> or <li830>	<cal>	<date>	20 character date	W	The current date
		<h2ozero>	True | False	W	Start H_2O zero
		<h2ospan>	Float (h2o)	W	Start the H_2O span 1
		<h2ospan2>	Float (h2o)	W	Start the H_2O span 2
		<h2olastzero>	20 character date	R	Date of last H_2O zero
		<h2olastspan>	20 character date	R	Date of last H_2O span
		<h2okzero>	Float	R/W	Calibration constant
		<h2okspan>	Float	R/W	Calibration constant
		<h2okspan2>	Float	R/W	Calibration constant
		<co2zero>	True | False	W	Start a CO_2 zero
		<co2span>	Float (co2 ppm)	W	Start the CO_2 span 1
		<co2span2>	Float (co2 ppm)	W	Start the CO_2 span 2
		<co2lastzero>	20 character date	R	Date of last CO_2 zero
		<co2lastspan>	20 character date	R	Date of last CO_2 span
		<co2kzero>	Float	R/W	Calibration constant
		<co2kspan>	Float	R/W	Calibration constant
		<co2kspan>	Float	R/W	Calibration constant

Calibration instructions are given in *Zero and span settings* on page 1-8. To read the current calibration, send:

```
<li850>
  <cal>?</cal>
</li850>
```

Polynomial tags

Polynomial tags contain calibration information from the instrument. The values included are determined at the factory. Do not change the polynomial values because that will adversely affect the analyzer performance. The <h2o>-related tags apply to the LI-850 only.

Table 2-9. Calibration polynomial related tags.

Root Tag	Parent	Children	Value(s)	R/W	Comments
<li850> or <li830>	<poly>	<date>	Serial number and ISO date	R/W	Serial number and factory calibration date: HGA XXXX yyyy-mm-dd
		<bb>	Float	R/W	Band broadening value
		<xs>	Float	R/W	Cross sensitivity value
		<co2>	<a1><a2> <a3><a4>	R/W	Floating point coefficients for the CO_2 calibration inverse rectangular hyperbola
		<h2o>	<a1><a2> <a3>	R/W	Floating point coefficients for the H_2O calibration polynomial
		<press>	<a0><a1>	R/W	Floating point coefficient for CO_2 pressure correction

To read the polynomial information, send:

```
<li850>
   <poly>?</poly>
</li850>
```

Tech tags

Tech tags indicate information about the instrument, including pump and optical source information. They are not included in the status information returned by the instrument. You can poll the tech information specifically.

Table 2-10. Tags used to read information about the pump and source.

Root	Parent	Parent	Children	Values	R/W	Comments
<li850> or <li830>	<tech>	<pump>	<model>	String	R/W	Pump model
			<ki>	Integer	R/W	Integer value for PID control
			<kp>	Integer	R/W	Proportional value for PID control
			<kd>	Integer	R/W	Derivative value for PID control
			<offset>	Integer	R/W	Pump control offset
			<gain>	Integer	R/W	Pump control gain
			<flow>	0 to 1.0	R/W	Flow setting in LPM
		<source>	<voltage>	0 to 5.0	R/W	Source voltage setting

To read the tech information, send:

```
<li850>
   <tech>?</tech>
</li850>
```

Full XML grammar

The full configuration grammar for the LI-850 is given below. The LI-830 grammar is identical except that the root tag is `<li830>`, and the tags related to H_2O will be absent.

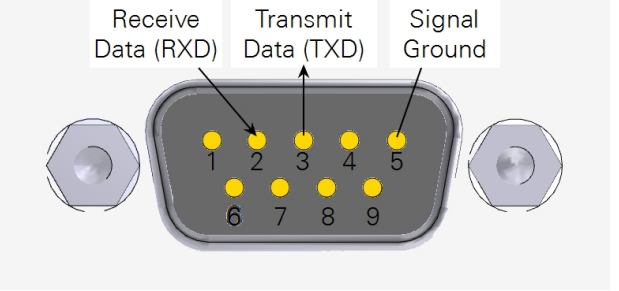
```
<li850>
    <data>
        <flowrate>{float}</flowrate>
        <celltemp>{float}</celltemp>
        <cellpres>{float}</cellpres>
        <co2>{float}</co2>
        <co2abs>{float}</co2abs>
        <h2o>{float}</h2o>
        <h2oabs>{float}</h2oabs>
        <h2odewpoint>{float}</h2odewpoint>
        <ivolt>{float}</ivolt>
        <raw>
            <co2>{int}</co2>
            <co2ref>{int}</co2ref>
            <h2o>{int}</h2o>
            <h2oref>{int}</h2oref>
        </raw>
    </data>
    <auxdata>
        <pca>{float}</pca>
        <pha>{float}</pha>
        <bb_eff>{float}</bb_eff>
        <psi>{float}</psi>
    </auxdata>
    <cfg>
        <heater>{bool}</heater>
        <pcomp>{bool}</pcomp>
        <filter>{int}</filter>
        <outrate>{float}</outrate>
        <alarms>
            <logic>ttl or swg</logic>
            <source>h2o or co2<source>
            <enabled>{bool}</enabled>
            <high>{float}</high>
            <hdead>{float}</hdead>
            <low>{float}</low>
            <ldead>{float}</ldead>
        </alarms>
        <bench>{14}</bench>
        <span>{int}</span>
        <dacs>
            <range>{2.5 or 5.0}</range>
            <d1>{none|co2|h2o|h2odp|celltemp|cellpres}</d1>
            <d1_0>{float}</d1_0>
            <d1_f>{float}</d1_f>
            <d2>{none|co2|h2o|h2odp|celltemp|cellpres}</d2>
            <d2_0>{float}</d2_0>
            <d2_0>{float}</d2_f>
        </dacs>
    </cfg>
```

```
    <pump>
        <enabled>{bool}</enabled>
        <time>{int}</time>
        <status>{int}</status>
    </pump>
    <source>
        <time>{int}</time>
    </source>
    <cal>
        <co2lastzero>{iso date}</co2lastzero>
        <co2kzero>{float}</co2kzero>
        <co2lastspan>{iso date}</co2lastspan>
        <co2lastspan2>{iso date}</co2lastspan2>
        <co2kspan>{float}</co2kspan>
        <co2kspan2>{float}</co2kspan2>
        <h2olastzero>{iso date}</h2olastzero>
        <h2okzero>{bool}</h2okzero>
        <h2olastspan>{iso date}</h2olastspan>
        <h2olastspan2>{iso date}</h2olastspan2>
        <h2okspan>{float}</h2okspan>
        <h2okspan2>{float}</h2okspan2>
    </cal>
    <poly>
        <date>{string}</date>
        <bb>{float}</bb>
        <xs>{float}</xs>
        <reset>{bool}</reset>
        <co2>
            <a1>{float}</a1>
            <a2>{float}</a2>
            <a3>{float}</a3>
            <a4>{float}</a4>
        </co2>
        <h2o>
            <a1>{float}</a1>
            <a2>{float}</a2>
            <a3>{float}</a3>
        </h2o>
        <press>
            <a0>{float}</a0>
            <a1>{float}</a1>
        </press>
    </poly>
    <rs232>
        <flowrate>{bool}</flowrate>
        <co2>{bool}</co2>
        <h2o>{bool}</h2o>
        <celltemp>{bool}</celltemp>
        <cellpres>{bool}</cellpres>
        <ivolt>{bool}</ivolt>
        <co2abs>{bool}</co2abs>
        <h2oabs>{bool}</h2oabs>
        <h2odewpoint>{bool}</h2odewpoint>
        <raw>
            <co2>{bool}</co2>
            <co2ref>{bool}</co2ref>
            <h2o>{bool}</h2o>
            <h2oref>{bool}</h2oref>
        </raw>
        <echo>{bool}</echo>
        <strip>{bool}</strip>
    </rs232>
    <ver>{string}</ver>
    <serialnum>{string}</serialnum>
    <ack>{bool}</ack>
    <error>{string}</error>
</li850>
```

Appendix A.
Supplemental information

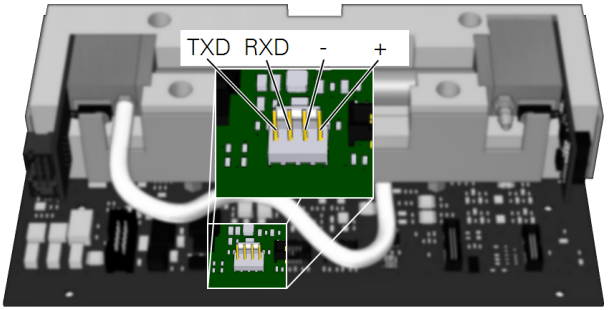
Serial cable pin assignments

The image below shows the pin assignments for the 9-pin RS-232 serial connector.



Circuit board connector

The LI-830 and LI-850 circuit board has a connector that can be used as an alternative to the DB-9 and USB connectors on the case, or if your instrument was provided without a case in the OEM configuration. The terminals are labeled on the board.


TXD RXD - +

Details on the serial connection

If you are experiencing difficulty connecting to the instrument, here are some tips that may help resolve the issue.

Serial communication parameters

The LI-830 and LI-850 can communicate through a RS-232 serial port on the front of the instrument. You may need to set the communication parameters on your computer or your terminal emulator program. The RS-232 port is configured as Data Terminal Equipment (DTE) with no hardware handshaking. It is bi-directional, meaning information can be transferred both into and out of the instrument. The port is configured as follows:

- Baud Rate: 9600 bps
- Data Bits: 8
- Parity: None
- Stop Bits: 1
- Flow Control: None

Finding your Windows serial port

Although unlikely, you may need to manually identify your serial port before you can connect with the instrument. Here's how to find it in Windows:

1. Press the **Windows** key (), type in **Device Manager**, and press **Enter**.
2. Expand the entry called **Ports (COM & LPT)**.
3. Look for **USB Serial Port (COM#)**.

Your serial port number is indicated by the number.

Connecting with a Windows terminal program

If you have trouble connecting using TeraTerm, you may need to change the serial settings. Under **Setup > Serial Port**, you can set the baud rate, data bits, parity and stop bits, as described in *Serial communication parameters* above.

Connecting with a Mac terminal program

There are many terminal programs available (in addition to Mac's built in command prompt). Most modern programs will work, and you will ***not*** need to identify the port on a Mac.

We tested a terminal program for Mac called Serial. Serial is available from the App Store and the developer: https://www.decisivetactics.com/products/serial/

Typically, you can connect to the instrument immediately without making any changes to the configuration. The program will automatically identify serial devices and allow you to select the analyzer from a list. You can, however, set the baud rate, data bits, parity and stop bits under **Terminal > Settings**, as described in *Serial communication parameters* on the previous page.

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