**LI-8100 Communication Grammar**

[Revision History 2](#_Toc69029362)

[LI-8100 Communications and XML 2](#_Toc69029363)

[Connecting to the LI-8100 2](#_Toc69029364)

[Instrument Settings (CFG) 3](#_Toc69029365)

[Auxiliary Inputs (AUX) 5](#_Toc69029366)

[Calibration (CAL) 5](#_Toc69029367)

[Outputs (DATA, IP, LOG) 7](#_Toc69029368)

[Measurement Setup (MEAS) 7](#_Toc69029369)

[Network Setup 9](#_Toc69029370)

[Measurement Management 10](#_Toc69029371)

[Queries 13](#_Toc69029372)

[Commands 15](#_Toc69029373)

[The LI-8100 Grammar Document 16](#_Toc69029374)

# Revision History

**I**ntroduction

The LI-8100 communicates through either serial interface or on a network. This document describes the techniques used to communicate to the LI-8100 using the LI-8100 Communication Grammar.

# LI-8100 Communications and XML

The configuration grammar used to communicate with the LI-8100 is based on the Extensible Markup Language (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. When a data value is “marked up”, the value is enclosed between two tags: a start tag and an end tag. An end tag is almost the same as the start tag except that the identifier is prefixed with a /.

Start tag: <IDENTIFIER>

End tag: </IDENTIFIER>

Elements are the basic unit of XML content. Syntactically, 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 case, the <NAME> (start tag) and </NAME> (end tag) comprise the markup and “George" is 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 instead of data.

<NAME>

<FIRST>George</NAME>

<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.

# Connecting to the LI-8100

The LI-8100 can communicate over a RS-232 serial interface or on a TCP/IP network (wired or wireless).

Serial Port Setup:

Baud Rate: 57600 bps

Data Bits: 8

Parity: None

Stop Bits: 1

Flow Control: None

TCP/IP Setup:

Once the network is configured, the LI-8100 opens port 1526 and waits for incoming socket connections.

**LI-8100 Configuration using the LI-8100 Communication Grammar**

# Instrument Settings (CFG)

<NAME>

A user defined name given to the instrument used to provide a meaningful method to identify an instrument.

Accepted Values: Up to 30 characters from the set { A-Z, a-z, 0-9, ~, -, \_ }

<FILTER>

IRGA signal averaging length

Accepted Values: 1 to 20

<RS232OUTRATE>

Data output rate in seconds over the serial RS-232 connection. Data will be output at 1/n Hz. A value of 0 disables output.

Accepted Values: 0 to 20

<IPOUTRATE>

Data output rate in seconds over the TCP/IP connection. Data will be output at 1/n Hz. A value of 0 disables output.

Accepted Values: 0 to 20

<PCOMP>

Turn on/off the IRGA pressure compensation

Accepted Values: TRUE, FALSE

<CLOCK>

<TIME></TIME>

<DATE></DATE>

</CLOCK>

Set the date and time of the on board real-time clock.

Accepted Values: Integers formatted in HHMM for TIME and YYYYMMDD for DATE.

<COLLARHEIGHT>

Chamber offset

Accepted Values: Floating point numbers

<SOILAREA>

The soil surface area enclosed by the collar.

Accepted Values: Floating point numbers

<CHAMVOLUME>

Volume of the chamber connected to the LI-8100

Accepted Values: Floating point numbers

<IRGAVOLUME>

Volume of the IRGA inside the LI-8100

Accepted Values: Floating point numbers

<SPAN>

The IRGA span range.

Accepted Values: Integers up to 3000

<FLOWRATE>

Flow pump rate

Accepted Values: 0 to 10. 0 =low, 10 =high

<SMARTPUMP>

Allow the flow pump to turn off between repeated measurements to increase pump life and to save power.

Accepted Values: TRUE, FALSE

<MEASRESTART>

Allow the measurement to resume in the event the instrument is restarted while a measurement is in progress,

Accepted Values: TRUE, FLASE

# Auxiliary Inputs (AUX)

Configuration of the four thermocouple and four voltage inputs. V4 is dedicated for a soil moisture probe

Thermocouple Inputs

<T1>, <T2>, <T3>, <T4>

Thermocouple inputs 1 through 4 can be independently configured to accept thermocouple types E, J or K

Accepted Values: E, J, K

Voltage Inputs

<V1>, <V2>, <V3>, <V4>

<M>

Slope for the equation y=mx+b

Accepted Values: Floating point numbers

<B>

Offset for the equation y=mx+b

Accepted Values: Floating point numbers

<INTERVAL>

IINTERVAL represents the sampling interval of V4. V4 can be sampled every 1 to 60 minutes.

Accepted Values: Integers from 1 to 60

# Calibration (CAL)

Performing a zero and a span

The LI-8100 is zeroed or spanned using the XML grammar in three steps.

1. Send the calibration command to the LI-8100
2. An ACK (<LI8100><ACK>TRUE</ACK></LI8100>) is immediately sent back if the command was accepted.
3. When the calibration operation is finished, the calibration constants are sent from the LI-8100 indicating that it has finished the zero or span.

<LI8100>

<CAL>

<CO2LASTSPAN>{iso date}</CO2LASTSPAN>

<CO2LASTZERO>{iso date}</CO2LASTZERO>

<CO2KZERO>{float}</CO2KZERO>

<CO2KSPAN>{float}</CO2KSPAN>

</CAL>

</LI8100>

If the calibration cannot be performed, an ERROR is sent in place of the calibration constants.

<LI8100><ERROR>{TEXT}</ERROR></LI8100>

Example

To Zero:

1. Send the XML command to initiate the zero.

<LI8100>

<CAL>

<CO2ZERO>TRUE</CO2ZERO>

</CAL>

</LI8100>

Note: Replace CO2 with H2O to zero the water channel.

1. Get the ACK
2. Wait for the data to be sent back to verify the zero operation succeeded. If the operation failed an <ERROR> will be sent.

To Span:

1. Send the XML command to initiate the span.

<LI8100>

<CAL>

<CO2SPAN>Gas Concentration in ppm</ CO2SPAN>

</CAL>

</LI8100>

Note: Replace CO2 with H2O to span the water channel. The H2O concentration units are in °C.

1. Get the ACK
2. Wait for the date to be sent back to verify the span operation succeeded. If the operation failed an <ERROR> will be sent.

# Outputs (DATA, IP, LOG)

Data output the serial port, TCP/IP port and to the log file are independently configurable. For each data item, set the value to TRUE if the item is to be output and set the value to FALSE if the item is not to be output.

Example:

Configure the LI-8100 to output CO2 on the serial port.

<SR><RS232><CO2>TRUE</CO2></RS232></SR>

As a result, data output to the serial port will now contain CO2 values. Data output to the serial port or TCP/IP port is embedded in a set of DATA tags.

<STRIP>

Set the value of strip to TRUE to remove the XML from the data. Each data value will be output delimited by a space.

Accepted Values: TRUE, FALSE

<ENABLECRC>

When set to TRUE, a CRC is appended to all data packages output the serial port and the TCP/IP port. The CRCs are placed between a set of CRC tags.

For example, data output with CRCs enabled will appear like the following:

<SR><DATA><CO2>380.25</CO2></DATA></SR><CRC>12345</CRC>

The CRCs are calculated using the Posix 32 CRC algorithm.

Accepted Values: TRUE, FALSE

<LOG><LOCATION>

Log file destination

Accepted Values: INT, EXT, NONE

# Measurement Setup (MEAS)

<FILE>

Determine the type of data file to create.

Accepted Values: NEW, APPEND

<NAME>

The name of the data file.

Accepted Values: Up to 30 characters from the set { A-Z, a-z, 0-9, ~, -, \_ }

<ALLRECS>

Set ALLRECS to TRUE to log type 1 data.

Accepted Values: TRUE, FALSE

<OBLENGTH>

Observation length.

Accepted Values: Time must be in format: HHMMSS

<OBCOUNT>

Observation count

Accepted Values: 1 to 32767

<CYCLEDELAY>

Cycle delay in minutes

Accepted Values: Time must be in format: HHMMSS

<STARTTIME>

Start the measurement when the current time is greater that the start time.

Accepted Values: Time must be in format:YYYYMMDD HHMMSS

<LOGRATE>

Data output rate in seconds to the log file. Data will be logged at 1/n Hz.

Accepted Values: 0 to 20

<LOGDELAY>

Dead band. The amount of time to ignore data for calculations

Accepted Values: 0 to 999

<COMMENTS>

Comments to be placed in the data file header.

Accepted Values: Up to 100 characters.

The following characters are unsafe and must be encoded:

\r\n to %0xA

< to %0x3C

> to %0x3E

/ to %0x2F

<RESCHEDULE>

Repeat the same protocol at a later time.

<WHEN>

The WHEN value is the time from the start of the measurement the next measurement will be scheduled

Accepted Values: Time must be in format: HHMMSS

<COUNT>

The number of times to repeat the measurement

Accepted Values: 0 to 30000

<CHECKRH>

Periodically check the RH and stop the observation if it is greater than this value. If the value is -1 the LI-8100 will not perform the RH check

Accepted Values: -1 to 100.

<LABEL>

Treatment Label

Accepted Values: Up to 30 characters from the set { A-Z, a-z, 0-9, ~, -, \_ }

# Network Setup

Networking will work for both wired and wireless Ethernet cards. In order to configure the LI-8100 for networking, the instrument must be given an IP address, net mask, network name, encryption key and a channel to operate on. When in wired mode, only the IP address and net mask need to be set.

<IPADDRESS>

The IP address is a number that uniquely identifies each node on the network. The address is composed of a set of four numbers called octets, where each octet ranges in value from 0 to 255. When entering an IP address, the octets are separated with a period. For example, 192.168.100.2 is a valid IP address

Accepted Values: Valid IP address in dotted decimal notation

<NETMASK>

The net mask is a set of four octets used to separate an IP address in to the network address and the host address. If you are using LI-COR’s recommended IP address range, the net mask should be set to 255.255.255.0.

Accepted Values: Valid net masks in dotted decimal notation

<NETWORKNAME>

The network name or SSID (service Set Identifier) is a name given to a wireless network (WLAN). Each device that needs to communicate must have the same SSID. The LI-8100 supports a network name of up to 30 characters.

Accepted Values: Up to 30 alpha-numeric (a-z, A-Z, 0-9) characters including spaces

<KEY>

The key is 5 ASCII characters (a-z, A-Z, 0-9). . If data encryption is enabled, the same 40 bit (5 character) key must be entered on all devices of the WLAN. The key is used for data encryption and decryption. To disable encryption set the key to a \*.

Accepted Values: A 5 alpha-numeric (a-z, A-Z, 0-9) character string to set the key. Use a \* to disable data encryption.

<CHANNEL>

A range of radio frequencies between 2.4 GHz and 2.5 GHz have been designated for public use in most countries. The channel refers to a specific portion of the total frequency range that is given to a device for communication. The LI-8100 supports channels 1 to 11. Choose and appropriate channel for the country where the instrument will be located.

|  |  |
| --- | --- |
| Country | Channels |
| Europe | 1-13 |
| USA | 1-11 |
| France | 10-13 |
| Japan | 1-14 |

Accepted Values: 1 to 11

Configuring the network requires two steps. First, all network parameters need to be set and then a commit command is sent to perform the setup. For the changes to take effect the instrument needs to be restarted.

Example:

First configure all settings:

<SR><CFG><NETWORK>

<IPADDRESS>192.168.100.110</IPADDRESS>

<NETMASK>255.255.255.0</NETMASK>

<NETWORKNAME>Soil Network 1</NETWORKNAME>

<KEY>\*</KEY>

<CHANNEL>2</CHANNEL>

</NETWORK></CFG></SR>

Commit the settings:

<SR><CMD><ACTION>NWCOMMIT</ACTION></CMD></SR>

# Measurement Management

Measurements can be stored in internal flash or on a Compact Flash card. Depending on the storage format, the measurements can be transferred to a PC, copied to compact flash, deleted or listed.

Obtaining the number of measurements stored on internal flash memory.

Send:

<SR><CMD><QUERY>LISTSIZE</QUERY></CMD></SR>

Reply:

<SR><LIST><SIZE>{int}</SIZE></LIST></SR>

Listing Measurements stored on internal flash memory.

You can request the whole list or only a portion at a time. The list command takes the form: <SR><CMD><MEAS><LIST>start:stop</LIST></MEAS></CMD></SR>. Start is the beginning index. Likewise, Stop is the ending measurement index. The list of measurements is returned in a colon-delimited list of measurement names embedded in an XML document.

To request all of the measurements:

Send:

<SR><CMD><MEAS><LIST>1:\*</LIST></MEAS></CMD></SR>

Note: \* denotes the end of the list.

To request a range of measurements

Send:

<SR><CMD><MEAS><LIST>1:5</LIST></MEAS></CMD></SR>

Reply:

<SR><LIST>m1:m2:m3:m4:m5</LIST></SR>

Transferring a measurement to a PC:

To begin transferring a measurement to a PC, set the name of the measurement to transfer.

Send:

<SR><TRANSFER><NAME>m1</NAME></TRANSFER></SR>

or provide a colon delimited list of measurements to be transferred.

<SR><TRANSFER><NAME>m1:m2:m3</NAME></TRANSFER></SR>

This sets m1 to be the next measurement transferred.

Next, the instrument needs to be set into “transfer mode.”

Send:

<SR><CMD><TRANSFER>START</TRANSFER></CMD></SR>

Reply:

<SR><TRANSFER><SIZE>4452</SIZE></TRANSFER></SR>

<SR><STATE><CHAMBER>OPEN</CHAMBER><INSTRUMENT>

TRANSFERING</INSTRUMENT><CUROB>0</CUROB></STATE></SR>

After this command is sent, data is not output and the instrument will only reply to transfer commands (GET, RETRY, CANCEL). The reply of the START command consists of the total number of bytes in the measurement file and also state information that shows the instrument in transfer mode.

All data needs to be requested from the instrument. The data packet contains up to 1024 bytes of data followed by a CRC

0.00596623 2002-10-10 16:13:17 … 96.8002 26.7155<CRC>1800749180</CRC>

Send:

<SR><CMD><TRANSFER>GET</TRANSFER></CMD></SR>

Reply:

1 data packet

or

<SR><TRANSFER>COMPLETE</TRANSFER></SR>

Once the COMPLETE message is received, the STOP command must be sent to inform the instrument that the transfer is complete.

If the calculated CRC does not match the sent CRC the last packet can be resent by sending the RETRY command: <SR><CMD><TRANSFER>RETRY</TRANSFER></CMD></SR>

To cancel a transfer:

Send:

<SR><CMD><TRANSFER>CANCEL</TRANSFER></CMD></SR>

The reply will consist of the transfer complete message and also a state message to show the current state of the instrument changed.

Transferring measurements to a compact flash card.

An alternate method to transferring measurements to the PC is to transfer (copy) the measurement to a compact flash card. When a measurement is copied to compact flash, it is stored in a directory that is named after the instrument. For example, assume the name of the soil respirator is SR-1, when a copy is executed, a directory named SR-1 will be created on the CF card if it does not exist. The measurement will then be copied into this directory.

Send:

<SR><CMD><COPY>m1</COPY></CMD></SR>

This informs the instrument to start the copy. Once the copy is started, a message is sent to show the copy operation has begun.

Reply #1:

<SR><CFOP>COPYING</CFOP></SR>

Normal operation of the soil respirator continues. When the copy operation is complete another message is sent.

Reply #2:

<SR><CFOP>COMPLETE</CFOP></SR>

Deleting measurements from internal flash memory.

a single measurement or all measurements can be deleted from memory.

Delete a single measurement:

Send:

<SR><CMD><MEAS><DELETE>name</DELETE></MEAS></CMD></SR>

Delete all measurements:

Send:

<SR><CMD><MEAS><DELETE>\*</DELETE></MEAS></CMD></SR>

Delete a list of measurements:

Note: The list of names is colon delimited.

Send:

<SR><CMD><MEAS><DELETE>name1:name2:name3</DELETE></MEAS></CMD></SR>

Deleting measurements from a compact flash card.

When deleting measurements from a compact flash card, all measurements will be deleted for that instrument.

Send:

<SR><CMD><ACTION>ERSAEMEASUREMENTS</ACTION></CMD></SR>

Deleting all measurements from a compact flash card (format).

When deleting measurements from a compact flash card, all measurements will be deleted for all instruments.

Send:

<SR><CMD><ACTION>FORMATCF</ACTION></CMD></SR>

# Queries

Query commands are sent to the LI-8100 to instruct it to return the portion of the configuration grammar of interested.

All queries are sent in this manner:

<SR><CMD><QUERY>QUERY\_NAME</QUERY></CMD></SR>

CFG - The CFG query returns the instrument setup information from the CFG portion of the grammar.

CAL – Query the current calibration information

IP - Query how the IP outputs are configured

RS232 - Query how the RS232 outputs are configured

LOG - Query how the log file is configured

MEAS – Query the last measurement setup

DATA – Request the most recent data.

STRIPPEDDATA – Request the most recent data with no XML

DATAHEADINGS – Query the position of each data item

STATE – Request the current of the instrument

VERSION – Query the current embedded software version

AUX – Query the auxiliary input setup

LISTSIZE – Returns the number of measurements on the system

CFOP - Returns the state of the current compact flash operation.

DISK - Returns the size and free space of the internal and external storage.

Send:

<SR><CMD><QUERY>DISK</QUERY></CMD></SR>

Reply:

<SR><DISK><FLASH><SIZE>49283072</SIZE><FREE>47960064</FREE></FLASH><CF><SIZE>7987200</SIZE><FREE>7979008</FREE></CF></DISK></SR>

FLASH: The internal/onboard flash

CF: A compact flash card inserted in the PCMCIA socket.

If the SIZE and FREE are 0, a compact flash card is not present.

SNAP - Query the entire state at the time of the last SNAP command

SUMMARY1 – Query summary type 2

SUMMARY2 – Query summary type 3

SUMMARY3 – Query summary type 4

All – Performs all queries

# Commands

<MIX>

Turn the flow pump on or off

Accepted Values: ON, OFF

<CHAMBER>

Open or close the connected chamber

Accepted Values: OPEN, CLOSE

<TRANSFER>

Refer to Measurement Management

<COPY>

Refer to Measurement Management

<QUERY>  
 Refer to Queries

<MEAS>

START – Start the configured measurement

STOP – Stop the running measurement

MARK – Place a marker in the data file

<DELETE>, <LIST>

Refer to Measurement Management

<ACTION>

Actions are non configuration commands.

REBOOT – Restart the LI-8100

RESEND – Resend the last item output

FORMATCF – Format the compact flash card

ERASEMEASUREMENTS – Erase all measurements from the compact flash card

SNAP – Record a snapshot of the instrument configuration

SNAPRESET – Restore the configuration from the last SNAP

NWRESTART – Restart networking (under development)

NWCOMMIT – Commit network configuration

COMMITCC – Commit the set of coefficients to the IRGA

RESETCC – Tell the IRGA to use it’s default set of coefficients

RESTOREDEFAULTCC – Restore the factory calibration polynomial

TESTCF – Run a compact flash card test