LI-7500 RS

Open Path CO_2/H_2O Gas Analyzer

Instruction Manual

LI-COR®

LI-7500RS

Open Path CO_2/H_2O Gas Analyzer

and the SmartFlux 2 System

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CE Marking:

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LI-7500RS/ LI-7541开路式CO2 / H2O分析仪 LI-7500RS/LI-7541 Open Path CO_2/H_2O Analyzer						
部件名称 **Part Name**	有毒有害物质或元素 **Toxic and Hazardous Substances or Elements**					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr(VI))	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
印刷电路板 (PCBs)	X	O	O	O	O	O
光学 (Optics)	X	O	O	O	O	O
电缆**和**电线 **(Cables and Wires)**	X	O	O	O	O	O
金属部件 (Metal Parts)	X	O	O	O	O	O
塑料零件 **(Plastic Parts)**	O	O	O	O	O	O

本表格依据 SJ/T 11364 的规定编制

O = 表示该有害物质在该部件所有均质材料中的含量均在 GB/T 26572规定的限量要求以下 (indicates that the content of the toxic and hazardous substance in all the Homogeneous Materials of the part is below the concentration limit requirement as described in GB/T 26572).

X = 表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572规定的限量要求 (indicates that the content of the toxic and hazardous substance in at least one Homogeneous Material of the part exceeds the concentration limit requirement as described in GB/T 26572).

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Section 1.
Overview of the instrument

The LI-7500RS is a high performance open-path CO_2/H_2O analyzer designed for use in eddy covariance flux measurement systems. It features simultaneous, high-speed measurements of CO_2 and H_2O in the free atmosphere (150 Hz measurements) are digitally filtered to provide true 5, 10, or 20 Hz bandwidth.

The LI-7500RS is also suitable for profile measurements, relaxed eddy accumulation measurements, gradient flux techniques, or any other application that depends on high-speed CO_2 gas or water vapor measurements. Here we describe how to use the LI-7500RS in combination with the SmartFlux 2 System. However, you can use the LI-7500RS without the SmartFlux 2 System as described in *Software reference* on page 10-1.

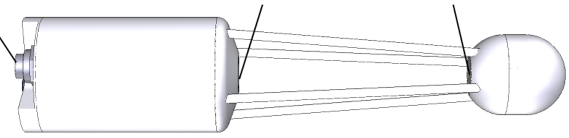
Note: LI-COR, Inc. does not endorse the use of the LI-7500RS on moving platforms or in applications where the instrument is exposed to corrosive elements (i.e., oceanic salt water spray). If you have questions about the suitability of the instrument for your application, please contact LI-COR.

What's what

If you have just taken delivery of your instrument, check the packing list to verify that you have received everything that was ordered.

LI-7500RS sensor head

The sensor head is the gas analyzer. It includes the optics and electronics.



LI-7500RS sensor head spares kit

Part Number: 7500-028

The LI-7500RS sensor head spare parts kit includes accessories and replacement parts for the sensor head.

Description	Quantity	Part Number
Head Mounting Post (blue dampers)	1	9975-010
Air Temperature Sensor (connects to LI-7550)	1	9975-026
Bev-a-line Tubing (4.6 m)	1	222-01824
Calibration Accessory	1	9975-024
Calibration Accessory Gaskets	1	9975-014

Head cable

Part Number: 392-13984

Connects the sensor head to the LI-7550 Analyzer Interface Unit.

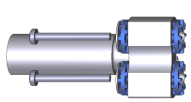
Gas analyzer accessories

The following accessories are available for the instrument. Some components are included with the instrument; others are sold separately as indicated.

Head mounting post

Part Number: 9975-010

Included with the instrument. The mounting post is to mount the LI-7500x head in a ¾" swivel mount or the combination mount. It has blue dampers that protect the instrument from vibrations.



Head mounting kit

Part Number: 7900-340

Available as an option. The head mounting kit is used to install the gas analyzer head on a cross arm.

Table 1-1. The gas analyzer head mounting kit (7900-340) and components.

Description	Quantity	Part Number
Swivel Mount (¾")	1	7900-344
56 cm Riser Bar (¾" IPS)	1	9879-046
Crossover Fitting (¾" × 1")	1	7900-342

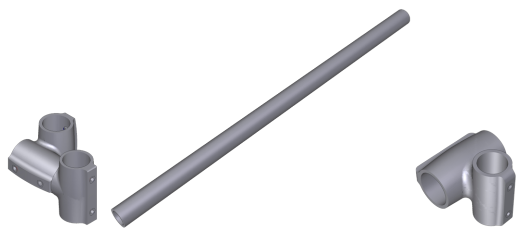


Figure 1-1. The head mounting kit has a ¾" × ¾" swivel mount (left), 56 cm by ¾" IPS riser bar (middle), and a ¾" × 1" crossover fitting (right).

Combination mount for LI-7500x and WindMaster/Pro

Part Number: 7900-320

Available as an option. The combination mount is used to mount a Gill WindMaster/Pro or R3-50 sonic anemometer with an LI-7500A/RS/DS. It positions the gas analyzer next to the anemometer.

Description	Quantity	Part Number
Bolts (M6 x 35)	3	150-16757
Flat washers (A6)	6	159-15104
Star lock washers (J6)	3	159-16756
Hex Nuts (M6 x 35)	3	157-15095

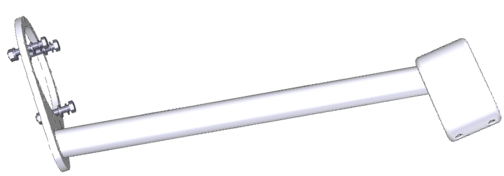


Figure 1-2. The combination mount attaches to the WindMaster/Pro mounting post.

Head cable extension

Part Number: 392-13984

An optional 5-meter extension can be connected to extend the distance between the sensor head and the LI-7550 Analyzer Interface Unit to 10 meters. Only one extension cable can be used.

Calibration certificate

The certificate lists the calibration coefficients for your sensor head. These values are unique to each sensor head and have been entered into the corresponding LI-7550 at the factory. Keep this sheet in case you need to re-enter these values. You can acquire a copy of your calibration certificate from the LI-COR support web site.

LI-7550 Analyzer Interface Unit

The LI-7550 Analyzer Interface Unit houses the gas analyzer electronics. There is a USB port and three Ethernet connectors inside the LI-7550. Two of the Ethernet ports are connected to the connector panel.

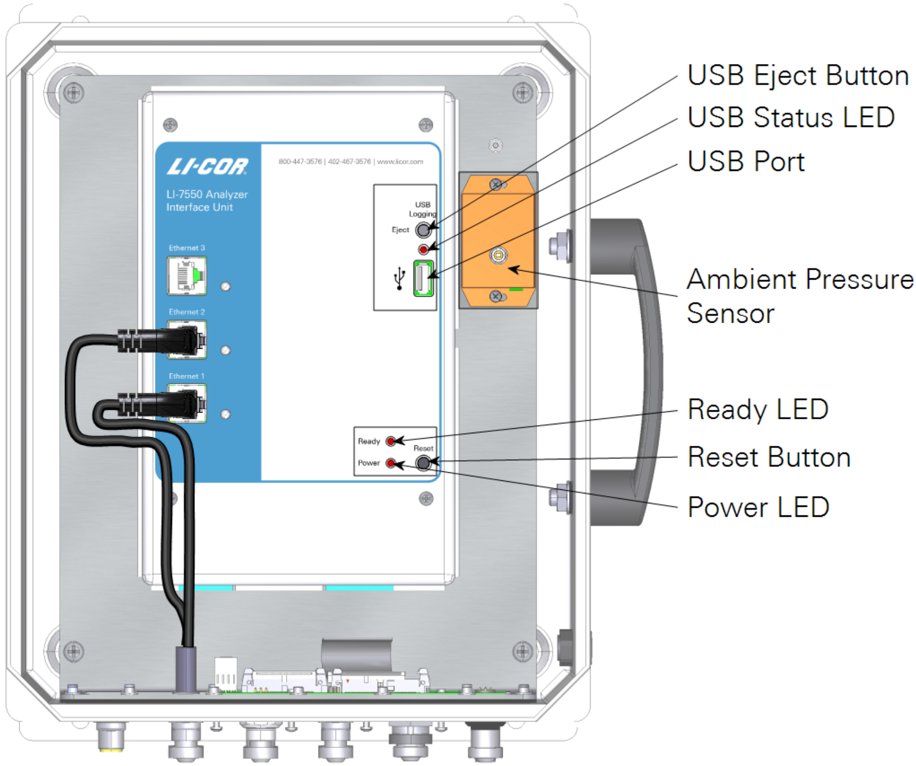


Figure 1-3. LI-7550 interior.

- **USB Eject Button**: Press to eject the USB drive. Failure to press the eject button before removing the USB flash drive may result in the loss of data and may require a restart to resume normal operation.
- **USB Status LED**: Indicates the status for the flash drive:
  - **Solid**: Drive mounted, not logging.
  - **Rapid Blink**: Logging data.
  - **Slow Blink**: Error. Eject and reinsert the drive.
  - **Off**: Drive not mounted; OK to remove.
- **USB Port**: A USB drive must be installed in order to log data. Two compatible drives are in the spares kit.
- **Ready LED**: On when the instrument is warmed up and ready to measure.

- **Reset Button**: Press to restart the LI-7550 and gas analyzer.
- **Power LED**: On when the instrument is powered on.

The connector panel has connectors for the sensor head and other cables.

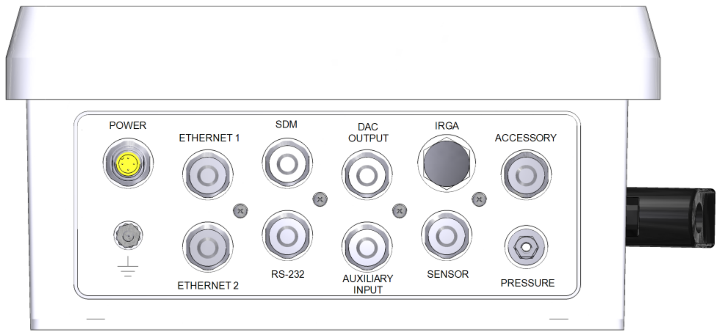


Figure 1-4. LI-7550 connector panel.

- **POWER**: For the power cable (9975-030). Apply 10.5 to 30 VDC, 30 W minimum to power on the instrument.
- **ETHERNET 1** and **2**: Sealed connectors for network cables. Typically connected to cable part numbers 392-10107 and 392-10108 to connect with other networked devices through the Brainboxes SW-508 network switch.
- **SDM**: Connector for an SDM outputs using cable 392-10093.
- **DAC OUTPUT**: Connector for analog outputs. Connects to cable 392-10109 or the 7550-101 Auxiliary Sensor Interface.
- **IRGA**: Connector for the data cable from the gas analyzer.
- **ACCESSORY**: Connector for accessories, including the flow module and heated intake tube. A splitter cable is required to use both.
- **GROUND** lug: Connects the gas analyzer to an earth ground.
- **RS-232**: Connector for serial data using cable 392-10268.
- **AUXILIARY INPUT**: Connector for inputs. Connects to cable 392-10109 or the 7550-101 Auxiliary Sensor Interface.
- **SENSOR**: Connector for air temperature thermistor.
- **PRESSURE**: Vent air pressure sensor.

LI-7550 spare parts kit

Part Number
9975-023

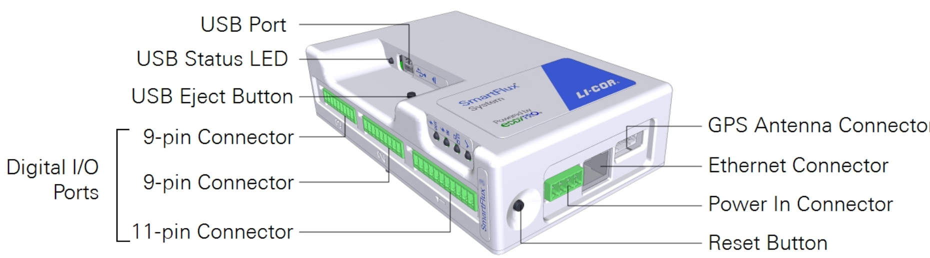
The LI-7550 Analyzer Interface Unit has a spare parts kit. It includes the cables and mounting bracket. As you become familiar with the analyzer you will learn which items to keep close at hand and which items can be stored away.

Description	Quantity	Part Number
Power Cable (5 m)	1	9975-030
16 GB USB Flash Drive	2	616-10723
Mounting Kit	1	9979-022
RS-232 Serial Cable (5 m)	1	392-10268
Analog Input/Output Cable (5 m)	1	392-10109
Ethernet Cable (8-pin Turck® Connectors; 5 m)	1	392-10108
Ethernet Adapter Cable, 8-pin Turck to RJ45	1	392-10107
Standard Ethernet Cable (2.1 m)	1	616-06116
SDM Cable (5 m)	1	392-10093
5 Amp Fuse	2	439-04214

The SmartFlux® 2 System

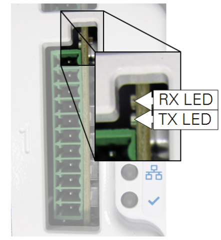
Part Number:
7900-600

The SmartFlux 2 System houses the datalogging and processing computer. It provides GPS position and time synchronization, connections for digital sonic anemometer data, a USB port for logging data to a USB storage device, and a micro-computer that runs EddyPro Software.



- **USB Port**: Hosts a USB drive for data logging.
- **USB Status LED**: Indicates data transfer status.
  - **Solid**: Normal operation.
  - **Rapid Blink**: Logging or reading data.
  - **Slow Blink**: Error. Eject and reinsert the drive.

- **USB Eject Button**: Press to eject the drive. Failure to press the eject button before removing the USB flash drive may result in the loss of data.
- **Digital I/O Terminals**: These three ports can read digital data from a sonic anemometer and a LI-COR Data Acquisition System. Each digital I/O port has two LEDs that are visible at the top of each connector:



  - **RX LED (receiving) and TX LED (transmitting)**:
    - **Rapid Blink or On**: Receiving or transmitting data.
    - **Off**: Normal operation; waiting.
- **GPS Antenna Connector**: Accepts the GPS antenna cable. When connected, time and location data can be set by GPS satellites.
- **Ethernet Connector**: Standard RJ45 jack for an Ethernet cable. Connects to a port on the Brainboxes SW-508.
- **Power In Connector**: Requires a 10 to 30 VDC power supply capable of providing 3.5 W.
- **Reset Button**: Press to reboot the SmartFlux System.
- **Indicator LEDs**: In addition to the digital I/O port LEDs and USB status LEDs, the SmartFlux System has four status LEDs:
  - **Power IN** (ϟ):
    - **Solid**: System is powered.
    - **Off**: System not powered.
  - **Power OUT** (ϟ):
    - **Solid**: Power delivered to digital I/O ports 1, 2, or 3, on pins 1 and 2.
    - **Off**: Power not delivered. If **Power IN** is on, but **Power OUT** is off, then a fuse inside the SmartFlux System has failed.
  - **Ethernet Activity** ():
    - **Rapid Blink or On**: Network communication.
    - **Off**: No network communication
  - **Status** (✓):
    - **Slow Blink**: System is ready.
    - **Solid**: Starting up.

The SmartFlux 2 System includes the following components:

Description	Quantity	Part Number
GPS Antenna with Mounting Bracket and 5 m cable	1	9979-035

Description	Quantity	Part Number
GPS Mounting Bolt, Hex Head 5/16-24 x 3/4"	1	140-16077
GPS Mounting Nut, Hex Head 5/16-24	1	163-16076
Ethernet Cable, 30 cm	1	616-16844
Power Supply Wires, red and black, 18 AWG, 25 cm	1 each	9579-004
Power Terminal Strip, 4 Pin	1	331-13569
Data Input Terminal Strip, 9 Pin	2	331-15376
Data Input Terminal Strip, 11 Pin	1	331-15378

Important: A USB flash drive must always be mounted inside the LI-7550 when recording data. A USB flash drive mounted on the SmartFlux 2 System provides duplicate data storage for added security and convenience. In a tower installation, the USB drive in the SmartFlux System can be accessible from the ground.

Brainboxes SW-508 network switch

Part Number:
616-16771

8-port unmanaged network switch with power wires. Expands the number of Ethernet connections available. Complete documentation for the switch is available from brainboxes.com.

Caution: Do not use network switches other than the Brainboxes SW-508. Other network switches may provide undependable network performance that could result in data loss.

Software

Several software applications are available for the LI-7500RS, including the Windows application software, embedded instrument firmware, EddyPro Software, and other applications. Go to licor.com/7500rs-software for the latest versions. Update the instrument firmware before deploying it.

Windows interface application software

The Windows interface software is used to configure the gas analyzer and SmartFlux System and set parameters for the eddy covariance system. It is compatible with Windows computers running Windows 7 and newer operating systems.

EddyPro® Software

EddyPro Software for the desktop (macOS or Windows) is not required to use the instrument because EddyPro is installed on the SmartFlux System. The EddyPro desktop application is required if you want to run an advanced configuration on the SmartFlux System or if you want to reprocess eddy covariance raw data.

File viewer software

The File Viewer is a simple application for viewing raw data from LI-COR sensors. It reads compressed data files and displays plots of the data.

FluxSuite® Software

FluxSuite is a web-based application that enables you to monitor LI-COR eddy covariance systems that are connected to the internet through a direct Ethernet connection, cellular gateway, or satellite internet terminal. FluxSuite provides site status information, summary results, and configurable email alerts regarding site status. See licor.com/fluxsuite/ for details.

Tovi™ Software

Tovi is a suite of tools for analyzing eddy covariance flux and meteorological datasets that have been processed with EddyPro Software. Tovi is designed to bring together analysis tools, developed by or with the scientific community, into a unique, interactive and intuitive environment, to facilitate and streamline typical processes such as quality control, flux gap filling and flux partitioning, as well as to enable novel analysis such as footprint-based flux allocation. Go to licor.com/tovi for more information.

Enclosures and accessories

Electronics enclosures are available as optional accessories for the system.

Pre-configured biomet system enclosure

Part Number: 7900-126

The pre-configured enclosure is a large weather resistant box with mounting hardware. It is set up for the LI-COR Biomet Data Acquisition System and other accessories. It includes all of the terminal connections and DIN rails required for a complete eddy covariance system.

Table 1-2. Components included with the enclosure. Many of these parts are installed in the enclosure prior to delivery.

Component	Qty.	Part Number
10-amp Circuit Breaker; DIN Mountable	2	275-13499
Red 1-tier Terminals; DIN Mountable	8	331-12822
Gray 2-tier Terminals; DIN Mountable	3	331-12885
Blue 2-tier Terminals; DIN Mountable	4	331-12959
Red 4 mm Terminals; DIN Mountable	3	331-13508
Green 4 mm Terminal; DIN Mountable	1	331-13510
Black 4 mm Terminals; DIN Mountable	3	331-13511
4-position Shorting Blocks	2	331-17204
3-position Shorting Blocks; 4 mm	2	331-16821
2-position Shorting Blocks	2	331-13646
DIN Terminal Covers	5	331-12825
DIN End Bracket	4	331-12922
DIN Terminal Labels	2	331-12934
Adhesive Cable Tie Mounts	5	218-03683
Phillips Pan Head Screw (10-32; 3/8")	4	122-00072
Risers to mount the battery	2	9879-090
Riser Plate	1	9879-091
Raised Terminal Block and DIN Mount	1	6579-078
DIN Rail (14 cm)	4	6579-079

Eddy covariance system enclosure

Part Number: 7900-050

A basic enclosure with a minimal set of internal components. Includes a pre-drilled internal back plate, three DIN rails for mounting components, and three strain relief fittings. It is best to pair this with the Power Distribution Kit (7900-235).

Power distribution kit

Part Number: 7900-235

Includes DIN-mountable terminal connections, shorting blocks, and a 10-amp circuit breaker. Provides 11 individual positive and negative power terminals for the system. Installs in the 7900-050 eddy covariance system enclosure.

Description	Quantity	Part Number
10-amp Circuit Breaker; DIN Mountable	1	275-13499
DIN Terminal Cover	1	331-12825
DIN Terminal End Bracket	2	331-12922
Red 4 mm Terminals; DIN Mountable	6	331-13508
Green 4 mm Terminals; DIN Mountable	1	331-13510
Black 4 mm Terminals; DIN Mountable	6	331-13511
6-position Shorting Box	2	331-13512
14 AWG Red Wire Lead	1	392-13829
18 AWG Green/Yellow Ground Wire Lead	1	372-04621

Auxiliary Sensor Interface

Part Number: 7550-101

An O-ring sealed, weatherproof junction box that can be used to connect analog inputs or outputs to the LI-7550 Analyzer Interface Unit. It has connections for up to six analog outputs or four general purpose analog inputs and a constant 5 VDC source (5 mA maximum). The 7550-101 includes mounting hardware, Santoprene™ tubing and plugs for unused openings.

Description	Quantity	Part Number
U-Bolt, ¼ x 20	2	184-09842
Hex Nut	4	163-00138
Santoprene (1/16” inside diameter; 0.6 m)	1	222-08325
Quick Connect Plug	10	300-07393

Sonic anemometer cables and mounting hardware

Optional data and power cables are available for all supported anemometer models. Mounting hardware is available for several models.

Gill WindMaster/Pro and R3

Data and power cables

Part Number: 7900-415-x

The data/power cable is available in three lengths. The USB-to-RS-422 cable is used to connect the anemometer to a computer.

Table 1-3. WindMaster/Pro power and data cables that are compatible with the SmartFlux 2 and 3 Systems.

Cable Type	Length	Part Number
Data and Power	5 m	7900-415-5
Data and Power	25 m	7900-415-25
Data and Power	50 m	7900-415-50
USB to RS-422	1.8 m	392-16348

Mounting hardware

Part Number: 7900-342

To mount the WindMaster/Pro and R3, use a ¾" × 1" cross-over fitting (7900-342) and anemometer mounting post (9975-037). The mounting post is included with WindMaster/Pro anemometers purchased from LI-COR. The cross-over fitting is available seperately.

Description	Quantity	Part Number
WindMaster/Pro Mounting Post	1	9975-037
Crossover Fitting (¾" × 1")	1	7900-342

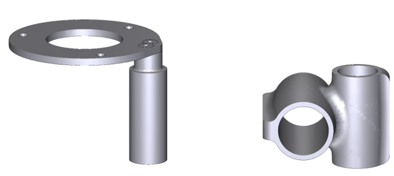


Figure 1-5. Mounting post (left) and crossover fitting (right) are to install a WindMaster-/Pro or R3 anemometer.

Gill HS-50 and R3-50

Data and power cables

Part Number: 7900-445-x

The data/power cable is available in three lengths. The USB-to-RS-422 cable is used to connect the anemometer to a computer.

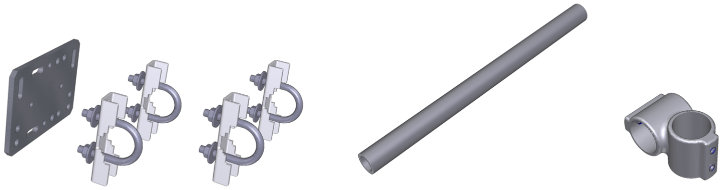
Table 1-4. Power and data cables to connect Gill HS-50 or R3-50 anemometers with the SmartFlux 2 or 3 System.

Cable Type	Length	Part Number
Data and Power	5 m	7900-445-5
Data and Power	25 m	7900-445-25
Data and Power	50 m	7900-445-50
USB to RS-422	1.8 m	392-16348

HS-50 Mounting hardware

The HS-50 can be mounted with the following components. The R3-50 mounting options are similar to the WindMaster/Pro. Mounting is accomplished with two hardware packs. Use the two 35 mm U-bolts from each cross arm hardware pack. The larger 64 cm U-bolts are not used.

Description	Quantity	Part Number
Crossover Fitting (1" × 1")	1	259-17893
45 cm Riser Bar (1" IPS)	1	9879-095
Cross-arm Plate	1	9879-020
Cross-arm Brackets	4	9879-043
Cross-arm Hardware Pack	2	9979-118



Campbell Scientific CSAT3

Part Numbers: 7900-454-x and 7900-452-x

Data and power cables are available in two lengths. The USB-to-RS-232 cable is used to connect the anemometer to a computer.

Table 1-5. CSAT3 power and data cables that are compatible with the SmartFlux 2 and 3 Systems.

Cable Type	Length	Part Number
RS-232 Data	5 m	7900-454-5
Power	5 m	7900-452-5
RS-232 Data	50 m	7900-454-50
Power	50 m	7900-452-50
USB to RS-232	1.8 m	392-16347

Campbell Scientific CSAT3B

Part Numbers: 7900-464-x and 7900-462-x

Data and power cables are available in two lengths.

Table 1-6. CSAT3B power and data cables that are compatible with the SmartFlux 2 and 3 Systems.

Cable Type	Length	Part Number
RS-485 Data	5 m	7900-464-5
Power	5 m	7900-462-5
RS-485 Data	50 m	7900-464-50
Power	50 m	7900-462-50

Metek MultiPath Class A

Data and power cables

Part Number: 7900-492-x

The data/power cable is available in three lengths. The USB-to-RS-232/RS-485 cable is used to connect the anemometer to a computer.

Table 1-7. Metek Class-A power and data cables that are compatible with the SmartFlux 2 and 3 Systems.

Cable Type	Length	Part Number
Data and Power	5 m	7900-492-5
Data and Power	25 m	7900-492-25
Data and Power	50 m	7900-492-50
USB to RS-232/RS-485	1.8 m	392-16348

Mounting kit

Part Number: 7900-336

Mount the Metek Class A anemometer with the Metek mounting kit (7900-336).

Table 1-8. The Metek Class A mounting kit and components.

Description	Quantity	Part Number
Crossover Fitting (1" × 1")	1	259-17893
45 cm Riser Bar (1" IPS)	1	9879-095
Cross-arm Plate	1	9879-020
Cross-arm Brackets	2	9879-043
Cross-arm Hardware Pack	1	9979-118

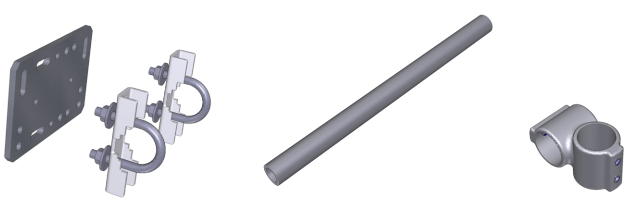


Figure 1-6. The cross-arm plate with brackets, riser bar, and crossover fitting used to mount a Metek Class A sonic anemometer in LI-COR eddy covariance systems.

Metek MultiPath Cage

Data and power cables

Part Numbers: 7900-482-x

The data/power cable is available in three lengths. The USB-to-RS-232/RS-485 cable is used to connect the anemometer to a computer.

Table 1-9. Metek Cage power and data cables that are compatible with the SmartFlux 2 and 3 Systems.

Cable Type	Length	Part Number
Data and Power	5 m	7900-482-5
Data and Power	25 m	7900-482-25
Data and Power	50 m	7900-482-50
USB to RS-232/RS-485	1.8 m	392-16348

Mounting kit

Part Number: 7900-346

Mount the Metek Cage anemometer with one 1" × 1" crossover fitting (7900-346).

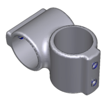


Figure 1-7. A simple 1" × 1" crossover fitting can mount the Metek Cage to the LI-COR tripod crossarm.

RM Young 81000x

Data and power cables

Part Number: 7900-472-x

The data/power cable is available in three lengths. The USB-to-RS-232/RS-485 cable is used to connect the anemometer to a computer.

Table 1-10. RM Young 81000 series power and data cables that are compatible with the SmartFlux 2 and 3 Systems.

Cable Type	Length	Part Number
Data and Power	5 m	7900-472-5
Data and Power	25 m	7900-472-25
Data and Power	50 m	7900-472-50
USB to RS-232/RS-485	1.8 m	392-16348

Mounting kit

Part Number: 7900-332

Mount the RM Young 81000, 81000V, 81000RE, or 81000VRE sonic anemometer with the RM Young mounting kit (7900-332).

Table 1-11. The RM Young mounting kit and components.

Description	Quantity	Part Number
Crossover Fitting (1" × 1")	1	7900-346
45 cm Riser Bar (1" IPS)	1	9879-095

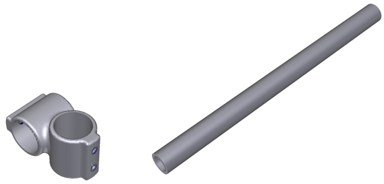


Figure 1-8. A crossover fitting and 45 cm riser bar are can mount the 81000 series anemometers to the cross arm.

Section 2.
Initial assembly

This section covers the basic steps you will follow to assemble the LI-7500RS for the first time. You'll need the analyzer head, LI-7550, Temperature Sensor, SmartFlux 2 System, and the accessories.

Preparing the gas analyzer

Begin by installing the temperature sensor, head cable, and USB drive.

Connecting the temperature sensor

The air temperature sensor (part number 9975-026) connects to the **SENSOR** connector on the LI-7550.

Connecting the head cable

The head cable connects to between the bottom of the head and the **IRGA** connector on the LI-7550. Align the notches on the cable connectors, then push in and turn the connector clockwise until it is tight. Continue to push in while tightening the connector until the connector is fully seated. The gasket must be compressed to ensure a watertight seal.

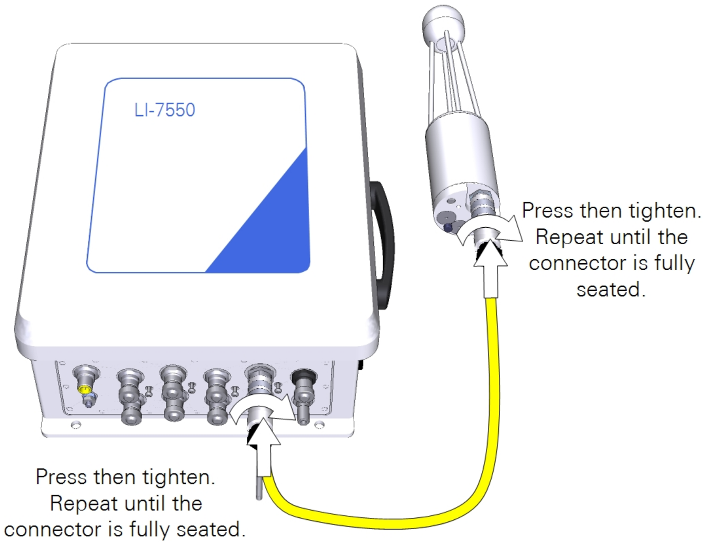


Figure 2-1. To install the head cable, align the notches on the cable connectors, then tighten while pressing the connectors together. Repeat until the connector is fully seated.

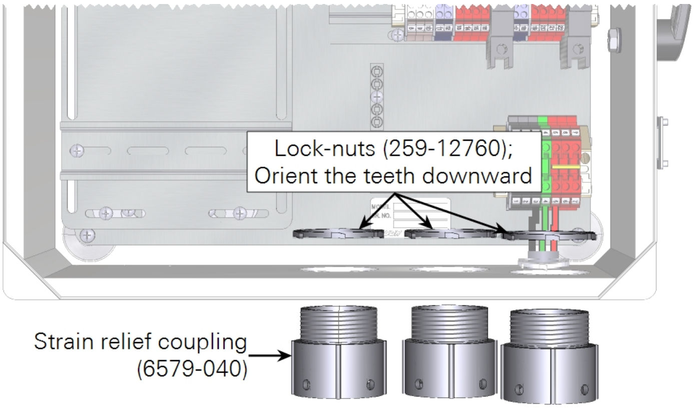
Installing the LI-7550 USB drive

Open the cover to the LI-7550 and insert the USB drive from the spares kit into the USB port. Close and latch the cover.

> **Important:** A USB drive must be installed in the LI-7550 to log data. A USB drive can also be installed in the SmartFlux 2 System, where a full duplicate of the data is stored.

Preparing the enclosure

In both the eddy covariance system enclosure (7900-050) and the Biomet Data Acquisition System enclosure (7900-126), install the three strain-relief couplings in the three bottom openings.



In the eddy covariance system enclosure (7900-050), install the Power Distribution Kit (7900-235) on the raised DIN rail. Connect the red wire lead between the top of the breaker and top right red terminal. Install one shorting block to connect all black terminals and another to connect all red terminals.

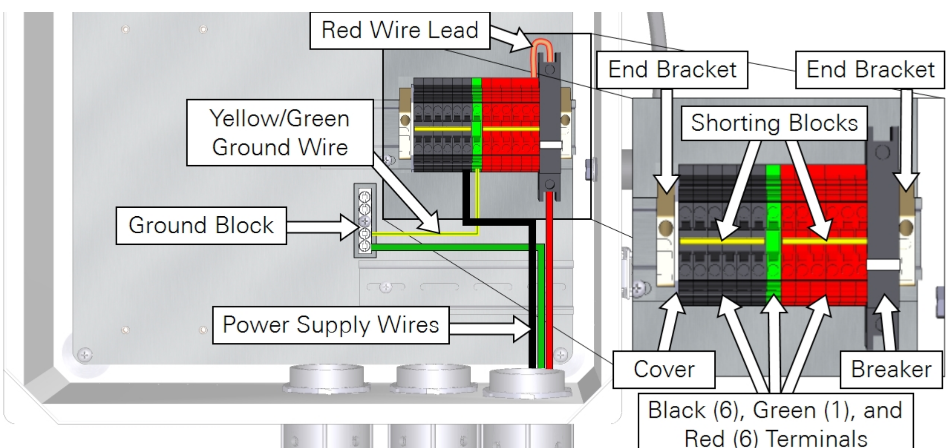


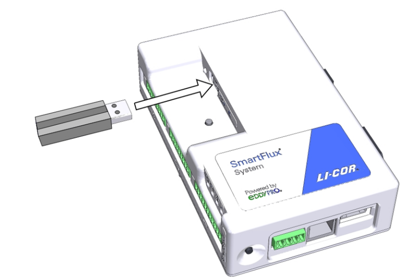
Figure 2-2. The power distribution kit (7900-235) installed in the enclosure (7900-050).

Preparing the SmartFlux System and network switch

Follow the steps below when installing the SmartFlux System in the 7900-050 Eddy Covariance System Enclosure or 7900-126 Biomet Data Acquisition System Enclosure. If you are using a different enclosure, connect the power and data cables similarly to what is described here.

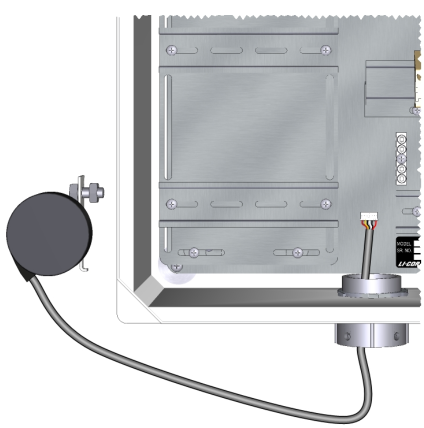
Install the USB drive

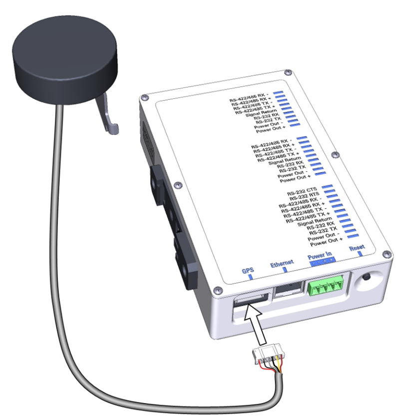
Data are recorded to the USB drive. Install the USB drive in the USB port on the SmartFlux System.



Connect the GPS antenna cable

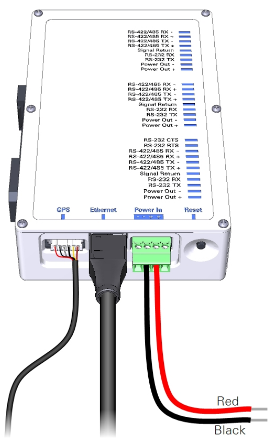
Route the GPS cable through the left opening at the bottom of the enclosure and plug it into the GPS port on the SmartFlux System.





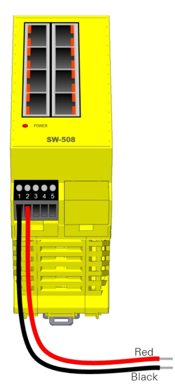
Connect power wires and the Ethernet cable to the SmartFlux System

Connect wire leads to the positive and negative terminals on the SmartFlux System. The black lead connects to negative (-), the red lead connects to positive (+). Plug in the 30 cm Ethernet cable that came with the SmartFlux System. There are two connections for positive (+) and two for negative (-). Use only one pair of +/- terminals.



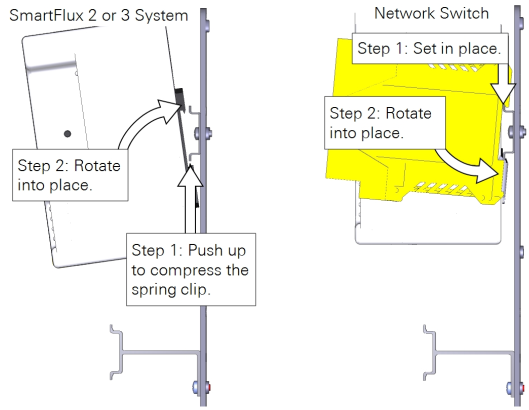
Connect power wires to the Brainboxes network switch

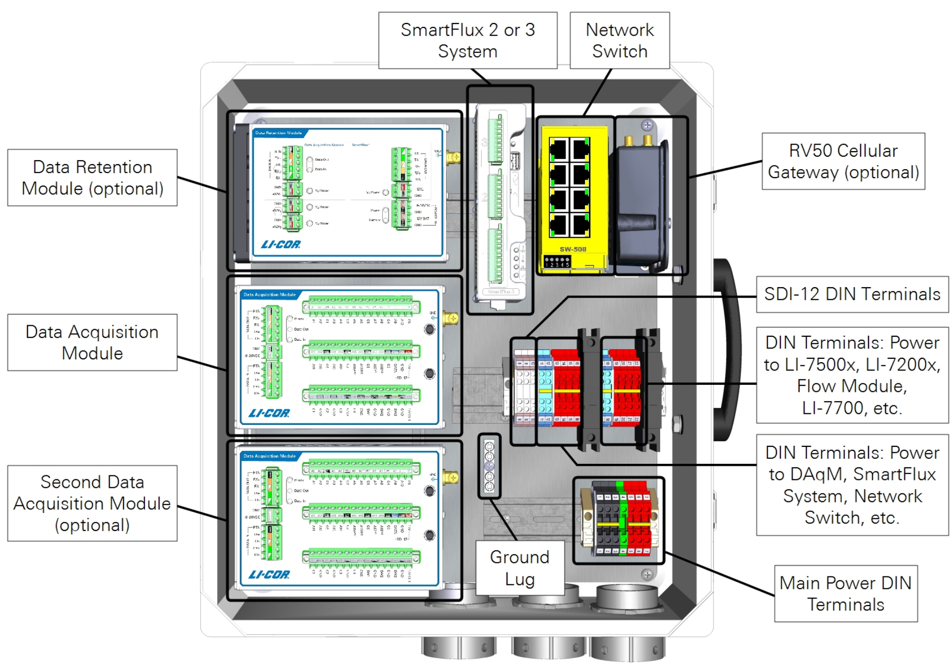
Power wires connect to the positive and negative terminals on the switch. The black lead connects to terminal 1 (-), the red lead connects to terminal 2 (+).



Installing the SmartFlux System and network switch

Install the SmartFlux 2 or 3 System onto left side of the upper-right DIN rail. Insert the spring-loaded clip on the bottom edge of the DIN rail and compress the spring. Rotate it into place. Mount the switch next to it.





Connecting component power wires

The 7900-050 and 7900-126 enclosures present different wiring options. Be sure the power supplied to the enclosure is within the upper voltage limits of attached components, but capable of providing 4 to 5 amps. Keep the breaker **OFF** while connecting power wires.

7900-050 Eddy Covariance System Enclosure

With the 7900-050 enclosure, keep the breaker **OFF**. Connect the positive (+) leads to the red terminals and the negative leads (-) to the black terminals for all components of the system, including the SmartFlux System, network switch, and gas analyzer. Proceed to *Connecting gas analyzer power wires* on page 2-17.

7900-126 Biomet Data Acquisition System Enclosure

With the 7900-126 enclosure, each component is powered individually from the power supply terminals, the DC-DC converter, or the DRM power outputs. 24-volt and 12-volt power supplies will be wired differently.

> **Caution:** Do not short circuit the power supplies. For example, avoid connecting the **V_4 POWER OUT** terminals from a Data Retention Module to the **Power In** terminals on a device that is powered from another power supply. Doing so will damage components and may present risk of a fire.

Select the power supply option that describes your system:

- *24 VDC power supply with Data Retention Module* on the next page. This configuration uses the 24 volt output from a SunWize solar power supply. The DRM provides voltage regulation for devices that are not compatible with the 24 volt power supply.
- *12 VDC power supply with Data Retention Module* on page 2-10. With a 12 volt power supply, no voltage regulator is needed.
- *12 VDC power supply with no Data Retention Module* on page 2-12. With a 12 volt power supply, no voltage regulator is needed.
- *24 VDC power supply with the TDK-Lambda DC-DC converter* on page 2-14. With a 24 volt power supply and no Data Retention Module, the TDK-Lambda voltage regulator should be used to power devices that have maximum power supply limits lower than 24 VDC.

24 VDC power supply with Data Retention Module

With a 24 VDC power supply, the DRM V_3 power outputs can be used to power low-voltage components through the left 10-amp breaker and DIN terminals. Components powered in this manner include the network switch, PhenoCam, cellular gateway, satellite modem, CNF4 heater and ventilation unit (for the CNR4), or self-calibrating soil heat flux plates (HFP01SC).

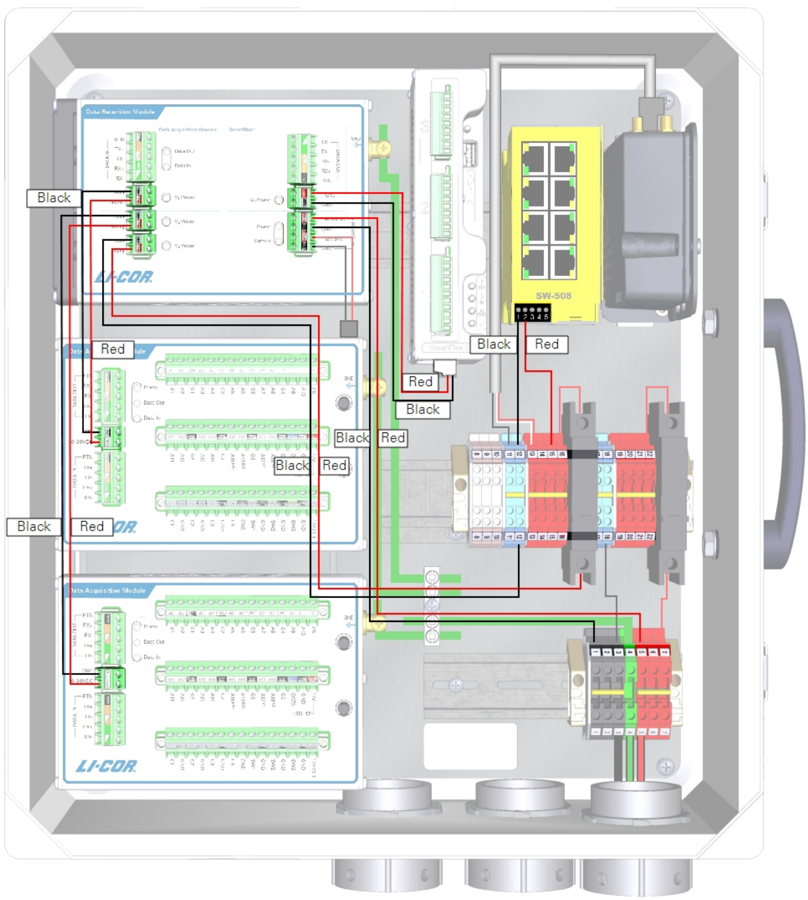
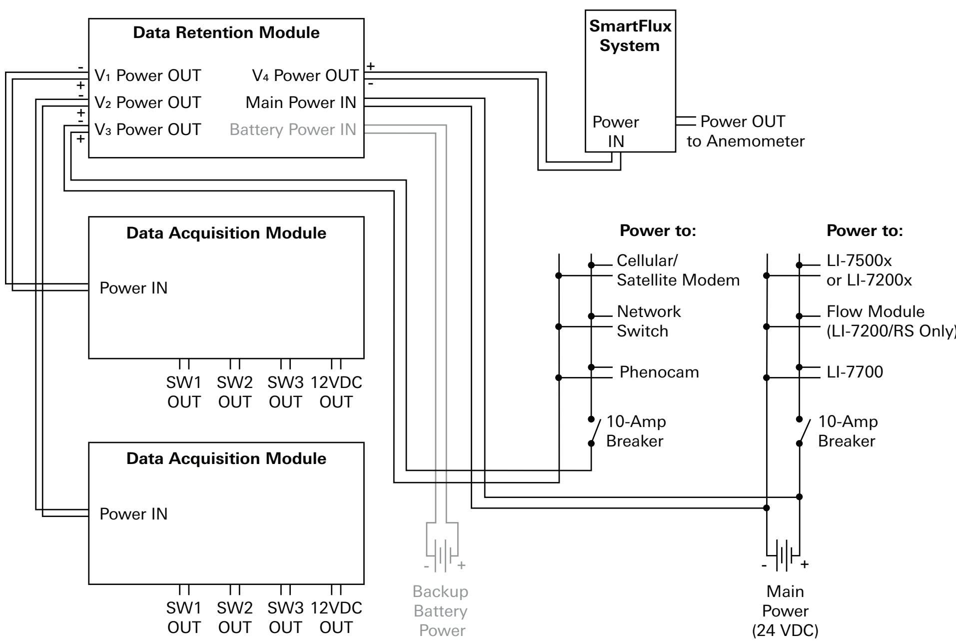


Figure 2-3. Power to two DAqMs and accessories when controlled by the DRM. One DAqM is powered from V_1; the second DAqM is powered from V_2 through; the 10-amp breaker and DIN terminals are powered through V_3. The SmartFlux System (and thus, the sonic anemometer) is powered from V_4.

Table 2-1. Power wire connections for a system powered by a 24 VDC supply that includes a Data Retention Module.

From	Wire Color	To
DRM and DAqM Ground Lugs	yellow/green	Enclosure Ground Lug
DIN Terminal 1 (top)	black	DRM POWER IN GND (-)
DIN Terminal 5 (top)	red	DRM POWER IN +9-30 VDC (+)
DRM V_1 Power GND	black	DAqM 1 GND (-)
DRM V_1 Power $+12V_1$	red	DAqM 1 PWR (+)
DRM V_2 Power GND	black	DAqM 2 GND (-)
DRM V_2 Power $+12V_2$	red	DAqM 2 PWR (+)
DRM V_3 Power GND	black	DIN Terminal 12 (bottom)
DRM V_3 Power $+12V_3$	red	Left Breaker (bottom)
DRM V_4 Power GND	black	SmartFlux System (-)
DRM V_4 Power $+12\ V_4$	red	SmartFlux System (+)
DIN Terminal 12 (top)	black	Network Switch (-)
DIN Terminal 15 (top)	red	Network Switch (+)
DIN Terminal 11 (top)	black	Cellular/Satellite Modem (-)
DIN Terminal 13 (top)	red/white	Cellular/Satellite Modem (+)



12 VDC power supply with Data Retention Module

With a 12 VDC power supply, you do not need to connect the DRM power out to the breaker or terminal strips because 12 VDC is within the limits of all components.

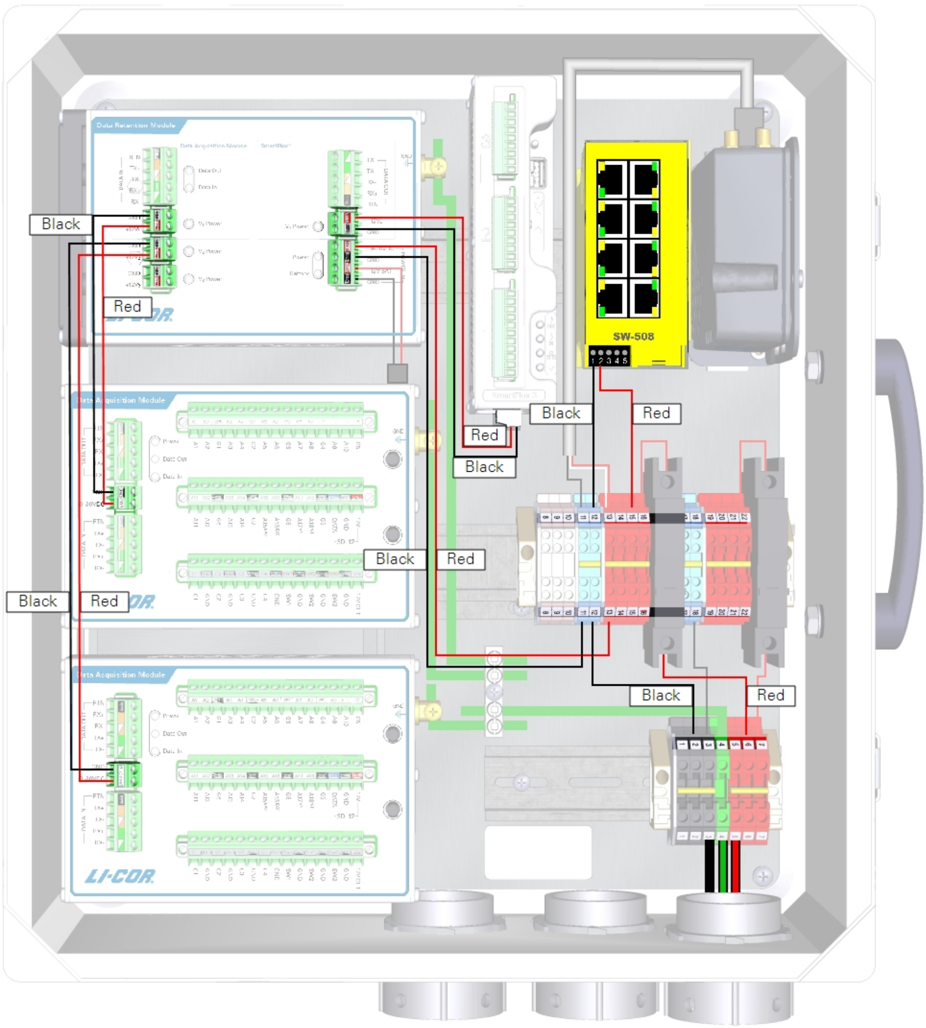
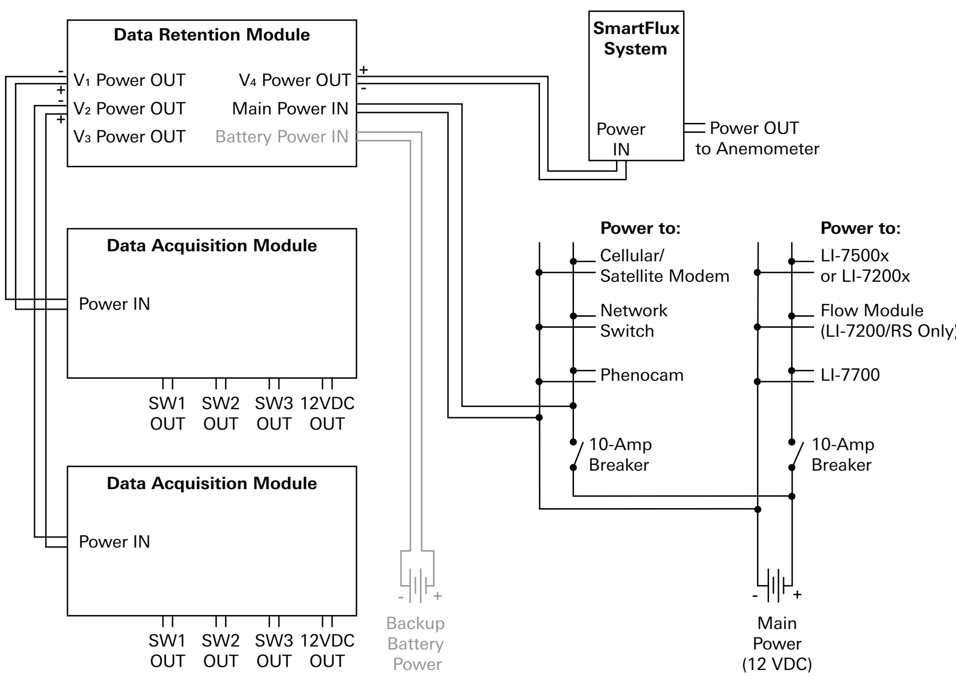


Figure 2-4. Power to DAqMs when controlled by the DRM. In this example, the DAqMs are powered directly from V_1 and V_2 power outputs on the DRM.

Table 2-2. Power wire connections for a system powered by a 12 VDC supply that includes a Data Retention Module.

From	Wire Color	To
DRM and DAqM Ground Lugs	yellow/green	Enclosure Ground Lug
DIN Terminal 11 (bottom)	black	DRM POWER IN GND (-)
DIN Terminal 13 (bottom)	red	DRM POWER IN +9-30 VDC (+)
DRM V_1 Power GND	black	DAqM 1 GND (-)
DRM V_1 Power $+12V_1$	red	DAqM 1 PWR (+)
DRM V_2 Power GND	black	DAqM 2 GND(-)
DRM V_2 Power $+12V_2$	red	DAqM 2 PWR (+)
DRM V_4 Power GND	black	SmartFlux System (-)
DRM V_4 Power $+12\ V_4$	red	SmartFlux System (+)
DIN Terminal 12 (top)	black	Network Switch (-)
DIN Terminal 15 (top)	red	Network Switch (+)
DIN Terminal 11 (top)	black	Cellular/Satellite Modem (-)
DIN Terminal 13 (top)	red/white	Cellular/Satellite Modem (+)



12 VDC power supply with no Data Retention Module

If your system does not have a Data Retention Module, the SmartFlux System will be powered from the enclosure power terminals rather than the DRM power outputs.

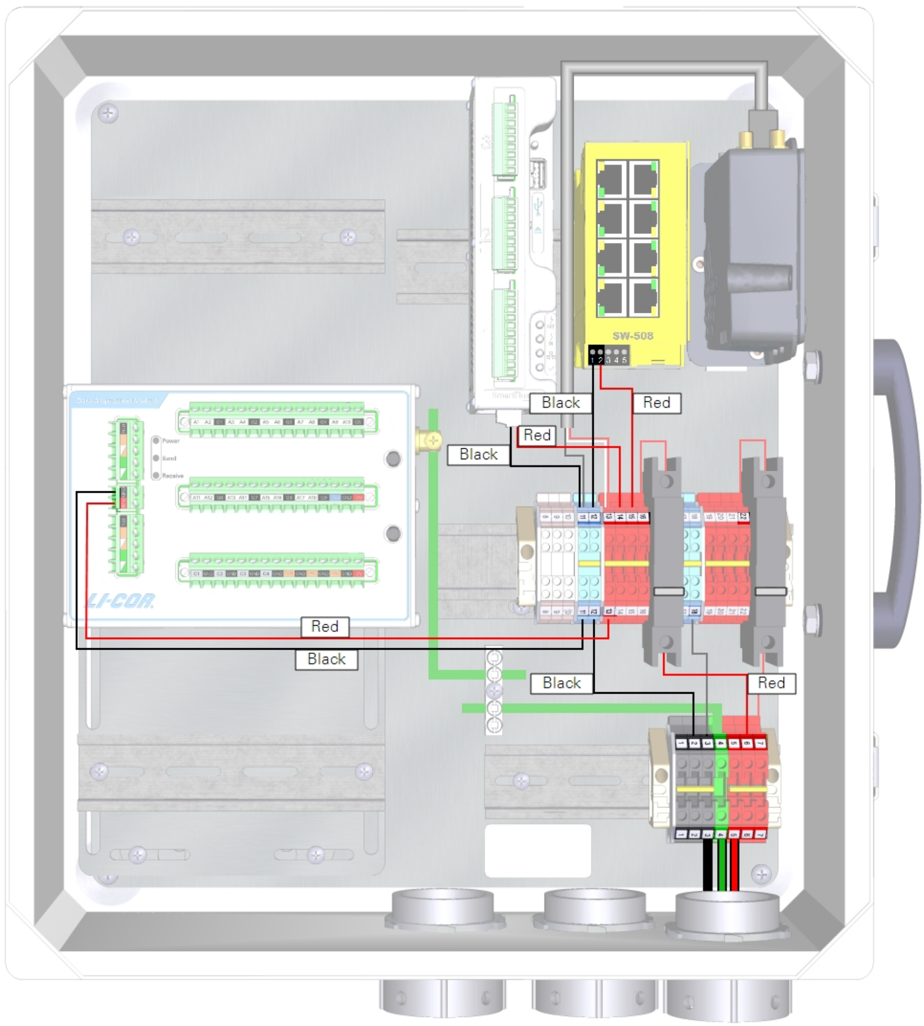
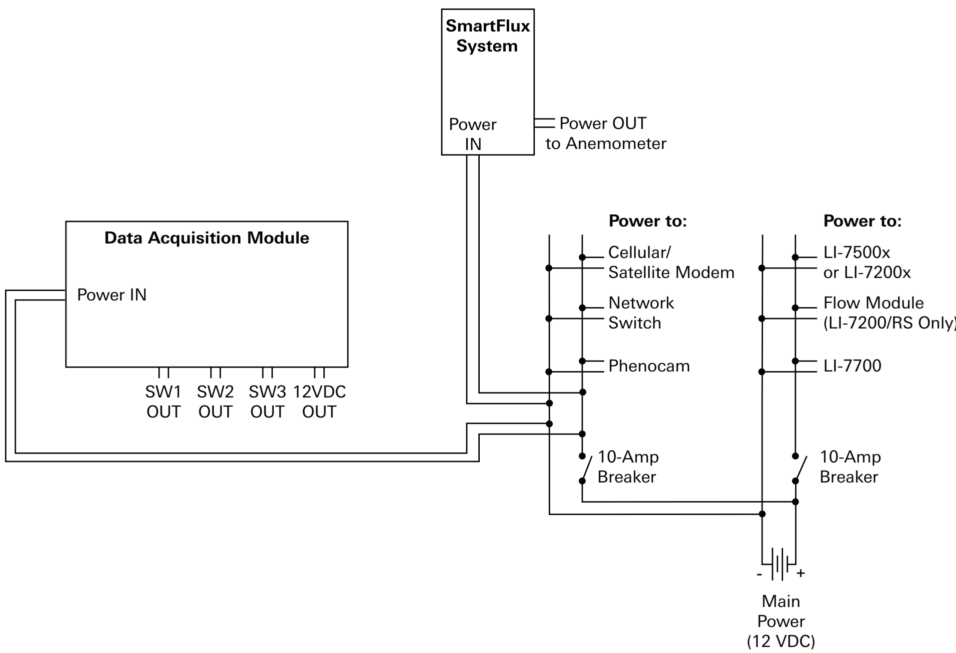


Table 2-3. Power wire connections for a system powered by 12 VDC with no Data Retention Module.

From	Wire Color	To
DRM and DAqM Ground Lugs	yellow/green	Enclosure Ground Lug
DIN Terminal 11 (bottom)	black	DAqM GND (-)
DIN Terminal 13 (bottom)	red	DAqM PWR (+)
DIN Terminal 17 (top)	black	SmartFlux System GND (-)
DIN Terminal 11 (top)	red	SmartFlux System (+)
DIN Terminal 14 (top)	black	Network Switch (-)
DIN Terminal 15 (top)	red	Network Switch (+)
DIN Terminal 11 (top)	black	Cellular/Satellite Modem (-)
DIN Terminal 13 (top)	red/white	Cellular/Satellite Modem (+)

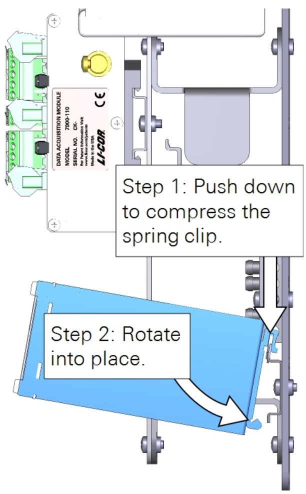


24 VDC power supply with the TDK-Lambda DC-DC converter

The TDK-Lambda DC-DC Converter (model DPX60) regulates output voltage to about 12 VDC, which makes it possible to power low-voltage devices from a 24 VDC solar power supply. The DC-DC converter should be used to power the left 10-amp accessory breaker (and the SmartFlux System) if you have a 24 VDC power supply and no DRM.

Full documentation for the TDK-Lambda DC-DC converter is available from the manufacturer's website: us.tdk-lambda.com/lp/products/dpx-series.htm.

The DC-DC converter mounts to a DIN rail in the lower right of the enclosure. Compress the spring the in the DIN clip and rotate the converter into place.



Connect the incoming power to the charge controller **Input** terminals (-Vi and +Vi) and connect the regulated power from the charge controller output terminals (COM and +V1) to the left breaker and DIN terminal 12. See *Figure 2-5* on the facing page and *Table 2-4* on page 2-16 for details.

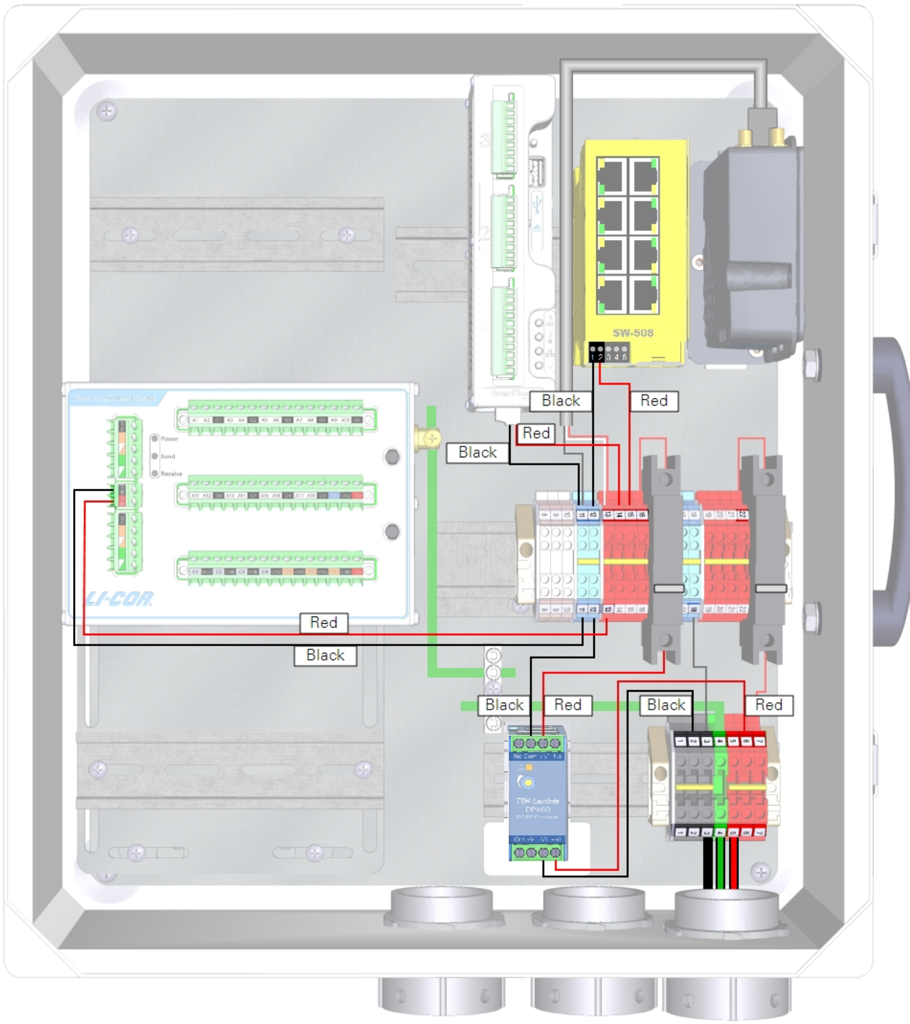
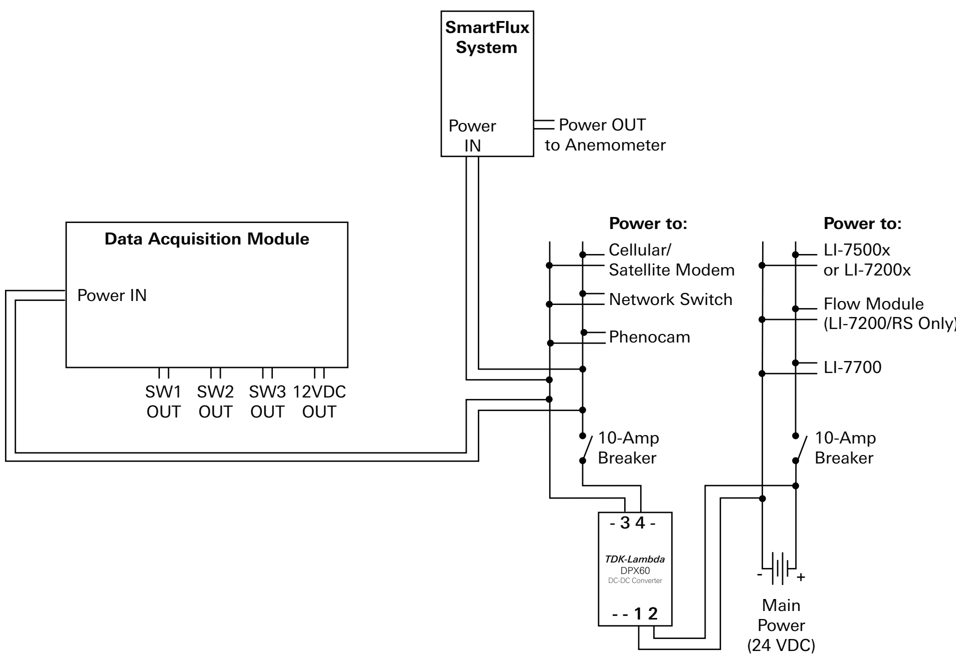


Figure 2-5. Power to a single DRM when using a 24 VDC power supply and the TDK-Lamda DC-DC Converter.

Table 2-4. Power wire connections for a system with the TDK-Lambda DC-DC converter.

From	Wire Color	To
DRM and DAqM Ground Lugs	yellow/green	Enclosure Ground Lug
DIN Terminal 2 (top)	black	TDK-Lambda Input 1 (-Vi)
DIN Terminal 6 (top)	red	TDK-Lambda Input 2 (+Vi)
TDK-Lambda Output 3 (COM)	black	DIN Terminal 12 (bottom)
TDK-Lambda Output 4 (+V1)	red	Left Breaker (bottom)
DIN Terminal 11 (bottom)	black	DAqM GND (-)
DIN Terminal 13 (bottom)	red	DAqM PWR (+)
DIN Terminal 11 (top)	black	SmartFlux System GND (-)
DIN Terminal 14 (top)	red	SmartFlux System (+)
DIN Terminal 12 (top)	black	Network Switch (-)
DIN Terminal 15 (top)	red	Network Switch (+)
DIN Terminal 11 (top)	black	Cellular/Satellite Modem (-)
DIN Terminal 13 (top)	red/white	Cellular/Satellite Modem (+)



Connecting gas analyzer power wires

Power wires for the gas analyzer connect to terminals in the enclosure. With the eddy covariance system enclosure (7900-050) and Power Distribution Kit (7900-235), connect the red and black power wires leads to corresponding red and black terminals. With the Biomet Data Acquisition System enclosure (7900-126), connect the leads as described in *Table 2-5* below.

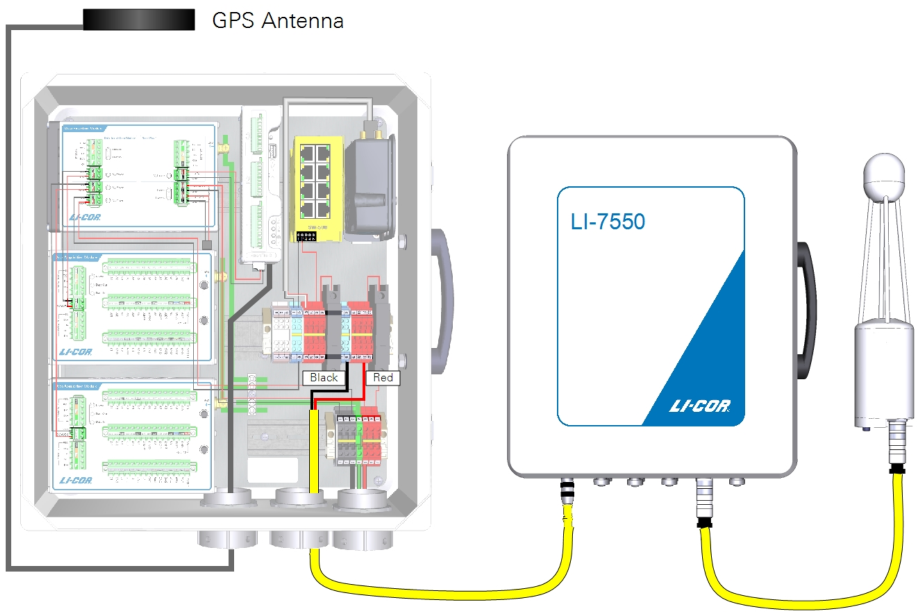


Table 2-5. Power wire connections in the Biomet Data Acquisition System.

From	Wire Color	To
Terminal 17 (bottom)	black	LI-7550 Power (-)
Terminal 19 (bottom)	red	LI-7550 Power (+)

Connecting Ethernet cables

Ethernet cables connect the SmartFlux 2 System and LI-7550 to the network switch. Vacant ports on the network switch are for other networked components, such as the cellular gateway, PhenoCam, LI-7700, or connecting a PC.

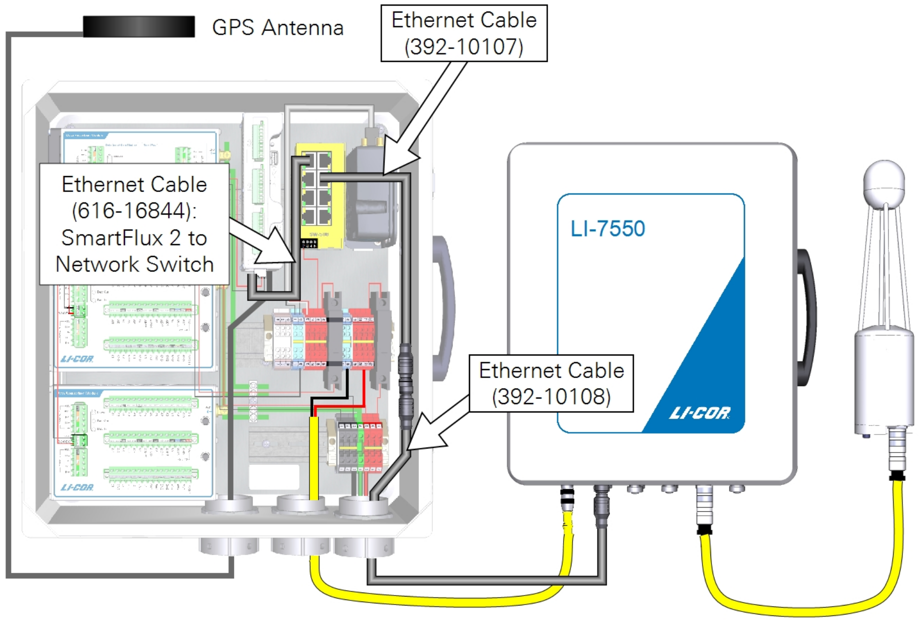


Figure 2-6. Install Ethernet cables to connect the SmartFlux 2 System and LI-7550 to the Network Switch.

Connecting sonic anemometer data and power cables

The SmartFlux 2 System can record digital data from a number of sonic anemometer models. These are described below. Power for the sonic anemometer is provided through the SmartFlux System.

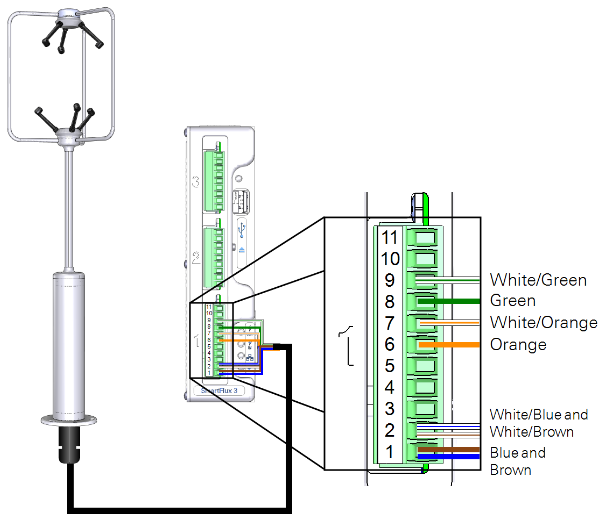
Gill WindMaster or WindMaster Pro

Part Number: 7900-415-x

A combined power and data cable is available for the Gill WindMaster/Pro sonic anemometers. The sonic anemometer will be configured automatically when it is connected to the SmartFlux System and selected in the software. The cable connects to one of the digital I/O ports on the SmartFlux System (port 1 recommended).

Table 2-6. WindMaster/Pro data and power cable wire colors and pin assignments.

SmartFlux Terminal	SmartFlux Label	Wire Color
9	RS-422/485 RX-	White/Green
8	RS-422/485 RX+	Green
7	RS-422/485 TX-	White/Orange
6	RS-422/485 TX+	Orange
2	Power to Anemometer (-)	White/Blue and White/Blue
1	Power to Anemometer (+)	Blue and Brown



Gill HS-50 or R3-50

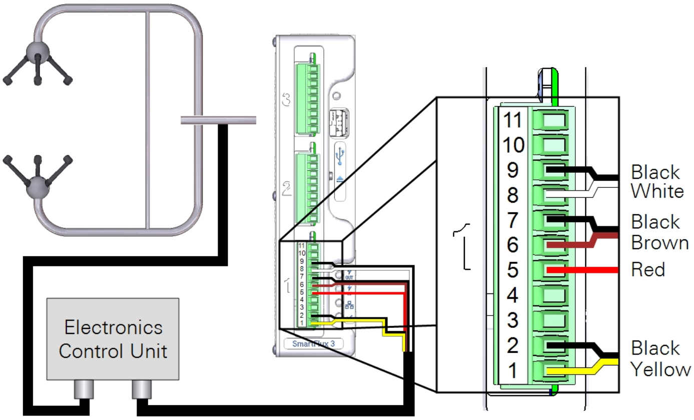
Part Number: 7900-445-x

A combined power and data cable is available for the Gill HS-50 or R3-50 sonic anemometers. The sonic anemometer will be configured automatically when it is connected to the SmartFlux System and selected in the software. The cable connects to one of the digital I/O ports on the SmartFlux System (port 1 recommended). The R3 uses the same cable as the HS, but the cable connects to the base of the R3 rather than the electronics control unit.

> **Important:** At least 13 VDC must be supplied when using a 50 meter power cable because of voltage drops.

Table 2-7. Wire assignments for the HS-50 data and power cable. The three black wires are bundled with their counterpart in the cable.

SmartFlux Terminal	SmartFlux Label	Wire Color
9	RS-422/485 RX-	Black (bundled with white)
8	RS-422/485 RX+	White
7	RS-422/485 TX-	Black (bundled with brown
6	RS-422/485 TX+	Brown
5	Signal Return	Red
2	Power Out (-)	Black (bundled with yellow)
1	Power Out (+)	Yellow



Campbell Scientific CSAT3

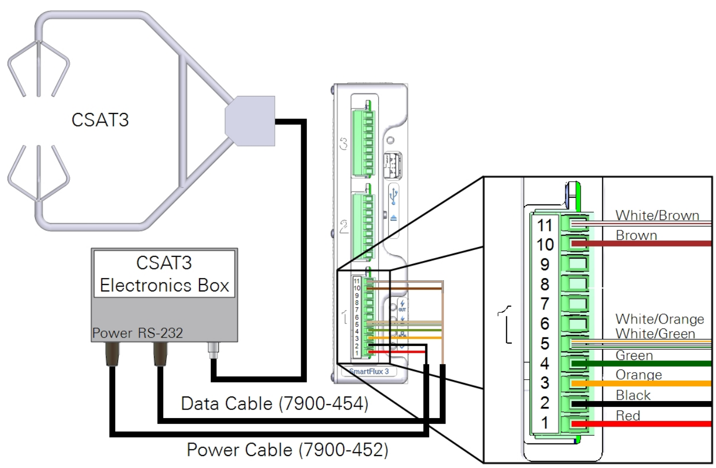
Data Cable: 7900-454-x; Power Cable: 7900-452-x

Power and data cables are available for the Campbell Scientific, Inc. CSAT3 sonic anemometers. The sonic anemometer will be configured automatically when it is connected to the SmartFlux System and selected in the software. The cable connects to digital I/O Port 1 on the SmartFlux System.

> **Important:** The CSAT3 requires 10 to 16 VDC. Supplying an incoming 24 VDC to the SmartFlux System will damage a CSAT3.

Table 2-8. CSAT3 data and power cable terminal connections.

SmartFlux Terminal	SmartFlux Label	Wire Color
11	CTS	White/Brown
10	RTS	Brown
5	Signal Return	White/Orange and White/Green
4	RS-232 RX	Green
3	RS-232 TX	Orange
2	Power Out (-)	Black
1	Power Out (+)	Red



Campbell Scientific CSAT3B

See *CSAT3B and CSAT3* on page A-3 for details on the USB connection.

Data Cable: 7900-464-x; Power Cable: 7900-462-x

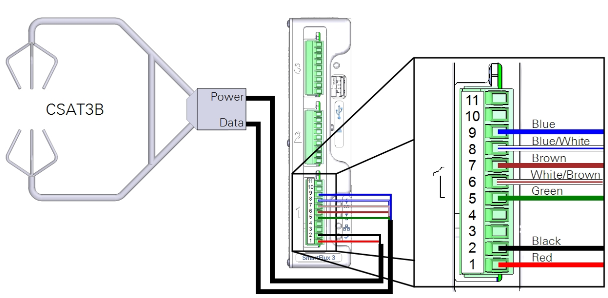
You can use a Campbell Scientific, Inc. CSAT3B sonic anemometer with the data cable (part number 7900-464-x) and power cable (part number 7900-462-x). The CSAT3B anemometer must be configured before it will work with the SmartFlux System. Using the Campbell Scientific **Device Configuration Utility**, apply the following settings.

Parameter Name	Correct Setting
Communication Protocol	RS-485 Enabled
RS-485 Baud Rate	115200
Unprompted Output Port	RS-485 Port
Unprompted Output Rate	50 Hz
Operating Mode	Unprompted Output - No Filters

The cable connects to one of the digital I/O ports on the SmartFlux System (port 1 recommended).

Table 2-9. CSAT3B data and power cable pin assignments and colors.

SmartFlux Terminal	SmartFlux Label	Wire Color
9	RS-422/485 RX-	Blue
8	RS-422/485 RX+	Blue/White
7	RS-422/485 TX-	Brown
6	RS-422/485 TX+	White/Brown
5	Signal Return	Green
2	Power Out (-)	Black
1	Power Out (+)	Red

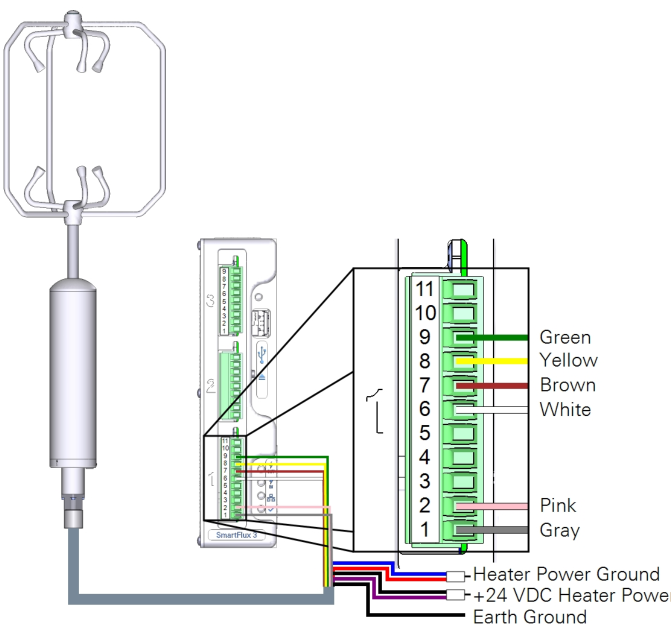


Metek Cage or Class-A

Cage Cable: 7900-482-x; Class-A Cable: 7900-492-x

A combined power and data cable is available for the Metek Multi-Path Class A and Cage sonic anemometers. We show the cage anemometer in this example. The Class-A is connected similarly. The anemometer will be configured automatically when it is connected to the SmartFlux System and selected in software. The cable connects to one of the digital I/O ports on the SmartFlux System (port 1 recommended). The wind-sensing components can be powered through the SmartFlux System, but the heater will need to be powered from the system because the heaters draw too much current.

SmartFlux Terminal	SmartFlux Label	Wire color
9	RS-422/485 RX-	Green
8	RS-422/485 RX+	Yellow
7	RS-422/485 TX-	Brown
6	RS-422/485 TX+	White
2	Power Out (-)	Pink
1	Power Out (+)	Gray



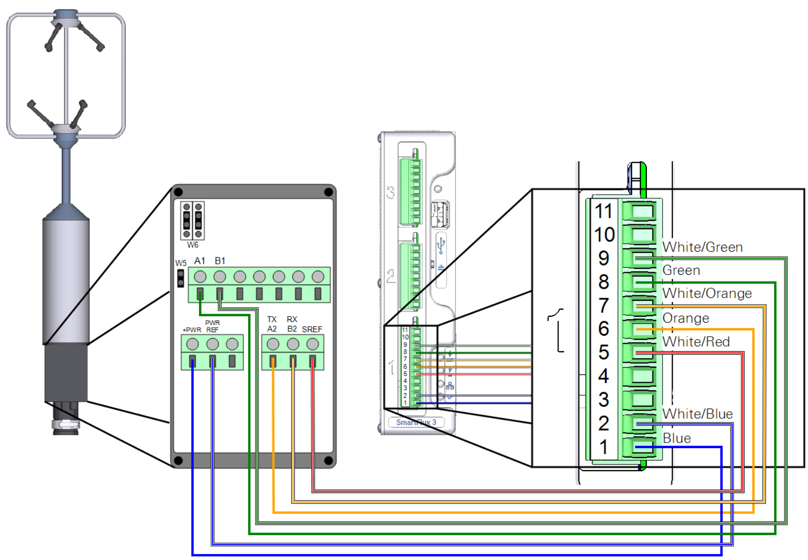
RM Young 81000x

Part Number:
7900-472-x

A combined power and data cable is available for the RM Young 81000 series sonic anemometers. The anemometer will be configured automatically when it is connected to the SmartFlux System and selected in software. The cable connects to one of the digital I/O ports on the SmartFlux System (port 1 recommended).

Table 2-10. RM Young data and power cable wire colors and pin assignments.

SmartFlux Terminal	SmartFlux Label	RM Young Label	Wire Color
9	RS-422/485 RX-	B1	White/Green
8	RS-422/485 RX+	A1	Green
7	RS-422/485 TX-	B2 (RX)	White/Orange
6	RS-422/485 TX+	A2 (TX)	Orange
5	Signal Return	SREF	White/Red
2	Power Out (-)	+PWR	White/Blue
1	Power Out (+)	PWR REF	Blue



There are three shorting block jumpers in the anemometer that must be in the correct position. Two jumpers connect each pair of middle pins at W6. One jumper connects the two pins at W5.

Section 3.
Initial configuration

The LI-7500RS Windows software is used to configure the instrument. Go to licor.com/7500rs-software for the latest version and install it on your computer. Download embedded firmware and interface software for all components in your system. We recommend using the latest software for the best performance.

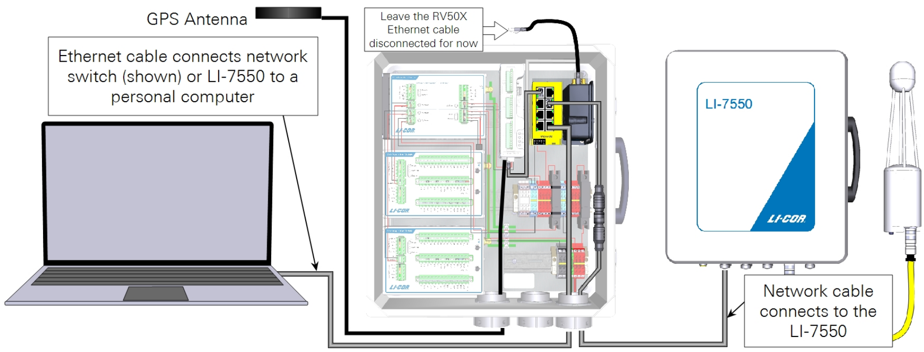
1 Power on the system

With all of the wire leads and data cables connected as described in *Initial assembly* on page 2-1, you are ready to power on the system. Provide power (12 or 24 VDC; 4 to 5 amps) to the system enclosure terminals, then turn the breakers to the **ON** position. Allow several minutes for the instruments to start up then check the LEDs:

- LI-7550 (inside): **Power** and **Ready** LEDs solid when ready.
- SmartFlux System: **Power IN** LED solid; **Status** LED slow blink when ready.

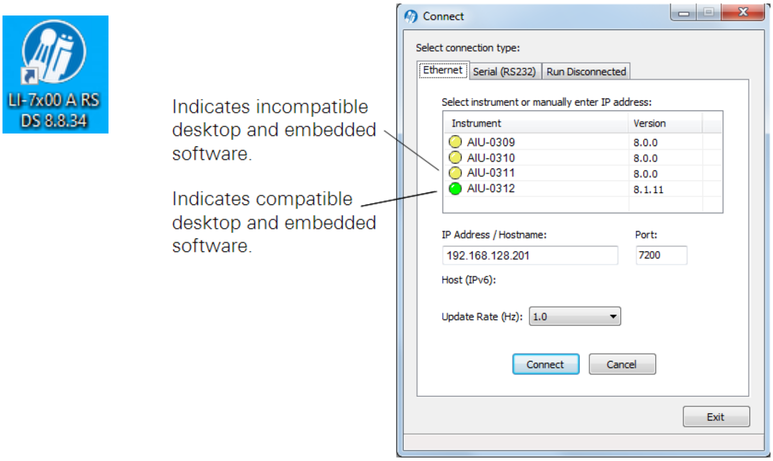
2 Install an Ethernet cable between the system and a computer

A standard Ethernet cable (616-06116) can be connected between a computer and the network switch or a vacant port inside the LI-7550.



3 Connect with the gas analyzer

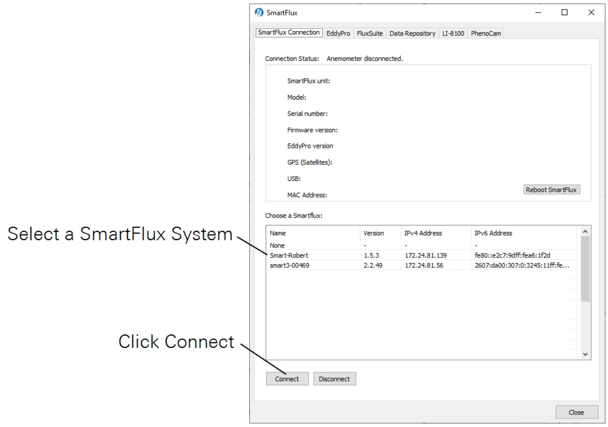
Launch the application (called **LI-7x00 A RS DS 8.x**). Instruments will be listed by LI-7550 serial number (AIU-XXXX). Select one from the list and click **Connect.**



- If there is a yellow dot beside the instrument ( ), update the firmware as described in *Software updates* on page 9-7.
- If you are connecting the instrument to an RV50X cellular gateway, set the IP address as described in the RV50X instruction manual from LI-COR.

4 Connect with the SmartFlux 2 System

Click the **SmartFlux** button. Select the SmartFlux 2 System and click **Connect.**



5 Configure the gas analyzer

Proceed through the steps in *Configuring gas analyzer settings* on the next page.

6 Connect with accessory components

If you are using an LI-7700, a Biomet Data Acquisition System, PhenoCam, LI-8100A, FluxSuite, or an RV50X cellular communication system, additional settings must be configured. See *Additional eddy covariance options* on page 3-6.

7 Configure the eddy covariance system

Some of the required information is determined by the site characteristics and instrument arrangement (see *Collect data on the setup* on page 4-9). The remaining steps for a basic eddy covariance system are taken in the gas analyzer PC software (see *Configuring the eddy covariance system* on page 5-1).

> **Important:** Some settings are required for the SmartFlux System to proceed with calculations. ***If you do not enter this information or enter it incorrectly, the EddyPro on the SmartFlux System will not calculate fluxes or will compute incorrect results.*** Required fields are marked as ***mandatory***.

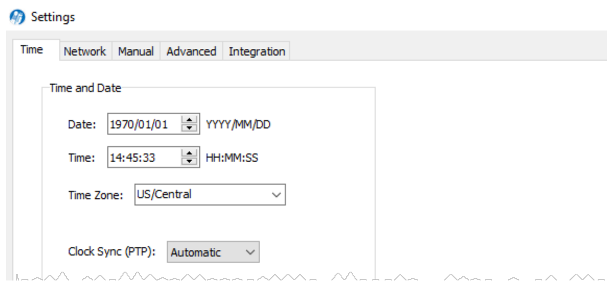
The SmartFlux System uses EddyPro express settings by default. If you want to use advanced processing, additional steps must be taken to configure the system. See *EddyPro processing on the SmartFlux System* on page 7-1 for more information about Express and Advanced modes.

Configuring gas analyzer settings

These settings are related to the system clock, the operating temperature range, and the instrument bandwidth.

Setting the system clock

Under **Settings > Time**, two settings must be configured: Time Zone and Clock Sync (PTP).



- **Time Zone**: Select the time zone to use for the site. If the location observes daylight savings time, choose an offset from Etc/GMT to avoid overwriting or creating duplicate files during a switch between standard time and daylight savings time.

Important: Etc/GMT offset is the number of hours added to or subtracted from the local standard (non-daylight savings) time in order to equal GMT. For example, Lincoln Nebraska is in Central Standard Time, 6 hours behind GMT (when daylight savings is not in effect), so you would choose **Etc/GMT+6** from the list. This is different from the usual GMT offset convention which would use -6.

- **Clock sync (PTP):** Set to **Automatic.** The time and location will be updated when data are received from GPS satellites. When using PTP, the **Date** and **Time** are set automatically and offset by the time zone setting.

> **Important:** The **Clock sync (PTP)** setting must be set to **Automatic** or **On.** Time synchronization of the LI-7550, LI-7500DS, SmartFlux System, and LI-7700 are based on the PTP protocol. If PTP is off, the recorded data will be prone to synchronization problems.

If a GPS antenna is connected to SmartFlux System, the system time will be synchronized with GPS satellite clocks (**Clock Sync (PTP)** must be set to **Automatic**). This prevents time drift for the site clock and maintains time synchronization between sites.

When configuring the system in a building, GPS satellite signals may not be detected, causing a delay in the setting taking effect. When no or few satellites are visible, time-keeping for the eddy covariance system will normally revert to the gas analyzer clock.

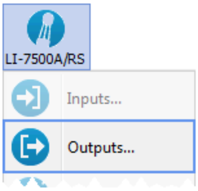
Setting the operating temperature range

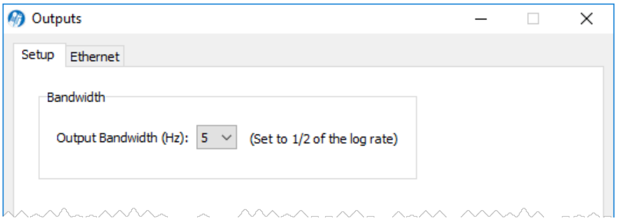
Under **Settings > Advanced**, check the chopper housing temperature setting. Use the **5 °C (winter)** setting when the average ambient temperature is below 5 °C. This will reduce power consumption and minimize heating by the electronics. Use the **30 °C (summer)** setting when the average ambient temperature is above 5 °C. The instrument will still function properly when the chopper motor housing temperature is set to 30 °C, even at temperatures below 5 °C. Do not set the chopper housing temperature to 5 °C when the average ambient temperature is above 5 °C.

> **Important:** If you change the **Chopper Housing Temperature** setting, be sure to check the zero and span.

Setting the bandwidth

Under **LI-7500A/RS > Outputs**, set the **Bandwidth** to 1/2 of the log rate. For example, when logging 10 samples per second, the bandwidth should be set to 5 Hz.



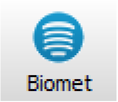


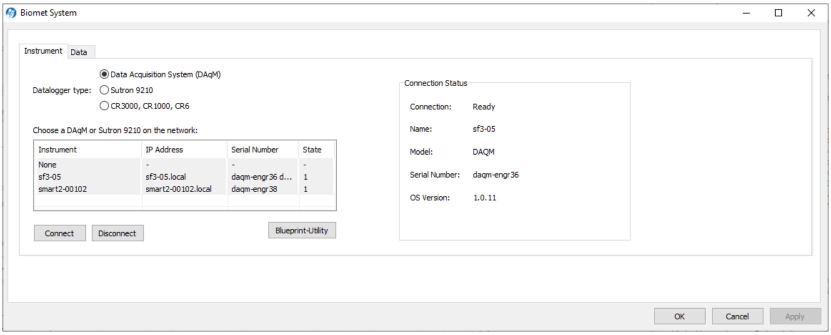
Additional eddy covariance options

This section describes how to configure additional settings to connect a LI-COR Biomet Data Acquisition System, LI-7700 Open Path CH_4 Analyzer, FluxSuite Software, Biomet System (Sutron Datalogger), data repository, LI-8100A, and PhenoCam.

Connecting a LI-COR Biomet Data Acquisition System

A LI-COR Biomet Data Acquisition System, Biomet system (Sutron 9210 datalogger), or properly configured Campbell Scientific® CR3000, CR1000, or CR6 datalogger can be connected to the SmartFlux 2 or 3 System to collect biomet data with the eddy covariance dataset. Biomet data are summarized by EddyPro on the SmartFlux System and can be used in the flux calculations.





Select **Data Acquisition System (DAqM)** to display the LI-COR Biomet Data Acquisition Systems that have been configured for the shared SmartFlux 2 or 3 System. Select the Data Acquisition System and click **Connect**.

> **Note:** The LI-COR Biomet Data Acquisition System must be configured through the Blueprint Utility (software) before it will be listed here.

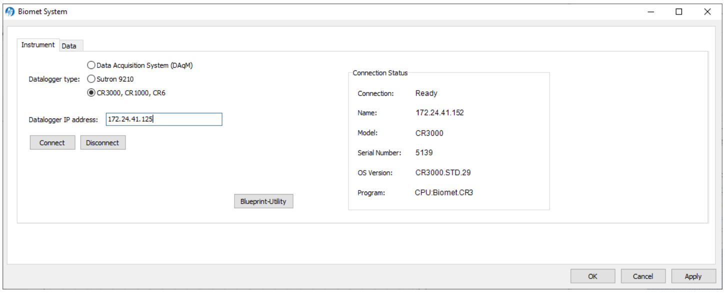
Connecting a Sutron 9210 or Campbell CR3000, CR1000, or CR6

Sutron 9210

Select **Sutron 9210** to displays a list of Sutron 9210 Dataloggers available on the network (same subnet mask as computer). Select a Sutron 9210 from the list or enter an IP address in the **Datalogger IP Address** field (networked device on different subnet mask as computer) and click **Connect.**

CR3000, CR1000, or CR6

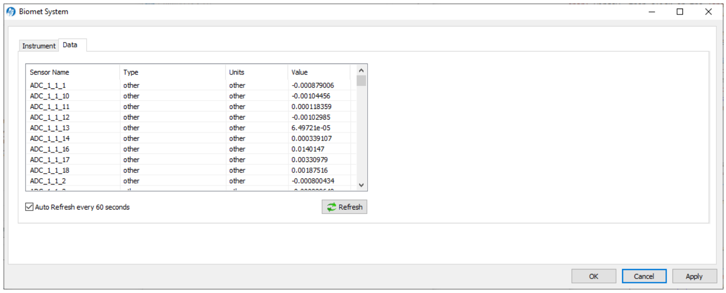
Select **CR3000, CR1000, CR6**, enter the IP address in the **Datalogger IP Address** field and click **Connect.** The datalogger IP address is a user-assigned static IP address that is also set in the datalogger software. When you start logging data, data values from the Campbell Scientific datalogger will be logged and summarized in the SmartFlux System output. See the *Campbell Scientific Dataloggers Installation Guide* for instructions on programing the CR3000, CR1000, or CR6 datalogger for the SmartFlux System.



Biomet system connection status and data

Connection information and recent data are displayed in the window.

- **Connection Status**: The right side of the **Instrument** screen displays the datalogger connection status, IP address, model name, serial number, operating system version, and program name.
- **Data**: After connecting, click the **Data** tab to display a list of biomet sensors configured for use with the selected datalogger (under **Sensor Name**). The list displays the Sensor Properties (Type, Units, and Value) for the selected sensor. Note that the **Sensors** and **Sensor Properties** are configured through the datalogger software; this list is for reference only.

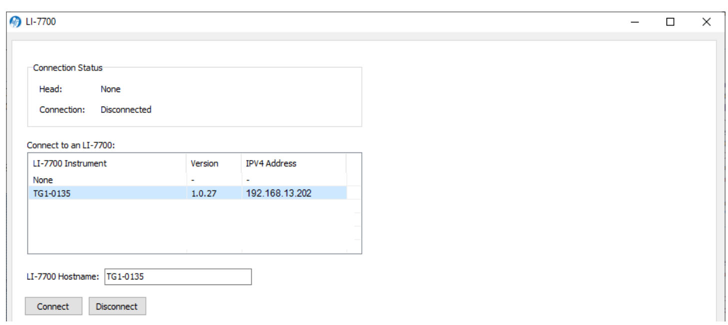


Note: Enable the **Sync clock** setting under **Site Setup > Biomet** to synchronize the datalogger and gas analyzer clocks. When checked, the biomet system clock will be adjusted to match the LI-7250 clock every 30 minutes.

Refer to the Data Acquisition System or Biomet Station Instruction Manual for more information.

Connecting an LI-7700

To connect with an LI-7700 Open Path CH_4 Analyzer, install an Ethernet cable between the LI-7700 and the network switch. Click the **LI-7700** button, or under **Site Setup > LI-7700** , click settings ( ) to open the connection window.



Select the LI-7700 from the list or enter an IP address in the **LI-7700 Hostname** field (for networked device on different subnet mask as computer) and click **Connect**. Click **Apply** or **OK**.

Important: To synchronize the clocks of the LI-7550 and the LI-7700, be sure to configure the PTP time setting in the LI-7700 to **Slave** or **Automatic**.

Connecting to FluxSuite

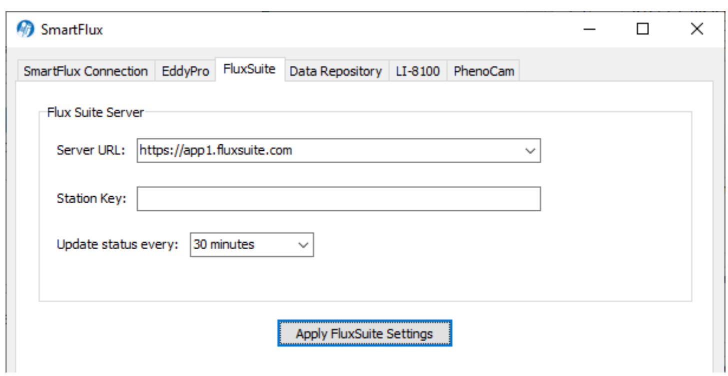
Any internet-connected LI-COR eddy covariance system that is running the SmartFlux 2 or 3 System can be connected to the FluxSuite Software. FluxSuite provides online results computed by your system in real time, daily email alerts based on thresholds you set, and the ability to assign collaborators to each site. To configure FluxSuite:

1. Register for an account.

   Go to www.fluxsuite.com to register for a free trial.

2. Log into your account and create a station key.
   - **A** Log into your account.
   - **B** Go to the **Stations** view and click **Add Entry**.
   - **C** Enter a station name and the additional information about the station, then click **Save**.
   - **D** Click the **Information** button for the station you added, then click **Generate Station Key**.

3. Enter the server information and station key into your gas analyzer.



   - **A** In the gas analyzer software, click the SmartFlux button.
   - **B** Click the tab called FluxSuite.
   - **C** Enter the server (www.app1.fluxsuite.com) and station key.

4. Check the results online.

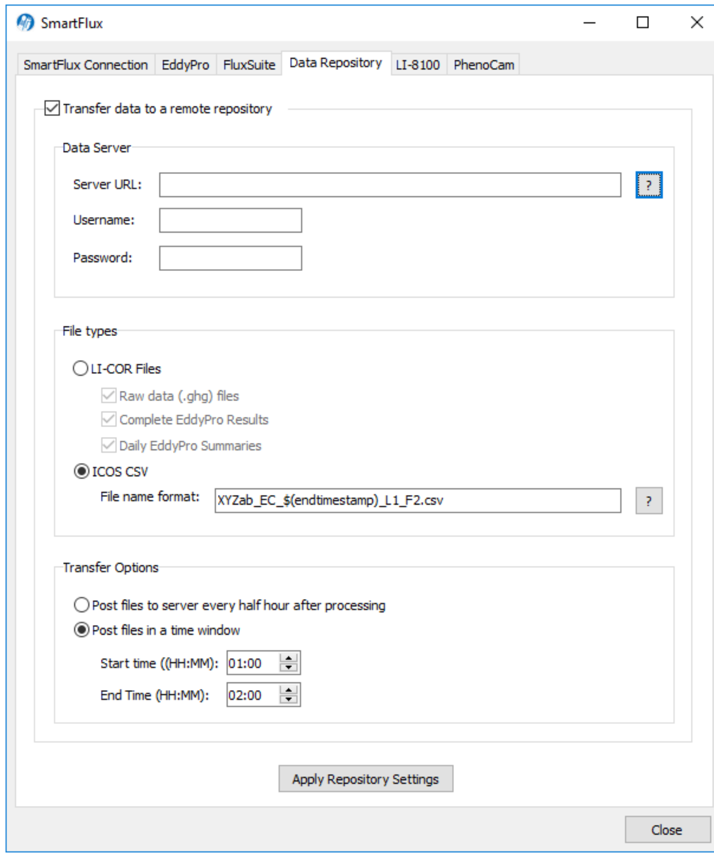
   Your system will update the flux results online every 30 minutes.

5. Configure your notification settings.

   You can adjust alert thresholds for each variable.

Connecting to a data repository

The **Data Repository** tab is where you configure the eddy covariance system to push data to a server. You can push raw data (lots of data), complete EddyPro results (a moderate amount of data), or daily summary files (a small amount of data).



The options available include:

Transfer data to a remote repository: Check this box to enable transfer.

Data Server: Here you enter the Server URL and login credentials. In the **Server URL**: field, you have some options that enable you to specify which data should be transferred.

Suitable URLs:

- https://server-address
- sftp://server-address/path/$(filename)
- ftp://server-address/path/$(filename)

In the examples above, the server-address is the URL of the server where SmartFlux will transfer data. Depending on how the server is set up, the path may or may not be needed.

SmartFlux expects the server to ask for a username and password, so they are mandatory fields.

Depending on the server implementation, you may want to add other information onto the path of the URL. When any of the items below are added to the URL, SmartFlux will replace the **$(variable)** with the corresponding value. For example, **$(hostname)** is replaced with the hostname of the SmartFlux.

Information	Description
$(checksum)	MD5 sum of the file being uploaded
$(filename)	The name of the file being uploaded
$(fullname)	The name of the file including the path
$(hostname)	SmartFlux hostname
$(timestamp)	Data collection start time
$(endtimestamp)	Data collection end time

Some examples follow:

- sftp://192.168.100.100/$(filename)
- sftp://192.168.100.100/home/station/$(filename)
- https://some_url.com/upload/etc/$(md5)/$(filename)

File Types: The types of files that are sent to the server can be a combination of the raw data file (.ghg), the full EddyPro output package for each processing period, or a file that contains the daily EddyPro output summaries.

Alternately, if you wish to submit files in the format specified by the ICOS network, choose the ICOS CSV option.

The file name for the ICOS CSV file needs to be specified in the following format:

```
#[SiteID]_EC_$(endtimestamp)_L#[logger_number]_F#[file_number].csv
```

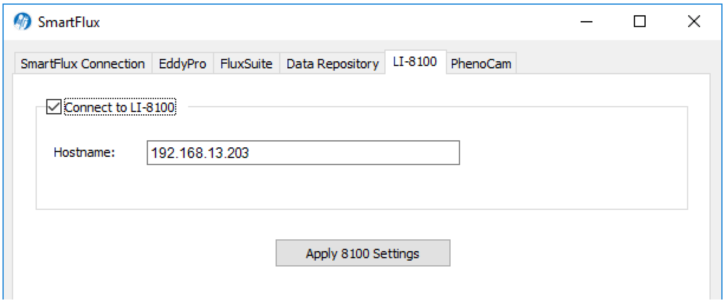
- The fields indicated by #[…] must be edited by the user
- The fields indicated by $(variable) are dynamically created by the software
- The text in bold typface must not be modified

For example, for Site ID XYZab, Logger Number 1 and File Number 2, the file name template must be:

```
XYZab_EC_$(endtimestamp)_L1_F2.csv
```

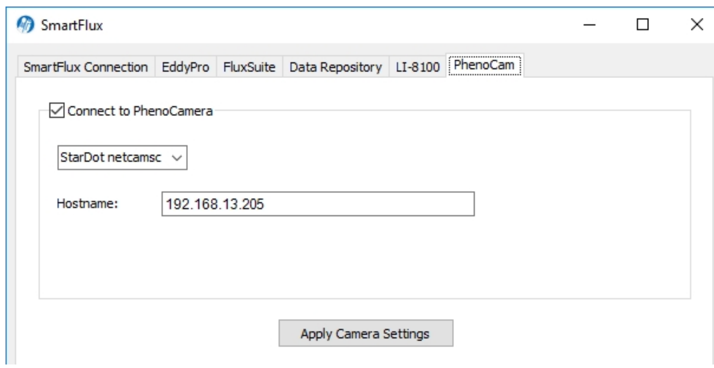
Connecting an LI-8100A system

To connect an LI-8100A to FluxSuite, enter the LI-8100A IP address in the field labeled **Hostname**. Click **Apply 8100 Settings** after entering the **Hostname**.



Connecting a PhenoCam camera

Under the PhenoCam tab, you can connect to a StarDot PhenoCam available from LI-COR or a CC5MPX digital camera available from Campbell® Scientific, Inc. When connected, the images will be posted to FluxSuite (assuming you have registered and configured everything else). To connect with the camera, check the box, then select a camera model. For the StarDot PhenoCam, enter the camera IP address in the field labeled **Hostname**. For the CC5MPX, enter the Hostname and the MAC Address that is printed on the camera's exterior label. Click **Apply Camera Settings** to connect the camera to the system.



Configuring the system for cellular communication with the RV50X

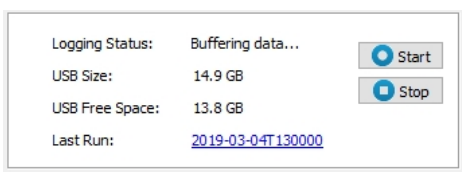
If you are using a cellular communication system (Sierra Wireless AirLink RV50X), refer to the LI-COR cellular communication instruction manual for full details. Here, we show how to set the gas analyzer IP address, as required for the cellular communication. We recommend the following IP addresses with the RV50X .

Table 3-1. Suggested IP addresses for instruments in an eddy covariance system.

Device	Suggested IP Address
SmartFlux 2 System[1]	192.168.13.200
LI-7550 / SmartFlux 3 System	192.168.13.201
LI-7700	192.168.13.202
LI-8100A	192.168.13.203
Biomet System (Sutron Datalogger)	192.168.13.204
PhenoCam	192.168.13.205

1 Stop data logging.

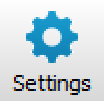
Click the **Stop** button on the software dashboard.

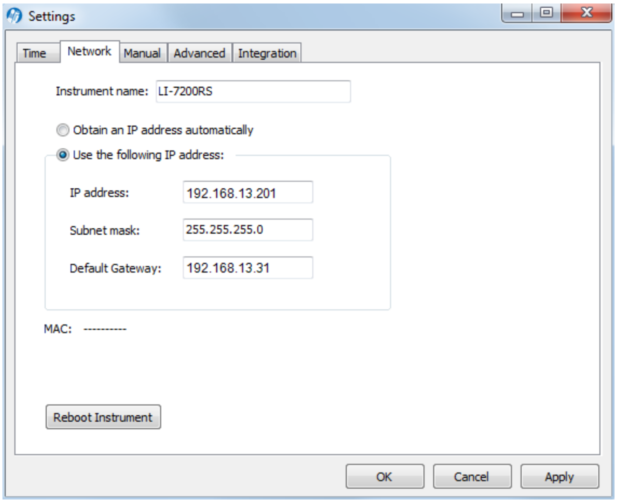


2 Configure the LI-7500A/RS/DS or LI-7200/RS for a Static IP Address: Click **Settings > Network** and enter the **IP Address**, **Subnet Mask**, and **Default Gateway**.

- **IP Address:** 192.168.13.201, as specified the LI-COR cellular communication instruction manual.
- **Subnet Mask:** Typically 255.255.255.0
- **Default Gateway:** Set this to the local IP address of the RV50X (192.168.13.31).

[1] Required only to enable the NTP (network time protocol) and two-way communication with a Biomet Data Acquisition System connected to the SmartFlux 2 System.





3 **Reboot** the instrument after changing the network settings.

Proceed to configure the RV50X as described in the included documentation.

Section 4.
Field installation

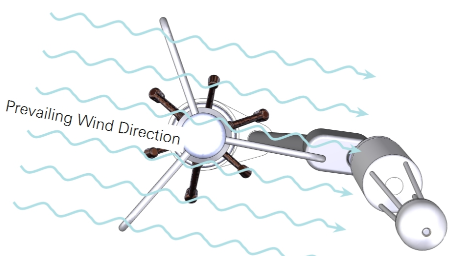
This section describes how to install the instrument and its associated components on a tower or tripod in a typical eddy covariance application.

Mounting the gas analyzer and sonic anemometer

The sensor head should be mounted to a tripod or tower using the mounting kit (part number 7900-340) or a ¾ inch swivel mount. The head should be tilted at a 10 to 15° angle to ensure water does not pool on the lower lens.

Site considerations

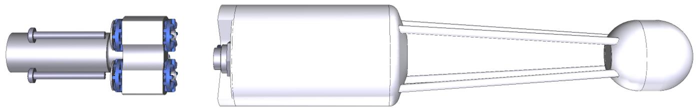
Plan your site with respect to the geographical area that is contributing to fluxes. Position the system downwind from that area. For mast-style anemometers, position the gas analyzer adjacent to a spar on the downwind side of the anemometer.



The sensor head can be positioned 10 to 20 cm from the anemometer in the horizontal direction. If mounted close to the canopy, the center of the analyzer and sonic anemometer should be at equal heights (within 20 cm). If mounted over 15 m up on a tall tower, horizontal and vertical sensor separation can be as large as 30 to 50 cm.

Installing the head mounting post

Begin by attaching the head mounting post to the analyzer head.



Mounting with mast-style anemometers

The head can be installed with mounting kit (part number 7900-340), which includes a cross-over fitting, riser bar, and swivel mount. The head should be tilted at a 10 to 15° angle to prevent water from pooling on the optics. Alternatively, it can be mounted with the combination mount (part number 7900-320) when using the WindMaster/Pro sonic anemometer.

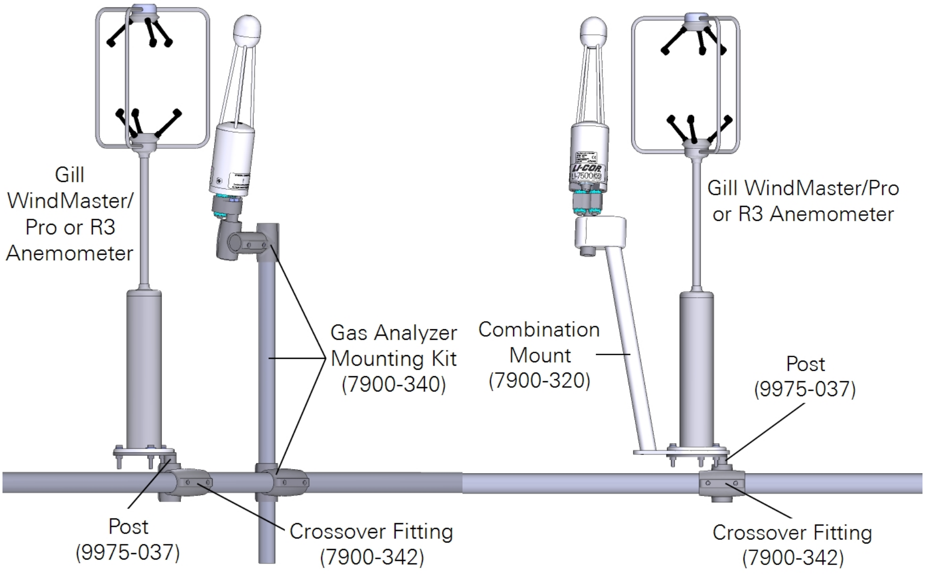


Figure 4-1. Mounting position for WindMaster/Pro anemometers using the the gas analyzer mounting kit (left) and the combination mount (right).

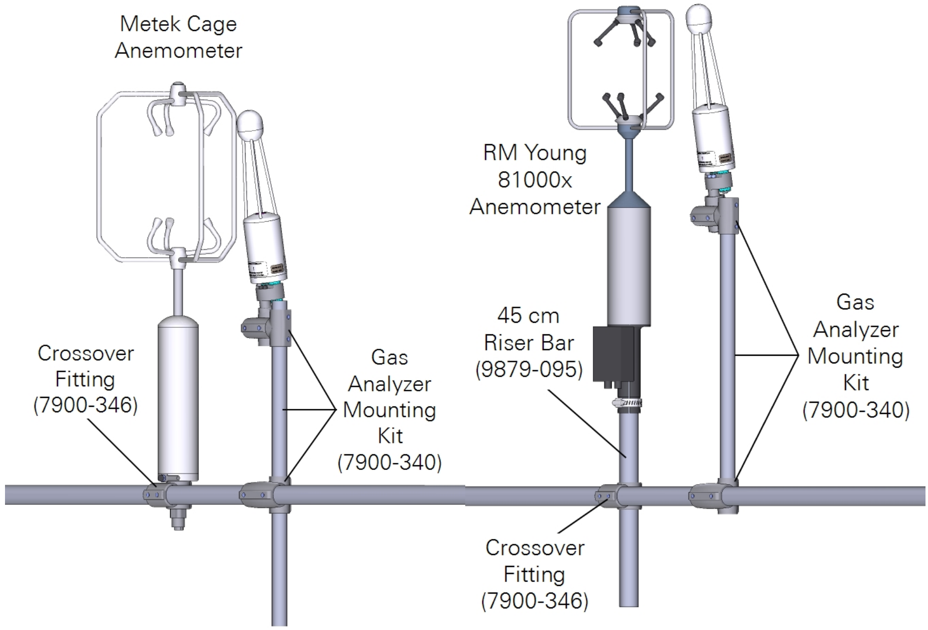


Figure 4-2. Mounting position with Metek Cage (left) and RM Young 81000, 81000V, 81000RE, and 81000VRE anemometers (right).

Mounting with c-clamp style anemometers

The head can be installed with mounting kit (part number 7900-340), which includes a cross-over fitting, riser bar, and swivel mount. The head should be tilted at a 10 to 15° angle to prevent water from pooling on the optics.

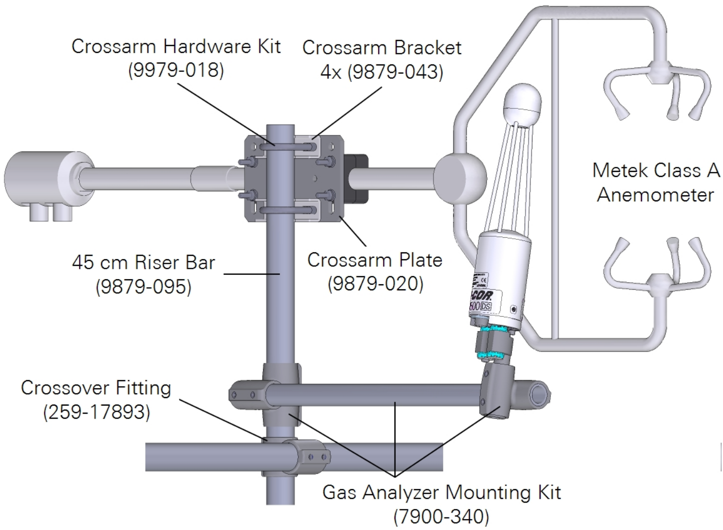


Figure 4-3. Metek MultiPath Class A mounting kit (7900-336) with the gas analyzer mounting kit (7900-340).

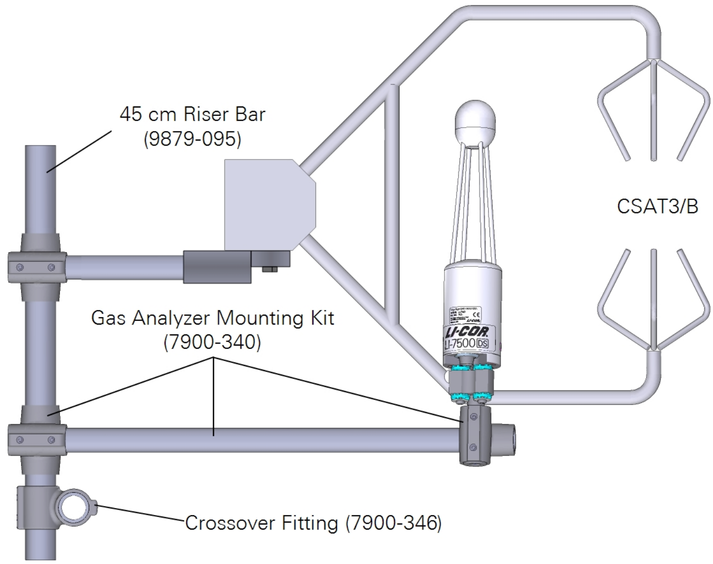


Figure 4-4. CSAT3/CSAT3B mounting configuration with the gas analyzer mounting kit (7900-340)

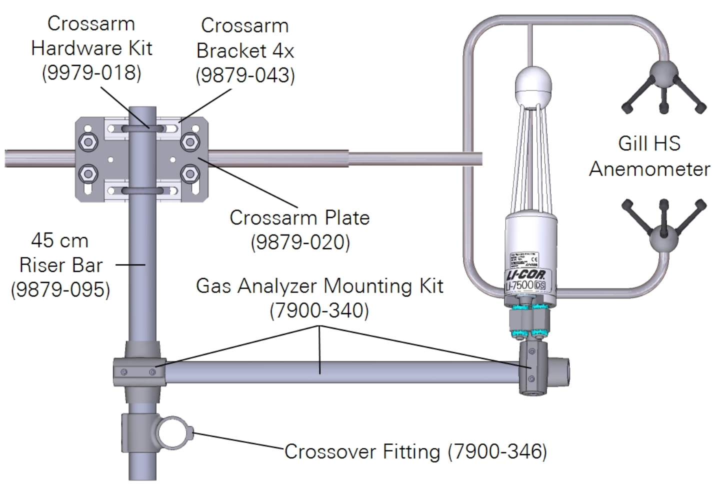


Figure 4-5. Gill HS mounting configuration with the gas analyzer mounting kit (7900-340).

Mounting the LI-7550

A mounting kit (part number 9979-022) are provided to mount the LI-7550 to a tripod or other post. You can also attach the box directly to a flat surface. The LI-7550 will operate according to specifications in direct sun. Determine the height at which the sensor head will be mounted, and plan to mount the Analyzer Interface Unit accordingly. The head cable is 5 meters long. An extension cable can extend the total cable length to a maximum of 10 meters.

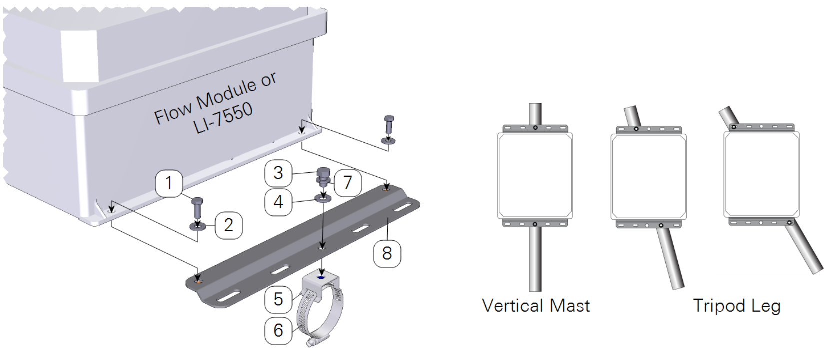


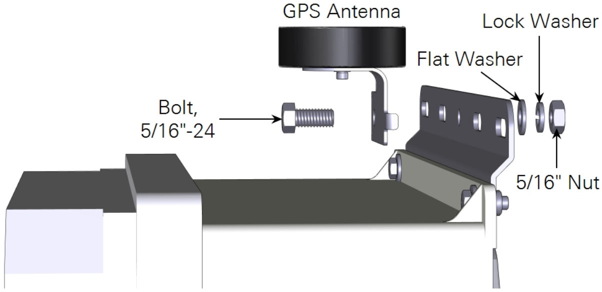
Figure 4-6. Attach mounting plates and band clamps to the LI-7550 and attach it to a mast or tripod leg.

Table 4-1. Mounting kit parts.

Item	Qty.	Part Number	Description
1	4	150-12943	Hex Head Bolt M6x1 × 16 MM
2	4	167-02054	Flat Washer 1/4 x 5/8"
3	2	included w/ item #4	Hex Head Bolt 5/16-24 × 1/2"
4	2	included w/ item #4	Flat Washer 5/16"
5	2	235-13234	Flared-Leg Mounting Bracket
6	2	300-13293	Band Clamp 9/16"
7	2	167-05635	Split Washer 5/16"
8	2	9879-045	Mounting Plate

Mounting the GPS antenna

Attach the GPS antenna to the mounting plate at the top of an enclosure with the included hex head bolt.

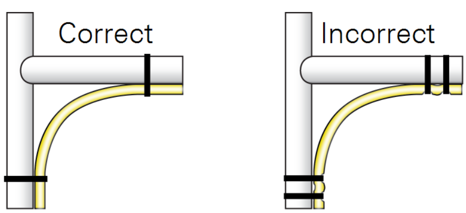


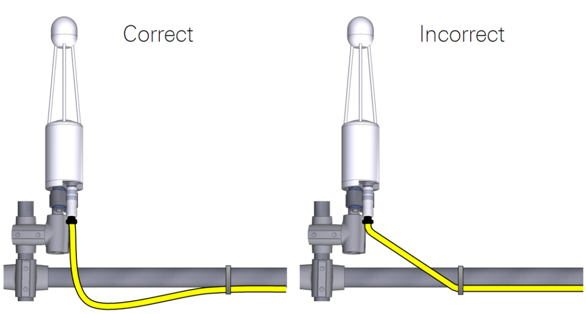
> **Important:** Do not install the antenna inside of an enclosure. The GPS antenna will not receive satellite signals and the system will be unable to set the clock if it is installed in this manner. For best results, but sure that the antenna has a clear, unobstructed view of the sky.

Securing the sensor head cable

It is important that the head cable be connected properly to the sensor head. Follow these guidelines:

- There is a gasket in the head cable connector that should be compressed when the cable is connected. When tightening the connector, wiggle and push the connecter while tightening to compress the gasket.
- Provide a loose bend radius to allow the cable to absorb the energy of the bending over a greater portion of its length. Use a minimum bend radius of 5 times the cable diameter. For the head cable, this is a 1.75” (4.5 cm) minimum bend radius (or 3.5” (9 cm) minimum loop width).
- When tying cables with cable ties, leave the ties loose enough for the cables to slide freely under the tie. Never overtighten the tie to the point where the cable jacket becomes pinched.





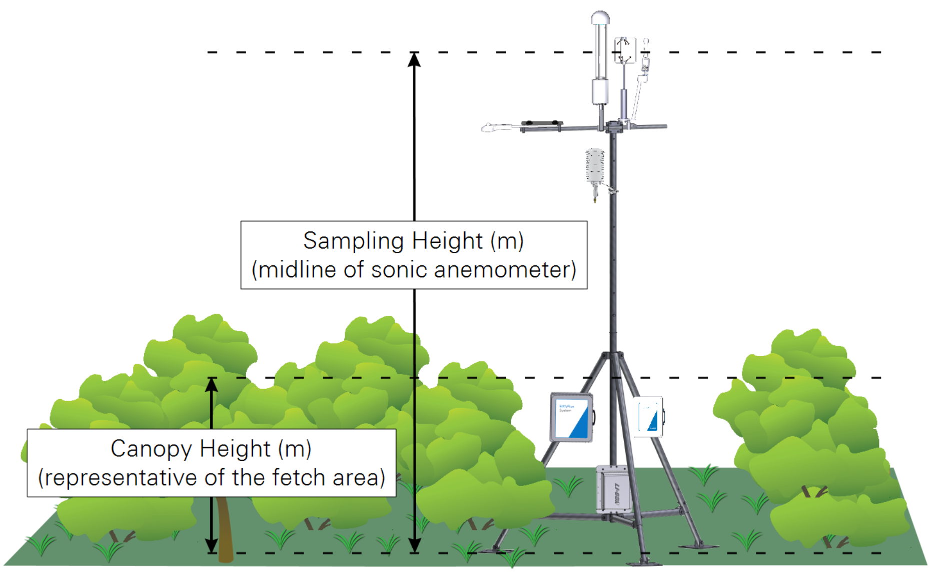
Collect data on the setup

The final step of the site setup is to measure a number of parameters at the site. Each of the following should be recorded for later entry into the software. These values are used in flux calculations.

Site information

Measure both the canopy height and sampling height.

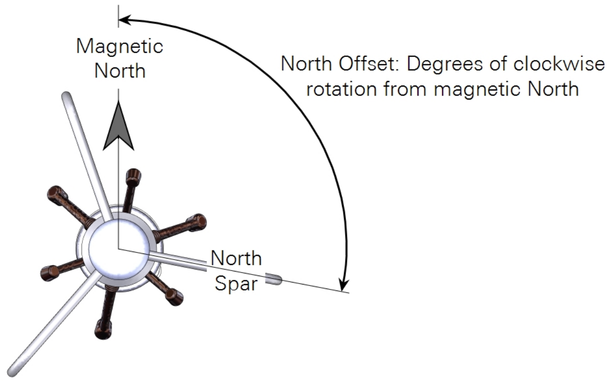
- **Canopy Height (m)**: The distance between the ground and the top of the canopy. Since canopy height can vary from place to place, select a height that is representative of the canopy. If the canopy height changes during the sampling period, you may need update the height as the canopy grows.
- **Sampling Height (m)**: The distance between the ground and the anemometer sample volume.



Sonic anemometer north offset

Determine the north offset of the anemometer.

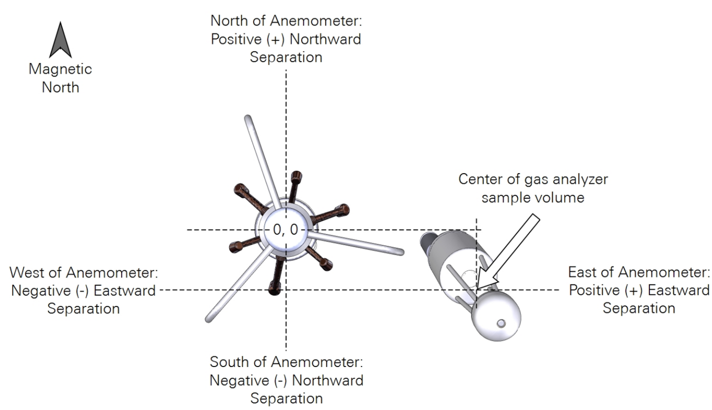
- **North Offset**: Degrees of clock-wise rotation of the North Spar or Transducer Axis 1 from magnetic north.



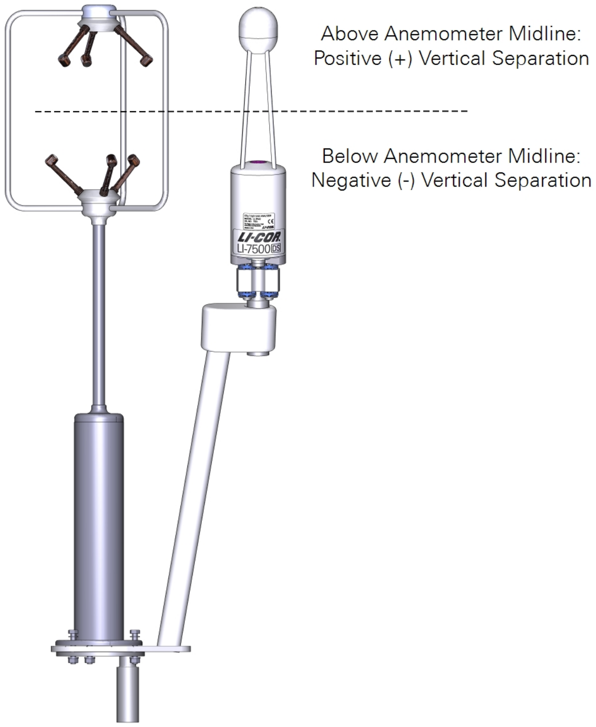
Gas analyzer position

Measure the north, east, and vertical offsets.

- **Northward Separation (cm)**: North (positive) or south (negative) distance between the anemometer and gas analyzer sample volumes.
- **Eastward Separation (cm)**: East (positive) or west (negative) distance between the anemometer and gas analyzer sample volumes.



- **Vertical Separation (cm)**: Distance between the anemometer midline and the gas analyzer sample midline. Positive value if the inlet is above the anemometer midline; negative value if the inlet is below the anemometer midline.



Section 5.
Configuring the eddy covariance system

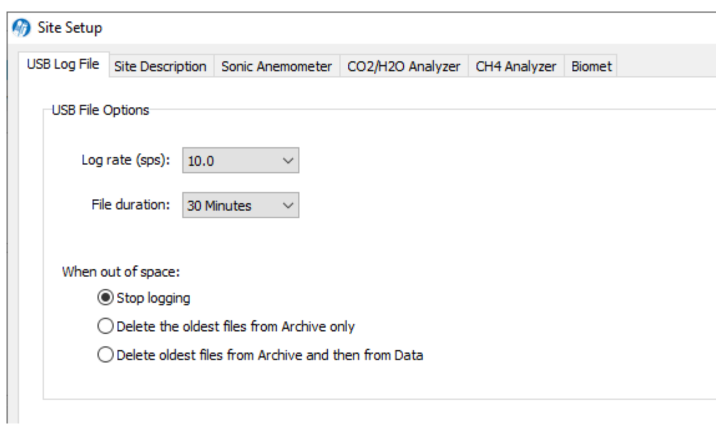
The following section describes how to configure the system. To connect to the instrument with a PC, see *Initial configuration* on page 3-1.

Configuring the site setup

Site setup includes a number of settings related to log files, site information, and instruments at the site.

Configuring the USB log file

Click **Site Setup > USB Log File** to configure datalogging.



- **Log Rate (sps; samples per second)**: 10.0, typically. Logging rates of 5, 10, or 20 sps may be acceptable in eddy covariance measurements, depending on site characteristics.

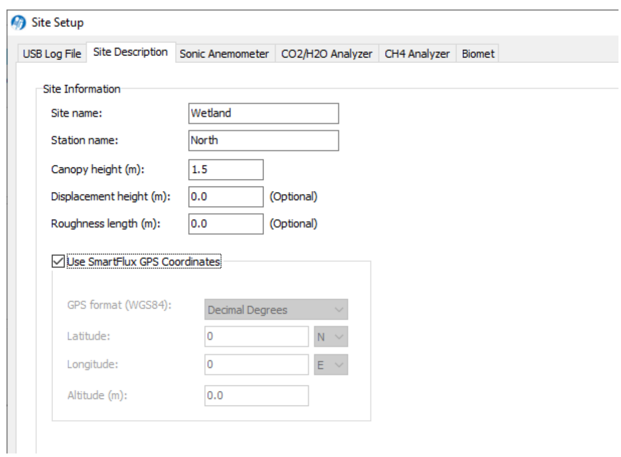
- **File Duration (*mandatory*)**: 30 Minutes. EddyPro requires 30 minute data files.
- **When out of space**: Select your preference for managing data when the USB drive becomes full.

> **Note:** Files are split based on the instrument clock. With a file duration of 30 minutes and logging starting at 10:22, the file will be split at 10:30, 11:00, etc.

All files are assigned a name using the timestamp with the format `YYYY-MM-DDTHHMMSS_InstrumentName.ext`, where date and time are year, month, day, and HHMMSS in 24-hour time (e.g., hour 15 is 3:00 p.m.). The file extension appended is either `.data`, `.metadata`, `.status`, or `.ghg`.

Entering the site description

Under **Site Description**, enter information about the site. This information is written in the metadata file that is used for flux processing.



- **Site name**: Name of the research site.
- **Station name**: Name of the flux stations within the site.
- **Canopy height *(mandatory)***: Site canopy height; meters.
- **Displacement height**: Also referred to as zero plane displacement height, the displacement height of a vegetated surface (*d*) is the height at which the wind speed would go to zero if the logarithmic wind profile was maintained from the outer flow all the way down to the surface (that is, in the absence of

vegetation). In other words, it is the distance over the ground at which a non-vegetated surface should be placed to provide a logarithmic wind field equal to the observed one. For forest canopies, the displacement height is estimated to vary between 0.6 and 0.8 times the height of the canopy. If not entered explicitly, EddyPro computes displacement height as $d = 0.67 \times$ canopy height.

- **Roughness length**: In the logarithmic wind profile, the roughness length is the height at which wind speed is zero (indicated by z_0). It provides an estimate of the average roughness elements of the surface. With vegetated surfaces, because the vegetation itself provides a certain roughness, the logarithmic wind profile goes to zero at a height equal to the displacement height plus the roughness length. If not entered explicitly, EddyPro computes roughness length as $z_0 = 0.15 \times$ canopy height.
- **Use SmartFlux GPS Coordinates (*mandatory*)**: Uses GPS location from the SmartFlux System for the station location. When selected, the remaining settings are configured automatically.

> **Note:** If you are testing the SmartFlux System in a building, the GPS signals may be too weak for the system to set the location. The system will get this information whenever it gets adequate GPS signals.

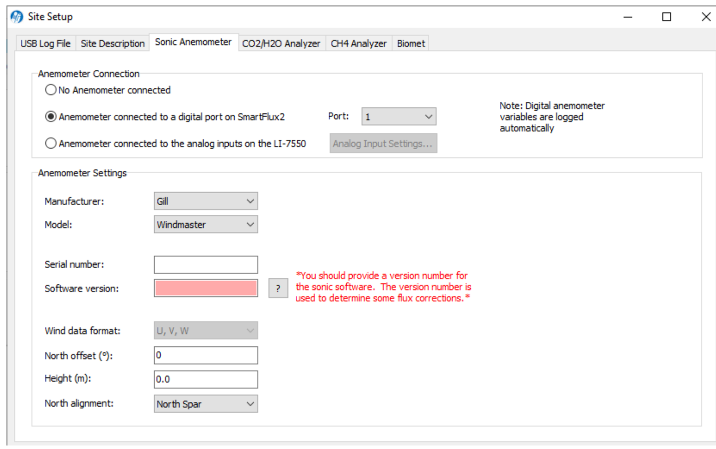
- **GPS format (WGS84)**: Latitude and longitude coordinates are automatically detected by the SmartFlux System or they can be entered manually.

Format	Description	Example
DDD MM SS.SSS	Degrees, minutes and seconds with North, South, East, or West suffix	12°20’44” N, 98°45’55” W
DDD MM.MMM	Degrees and decimal minutes with North, South, East, or West suffix	12°20.736’ N, 98°45.924’ W
Decimal Degrees	Decimal degrees with negative numbers for South and West	12. 3456, -98.7654

- **Latitude *(mandatory if "Use GPS Coordinates" is not selected)***: Site latitude.
- **Longitude (*mandatory if "Use GPS Coordinates" is not selected*)**: Site longitude.
- **Altitude *(mandatory if "Use GPS Coordinates" is not selected)***: Altitude (meters) at the base of the tower.

Entering anemometer information

Under **Sonic Anemometer**, enter information about the sonic anemometer, including the manufacturer, model, data output format, offset from true north, and height. Some of the available options (e.g., North Alignment) will change, depending on which model is selected.



Anemometer Connection

> **Important:** *It is mandatory to select one of the connection types. For the SmartFlux® 2 System, select* **Anemometer connected to digital port on the SmartFlux 2**.

- **No Anemometer connected**: Select this option if you want to operate the SmartFlux System without an anemometer.
- **Sonic connected to a digital port on SmartFlux 2:** Choose this option if the anemometer is connected to the SmartFlux 2 System.
- **Port (mandatory with SmartFlux 2 System)**: Choose the port to which the anemometer is connected (1 recommended).
- **Sonic connected to the analog inputs on the LI-7550:** Choose this option if the anemometer is connected to analog inputs on the LI-7550 Analyzer Interface Unit.

Anemometer Settings

- **Manufacturer**: Choose the sonic anemometer manufacturer and model in the menus. The gas analyzer supports the following sonic anemometer models with either digital or analog inputs:

Anemometers for use with SmartFlux 2	
Manufacturer	Model(s)
Campbell Scientific	CSAT3, CSAT3B
Gill Instruments	WindMaster/Pro, HS-50, HS-100, or R3-50
Metek	uSonic-3 Class-A MP, uSonic-3 Cage MP
RM Young	81000V, 8100RE, 8100VRE

Anemometers for use with LI-7550 Analog Inputs Only	
Manufacturer	Model(s)
Campbell Scientific	CSAT3
Gill Instruments	HS-50, HS-100, R2, R3-50, R3-100, WindMaster/Pro
Metek	uSonic-3 Class A (or USA-1 Standard) uSonic-3 Scientific (or USA-1 Fast)
R.M. Young	81000

- **Serial Number and Software Version**: These fields are important because they are used to determine some flux corrections. See the EddyPro® instruction manual or online help for more information.
- **Wind data format *(optional)***: From the three axis velocities, the wind speed is calculated, and output as either signed U, V, and W, as Polar and W, or as raw velocity values. The units of output are set during the anemometer configuration. Choose the wind data format from the menu:
  - U, V, W (some Gill anemometers): U is the direction aligned with the north spar. V is the direction 90° counter-clockwise from the N/Reference spar. W is vertical.
  - Polar, W - The wind speed in the UV plane, with direction in degrees clockwise from 0 to 359°, with respect to the Reference spar (normally aligned to North). **Note:** This option is not supported for Gill anemometers.
  - Axis velocities - Raw velocity values for U, V, W.

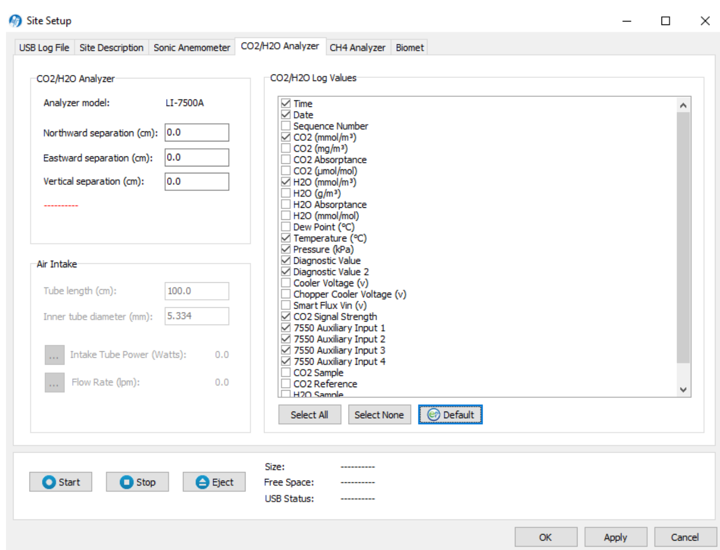
- **North offset (°)** ***(mandatory)***: Offset, in degrees (0-359°) from which the Reference spar/axis or orientation of the anemometer varies from geographic/magnetic north.

> **Important:** EddyPro requires the offset with respect to geographic north as two pieces of information: The offset with respect to geographic north and the magnetic declination. Currently the software does not provide an entry for magnetic declination. For the best results, enter the North Offset to magnetic North. This will create small differences in the wind direction between EddyPro and SmartFlux results (a constant offset equal to the magnetic declination), but the flux results will be the same, if all other settings are the same.

- **Height (m)** ***(mandatory)***: Sonic anemometer height above the ground, in meters, measured to center of the anemometer sample volume.

Entering CO_2/H_2O analyzer information

Under **CO2/H2O Analyzer**, enter the gas analyzer position relative to the sonic anemometer and select the values to log.



The distance between the gas analyzer and sonic anemometer is used to estimate the high-frequency flux losses. Distances are provided in a Cartesian coordinate system, which allows EddyPro to determine the distance from a gas analyzer and the anemometer.

> **Important:** At least one separation must be different from 0. Values are measured at the site and are relative to the sonic anemometer. Entering wrong values will result in incorrect flux calculations.
>
> - Measurements must be provided in the indicated units.
> - The anemometer is the center (0, 0) of the coordinate system.
> - For all gas analyzers, the distances from the reference anemometer are provided along the north-south east-west axes.

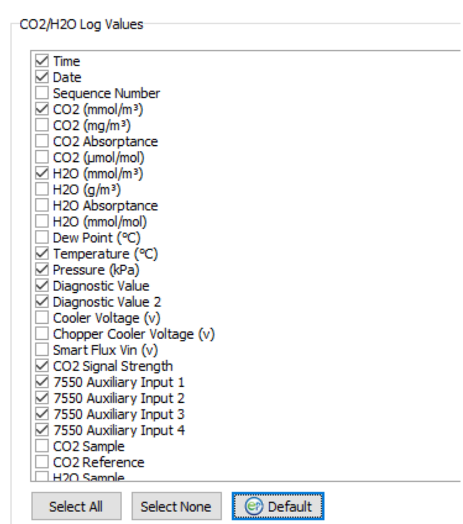
Separation values are specific to the site setup. See *Site information* on page 4-9.

- **Northward Separation (cm)** ***(mandatory)***: North or south distance between the LI-7500RS sample path and the anemometer.
- **Eastward Separation (cm)** ***(mandatory)***: East or west distance between the sample path and the anemometer.
- **Vertical Separation (cm)** ***(mandatory)***: Vertical distance between the sample path and the anemometer.

Selecting CO_2/H_2O log variables

Select variables to log under **CO2/H2O Log Values.**

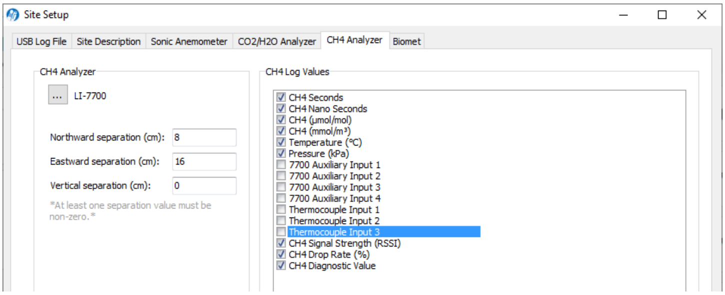
- Click **Select All** to record the full set of raw data, including absorptance values. This takes more storage space, but provides the most information on the instrument performance.
- Click **Default** select the minimum set of variables for flux computations. This is recommended if you need to maximize data storage space (e.g., you are unable to retrieve data from the site on a regular basis).



Click **OK** or **Apply** to implement the settings.

Entering CH_4 analyzer information (optional)

If the system is connected to an LI-7700 Open Path CH_4 Analyzer, under **Site Setup > CH4 Analyzer**, specify the separation between the sonic anemometer and the LI-7700 sample volume and select variables to log.



> **Important:** At least one separation must be different from 0. Values are measured at the site and are relative to the sonic anemometer. Entering wrong values will result in incorrect flux calculations.

- **Northward Separation (cm)** ***(mandatory)***: North/south distance between the LI-7700 Analyzer and the anemometer. Positive values if north and negative values if south of the anemometer.
- **Eastward Separation (cm)** ***(mandatory)***: East/west distance between the LI-7700 Analyzer and the anemometer. Positive values if east and negative values if west of the anemometer.
- **Vertical Separation (cm)** ***(mandatory)***: Vertical distance between the LI-7700 Analyzer and the anemometer. This value is negative if the center of the LI-7700 sample volume is below the center of the reference anemometer sample volume and positive if the gas sample is above.

Selecting CH_4 log variables (optional)

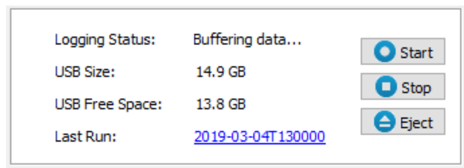
Under **Site Setup**, click the default button (Default) to select the recommended variables for processing. Or, click **Select All** to log all variables.

When you start logging data the selected variables for the LI-7700 will be logged with the dataset.

The LI-7700 data values to be logged to the USB drive are chosen under CH_4 Log Values. In addition, you can enable the **Log LI-7700 status records (.status)** check box to collect LI-7700 STATUS records. This is for diagnostic purposes.

Begin logging data

Start, **Stop**, and **Eject** buttons are on the main dashboard and on each tab under the **Site Setup** menu.



Click **Start** to begin logging data. Data logging will begin automatically when a suitable USB drive is inserted into the SmartFlux System and any time the instrument restarts. Click **Stop** to quit logging.

Always eject the USB drive before removing it. After pressing the **Eject** button, the LED inside the SmartFlux System will turn off when it is safe to remove the drive.

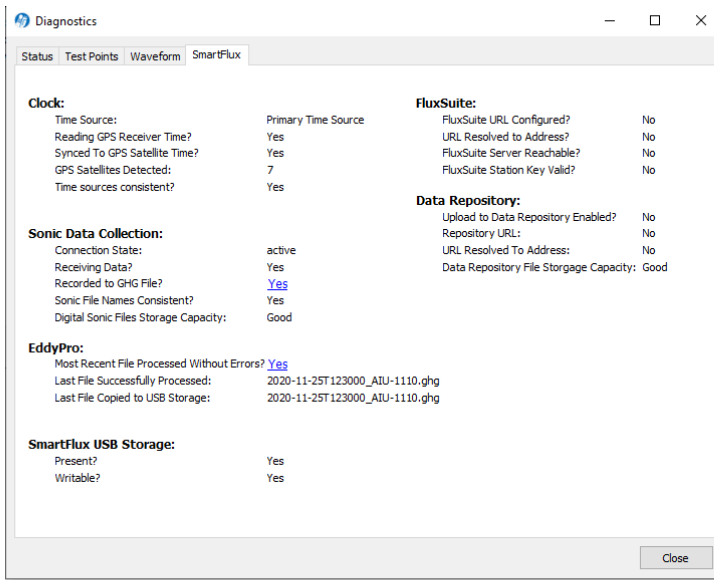
Verifying flux computations

To verify that fluxes are calculated, review the data after at least 30 minutes of data have been logged and processed. View the results under the **Results** graph in the software dashboard. To get a better idea of system performance, review 24 hours of data.

- System status information is summarized in *System diagnostics* on the next page. Review this to get a general idea of the system performance.
- Data download options are described in *Automatic file management* on page 6-5 and *Copying data files from USB storage* on page 6-6
- Data files are described in *Viewing and evaluating data* on page 6-1.

System diagnostics

SmartFlux System diagnostics are supported by the combined release of win-GHG interface software v8.8.36 and SmartFlux 2/3 System embedded firmware v2.2.50. This feature serves to summarize the system performance by providing status indicators for components and configurations, allowing you to evaluate the system at a glance. Diagnostics are under **Diagnostics > SmartFlux** tab.



Note: Diagnostics are updated every 15 seconds except when the SmartFlux System is executing an EddyPro run, as indicated by a banner:

SmartFlux is Processing a Measurement Interval. Status Indicators will not be accurate

Diagnostics refresh at the conclusion of the run (typically 7 to 15 minutes).

To support this feature, the win-GHG application attempts to open port 5050 for communication with the SmartFlux 2/3 System. If the local network prohibits opening port 5050, you will be presented an error message stating that the connection is not possible because port 5050 may be blocked. Contact your network administrator for assistance. If using win-GHG software v8.8.36 and SmartFlux v2.2.49 or earlier, the SmartFlux Diagnostics are not available.

Clock

Clock diagnostics show the time keeping status to help with troubleshooting of timing issues.

Issue	Status	Description
Time Source:		
	Primary	Precision Time Protocol is running on the SmartFlux 2/3 System in preferred mode. GPS-driven time in the SmartFlux System is the primary clock.
	Secondary	Precision Time Protocol is running on the SmartFlux 2/3 System in slave mode. The SmartFlux System is not the primary clock.
Reading GPS Receiver Time?		
	Yes	GPS receiver is providing valid time.
	No	GPS receiver time not valid. Receiver positioned poorly (inside)? Cable unplugged? Failed receiver or cable?
Synced to GPS Satellite Time?		
	Yes	System clock is synced with the GPS satellite time.
	No	System clock is out of sync with GPS satellite time.
GPS Satellites detected:		
	# of satellites detected. May be 0 when in a building. >4 is ideal.	
Time sources consistent?		
	Yes	The win-GHG software was able to sample the clocks on both the SmartFlux 2/3 System and the LI-7550 or DSI and that they were satisfactorily synchronized.
	No	The two clocks are >2 minutes off. If NO, an error icon will be displayed next to the **Time Sources Consistent** line and both the SmartFlux Epoch Time and GHG Epoch Time[1] will be displayed underneath for diagnostic purposes. To troubleshoot time issues: • Make sure the GPS receiver is not in an enclosure. • Make sure you are using LI-COR approved network switch. • Make sure PTP is set to **Automatic** on all LI-COR devices. • Make sure the date and time are set correctly. • Reboot all system components.

[1]The Unix epoch started at 00:00:00 UTC on 1 January 1970.

Sonic Data Collection

Sonic data collection shows the status of the sonic anemometer and SmartFlux System anemometer data handling.

Issue	Status	Description
Connection State		
	Active	The SmartFlux 2/3 System is configured and able to receive data from the sonic anemometer.
	Pending	The SmartFlux 2/3 System is attempting to connect with the anemometer and is not yet able to collect data.
Receiving Data?		
	Yes	The SmartFlux 2/3 System is receiving data from the sonic anemometer.
	No	The SmartFlux 2/3 System is NOT receiving data from the sonic anemometer.
Recorded to GHG file?		
	Yes	The SmartFlux 2/3 System was able to align the high-speed anemometer data and gas data and save the file.
	No	The SmartFlux 2/3 System was unable to align the high-speed anemometer and gas data. Expect the next EddyPro run to fail.
		Click **Yes/No** to view the log for more details (see *Sonic data collection information* on the facing page). Copy the log to the clipboard with **Ctrl + C** for consultation with a LI-COR technician.
Sonic File Names Consistent:		
	Yes	The SmartFlux 2/3 System has recorded anemometer data files that have consecutive time stamps.
	No	Raw anemometer data files have non-consecutive time stamps. If a response of NO is not resolved after rebooting the SmartFlux System, contact LI-COR for assistance.
Digital Sonic File Storage Capacity		
	Good	Anemometer data files stored on the SmartFlux 2/3 System are within the allotted storage space.
	Exceeded	Anemometer data stored has exceeded the storage allotment, indicating a data management issue. These files are automatically deleted normally. Contact LI-COR for assistance.

Sonic data collection information

Click **Yes/No** next to **Recorded to GHG file?** to view the logging information.

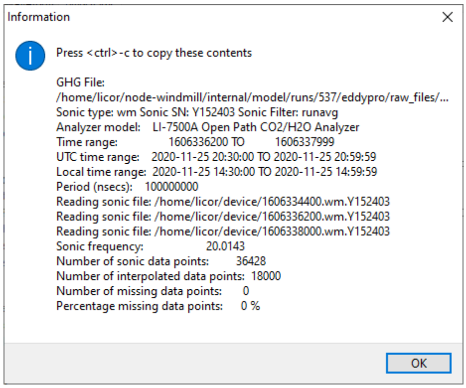


Table 5-1. Details of the GHG file log.

Entry	Description
GHG file:	The .ghg file that is recorded in temporary storage.
Sonic type:	The model, serial number, and filter setting of the anemometer.
Analyzer model:	The CO_2/H_2O gas analyzer model.
Time range:	Beginning and ending time in seconds past the universal epoch[1].
UTC time range:	Beginning and ending time in UTC.
Local time range:	Beginning and ending time in local time.
Period (nsec):	
Reading sonic file:	Temporary sonic data files are listed old to new. Names are the epoch time value, anemometer model, and serial number, separated by dots (.).
Sonic frequency:	Measurement frequency of the anemomter in Hz or samples per second.
Number of sonic data points:	Total number of anemometer points over the period.
Number of interpolated data points:	Total number of anemometer data points recorded to the .ghg file.
Number of missing data points:	Points missing from the expected total.

[1]The Unix epoch started at 00:00:00 UTC on 1 January 1970.

Table 5-1. Details of the GHG file log. (...continued)

Entry	Description
Percentage of missing data points:	Percentage of points missing from the expectd total.

EddyPro

EddyPro diagnostics are to indicate the status of EddyPro processing on the SmartFlux System.

Issue	Status	Description
Most Recent File Processed Without Errors?		
	Yes	Most recent dataset processed successfully.
	No	Unable to process most recent data set.
		Click **Yes/No** to view the EddyPro run log. You can copy the log to the clipboard with **Ctrl + C** for consultation with a LI-COR technician.
Last File Successfully Processed:		
	<filename>	This is the last file on the SmartFlux 2/3 System that was processed without error.
Last File Copied to USB Storage:		
	<filename>	The last file copied to the USB device. Note that a failed EddyPro run will not be copied. This file name will match the last successfully processed file name if everything is working correctly.

SmartFlux 2/3 USB Storage

SmartFlux 2/3 USB storage status indicates the status of the USB storage device. The test indicates whether the drive is present and whether data can be written to it.

Issue	Status	Description
Present:		
	Yes	USB storage device is recognized.
	No	System does not recognize a USB device. May be unplugged or disconnected in software. Unplug and plug back in to attempt to resolve.
Writable:		
	Yes	Data can be written to the USB device. Note that this may not be 100% reliable in detecting errors.

Issue	Status	Description
	No	USB write test has failed; unable to write data to the USB device. Unplug and plug back in to attempt to resolve.

FluxSuite

The FluxSuite diagnostics are used to troubleshoot a connection to the FluxSuite service.

Issue	Status	Description
FluxSuite URL Configured?		
	Yes	There is a FluxSuite Server URL (web address) in the SmartFlux 2/3 System memory (the setting has been configured).
	No	There is NO FluxSuite URL in the SmartFlux 2/3 System memory. If you have swapped one SmartFlux 2/3 System for another while using the same LI-7550, you must "re-push" the FluxSuite Server URL and Station Key to the SmartFlux 2/3 System. Even though it appears in the win-GHG interface, you must load the setting onto the new SmartFlux 2/3 System.
URL Resolved to Address?		
	Yes	The SmartFlux 2/3 System can convert the FluxSuite Server URL into an IP address.
	No	The SmartFlux 2/3 System cannot convert the FluxSuite Server URL into an IP address. May be an issue with the local DNS server.
FluxSuite Server Reachable?		
	Yes	The SmartFlux 2/3 System can ping the front-end of the FluxSuite Server.
	No	The SmartFlux 2/3 System cannot reach the FluxSuite Server.
FluxSuite Station Key Valid?		
	Yes	The Station Key associated with this instrument matches the Station ID within FluxSuite.
	No	The wrong Station Key is in place for this station, or the Station Key is not recognized by FluxSuite. Check that the key entered in this software is the same as that issued by FluxSuite.

Data Repository

Data repository diagnostics present the status of the setting and repository.

Issue	Status	Description
Upload to Data Repository Enabled:		
	Yes	The setting is enabled.
	No	The setting is not enabled.
Repository URL:		
	Yes	URL present.
	No	No URL present. The setting has not been configured.
URL Resolved to Address		
	Yes	The SmartFlux 2/3 System can convert the URL into an IP address.
	No	The SmartFlux 2/3 System cannot convert the URL into an IP address. Entered incorrectly? Not connected to internet?
Data Repository File Storage		
	Good	The data repository files stored on the SmartFlux 2/3 System USB device are remaining within their allocation of 30% of the full storage device (4 GB).
	Exceeded	The data repository files stored on the SmartFlux 2/3 System USB device are using more than the 30% allocation they were allotted. Contact LI-COR for assistance.

Tips for success

This section provides some tips for operating the instrument is difficult site conditions.

Site maintenance schedule

A good site maintenance plan will help ensure more complete data coverage. Follow these recommendations when you first deploy the site.

When you first deploy the instrument:

Check the signal strength and record this for a baseline. This will help you determine when the optics should be cleaned.

Every day or every few days:

Check the overall performance of the instruments, including the measured values and diagnostic information. This will ensure that you don't lose data (or that you lose less data) if something is wrong.

Check the measured values. Air temperature, pressure, sonic temperature, dew point, gas concentrations, covariances and fluxes. Any unexpected readings may indicate an issue.

Check the diagnostics. Signal strength, detector temperature, chopper housing temperature, and thermocouples.

Once per week:

After installing the new system, start by checking the signal strength once per week. There is no absolute guideline for good or bad signal strength, but 100% indicates very clean optics and optimal performance from the analyzer. If the signal strength has dropped, it is a good idea to clean the optics. For most sites, the maintenance frequency is once every 3-4 weeks. The signal strength limit, below which the instrument readings are compromised, varies due to the spectral characteristics of the contaminants involved. Typically, signal strength values should be maintained in the upper 90's for consistent performance.

Once per month:

Check the zero and span. As you become familiar with your instrument, you will probably find that this does not need to be checked as often.

Clean the upper and lower windows of the analyzer.

Download all your data and store it to an archive.

Check cables for damage. Tighten any loose cable connections.

Every six months:

If your instrument is in a humid environment, replace the head chemicals.

Once per year:

Replace the head chemicals.

Every two years:

Check the instrument calibration with one or more span gases. If it is outside the specifications, return the instrument to LI-COR for recalibration.

Operating the instrument in dew

The LI-7500RS can tolerate droplets on the windows to a certain extent. The automatic gain control will increase, but the calibration is unchanged. If the droplets coalesce and get big enough, the CO_2 Signal Strength will approach 0, and eventually the readings will become unusable. This can be minimized by tilting the sensor head 10 to 15° from vertical and by applying a water-shedding coating such as RainX® to the lower window.

Operating the instrument in rain and snow

Raindrops and snowflakes in the optical path will affect the performance of the LI-7500RS, even if the total light blockage does not drive the CO_2 Signal Strength close to 0. The reason is that the droplets and flakes are moving, and if one is in the path for a sample measurement, but out of the path for a reference measurement (or vice versa), it will influence the reading. *Figure 5-1* on the next page is data taken with an original LI-7500 during a light snow shower. The spikes are due to blockage changes between sample and reference readings. Notice that in some cases both CO_2 and H_2O are affected, and sometimes just one. Also, the spikes are equally likely to be up or down.

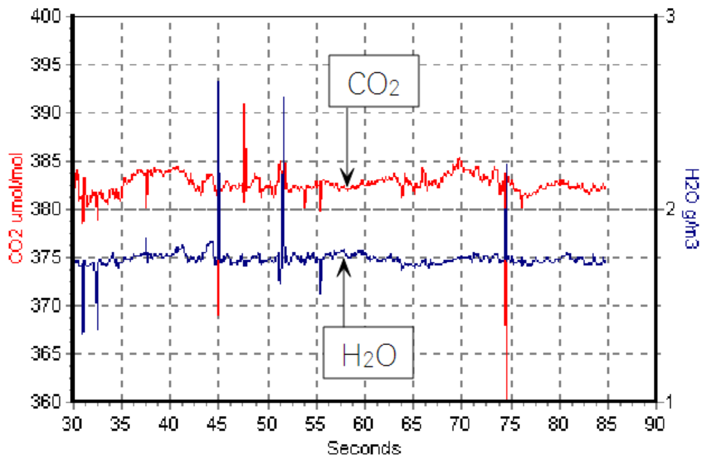


Figure 5-1. Small spikes may be evident when raindrops and snowflakes pass through the optical path.

The higher the bandwidth, the more pronounced this effect, since less averaging is done.

Operating in cold weather (<5 °C)

The instrument has a temperature setting that reduces the dissipation of heat in cold weather. We recommend that you change the setting when the average ambient temperature drops below 5 °C. See *Setting the operating temperature range* on page 3-5 for details.

Considerations for dust, pollen, and salt deposits

The LI-7500RS is quite tolerant of particulates on the windows, as long as they are small, and spectrally neutral. Pollen and salt deposits may become a problem because they are sticky and can accumulate, so monitor the CO_2 Signal Strength value and clean the windows as needed.

Operating in environments with high-frequency vibrations

The LI-7500RS is vibration sensitive to frequencies of 150 Hz ± the bandwidth. Thus, if the bandwidth is 10 Hz, the frequency problem range is 140 to 160 Hz (and upper harmonics). The instrument is completely insensitive to vibrations slower than this, and very slightly sensitive at frequencies higher than this.

For land-based installations, probably the most likely source of vibrational problems would be on a tower with tight guy wires. For other settings (aircraft, ships, etc.) where there may be vibrations in the problem range, you should try to minimize the problem through alternative mounting attachments.

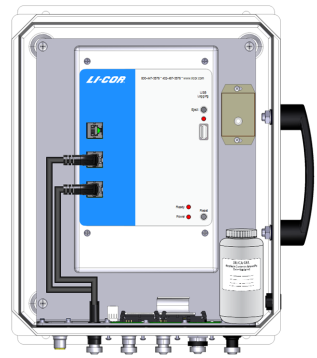
Operating in extreme humidity

In extremely humid conditions (that exceed the specifications of the instrument) water vapor can be drawn into the LI-7550 and condense, which could result in damage to the electronics. Under normal operating conditions, the heat dissipated in the LI-7550 is sufficient to prevent condensation from forming on the electronics. However, if your site experiences condensing conditions on a daily basis, the desiccant pack kit (part number 7550-950) can help prevent condensation from forming inside the LI-7550. It includes a bottle (part number 6572-055) and desiccant (part number 9975-042).

To use the desiccant pack:

1. Cut open the silver Mylar bag and open the internal bag.
2. Pour the desiccant into the desiccant bottle and tighten the lid.
3. Write the installation date on the bottle label.

4 Place the desiccant bottle upright in the LI-7550, then close and latch the door.



To help ensure that the desiccant does not become saturated, open the LI-7550 door only when needed. Opening the door allows humid air into the LI-7550, which depletes the desiccant.

The desiccant should be sufficient for one year of operation in most environments. Replace or recharge the desiccant after one year in normal conditions or more often in extremely humid conditions (e.g., if condensing conditions occur daily).

Saving the configuration file

A copy of the configuration file can be saved for record keeping or to be loaded onto another instrument. To save the current configuration, click **Config File > Save Configuration**. Select the items to include in the file and click **Continue**. Select a directory and save the file. It will have a `.l7x` extension.

Exchanging sensor heads

Sensor heads are freely interchangeable between LI-7550 Analyzer Interface Units. Calibration information that is specific to the head is saved on the LI-7550. Therefore, you must enter calibration coefficients and current zero and span information for the attached sensor head. Calibration information can be entered directly into the software, or the calibration file can be loaded.

Manually entering calibration coefficients

1. Attach the new sensor head to the LI-7550.
2. Connect the instrument to a computer and establish communications.
3. Click **LI-7500A/RS** or **LI-7200/RS > Calibration > Coefficients** and enter the calibration coefficients from the Calibration Certificate.
4. Zero and span the instrument.

Loading the calibration file

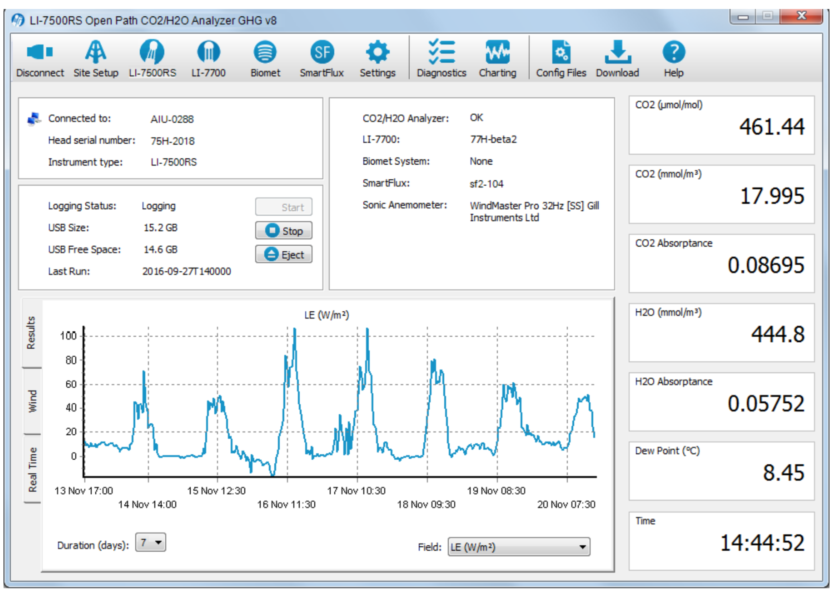
Acquire a calibration file for your instrument. You can get it from the LI-COR support site (www.licor.com/env/support) under calibration information, or you can save it from the LI-7550 (**Config Files > Save Configuration**). The file has a *.7x extension. To move a sensor head to another LI-7550:

1. Attach the new sensor head to the LI-7550.
2. Connect the instrument to a computer and establish communications.
3. Select **Config Files > Open Configuration**. Choose the file saved earlier; the coefficients will automatically be loaded.
4. Click **LI-7500A/RS** or **LI-7200/RS > Calibration > Coefficients**. Manually enter the Box Pressure calibration coefficients from the Calibration Certificate.

   The Box Pressure coefficients saved in the old configuration file should not be used with the new Analyzer Interface Unit.

Section 6.
Viewing and evaluating data

Real-time and recent data can be viewed in the software dashboard, including CO_2 and H_2O measurements, wind speed measurements, and computed fluxes. Recent Biomet data can be checked under the **Biomet > Data** tab.



See *Dashboard* on page 10-6 for details.

Logged data files

The SmartFlux 2 and 3 System records raw data and processed flux results to its USB drive. To retrieve the data, you can download it directly to a computer or you can eject the USB drive and copy files from it. We recommend downloading data directly so that you do not have to eject the USB drive. The basic set of folders on the USB drive are given in *Table 6-1* below.

Table 6-1. Folders include files that are created by the SmartFlux System.

Folder	Description
raw	Raw data in compressed files (.ghg) that includes the high-speed gas and wind measurements (.data), site information (.metadata), and optional biomet data. Typically about 120 MB per day.
results	Flux results and other information about the data and processing steps. Typically about 1 MB per day.
summaries	Summary of results for a 24-hour period, summarized on a 30-minute basis. Typically about 0.1 MB per day.
archive	A repository of files (data, images, etc) that have already been copied using the Download utility.
daqm	A daily file that includes biomet data from sensors connected to the Data Acquisition Module(s).
image	Images taken by the PhenoCam. One image is stored per day. Typically about 3 MB per day, depending on the camera configuration.
icos	Summaries that are to meet the specifications of ICOS .

The Raw data folder

The raw data are compressed in a folder with a `.ghg` file extension. You can unzip the file to view the contents. You may need to change the extension from `.ghg` to `.zip` before unzipping the file. It includes high speed gas and wind measurements in a file with a `.data` extension, as well as site information in a file with a `.metadata` extension. The file may also include biomet data and biomet metadata if the system was equipped with a biomet system. Depending on the variables selected when configuring the system (see *Selecting CO2/H2O log variables* on page 5-7), you may find some or all of the variables in *Table 6-2* below in the data file. Typically, the file will include a smaller subset of variables.

Table 6-2. Variables available for display and logging to the USB drive.

Variable	Description
Time	Time in HH:MM:SS:MS
Date	Date in YY:MM:DD

Table 6-2. Variables available for display and logging to the USB drive. (...continued)

Variable	Description
Sequence Number[1]	Index value, increments every 3.3 ms (1/300s)
CO2 (mmol/m^3)	CO_2 molar density
CO2 (mg/m^3)	CO_2 mass density
CO2 Absorptance	CO_2 raw absorptance value
CO2 (µmol/mol)	CO_2 mole fraction
H2O (mmol/m^3)	H_2O concentration density
H2O (g/m^3)	H_2O mass density
H2O Absorptance	H_2O raw absorptance value
H2O (mmol/mol)	H_2O mole fraction
Dew Point (°C)	Dew point temperature (°C)
Temperature (°C)	Temperature measured at LI-7550
Pressure (kPa)	Pressure measured in LI-7550
Cooler Voltage (v)	Detector cooler voltage
Chopper Cooler Voltage (V)	Chopper cooler voltage
SmartFlux Vin (v)	Voltage in to the SmartFlux System
Diagnostic Value	Diagnostic value 0-255
Diagnostic Value 2	Diagnostic value 0 or 1 (sync clocks)[2]
CO2 Signal Strength	CO_2 Signal Strength
7550 Auxiliary Input 1	Auxiliary input 1 value
7550 Auxiliary Input 2	Auxiliary input 2 value
7550 Auxiliary Input 3	Auxiliary input 3 value
7550 Auxiliary Input 4	Auxiliary input 4 value
Integral	Integration result (area under curve)
Peak Height	Integration peak height
CO2 Sample	Floating point value, power received from source in absorbing wavelength for CO_2
CO2 Reference	Floating point value, power received from source in reference (non-absorbing) wavelength for CO_2

[1]Sequence number is displayed as **Ndx** (Index) in data output header

[2]A value of 0 indicates that the clocks in the LI-7550 and LI-7700 (if connected) are not synchronized, and/or the LI-7550 may not be logging data to the USB drive. A flag will appear next to 'LI-7700' in the dashboard in this state. A value of 1 indicates clocks are synchronized, and data are being logged to the USB drive.

Table 6-2. Variables available for display and logging to the USB drive. (...continued)

Variable	Description
H2O Sample	Floating point value, power received from source in absorbing wavelength for H_2O
H2O Reference	Floating point value, power received from source in reference (non-absorbing) wavelength for H_2O
CH4 Seconds	Time from the LI-7700
CH4 Nanoseconds	Time from the LI-7700
CH4 (µmol/mol)	CH_4 mole fraction (LI-7700 required)
CH4 (mmol/m^3)	CH_4 molar density (LI-7700 required)
CH4 Signal Strength (RSSI)	RSSI value measured by the LI-7700
CH4 Diagnostic Value	Diagnostic value output by the LI-7700
U[1]	Horizontal wind speed as measured toward the direction in line with the north spar, SmartFlux 2 System required
V	Horizontal wind speed as measured toward the direction of 90° counterclockwise from the north spar, SmartFlux 2 System required
W	Vertical wind speed as measured up the mounting shaft, SmartFlux 2 System required
TS	Sonic temperature, SmartFlux 2 System required
SOS	Speed of sound, SmartFlux 2 System required
AnemDiag	Diagnostic value output by the anemometer, SmartFlux 2 System required

The **Results** folder

These are the output files from EddyPro. They follow a format typical of EddyPro outputs, as described in detail in the EddyPro help.

The **Summaries** folder

The EddyPro summaries, typically named something like `YYYY-MM-DD_EP-Summary`, include the half-hour eddy covariance flux results. These files are created and stored every 30 minutes. The variables included in this file are specified in EddyPro automatically if you select Basic processing or manually if you select Advanced processing.

[1]The sonic variables (U, V, W, T, and SOS) are logged at the same rate as high-speed data. The sonic variables and flow rate are displayed in the dashboard at 1 Hz for diagnostic purposes only.

The **Archive** folder

An emergency data backup archive is stored on the USB drive of the SmartFlux System, which may be useful if data are lost for any reason. The backup files are limited to the latest files recorded—the oldest files are overwritten when the internal memory gets full. Do not depend upon the internal memory as a primary backup for your data because old files are automatically overwritten by new ones.

The **DAqM** folder

If the system includes a biomet data acquisition system, the daily biomet data are summarized in this folder.

The **Images** folder

If the system is equipped with a StarDot PhenoCam, one image per day is stored in this folder. Images are typically about 3 MB each (per day), depending on the camera configuration.

The **ICOS CSV** folder

Summaries that are to meet the specifications of ICOS. This file may not be visible on the device itself, but will be created when files are pushed to a repository, where you can select it.

Automatic file management

The USB drive has limited space, and with continuous data logging, it will get full if files are not removed from it periodically. You have some options for manual and automatic file management when the USB drive gets full. The system will always maintain 10% of space on the drive as free space.

When the USB drive has <10% of space remaining, the SmartFlux System will either **Stop logging**, **Delete the oldest files from the Archive only**, or **Delete oldest files from Archive and then from Data**, depending upon the setting selected. Priorities for automatic file deletion are given in *Table 6-3* on the next page. If you store other files on the USB drive, the space available for data files will be reduced.

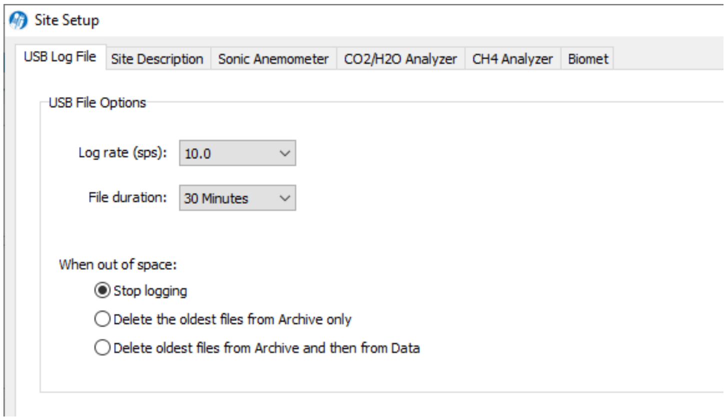


Table 6-3. Order of priority for files stored on the USB drive.

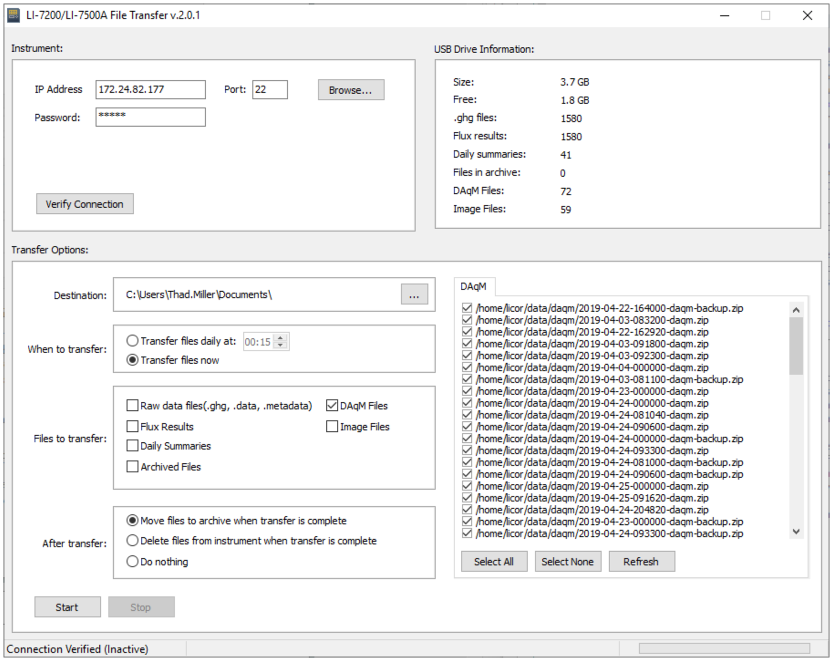
Priority	File type	Maximum space allocated
Deleted first	Archive	n/a
↓	Results	n/a
↓	PhenoCam Images	7%
↓	Daily Summary Results	n/a
↓	ICOS .csv files	40%
↓	Biomet files (data acquisition system only)	3%
Deleted last	Raw data files	n/a

Copying data files from USB storage

Files can be managed using the **Download** utility in the gas analyzer PC software or a Secure File Transfer Protocol (SFTP) application.

Using the **Download** utility

The **Download** utility allows you download and delete files that are stored on the USB drive. You can access the files remotely, so long as you can connect to your instrument over a network. The utility is a component of the gas analyzer software. Click the **Download** button to launch it.



The application should automatically connect to the instrument, but if it doesn't, click **Browse** to view a list of instruments on the network. Select the instrument, click **OK**, enter the password (**licor**) and click **Verify Connection**. You may need to set the port if you are connecting with a cellular or satellite gateway. If your instrument is not listed, type the IP address into the **IP Address** field. If you are using a RV50X, set the **Port** to the same number that you have opened in the RV50X software.

USB Drive Information displays the size of the USB drive, available memory, number of each type of file.

Transfer Options are used to configure settings and other features:

- **Destination**: This is where the transferred files will be saved. Ideally, this will be a directory on your computer. If you are transferring files to a server or cloud-based service such as a Dropbox, this is configured in the SmartFlux section of the application.
- **When to transfer**: You can **Transfer files daily** at a scheduled time or **Transfer files now** (click the start button).

You can close the application to your system tray (close it, but choose **No**) so it continues running in the background. Also be sure your computer does not go to sleep before the scheduled transfer. You may need to re-start the automatic download service if your computer is shut down and re-started.

Tips for the Scheduled Download utility:

- Set the download to begin at 00:15 (12:15 am) if you are using the SmartFlux System. That way all the logged files for the previous day will be processed before the download begins.
- Close the application to your system tray to keep it running in the background. Be sure the computer that runs the application is on and not in power saver mode.

- **Files to transfer**: Select any or all file types to transfer data files (you must select a file type before files are displayed). When you check a box, a corresponding tab is added to the box on the right. Here you can choose to download specific files or all of them.
- **After transfer**: You can choose **Move files to the archive**. This is useful if you want to keep a copy of the files on the USB drive but you want them compressed to save space. You can **Delete files** from the instrument will remove them from the USB drive. Use this option if you want to clear space from the drive and you have backed up the data elsewhere. You can also choose to **Do nothing** after the transfer. Files in the archive will be deleted automatically when the drive has less than 10% of capacity remaining, depending on the system settings.

After configuring the transfer and selecting files, click **Start**.

Using an SFTP application

You can also use third-party file transfer (SFTP) applications to transfer data, such as WinSCP. In this case, connect using the instrument IP address and the following settings:

- Port: **22** or **2200** if you have forwarded port 22 to port 2200.
- Username: **licor**
- Password: **licor**

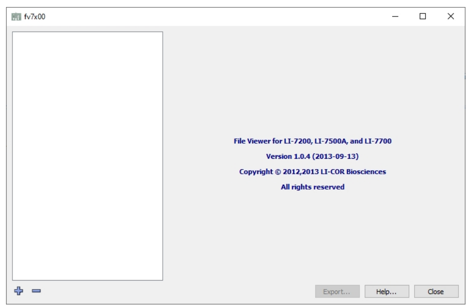
You will see all of the files in the file system. The files of interest are in a **data** folder.

Viewing raw logged data

To view raw data, copy raw data files from the SmartFlux System in one of two ways: connect the EC system to your computer or network and download the data using the gas analyzer PC application software, or eject the USB storage device from the SmartFlux System and connect it to your computer to read the data.

In the LI-7x00 File Viewer

The LI-7x00 File Viewer application (v1.0.4) is included with the gas analyzer software. If you didn't install with your gas analyzer application software, you can download it from www.licor.com/env/support. To view data:



1 Launch the LI-7x00 File Viewer application and open the .ghg file.

Drag files into the File Viewer interface or click the plus button (+) and select the files to open. You can load one or many files. They'll be in the order of the time stamps. When a file is open, you'll see a list of variables under the **Variables** tab on the right.

2 View one or more variables.

Double-click any variable to see a chart of the time-series. Drag any other variable onto the chart to view multiple variables. Use the zoom controls to examine the data in more detail.

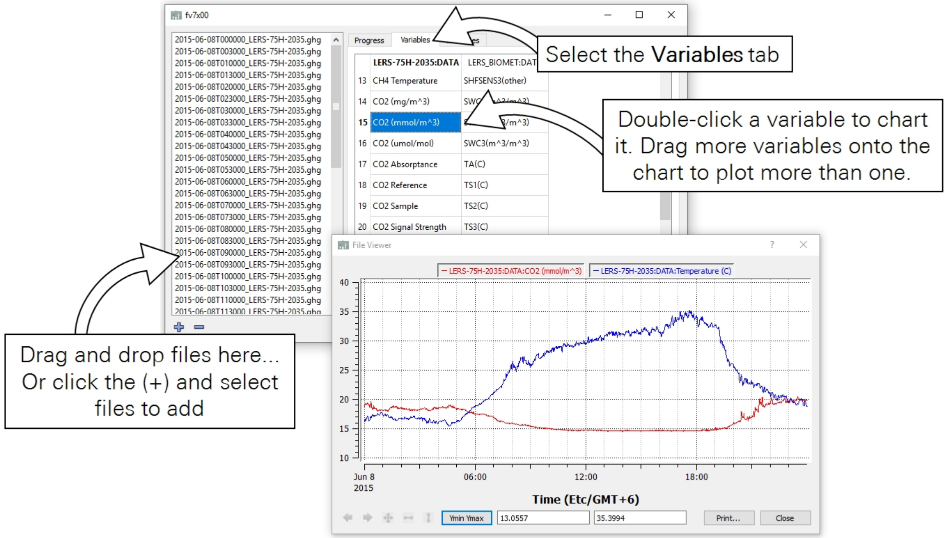


Figure 6-1. The file viewer plots raw data. Here it displays CO_2 molar density and air temperature measurements covering a 24-hour period.

The file viewer also provides options to export the dataset, which you can use at your discretion.

In a text editor

To see text data, you can extract the data files from the compressed eddy covariance data.

1 Copy the file of interest.

Copy the files before modifying them so that you are not altering the original data. If you alter the original data, EddyPro may be unable to process it.

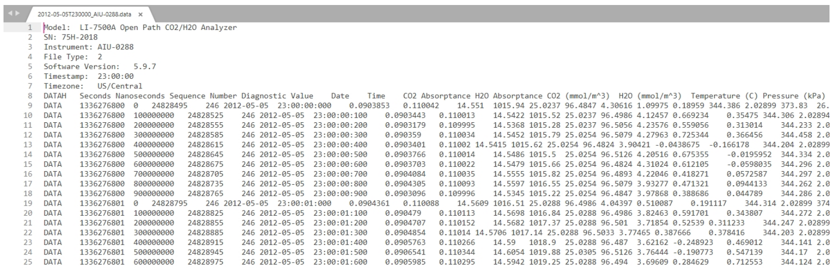
2 Change the `.ghg` file extension to `.zip`.

For example, the file name `2018-05-05T003000_AIU-0288.ghg` should be changed to `2018-05-05T003000_AIU-0288.zip`.

3 Extract the contents of the zipped file.

Data are stored in a file with a name like `2018-05-05T003000_AIU-0288.data`. The file contains a file header, data header, and data. The file header describes the system that collected the data. The data header identifies the variable and units. The data (typically 0.1-second or 0.05-second records, depending upon instrument settings) are in tab-delimited columns. A second file, with a name like `2018-05-05T003000_AIU-02880.metadata`, includes information about the site and instrument setup. You can open either of these files in a text editor or spreadsheet.

Although you can read the raw data and use it, we don't recommend working with the `.ghg` files outside of EddyPro Software. EddyPro will summarize and average the biomet data.

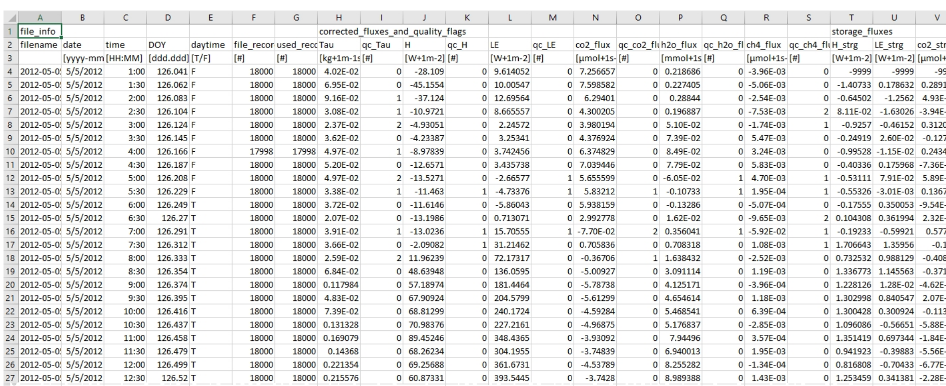



```
Model:  LI-7500A Open Path CO2/H2O Analyzer
SN: 75H-2018
Instrument: AIU-0288
File Type:  2
Software Version:   5.9.7
Timestamp:  23:00:00
Timezone:   US/Central
DATAH   Seconds Nanoseconds Sequence Number Diagnostic Value    Date    Time    CO2 Absorptance H2O Absorptance CO2 (mmol/m^3)  H2O (mmol/m^3)  Temperature (C) Pressure (kPa)
DATA    1336276800  0   24828495    246 2012-05-05  23:00:00:000    0.0903853   0.110042    14.551  1015.94 25.0237 96.4847 4.30616 1.09975 0.18959 344.386 2.02899 373.83  26.
DATA    1336276800  100000000   24828525    246 2012-05-05  23:00:00:100    0.0903443   0.110013    14.5422 1015.52 25.0237 96.4986 4.12457 0.669234    0.35475 344.306 2.02894
DATA    1336276800  200000000   24828555    246 2012-05-05  23:00:00:200    0.0903179   0.109995    14.5368 1015.28 25.0237 96.5056 4.23576 0.559056    0.313014    344.233 2.0
DATA    1336276800  300000000   24828585    246 2012-05-05  23:00:00:300    0.090359    0.110034    14.5452 1015.79 25.0254 96.5079 4.27963 0.725344    0.366456    344.458 2.0
DATA    1336276800  400000000   24828615    246 2012-05-05  23:00:00:400    0.0903401   0.11002 14.5415 1015.62 25.0254 96.4824 3.90421 -0.0438675  -0.166178   344.204 2.02899
DATA    1336276800  500000000   24828645    246 2012-05-05  23:00:00:500    0.0903766   0.110014    14.5486 1015.5  25.0254 96.5126 4.20516 0.675355    -0.0195952  344.334 2.0
DATA    1336276800  600000000   24828675    246 2012-05-05  23:00:00:600    0.0903703   0.110022    14.5479 1015.66 25.0254 96.4824 4.31024 0.612105    -0.0598035  344.296 2.0
DATA    1336276800  700000000   24828705    246 2012-05-05  23:00:00:700    0.0904084   0.110035    14.5555 1015.82 25.0254 96.4893 4.22046 0.418271    0.0572587   344.297 2.0
DATA    1336276800  800000000   24828735    246 2012-05-05  23:00:00:800    0.0904305   0.110093    14.5597 1016.55 25.0254 96.5079 3.93277 0.471321    0.0944133   344.262 2.0
DATA    1336276800  900000000   24828765    246 2012-05-05  23:00:00:900    0.0903096   0.109996    14.5345 1015.22 25.0254 96.4847 3.97868 0.388686    0.044789    344.286 2.0
DATA    1336276801  0   24828795    246 2012-05-05  23:00:01:000    0.0904361   0.110088    14.5609 1016.51 25.0288 96.4986 4.04397 0.510087    0.191117    344.314 2.02899 374
DATA    1336276801  100000000   24828825    246 2012-05-05  23:00:01:100    0.090479    0.110113    14.5698 1016.84 25.0288 96.4986 3.82463 0.591701    0.343807    344.272 2.0
DATA    1336276801  200000000   24828855    246 2012-05-05  23:00:01:200    0.0904707   0.110152    14.5682 1017.37 25.0288 96.501  3.71854 0.52539 0.311233    344.247 2.02899
DATA    1336276801  300000000   24828885    246 2012-05-05  23:00:01:300    0.0904854   0.11014 14.5706 1017.14 25.0288 96.5033 3.77465 0.387666    0.378416    344.203 2.02899
DATA    1336276801  400000000   24828915    246 2012-05-05  23:00:01:400    0.0905763   0.110266    14.59   1018.9  25.0288 96.487  3.62162 -0.248923   0.469012    344.141 2.0
DATA    1336276801  500000000   24828945    246 2012-05-05  23:00:01:500    0.0906541   0.110344    14.6054 1019.88 25.0305 96.5126 3.76444 -0.190773   0.547139    344.17  2.0
DATA    1336276801  600000000   24828975    246 2012-05-05  23:00:01:600    0.0905985   0.110295    14.5942 1019.25 25.0288 96.494  3.69609 0.284629    0.712553    344.124 2.0
```

Figure 6-2. Raw high-speed data are logged in text files.

Viewing processed data from the EddyPro output

Logged biomet data are processed by EddyPro, and in a typical eddy covariance system, these data will be recorded as 30 minute averages with flux data. The EddyPro output files include a file called something like `eddypro_Demo_full-output_2018-05-05T143614_adv.csv`. Data are stored as comma separated values (`.csv`) in a text file that can be opened in a spreadsheet or text editor. The header displays the variable label and position code, as well as the variable units.

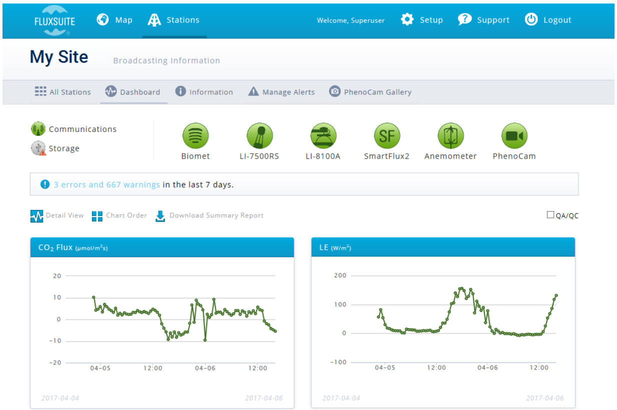


	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
1	file_info							corrected_fluxes_and_quality_flags												storage_fluxes		
2	filename	date	time	DOY	daytime	file_recor	used_recc	Tau	qc_Tau	H	qc_H	LE	qc_LE	co2_flux	qc_co2_flu	h2o_flux	qc_h2o_fl	ch4_flux	qc_ch4_flu	H_strg	LE_strg	co2_strg
3		[yyyy-mm	[HH:MM]	[ddd.ddd]	[T/F]	[#]	[#]	[kg+1m-1s	[#]	[W+1m-2]	[#]	[W+1m-2]	[#]	[µmol+1s-	[#]	[mmol+1s	[#]	[µmol+1s-	[#]	[W+1m-2]	[W+1m-2]	[µmol+1s-
4	2012-05-0	5/5/2012	1:00	126.041	F	18000	18000	4.02E-02	0	-28.109	0	9.614052	0	7.256657	0	0.218686	0	-3.96E-03	0	-9999	-9999	-999
5	2012-05-0	5/5/2012	1:30	126.062	F	18000	18000	6.95E-02	0	-45.1554	0	10.00547	0	7.598582	0	0.227405	0	-5.06E-03	0	-1.40733	0.178632	0.289146
6	2012-05-0	5/5/2012	2:00	126.083	F	18000	18000	9.16E-02	1	-37.124	0	12.69564	0	6.29401	0	0.28844	0	-2.54E-03	0	-0.64502	-1.2562	4.93E-02
7	2012-05-0	5/5/2012	2:30	126.104	F	18000	18000	3.08E-02	1	-10.9721	0	8.665557	0	4.300205	0	0.196887	0	-7.53E-03	2	8.11E-02	-1.63026	-3.94E-0
8	2012-05-0	5/5/2012	3:00	126.124	F	18000	18000	2.37E-02	2	-4.93051	0	2.24572	0	3.980194	0	5.10E-02	0	-1.74E-03	1	-0.9257	-0.46152	0.31205
9	2012-05-0	5/5/2012	3:30	126.145	F	18000	18000	3.62E-02	0	-4.23387	0	3.25341	0	4.376924	0	7.39E-02	0	5.47E-03	0	-0.24919	2.60E-02	-0.1275
10	2012-05-0	5/5/2012	4:00	126.166	F	17998	17998	4.97E-02	1	-8.97839	0	3.742456	0	6.374829	0	8.49E-02	0	3.24E-03	0	-0.99528	-1.15E-02	0.243472
11	2012-05-0	5/5/2012	4:30	126.187	F	18000	18000	5.20E-02	0	-12.6571	0	3.435738	0	7.039446	0	7.79E-02	0	5.83E-03	0	-0.40336	0.175968	-7.36E-02
12	2012-05-0	5/5/2012	5:00	126.208	F	18000	18000	4.97E-02	2	-13.5271	0	-2.66577	1	5.655599	0	-6.05E-02	1	4.70E-03	1	-0.53111	7.91E-02	5.89E-02
13	2012-05-0	5/5/2012	5:30	126.229	F	18000	18000	3.38E-02	1	-11.463	1	-4.73376	1	5.83212	1	-0.10733	1	1.95E-04	1	-0.55326	-3.01E-03	0.13671
14	2012-05-0	5/5/2012	6:00	126.249	T	18000	18000	3.72E-02	0	-11.6146	0	-5.86043	0	5.938159	0	-0.13286	0	-5.07E-04	0	-0.17555	0.350053	-9.54E-02
15	2012-05-0	5/5/2012	6:30	126.27	T	18000	18000	2.07E-02	0	-13.1986	0	0.713071	0	2.992778	0	1.62E-02	0	-9.65E-03	2	0.104308	0.361994	2.32E-0
16	2012-05-0	5/5/2012	7:00	126.291	T	18000	18000	3.91E-02	1	-13.0236	1	15.70555	1	-7.70E-02	2	0.356041	1	-5.92E-02	1	-0.19233	-0.59921	0.57753
17	2012-05-0	5/5/2012	7:30	126.312	T	18000	18000	3.66E-02	0	-2.09082	1	31.21462	0	0.705836	0	0.708318	0	1.08E-03	1	1.706643	1.35956	-0.19
18	2012-05-0	5/5/2012	8:00	126.333	T	18000	18000	2.59E-02	2	11.96239	0	72.17317	0	-0.36706	1	1.638432	0	-2.52E-03	0	0.732532	0.988129	-0.40866
19	2012-05-0	5/5/2012	8:30	126.354	T	18000	18000	6.84E-02	0	48.63948	0	136.0595	0	-5.00927	0	3.091114	0	1.19E-03	0	1.336773	1.145563	-0.37197
20	2012-05-0	5/5/2012	9:00	126.374	T	18000	18000	0.117984	0	57.18974	0	181.4464	0	-5.78738	0	4.125171	0	-3.96E-04	0	1.228126	1.28E-02	-4.62E-02
21	2012-05-0	5/5/2012	9:30	126.395	T	18000	18000	4.83E-02	0	67.90924	0	204.5799	0	-5.61299	0	4.654614	0	1.18E-03	0	1.302998	0.840547	2.07E-0
22	2012-05-0	5/5/2012	10:00	126.416	T	18000	18000	7.39E-02	0	68.81299	0	240.1724	0	-4.59284	0	5.468541	0	6.39E-04	0	1.300428	0.300924	-0.1131
23	2012-05-0	5/5/2012	10:30	126.437	T	18000	18000	0.131328	0	70.98376	0	227.2161	0	-4.96875	0	5.176837	0	-2.85E-03	0	1.096086	-0.56651	-5.88E-0
24	2012-05-0	5/5/2012	11:00	126.458	T	18000	18000	0.169079	0	89.45246	0	348.4365	0	-3.93092	0	7.94496	0	3.57E-04	0	1.351419	0.697344	-1.84E-02
25	2012-05-0	5/5/2012	11:30	126.479	T	18000	18000	0.14368	0	68.26234	0	304.1955	0	-3.74839	0	6.940013	0	1.95E-03	0	0.941923	-0.39883	-5.56E-0
26	2012-05-0	5/5/2012	12:00	126.499	T	18000	18000	0.221354	0	69.25688	0	361.6731	0	-4.53789	0	8.255282	0	-1.34E-04	0	0.816808	-0.70433	-6.77E-0
27	2012-05-0	5/5/2012	12:30	126.52	T	18000	18000	0.215576	0	60.87331	0	393.5445	0	-3.7428	0	8.989388	0	1.43E-03	0	1.253459	0.341381	-2.28E-03

Figure 6-3. EddyPro results can be opened in a spreadsheet. Results are 30-minute averages.

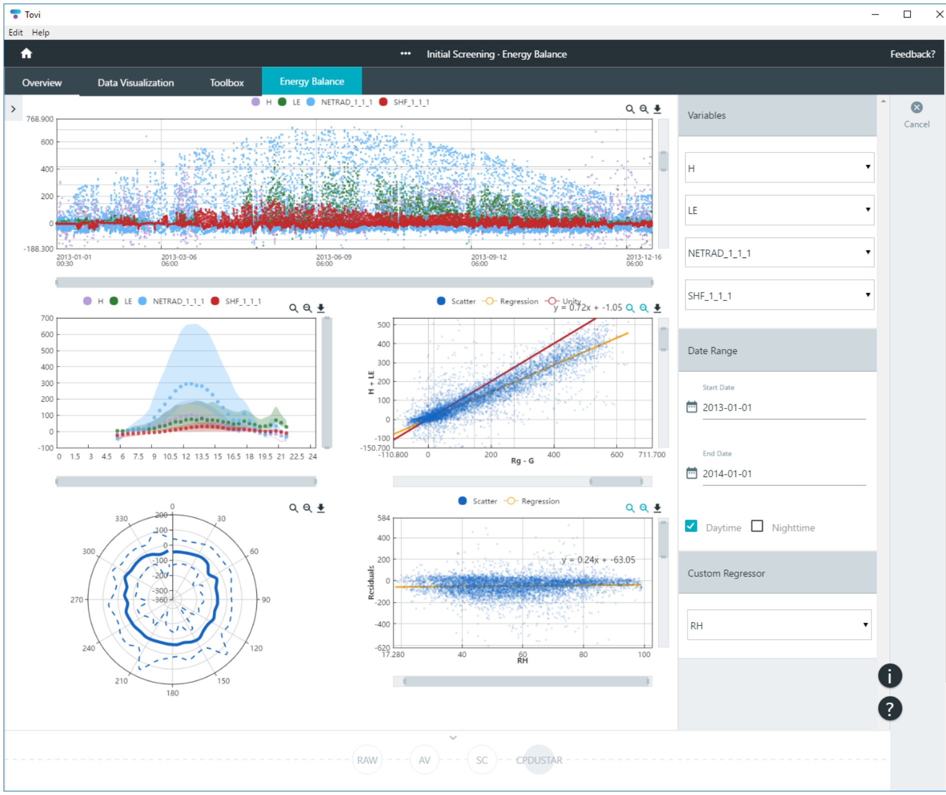
Viewing data in FluxSuite Software

FluxSuite Software (fluxsuite.com) is a cloud-based application that provides near real-time access to site status information, processed flux results, biomet data, and images taken with a PhenoCam. Contact LI-COR or your distributor for more information.



Evaluating long-term data in Tovi™ Software

Tovi Software provides tools to evaluate and process the fluxes and biomet data that have been processed by EddyPro. For example, you can average redundant measurements, merge variables and gap fill with data from your site, gap fill with data from nearby weather stations, evaluate the quality of data, and use the biomet data to interpret flux results. Tovi is designed to evaluate lengthy time-series eddy covariance data sets.


Tovi
Edit Help
Initial Screening - Energy Balance
Feedback?
Overview
Data Visualization
Toolbox
Energy Balance
Variables
H
LE
NETRAD_1_1_1
SHF_1_1_1
Date Range
Start Date
2013-01-01
End Date
2014-01-01
Daytime
Nighttime
Custom Regressor
RH
Cancel
Scatter
Regression
y = 0.72x + -1.05
y = 0.24x + -63.05
Rg - G
H + LE
Residuals
RAW
AV
SC
CPDUSTAR

Section 7.
EddyPro processing on the SmartFlux System

In **Express Mode**, EddyPro uses pre-determined processing settings that are well established and accepted in the research community. This approach dramatically reduces the need for user interaction, allowing you to get flux results with just a few clicks. Express Mode is suitable for most eddy covariance setups, including:

- Systems operated over relatively flat and homogeneous terrain,
- Systems with open path gas analyzers (e.g., LI-7500/A/RS/DS, LI-7700),
- Systems with closed path (LI-7000) or enclosed path (LI-7200/RS) gas analyzers with short or properly heated intake tubes, and
- Systems that include up to 3 analyzers.

In **Advanced Mode**, you can choose how corrections are applied and configure these settings to suit your research needs, making it the correct choice for data collected in situations that deviate from those listed above. Effective use of Advanced Mode requires both a deeper level of understanding of the eddy covariance theory and a deeper interaction with the software.

Note: Be sure that you are running the same version of EddyPro on your desktop that you are running on the SmartFlux System (the EddyPro processing engine is part of the SmartFlux System firmware). You can download the latest software from licor.com/env/support/EddyPro/home.html. To view the EddyPro desktop version number go to **EddyPro > Help > About**. To view the version running on the SmartFlux Syste,m open the gas analyzer software (LI-7x00 A RS DS), click the SmartFlux button, and look for **EddyPro version.**

Express processing

EddyPro Express mode is the default configuration for the flux computation in the SmartFlux System. Express settings are loaded automatically unless you specify an EddyPro Advanced configuration file.

Advanced processing

Advanced Mode provides you with the high-level capabilities of EddyPro Advanced, computing fully corrected flux results in real-time with the processing options of your choice. The SmartFlux configuration file, needed to run EddyPro in Advanced mode in the SmartFlux module, is created in EddyPro Software version 6 or newer. The file is loaded is using the gas analyzer PC software.

There are additional considerations if you use **EddyPro Advanced** in the SmartFlux System. For many scenarios, you will simply need to configure the advanced settings as you see fit, and load the SmartFlux configuration file into the SmartFlux System.

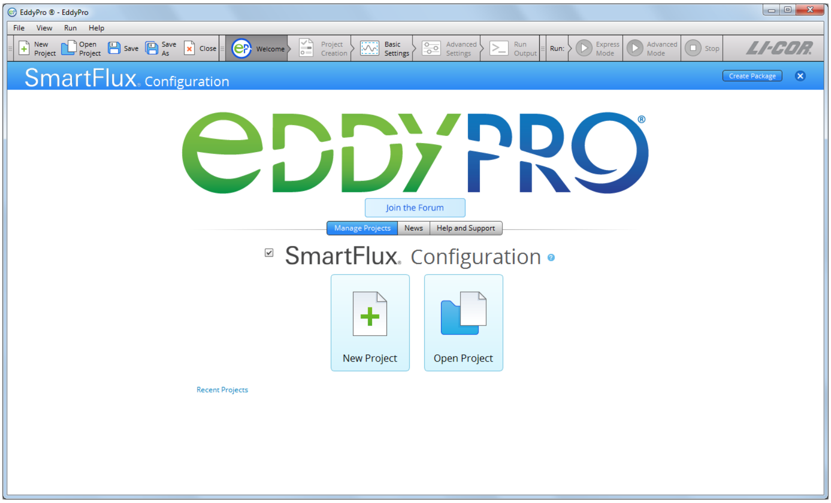
However, if you wish to use a **Planar-fit method for Axis Rotation**, the **Automatic Time Lag Optimization** option, or one of the **in situ spectral correction** methods (Horst, 1997; Ibrom et al., 2007), *you will need to process an existing data set from the site in order to configure the parameters for these settings*, as explained in *Planar fit, spectral corrections, and timelag optimization in the SmartFlux System* on page 7-5.

> **Important:** In order for the parameters to be valid, the site must not have undergone any significant changes between the time when the existing data set was collected and when the SmartFlux System is deployed. The instrument configuration should remain unchanged during the sampling period if the settings are to apply to the SmartFlux configuration file as well. For closed-path systems, the dataset used to optimize time lags and for the spectral assessment must refer to a period in which the sampling line did not undergo major modifications, such as replacement of tubing or filters, change of the flow rate, etc.

When you create the configuration file, only the controls that can be configured for the SmartFlux System are enabled, and the other controls are disabled.

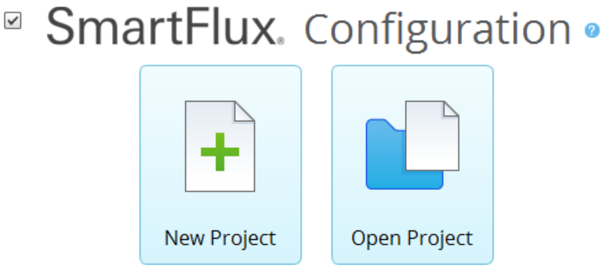
Configuring the SmartFlux System

SmartFlux Configuration mode inside the EddyPro® Software is used to create an advanced configuration file for the SmartFlux System.



To use this mode, check the box, and proceed through EddyPro as you normally would. The steps are summarized below:

1. Click the **SmartFlux Configuration** box on the EddyPro opening screen.
2. Select **New Project** or **Open Project**.



If you are creating a **New Project** and you do not intend to use planar-fit, automatic time-lag optimizations, or *in situ* spectral corrections:

- Set the Raw Data Directory to a .ghg file with metadata that applies to your site.
- Select variables and set flags as desired.
- Configure Advanced Settings (see *Advanced processing* on the previous page).

If you are creating the SmartFlux configuration file from an existing project:

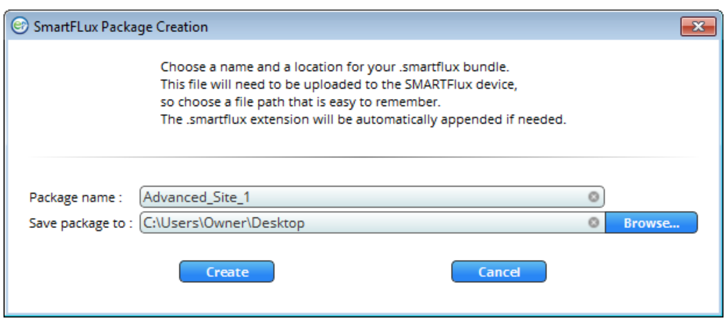
- Click Open Project and select the project.
- Alter any settings that need to be changed.
- Configure Advanced Settings (see *Advanced processing* on page 7-2).

If you are using **planar-fit**, automatic **time-lag optimization**, or **in situ spectral corrections** (see *Planar fit, spectral corrections, and timelag optimization in the SmartFlux System* on the facing page for details):

- Select a planar-fit file that was generated by EddyPro using data from your site.
- Select the automatic time-lag optimization file that was generated by EddyPro using data from your site.
- Select the *in situ* spectral corrections file that was generated by EddyPro using data from your site.

3 Click **Create Package** in the upper right of the EddyPro window.

4 When prompted, name the package, select a directory and click **Create**.



The configuration file has a `.smartflux` extension.

5 Upload the SmartFlux configuration file to the SmartFlux System.

See *Loading a SmartFlux configuration file* on page 7-10.

Planar fit, spectral corrections, and timelag optimization in the SmartFlux System

In order to use planar-fit, *in situ* spectral corrections or timelag optimization in the SmartFlux System, EddyPro needs to access the respective `_planar_fit_`, `_spectral_assessment_`, and `_timelag_optimization_` files, hereafter referred to as "additional configuration files". These files contain summaries of calculations performed on relatively large data sets (*Table 7-1* on the next page) and that also apply to data to be collected in the future.

> **Note:** File names of additional configuration files must remain unchanged from those assigned by EddyPro. The format will be similar to the following:
>
> eddypro_2020_planar_fit_2020-04-14T105944_adv.txt
> eddypro_2020_spectral_assessment_2020-04-15T194558_adv.txt
> eddypro_2020_timelag_opt_2020-04-14T105944_adv.txt

You can use three months of data to calculate a spectral assessment and then use this spectral assessment to correct fluxes calculated from data collected after those three months (if the system configuration didn't change to such an extent that the spectral assessment is no longer representative). Similar considerations apply to the planar fit and the timelag optimization procedures. Refer to EddyPro documentation for more details on when and how to use these three advanced procedures.

The additional configuration files are created by EddyPro (3.0 and above), when used in the standard desktop mode. If you have been running your EC system (the EC system in which you intend to use the SmartFlux System) for some time, you may have already created one or more of these files, or you may have a .ghg dataset suitable for creating them, if the corresponding implementation is deemed necessary to calculate accurate fluxes (again, refer to EddyPro documentation to learn more about when it is suggested to use these options). If you do not have previously-collected .ghg files, then you will need to run the system for a suitable amount of time (for example using SmartFlux in Express mode), then use EddyPro in desktop mode to create the additional configuration files, and then provide them to the SmartFlux System as explained below.

Table 7-1. Recommended dataset durations for Advanced settings.

EddyPro Advanced Setting	Recommended Dataset
Planar Fit Settings	2 weeks minimum; < 2 months
Time Lag Optimization	1 to 2 months or more
Spectral Corrections, Assessment of high frequency attenuation	1 month or more

Thus, assuming that you have a sufficiently long .ghg dataset (*Table 7-1* above), the procedure to correctly configure the SmartFlux System to use planar-fit, *in situ* spectral corrections or timelag optimization is illustrated here, using the *in situ* spectral corrections as an example. Analogous procedures shall be followed for the planar-fit or the timelag optimization.

1 Open EddyPro (5.0 or above recommended) in normal desktop mode and complete the **Project Creation** and **Basic Settings** pages as usual (refer to EddyPro documentation if needed).

In the **Advanced Settings > Spectral Corrections**, configure **Corrections for low-pass filtering effects** to use one of the *in situ* methods, i.e. Horst (1997), Ibrom et al. (2007) or Fratini et al. (2012). In the same page, customize the settings to instruct EddyPro to use the dataset of your choice and to filter data appropriately, so as to obtain a sound assessment of spectral attenuations. Click **Run** and when this is completed, locate the spectral assessment file (it contains the string "spectral_assessment" in the file name) in the subdirectory \spectral_analysis that you will find inside the selected Output folder. This is the file that you will use for the SmartFlux System.

2 Open EddyPro (5.0 or above) in SmartFlux Setup Mode.

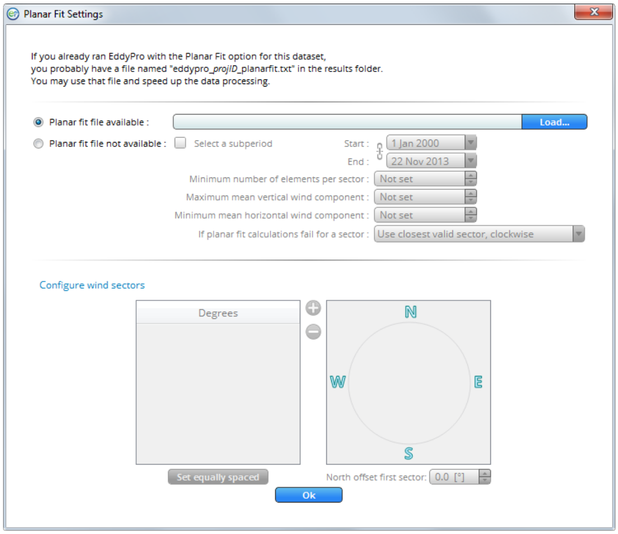
Configure everything as explained in the previous sections. In the **Advanced Settings > Spectral Corrections**, configure **Corrections for low-pass filtering effects** to use one of the *in situ* methods among Horst (1997) and Ibrom et al. (2007) (the method of Fratini et al. (2012) is currently not usable in the SmartFlux System). In the **"Spectral assessment file available"** entry, select the spectral assessment file created earlier. Then proceed normally and when done, click on the **Create File** button to create the `.smartflux` bundle, as explained above.

An analogous procedure can be used to create and use the planar fit and the timelag optimization configuration files.

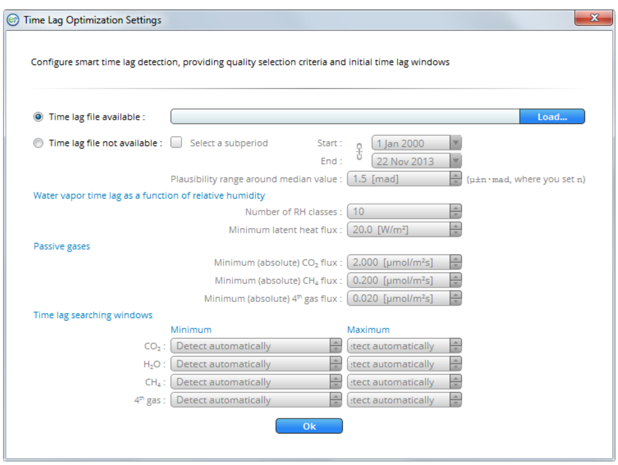
Advanced processing options

Similarly to EddyPro Advanced and Express, some controls must be configured, while others are optional. When you create the SmartFlux configuration file, only the controls that can be configured for the original SmartFlux System are enabled, and the other controls are disabled. In particular, you will find that:

- The **Project Creation** page is not available.
  This is because inside SmartFlux, EddyPro does not need any of the information that is entered in the Project Creation page. The file type (LI-COR .ghg), the use of metadata ("embedded") and the use of biomet data ("embedded") are all predefined settings in the SmartFlux.
- In **Basic Settings:**
  - A The selection of **Dataset dates** is deactivated because SmartFlux processes .ghg files one by one, as they are created by the gas analyzer software.
  - B The **Flux averaging interval** is deactivated because the SmartFlux System operates on a predefined interval of 30 minutes. In the SmartFlux System there is no option to calculate fluxes on any other time interval.
  - C The **Master Anemometer** is deactivated because LI-COR eddy covariance systems are designed around one only anemometer, which is detected automatically in the SmartFlux System as the "master".
- In **Advanced Settings > Processing Options**, all processing options are active, and you can select them as you would do in EddyPro.
  The only exceptions are:
  - A The **Planar Fit Settings…** window, which activates when the **Planar fit** or the **Planar fit with no velocity bias** option is chosen as the **Axis rotation for tilt correction** method, presents only the **Planar fit file available** option. If you want to use the planar fit method in the SmartFlux System, you will have to load a previously created planar fit file at this time. Refer to *Planar fit, spectral corrections, and timelag optimization in the SmartFlux System* on page 7-5 for instructions on how to create the planar fit file and more details on how to use it in the SmartFlux System.



B The **Time lag Optimization Settings…**, which activates when the **Automatic time lag optimization** option is chosen as a **Time lag compensation** method, only gives the **Time lag file available** option. If you want to use the automatic timelag optimization option in the SmartFlux System, you will have to load a previously created timelag optimization file at this time. Refer to *Planar fit, spectral corrections, and timelag optimization in the SmartFlux System* on page 7-5 for instructions how to create the timelag optimization file and more details on how to use it in the SmartFlux System.



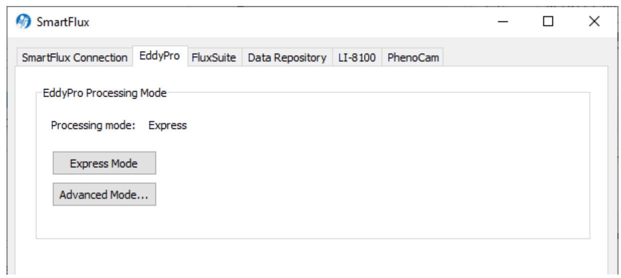
- In **Advanced Settings > Spectral Corrections** both low frequency and high frequency corrections are available.
  However:
  - **A** In the **Correction for low-pass filtering effects**, the method by Fratini et al. (2012) is deactivated, because this method requires an auxiliary file that is currently not available in the SmartFlux System.
  - **B** If an *in situ* method is selected (Horst 1997 or Ibrom et al., 2007), only the option **Spectral assessment file available** is active, similar to the planar fit and timelag optimization options discussed above. If you want to use one of these *in-situ* methods in the SmartFlux System, you will have to load a previously created spectral assessment file at this time. Refer to *Planar fit, spectral corrections, and timelag optimization in the SmartFlux System* on page 7-5 for instructions on how to create the spectral assessment file and more details on how to use it in the SmartFlux System.
- In **Advanced Settings > Statistical Analysis**, all processing options are active, and you can select them as you would do in EddyPro with no exceptions.
- In **Advanced Settings > Output Files**, most options are active, with the following exceptions:
  - **A** The **Set Minimal**, **Set Typical** and **Set Thorough** pre-selection buttons are deactivated, because those pre-selections do not apply completely to the SmartFlux System.
  - **B** The **Full output file** and related settings are deactivated because this file will always be created by the SmartFlux System or in a predefined format.
  - **C** The **Ensemble averaged cospectra and models** is unchecked and deactivated, because this output cannot be created in the SmartFlux System, where .ghg files are processed one at a time. To create those outputs, use standard EddyPro instead.
  - **D** All full length (co)spectra outputs are deactivated. These files occupy large amounts of disk space and are thus not allowed in the SmartFlux System. To obtain full length (co)spectra files, use standard EddyPro instead.
  - **E** Processed raw data outputs are deactivated. These files occupy large amounts of disk space and are thus not allowed in the SmartFlux System. To obtain those outputs, use standard EddyPro instead.

Loading a SmartFlux configuration file

Note: EddyPro Express settings are loaded by default. Only load a configuration file to use EddyPro Advanced settings.

1 Create the SmartFlux configuration file created in EddyPro.

2 Click the SmartFlux button.



3 Select the **EddyPro** tab, and click the **Advanced Mode...**. Read the warning dialog.

4 Browse to the advanced configuration file created in EddyPro (extension *.smartflux) and select it.

After loading the file, the SmartFlux System will compute flux results based upon the defined Advanced settings. Be sure to turn on datalogging after altering the configuration.

Section 8.
Troubleshooting

We address potential problems in this section.

Gas analyzer will not power on or repeatedly powers on and off

- Adequate power supply? The instrument requires between 11.5 and 30 VDC. During start up, 30 W is typically required, but it may be up to 37 W for a few seconds at cold temperatures. The power draw will decrease over a period of up to 10 minutes after start up until the internal temperatures have stabilized. Steady-state power draw is between 8 and 18 watts, depending upon the ambient temperature. Cold temperatures cause the instrument to draw more power.
- If the LI-7550 Power LED turns on but the Ready LED does not, the power supply may be inadequate or the firmware has locked up. Check the power supply, restart the instrument, and update the firmware.
- If the LI-7550 **Power** LED cycles on and off repeatedly, the power supply is not sufficient to start up the instrument. Measure the voltage at the 4-pin connector inside the LI-7550 (rather than the voltage at the battery bank). The blue/black leads are positive (+), the brown/white leads are negative (-). If voltage at the connector is below 11.5 VDC, shorten the length of the power cable if possible, use a larger gauge cable, or boost the power supply voltage.
- Loose connection? Make sure the power cable connector is tight. Also check the cable for damage and the connections to the power supply.
- Blown fuse? Check the fuse, as described in *Replacing LI-7550 Fuses* on page 9-4. Note that a blown fuse usually indicates some other problem. If the fuse blows repeatedly, carefully check the wiring.

Problems with the SmartFlux 2 System

System powers on/off unpredictably or not powering the anemometer

- Check connections in the power supply and correct any faulty connections.
- Check connections on the SmartFlux System power wiring harness and tighten any loose fittings.
- Check the power wires. The positive wire should go to the Power IN (+) terminal and the negative wire should go to the Power IN (–) terminal on the SmartFlux 2 module.
- If the **Power IN** LED is lit, but **Power OUT** LED is not lit, then a 3A fuse inside the SmartFlux 2 module may have failed.
- Check the VIN value in the GHG windows interface software (under **Diagnostics**). Some sonic anemometers have an upper voltage limit of 15 VDC. In this case, supplying an incoming 24 VDC to the SmartFlux System could damage the sonic anemometer. The same voltage provided to the SmartFlux System will be provided to a sonic anemometer powered through the **Power Out** terminals.

System not visible on the network (cannot connect)

- Check the Ethernet Activity LED light on the SmartFlux 2 or 3 System. If it is blinking rapidly, this indicates the system is communicating over the network.
- Check the Ethernet cable and connections to the SmartFlux 2 or 3 system and in the rest of your EC system.
- Check the power supply connections and correct any faulty connections.
- Reboot the SmartFlux 2 or 3 System by pressing the reset button.
- Reboot the gas analyzer.

System not connected to the sonic anemometer

- If you have renamed the SmartFlux 2 or 3 System, does it have a valid name? The SmartFlux System name can only include upper and lower case letters (A to Z; a to z), numbers (0 to 9), the dash character (-), and the period (.). All other characters are invalid and will prevent the system from working as expected. One indicator of this is that the sonic anemometer status is displayed as

disconnected in the gas analyzer software main window.
    - Invalid names: Flux_Site_01 (invalid underscore _ characters); Micromet@TheSwamp (invalid @ character).
    - Valid names: smart03-00901 (the default name).
- For manually configured anemometers, check to see that the sonic anemometer is set to the proper baud rate.
- Check the return signal LED lights next to the sonic anemometer data port. If they are flashing or solid, this indicates that the SmartFlux System is communicating with the sonic anemometer.
- Check the connections on the sonic data input plug wiring and tighten any loose fittings.
- Check the power supply to the anemometer.
- Reboot the SmartFlux System by clicking the Reboot button in the analyzer software (on the SmartFlux tab) or the reset button on the SmartFlux System.

USB flash drive not working properly

We recommend using a USB drive from LI-COR because it has been tested with the SmartFlux System. If you use a different USB drive, it should be industrial grade. If the USB LED blinks slowly (one time per second), this indicates an error. Try the following:

- Press the reset button on the SmartFlux System to re-boot the system.
- Unmount and re-mount the flash drive.
- Check to see if space remains on the USB drive. Remove files to free up some space.

Fluxes not being computed, are unreasonable, or raw data not time-aligned

- Check the time keeping settings for the system. Connect with the gas analyzer using the desktop software and verify that the **PTP time keeping** is **On** and set to **Automatic** for the gas analyzers.
- Be sure that the GPS antenna is installed outside of the enclosure and with a clear view of the sky. It must receive signals from GPS satellites in order to set the time.

- Check the results folder and look for the EddyPro log on the USB drive.
- Try processing data using EddyPro desktop.

Results are not identical to EddyPro desktop results

- Configuration settings are not the same. Review the configurations and ensure that they are identical.
- North Offset/Magnetic declination are set differently.
- Software versions not compatible. Although we attempt to test every possible scenario, there are cases that may lead to slight offsets in flux results. We fix bugs as they are identified. Ensure that you are running the most up-to-date version of EddyPro and the SmartFlux System embedded software. Contact LI-COR technical support (envsupport@licor.com) if you are unable to resolve the issue.

Ethernet connection problems

Most Ethernet problems are related to firewalls or network settings.

Instrument not visible in software

- Firewall rules prohibiting the connection? Attempt to connect to the gas analyzer using the RS-232 connection. If you are able to connect as expected, the problem may be related to your computer firewall settings. Create an exception that allows the gas analyzer through the firewall. Refer to documentation provided with that software.
- Instrument network settings incompatible with computer or local area network settings? If the instrument IP address is set to **Static**, you probably will not be able to connect to the instrument over a network unless you change the instrument IP address to **Dynamic** (Obtain IP address automatically). Alternatively, connect to the instrument using the RS-232 serial connection.

RS-232 serial connection problems

When connecting with RS-232 serial, the **Connect** button in the PC software causes the program to set a break condition on the communication line, signaling the instrument to change to 9600 baud and send its current configuration. The PC then sends the desired configuration (update rate, baud rate, etc.) back to the instrument. Both instruments then change to the desired baud rate, and operations begin.

When the **Disconnect** button is clicked, the PC signals to the instrument to change its RS-232 configuration back to what it was originally (or to that set up in the RS-232 panel).

"Port in use or does not exist"

- Correct COM port selected? This message indicates that the COM port setting on the **Connect** page is either incorrect, or else that COM port is already in use by some other program. If you are sure that the COM port is correct, and there is nothing else running, try rebooting the instrument.

"Not able to connect successfully"

- Click **Connect** again. Sometimes it takes a couple of attempts. If repeated attempts fail, then make sure the correct COM port is selected. Make sure the instrument is powered and running and see if the LED lights for about 5 seconds.

"Parse Error"

- Incompatible PC and instrument software? Update the PC application and embedded firmware on the instrument.
- Baud rate and update rate incompatible? In the **Connect** window, the Baud Rate menu is used to set the baud rate at which to communicate with the instrument. The rate of data transfer is also dependent upon the maximum rate available with your computer's serial port, and the update frequency to be used while the program communicates with the instrument.
- The **Update Rate** is the update frequency to be used while the PC software communicates with the instrument. Select from 0.1, 0.2, 0.5, 1, 2, 5, 10, or 20 Hz. **At 9600 baud, the maximum update frequency is 2 Hz; at 19200 baud, 5 Hz; at 38400 baud, 10 Hz; at 57600 baud, 15 Hz; and at 115200 baud, 20 Hz.** Use a faster Baud Rate and/or a slower Update Rate to resolve this problem.

Instrument software is unresponsive

- Incompatible PC and instrument software? Make sure that your PC software and instrument embedded software are compatible. Yellow indicators in the **Connect** dialog box are displayed when the instrument (embedded) software version is incompatible with the PC software. Green indicators are displayed when instrument and PC software are compatible.
- Reboot needed? The instrument can be rebooted using the **Reset** button on the LI-7550 control panel. Pressing the Reset button restarts the boot process; if connected via Ethernet, the instrument will attempt to reconnect to the PC software. If connected via RS-232, you may need to restart the PC software and reconnect manually.

Figure 8-1. Reset button in the LI-7550.

Issues with gas analyzer measurements

Bad temperature readings

Temperature sensor connected? Be sure that the sensor is connected to the LI-7550.

Bad pressure readings

- Pressure source set incorrectly? You can select the source of pressure measurements, as described in *Inputs* on page 10-18. If the source is **Measured**, the readings come from the pressure sensor inside the LI-7550. If the source is **Auxiliary Input 2** , then the pressure is from an external sensor that you have connected. This signal is modified according to the Auxiliary Coefficients that appear on that same page. If the source is **User-Entered**, then whatever you enter manually in the text box is used for the value.

- Instrument pressure doesn't match your barometer? The pressure sensor in the LI-7550 is good to about 0.1%. For operating purposes, it doesn't need to be very good (see *A note about pressure and temperature* on page 11-7). When setting the span(s) of the instrument, however, it is more important.

Bad CO_2 or H_2O readings

- Signal strength OK? Under the **Diagnostics** page, check the values of **Signal Strength**. Even if the signal strength looks acceptable, you may need to clean the optical windows.
- Are the diagnostic flags (PLL, etc.) OK? Under **Diagnostics**, check the diagnostics. See *Diagnostics* on page 10-33 for more information.
- Zero and Span OK? Go to the **Calibration** page and make sure the current values of zero and span are near 1.
- Calibration coefficients correct? Make sure all of the coefficients on **LI-7500/RS > Calibration > Coefficients** match the calibration sheet for the head. You can get the calibration certificate from the LI-COR web site. The Band Broadening coefficient should be 1.15.

Absorptances make sense, densities don't

If the absorptance value seems correct (rough rule of thumb: absorptance = 0 when density = 0, CO_2 absorptance is about 0.1 with a mole fraction of about 400 ppm, and H_2O absorptance is about 0.1 with a mole fraction of about 20 mmol/mol), but the displayed values of density or mole fraction are obviously bad, then the problem is in one of the following: calibration coefficients, span parameter, pressure value, and the band broadening value (CO_2 only).

Readings very noisy

The variability in absorptance values should be low, with only the 4th decimal place changing once in a while. If density or mole fraction is still noisy, watch the temperature and pressure values to see if they are the source of the noise (or change to a hand entered, constant value to try this). Check the calibration coefficients and band broadening value (if the problem is with CO_2) to make sure they are correct.

Gas analyzer diagnostics

Diagnostic information can help identify performance issues with the gas analyzer.

Diagnostic value in data files

The cell diagnostic value is a 1 byte unsigned integer (value between 0 and 255) with the following bit map. See *Gas analyzer diagnostics in EddyPro* on page 8-11 to learn how these are treated in data processing.

Bit	Name	Description
0 to 3	Signal Strength	Value × 6.67 = Signal Strength.
4	Sync	1 = OK
5	PLL	Phase lock loop, 1 indicates that optical wheel is rotating at the correct rate.
6	Detector	1 = Detector temperature is near setpoint 0 = Detector temperature is not near setpoint
7	Chopper	1 = Chopper wheel temperature is near setpoint 0 = Chopper wheel temperature is not near setpoint

Example: A value of 125 (01111101) indicates Chopper not ok, and Signal Strength = 87% (1101 binary converted to decimal is 13, times 6.67).

CO_2 signal strength

The raw reference signal A_{co} (for CO_2) can be used for diagnostic purposes. A_{co} is insensitive to CO_2 and H_2O concentrations, so if it is reduced, it could be due to obstructions (dirt, precipitation, etc.) in the optical path. The value of this signal by itself is not very informative: all you are guaranteed of is that it will be somewhere between 0 and 65535, but more typically between 25000 to 50000. To get a useful diagnostic out of A_{co}, one needs to know the expected value for a particular instrument when everything is clean and normal. If A_{cx} is the maximum expected value for A_{co}, then we could calculate a signal strength S_c for CO_2 from

$$S_c = \frac{A_{co}}{A_{cx}} \times 100 \qquad (8\text{-}1)$$

S_c is on a 0 to 100 scale, where 100 is clean. This value is not 'clipped' at 0 or 100, so may slightly exceed 100, especially after signal strength is reset. This simply reflects slight differences from reality of the temperature compensation function *f (T)*, as shown below in 8-3.

The problem with an implementation this simple is that the raw signals are a function of not only the optical throughput (obstructions, source and detector aging, etc.), but also temperature. Unless one accounts for that, the S_c could actually respond to diurnal temperature changes as much or more than contamination changes. Thus, the proper A_{cx} needs to be a function of temperature. Fortunately, we characterize this response at the factory as part of the factory calibration of each individual unit, which allows us to use the following formulation for signal strength for CO_2:

$$S_c = \frac{A_{co}}{C_x \times f(T)} \times 100 \qquad \text{8-2}$$

where C_x is the maximum value of A_{co} that we would expect from this unit. The function *f(T)* characterizes how the raw reference signal varies with cooler voltage, *V*:

$$f(V) = \frac{0.2}{1 + b \times e^{c(V-2.5)}} + 0.8 \qquad \text{8-3}$$

Average values of *b* and *c* are 1.6 and 3.2, but the values for a particular unit are found on its calibration sheet. *Figure 8-2* below illustrates this function by showing the range of responses for a large population of LI-7500RSs.

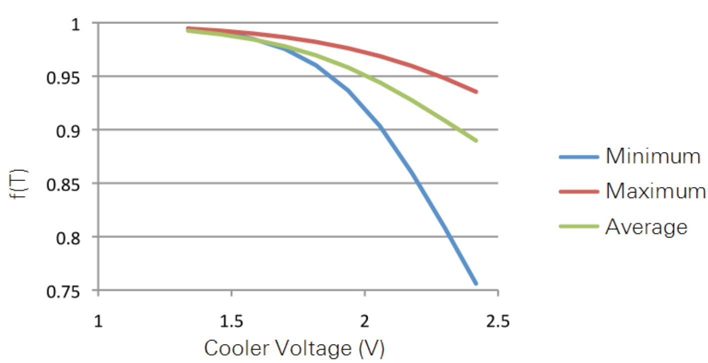


Figure 8-2. The function f(T) *characterizes how the raw reference signal varies with temperature.*

The C_x value is determined at the factory, but it is not really a “factory parameter”; it will likely change over time, due to source or detector aging, or even some thin-film contaminant that gets on a window that you just can’t clean off. Thus, the LI-7500RS has a provision for you to easily reset C_x to a value that reflects the reality of your instrument at any point in time. The Calibration button of the Windows Interface program (see *User calibration* on page 9-11) opens a window with a **Signal Strength** tab. There you will find a button labeled Reset Signal Strength that you can click if you’ve decided your instrument is as clean as you can reasonably make it, and you want to reset the signal strength to 100. It does this by using the current value of A_{co} and performing the following computation:

$$C_x = \frac{A_{co}}{f(V)} \tag{8-4}$$

A signal strength-based value is available from the LI-7500RS when using the PC software. The instrument’s grammar also makes S_c available for output.

Diagnostics in EddyPro on the SmartFlux System

Diagnostic information for the gas analyzer and sonic anemometer may be encoded in the data file. This information is then used by EddyPro to determine whether to use or discard the value. Details on EddyPro processing are provided in the EddyPro documentation. Here we provide a summary of the diagnostic information.

Gas analyzer diagnostics in EddyPro

The LI-7500RS diagnostics are encoded and logged in the `.ghg` data file as a column. EddyPro reads the diagnostic to determine how to use each value. The diagnostics are given in *Table 8-1* below.

Table 8-1. Diagnostics information for the LI-7500RS.

Bit (0=BAD, 1=OK)	Description	EddyPro Action if Bad
0-3	AGC	Calculate AGC
4	Sync	Keep the record
5	PLL	Discard the Record
6	Detector	Discard the Record
7	Chopper	Discard the Record

Sonic anemometer diagnostics

Diagnostics from sonic anemometers are encoded as described by the manufacturer, except for the CSAT3B. All anemometer diagnostics are summarized below.

WindMaster/Pro

The Gill WindMaster/Pro diagnostic tatus codes are logged in the dataset. EddyPro on the SmartFlux System either uses or excludes the data based on the status codes.

Table 8-2. WindMaster/Pro diagnostics information.

Status Code	Description	Comments	EddyPro Action
00	OK	When the diagnostic value is zero, data are OK	Keep the record

Table 8-2. WindMaster/Pro diagnostics information. (...continued)

Status Code	Description	Comments	EddyPro Action
01	Sample Failure	Insufficient samples in the average period from Transducer Pair 1	Discard the record
02	Sample Failure	Insufficient samples in the average period from Transducer Pair 2	Discard the record
03	Sample Failure	Insufficient samples in the average period from Transducer Pair 3	Discard the record
04	Sample Failure	Insufficient samples in the average period from Transducer Pairs 1 and 2	Discard the record
05	Sample Failure	Insufficient samples in the average period from Transducer Pairs 1 and 3	Discard the record
06	Sample Failure	Insufficient samples in the average period from Transducer Pairs 2 and 3	Discard the record
07	Sample Failure	Insufficient samples from all Transducer Pairs	Discard the record
08	NVM Error	NVM Checksum failed	Discard the record
09	ROM Error	ROM Checksum failed	Discard the record
0A	System gain at Maximum	Results OK, but marginal operation	Keep the record
0B	Retries	Retries used	Keep the record

HS-50

The Gill HS-50 diagnostics are encoded in the dataset. EddyPro on the SmartFlux System either uses or excludes the data based on the status codes.

Table 8-3. HS-50 diagnostics information

Status Code Bit	Value	Description	EddyPro Action
	0	No error	Keep the record
0	1	Transducer Pair 1 failed	Discard the record
1	2	Transducer Pair 2 failed	Discard the record
2	4	Transducer Pair 3 failed	Discard the record
3	8	Reserved	
4	16	Memory error	Discard the record
5	32	PRT failed	Discard the record

CSAT3

The Campbell Scientific, Inc. CSAT3 sonic anemometer diagnostics are logged with the dataset as a diagnostic value. EddyPro Software on the SmartFlux System extracts the 4 bits (12-15) out of diagnostic variable and treats it as 4 bit number (shifted to the right). If one of the bits is set the resulting integer is recorded in the data file.

Diagnostic Value	Decodes to	CSAT3 Bit Set
0	0000	None
1	0001	b12
2	0010	b13
3	0011	b12 and b13
4	0100	b14
5	0101	b12 and b14
6	0110	b13 and b14
7	0111	b12, b13, and b14
8	1000	b15
9	1001	b12 and b15
10	1010	b13 and b15
11	1011	b12, b13, and b15
12	1100	b14 and b15
13	1101	b12, b14, and b15
14	1110	b13, b14, and b15
15	1111	b12, b13, b14, and b15

The CSAT3 diagnostics and the way they are treated in EddyPro are given in *Table 8-4* below.

Table 8-4. CSAT3 diagnostics information.

Bit Set	Value	Description	Comments	EddyPro Action
	0	OK	When the diagnostics value is zero, data are OK.	Keep the record
12	4096	Sonic signal amplitude is too low	There may be an obstruction in the anemometer path or on the transducer face.	Discard the record

Table 8-4. CSAT3 diagnostics information. (...continued)

Bit Set	Value	Description	Comments	EddyPro Action
13	8192	Sonic signal amplitude too high	An obstruction was removed from the anemometer path or the transducer face.	Discard the record
14	16384	Low signal	The anemometer path length may have been altered or the anemometer head is broken.	Discard the record
15	32768	Difference in the speed of sound between the three non-orthogonal axes is greater than 2.360 m s^{-1} (~4 °C @ 25 °C)	The anemometer path length may have been altered or the anemometer head is broken.	Discard the record

CSAT3B

CSAT3B diagnostic values are logged in the data set.

Table 8-5. CSAT3B diagnostics information.

Bit Set	Value	Description	Comments	EddyPro Action
	0	OK	When the diagnostics value is zero, data are OK.	Keep the record
0	1	Low amplitude	Ultrasonic signal is too small.	Discard the record
1	2	High amplitude	Ultrasonic signal is too large.	Discard the record
2	4	Tracking	The signal lock is poor	Discard the record
3	8	High Delta C	Difference in the speed of sound between the three non-orthogonal axes is greater than 2.360 s-1 (~4 °C @ 25 °C).	Discard the record
4	16	Acquiring	Indicates that the anemometer is trying to acquire the sonic signal.	Discard the record
5	32	Low voltage	The supply voltage to the anemometer is below 9.0 VDC	Discard the record

Table 8-5. CSAT3B diagnostics information. (...continued)

Bit Set	Value	Description	Comments	EddyPro Action
6	64	Trigger error	A measurement trigger has not been received for at least 1 second, or the time interval between triggers is varying by greater than 5%.	Discard the record
7	128	Internal humidity warning	The relative humidity inside the CSAT3B block is greater than 80%	Discard the record
8	256	Memory error	There is a signature mismatch from the calibration file or another section of memory.	Discard the record

METEK

Diagnostic information from the METEK Class and Cage ultrasonic anemometers is encoded in the data file.

RM Young

Diagnostic information from the RM Young anemometers is encoded in the data file.

Section 9.
Maintenance

The section describes maintenance procedures for the gas analyzer and components.

Cleaning the gas analyzer optical path

Important: Power off the gas analyzer (disable the power supply or disconnect the power cable) before conducting any maintenance that involves disassembly or disconnecting cables. Disassembling the instrument or detaching or attaching head cables while the instrument is powered on may damage the instrument or result in a loss of data.

The upper and lower optical windows should cleaned when necessary (visible dirt or stains, or smaller than expected CO_2 Signal Strength).

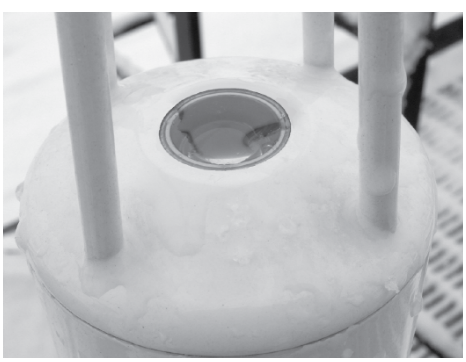


Figure 9-1. Water on the sapphire window can cause low signal strength (formerly AGC). Image from an original LI-7500 on a roof top on a snowy day (January 2001) in Lincoln, NE. Note the small puddle of water on the lower window. The signal strength was near 0.

The windows are sapphire, and are extremely durable and resistant to scratches; clean the windows with any mild detergent or glass cleaner. Also, coating the windows with a water resistant windshield type coating (such as Rain-X®) or a high quality automobile type wax may help prevent droplets from remaining on the windows during rainstorms. Mounting the sensor head at a 10 to 15° angle from vertical will help prevent water from pooling on the window (see *Figure 9-1* on the previous page).

Replacing SmartFlux 2 System fuses

Power for the SmartFlux System and the pass-through power supply are protected by fuses. This section describes how to replace a blown fuse. **Pass-through power** flows through the SmartFlux System to pins on ports 1, 2 and 3 to power a connected sonic anemometer. To change the fuses, power off the SmartFlux System. Remove the power and data terminal strips. Remove the six screws on the side of the case and remove the case lid.

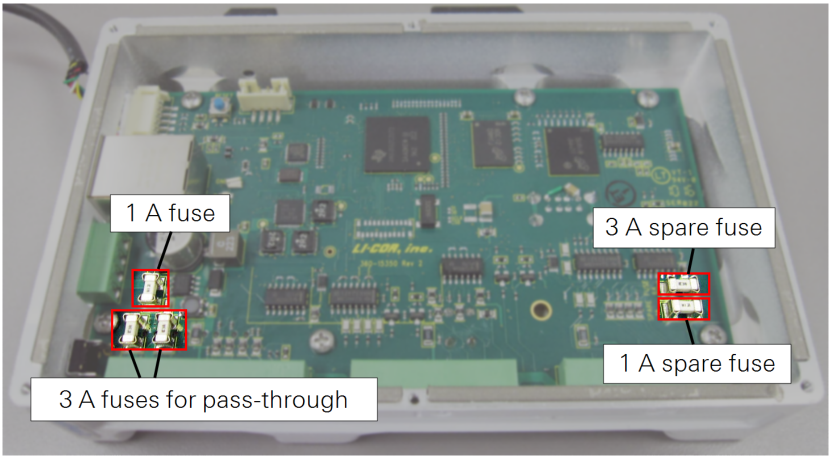
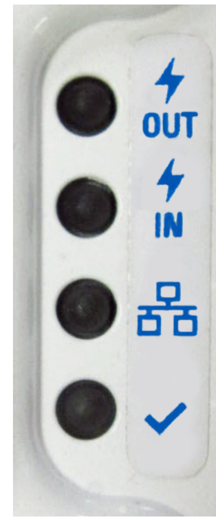


Figure 9-2. Fuses inside the SmartFlux 2 System.

> **Important:** Take care to avoid damaging nearby electronic components when removing fuses. Especially avoid prying on top of other electronic components.

3.0 Amp fuse for pass-through power



The SmartFlux System uses two 3.0 A fuses between the Power IN connector and the serial ports (see *Figure 9-2* on the previous page). One of these fuses is for the power wire to the anemometer or other connected device. The other 3.0 A fuse is for the power return wire and protects the system in case problems such as improper grounding cause a power surge.

If the SmartFlux System boots up and has power, but the **Power OUT** LED does not light up, it is likely that one of the two 3.0 A fuses has failed.

1. Measure both 3.0 A fuses with an ohmmeter. If one of them is an open circuit, replace it with the spare 3.0 A fuse.
2. Remove the failed fuse and the spare 3.0 A fuse by gently prying under each fuse with a small flat-bladed screwdriver.
3. Gently press the good (spare) fuse into the fuse holder. If both 3.0 A fuses are blown, you will need to order another 3.0 A fuse (part number 348-16020).
4. Replace the lid and six screws on the SmartFlux 2 case.

> **Important:** A blown 3.0 A fuse usually indicates a wiring problem between the SmartFlux System and the sonic anemometer or other connected device. Check for proper system grounding and remove possible causes of a short circuit in the power cable for the connected device. Also, while this fuse is rated at 3.0 A, keeping power use at 2.0 A or less will ensure a nearly unlimited lifetime for the fuse.

1.0 Amp fuse

If the **Power OUT** LED lights up, but the **Power IN** LED does not light up, it is likely that the 1.0 A fuse has failed (see *Figure 9-2* on the previous page).

1. Measure the 1.0 A fuse with an ohmmeter. If it is an open circuit, replace it with the spare 1.0 A fuse (part number 348-13880).
2. Remove the failed fuse and the spare 1.0 A fuse by gently prying under each fuse with a small flat-bladed screwdriver.

3 Gently press the good (spare) fuse into the fuse holder.

4 Replace the lid and six screws on the SmartFlux case.

> **Important:** A blown 1.0 A fuse may indicate a problem with the SmartFlux 2 or 3 System. If the spare 1.0 A fuse also fails when installed, contact LI-COR support.

Replacing LI-7550 Fuses

> **Important:** Power off the gas analyzer (disable the power supply or disconnect the power cable) before conducting any maintenance that involves disassembly or disconnecting cables. Disassembling the instrument or detaching or attaching head cables while the instrument is powered on may damage the instrument or result in a loss of data.

Early models of the LI-7550 have one fuse for the power supply. Later models have two fuses—one for the power supply and one for the accessory. To check a fuse, inspect it for evidence that it is burned and use an ohm meter to check the resistance. Resistance of <1 Ω (ohm) indicates that the fuse is OK.

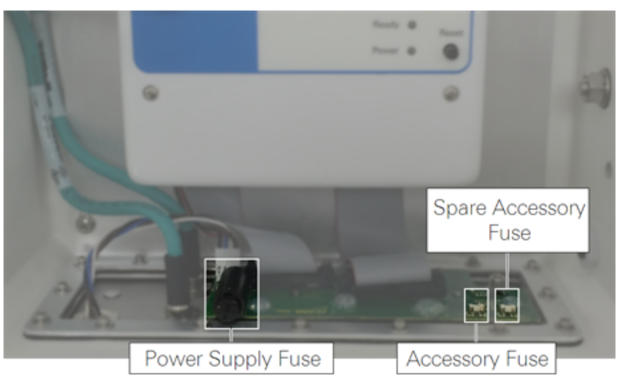


Figure 9-3. LI-7550 fuse locations.

Power Supply Fuse

The power supply is protected by a 5 A 125/250V, 5 × 20 mm fast-blow fuse (part number 439-04214). If the battery or other power source fails to power the instrument, check to see if the fuse has blown.

The fuse is located in the lower left-hand corner, as shown in *Figure 9-3* on the previous page. Replacement fuses (part number 439-04214) are in the spares kit. Use a flat blade screwdriver or your thumb to push down on the fuse holder cap and turn counterclockwise to release the cap.

Accessory Fuse

The accessory uses a 2 A $Nano^2$ SMF Fuse. There is one spare fuse included in the LI-7550. If the heated intake tube will not power on or continuously triggers an error, check the fuse and replace it if necessary.

Replacing the internal chemicals

> **Important:** Power off the gas analyzer (disable the power supply or disconnect the power cable) before conducting any maintenance that involves disassembly or disconnecting cables. Disassembling the instrument or detaching or attaching head cables while the instrument is powered on may damage the instrument or result in a loss of data.

There are two small plastic bottles, each containing Ascarite II and magnesium perchlorate, in the analyzer housing that keep the optics free of CO_2 and water vapor. These bottles should be replaced with new bottles annually (or every 6 months in hot, humid climates). Replacement bottles are available from LI-COR in sets of two (part number 7500-950). If you want to recharge the bottles yourself, see *Suppliers* on page D-1 for a list of suppliers of Ascarite II and magnesium perchlorate.

> **Note:** Calibration shifts will occur if CO_2 or H_2O are not kept out of the analyzer housing.

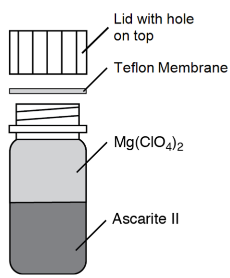
To change the sensor head soda lime and desiccant bottles:

1 Remove the chemical bottles.

The plastic bottles are in the lower analyzer housing in the sensor head. Remove the mounting bracket from the analyzer. Then remove the thumbscrew and thread it into a cap. Pull straight out to remove the plug.

2 Remove the lids from the old bottles (these lids have holes in them) and install them on the new bottles.

3 Place the Teflon membrane in the lid to keep the chemicals from spilling.



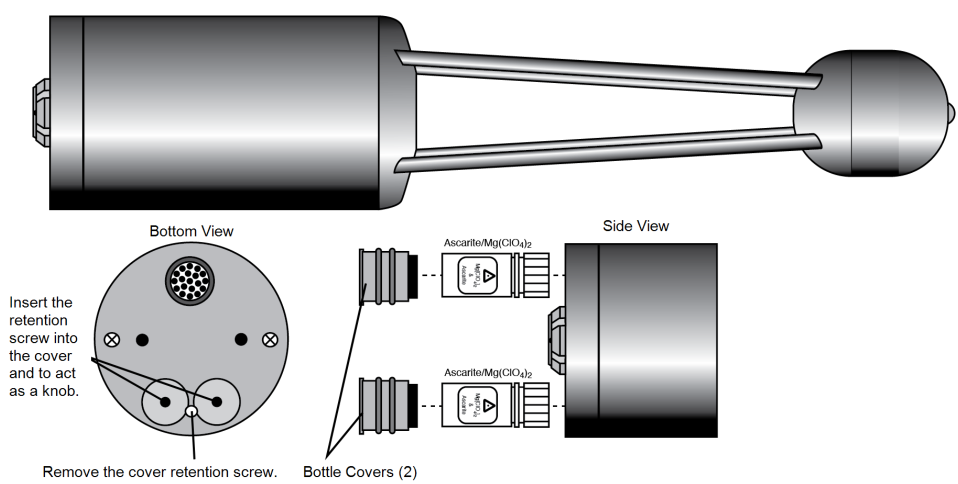


Figure 9-4. Remove the thumbscrew, thread into the bottle covers, and pull to remove the bottle cover.

4. Insert the new bottles into the analyzer housing cap first. Replace the bottle covers and the cover retention screw and reattach the mounting bracket.
5. After installing, ***allow at least 24 hours (with the instrument powered on)*** to scrub the housing; otherwise, the instrument may still drift.

   This should be followed by setting the CO_2 and H_2O zeros. Check the zero again, if possible, after one or two days.

> **Note:** Read the technical note called "Using CO_2 and H_2O Scrubbers with LI-COR Gas Analyzers" for information about the interactions between scrub chemicals and the air.
> See https://www.licor.com/documents/7i418s3uhd2uamoxfmjd.

Software updates

Go to licor.com/7500rs-software for the latest versions.

We recommend running the most current software at all times, including both the embedded and interface software for the LI-7500RS or LI-7200RS, EddyPro, and embedded software on the SmartFlux System. Check the installed version of the embedded analyzer software by clicking the **Diagnostics** tab at the top of the .

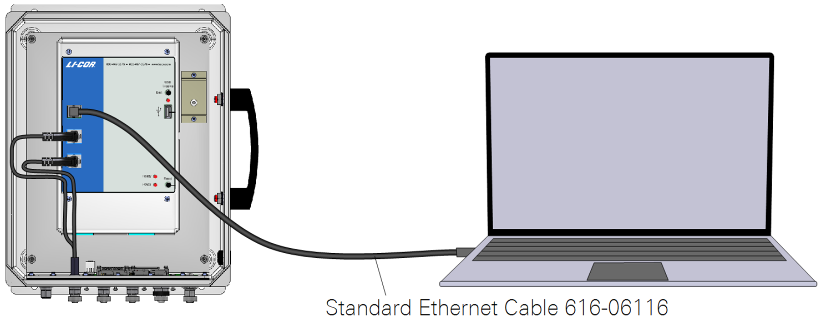
On the support web site, select your instrument, then select **Software.** Download both the **Instrument (Embedded) Software** and the **Windows Interface Software.**

Embedded instrument software

To update the embedded instrument software:

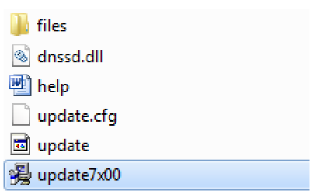
1. Make sure your gas analyzer sensor head is connected to the LI-7550 Analyzer Interface Unit. Power up the gas analyzer. Connect your computer to the system Ethernet switch (as shown) or to an open Ethernet port inside the LI-7550 using an Ethernet cable with standard RJ45 connectors.

   Important: *There must be a USB drive in the LI-7550 USB port. For the best speed and performance, it's best to use a USB drive with no data on it.*

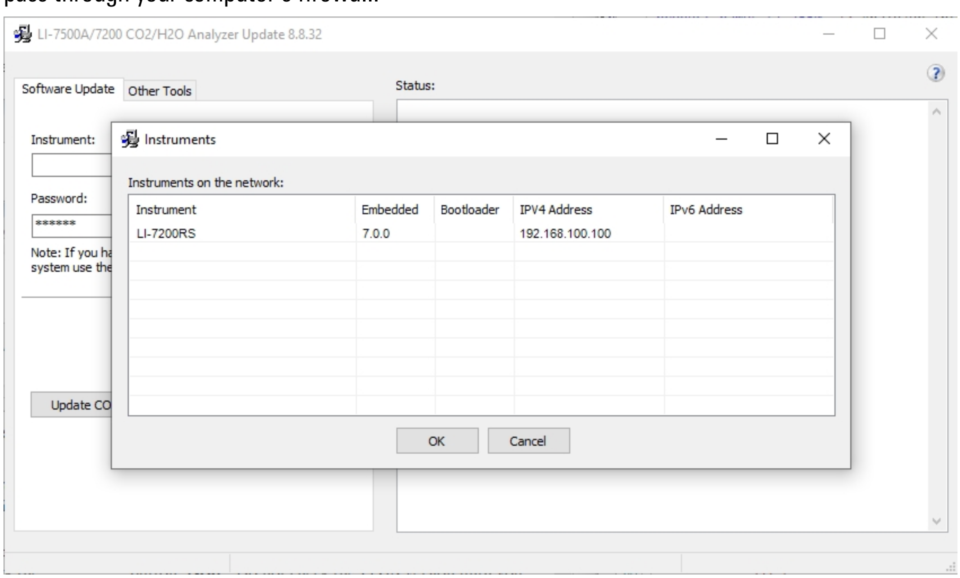


The Instrument (Embedded) Software is a zipped file named something similar to **LI-7xxx_embedded-7.0**. Unzip the files and save them.

2 Double-click the file called **update7x00**.



3 Click **Browse...** and select the instrument from the list. You may need to allow the application to pass through your computer's firewall.



4 Select the gas analyzer from the list and click **Update Software**.

The update will take about 5 minutes.

Important: *Do not close the software, let your PC go to sleep, or power off the instrument during the update process.* The software will notify you when the update is complete. If the update fails for any reason, repeat steps 2 and 3.

If you are updating from embedded version 4.x.x or earlier, you must also run the FPGA update. To check if this update is necessary click the **Check FPGA** button. **Note:** Do not check the FPGA version until you update the system software.

If the FPGA update is needed the **Update FPGA** button will become enabled in the application. The FPGA update takes approximately 10-12 minutes.

Important: *Do not close the software or reset the instrument while the update is taking place. The software will notify you once the FPGA programming is finished.*

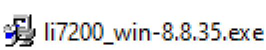
5 After updating the software, check all your instrument configuration settings. The instrument should retain all settings through a software update, but in unusual circumstances, some settings may be lost.

Troubleshooting: Getting an update error? There must be a USB drive installed in the LI-7550 USB port before you can update. Also, if the drive is inserted for the first time, the instrument will take a few minutes to connect with the drive.

Windows interface software update

To update the Windows interface software for gas analyzers:

1 The Windows interface software is an executable file named something similar to **LI-7x00_win-8.0**. Double click to launch the installer.



2 Follow the Windows Installation wizard to install the application.

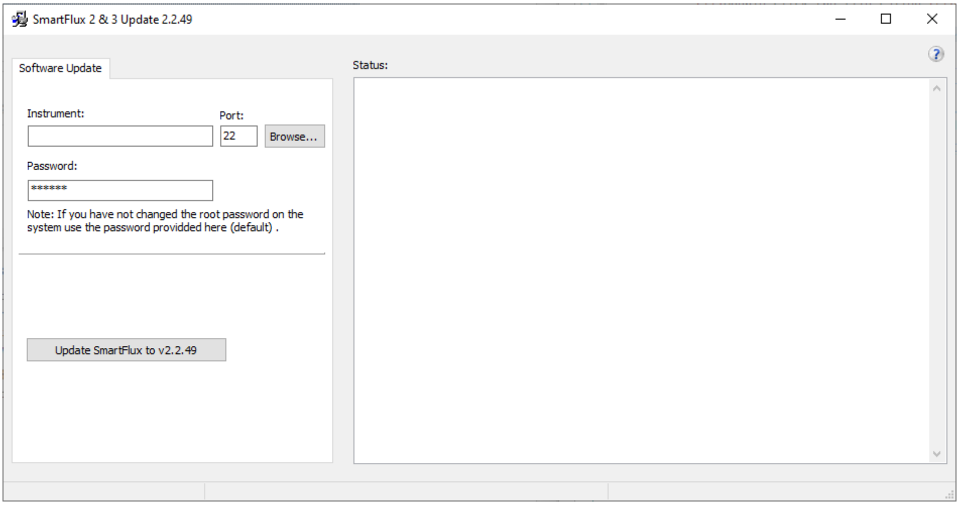
SmartFlux 2 System software update

To update the software:

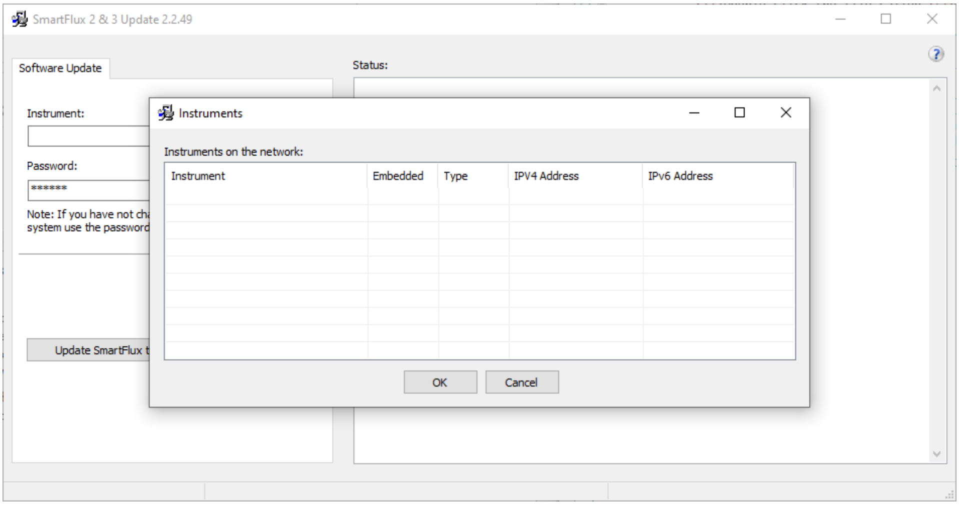
1 Save the SmartFlux software update package to your computer.

It is a collection of files in a zipped folder. Extract the contents of the file.

2 Double click the file called **update7x00.exe**.



3 Click Browse to view systems. You can also enter SmartFlux IP address or hostname as the Instrument.



You may need to allow the updater to pass through your computer firewall. Your computer firewall may prompt you if required. All SmartFlux 2 and 3 Systems connected to your network will be visible in the window.

4 After selecting system or entering the IP address, click **Update Firmware**.

The updater will load the new system files. This process takes about 30 seconds to a minute to complete the update. Do not power off the device while it is updating.

User calibration

The LI-7500RS's measurement accuracy depends upon its calibration. There are two major components to the calibration: 1) determining the values of calibration coefficients, and 2) setting zero and span. During a factory calibration, both of these steps are performed. The values of the coefficients that are determined should be valid for several years. The zero and span adjustments are used to bring the LI-7500RS's actual response into line with its previously determined factory response at least at two points.

Important: Check the zero and span at regular intervals; monthly at first, and then adjust the frequency according to the stability of the instrument; see *How stable are zero and span*? below.

How stable are zero and span?

The analyzer's zero is primarily affected by temperature and the condition of the internal chemicals. The internal chemicals should be changed annually (see *Replacing the internal chemicals* on page 9-5). The zero's response to temperature is relatively small (typically 0.1 or 0.2 ppm per °C for CO_2, or 0.01 mmol/mol/°C for H_2O). Also, this drift is measured at the factory, and subsequently compensated for in software (equation 11-3), so the effective zero drift should be quite small. Therefore, the zero should be quite stable over a several month period, but you might want to check it after an extreme temperature change (>30 °C).

The analyzer's span is affected by temperature, pressure, and the state of the internal chemicals.

- Temperature: A 10 °C change will typically change the H_2O span by 1 to 2%. For CO_2 at ambient concentrations, the span is very insensitive to temperature.
- Pressure: A large pressure change (40 kPa) will affect the CO_2 and H_2O spans by <1%, for ambient CO_2 concentrations (>400 ppm) and high humidities (20 mmol/mol). So, diurnal pressure variations should not be a concern.

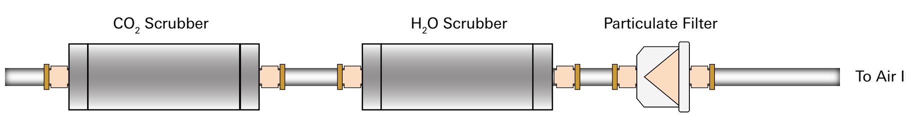
- Chemicals: Reduced internal chemical effectiveness will affect the span, but the effect on the zero will be much more pronounced. In summary, span stability is mostly a concern with H_2O, when there are large temperature changes.

> **Note:** Read the technical note called "Using CO_2 and H_2O Scrubbers with LI-COR Gas Analyzers" for information about the interactions between scrub chemicals and the air.
> See https://www.licor.com/documents/7i418s3uhd2uamoxfmjd.

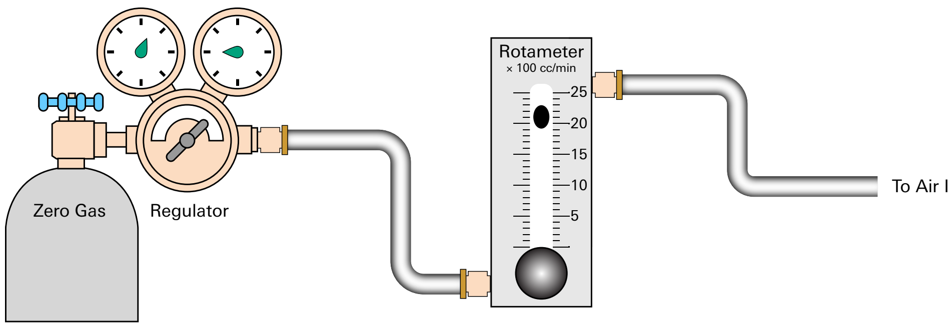
Checking the Zero

Flow a dry CO_2-free air through the optical path and check the analyzer reading in the software dashboard. A suitable source of air for setting the zero can be generated with chemical scrubbers (such as soda lime for removing CO_2 and magnesium perchlorate or Drierite® for removing water), or obtained from a cylinder of zero-grade gas.

When using chemical scrubbers, make sure that the chemicals are fresh and that air goes through the chemicals in the right order: Soda lime first, desiccant last (if the desiccant is Drierite®, allow time for the CO_2 to "wash out" of it). Use a small pump to push the air through the gas analyzer.

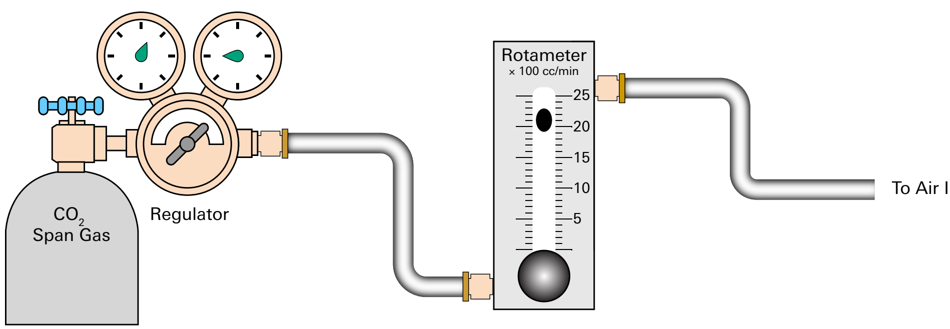


When using a cylinder, make sure that the air in the cylinder really is CO_2-free since a typical cylinder of standard grade nitrogen might have as much as 20 ppm of CO_2 in it. Compressed cylinders may be at pressures of several thousand pounds per square inch; before using them for calibration, they should be fitted with a regulator to reduce the pressure down to a range of around thirty pounds per square inch. Set the flow rate from 0.5 to 1.0 lpm.

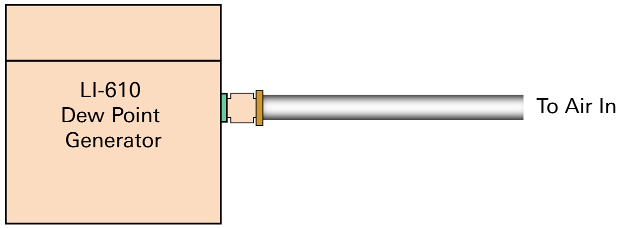


Checking the Span

Check the CO_2 span with a cylinder of CO_2 in air at a concentration that is at the higher end of the range of concentrations which may be encountered during measurements. For example, a 500 to 1000 PPM cylinder of CO_2 in air, which has been verified to be accurate to within at least 1% would be a suitable choice for many applications. Be cautious, as the stated value of the calibration cylinder may be significantly different from the actual gas concentration. Set the flow rate to 0.5 to 1.0 lpm. Check the analyzer reading in the software dashboard.



For the water vapor span, a convenient standard to use is a dew point generator such as the LI-COR LI-610. To avoid condensation problems choose a dew point temperature that is about 3 to 5 °C below the ambient temperature. Also, since water vapor sorbs and desorbs from surfaces, allow plenty of time for the reading to stabilize. Set the flow rate from 0.5 to 1.0 lpm. Check the analyzer reading in the software dashboard.



> **Note:** In general, if reliable calibration standards are not available or if there is not enough time to do the job properly, it is better to leave the zero and span settings alone than to rush through the procedure and make incorrect settings.

Span is a linear function of absorptance, so there is an offset term and a slope term. Both are determined at the factory, and when a (normal) span is set by the user, only the offset term changes. The slope term can be changed by performing a secondary span at a much different concentration than the previous (normal) span.

Step-by-step calibration instructions

To adjust the zero and span calibration:.

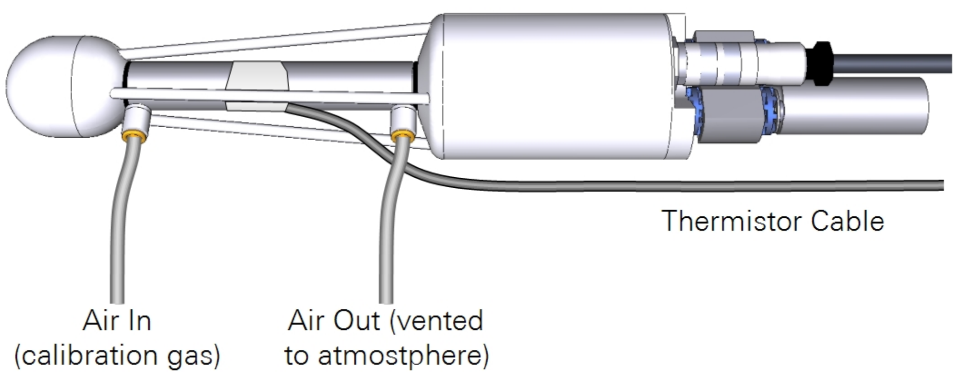


Figure 9-5. Flow calibration gas into the calibration fitting. Attach a 15 cm (6 in.) piece of tubing to the outlet to vent to the atmosphere and prevent diffusion of ambient air into the calibration fitting.

1. Clean the LI-7500RS lenses using a soft, lint-free cloth and mild detergent if needed.
2. Disconnect the temperature thermistor at the **Sensor** connector on the LI-7550 connector panel and connect the cable from the calibration shroud.

3 Insert the calibration shroud into the analyzer.

Insert the top of the fixture through the widest opening in the struts, near the bottom window. Slide it up, and then slide the bottom into place. It is important that the fixture is centered between the source and detector windows. View the CO_2 Signal Strength while centering the fixture. If the CO_2 Signal Strength value increases when the fixture is in place, it indicates that one or both of the windows are partially or totally obscured. Move the fixture back and forth until the CO_2 Signal Strength value reads the same as before the fixture was inserted. The fixture is easy to center; if it looks centered, it probably is.

4 Flow CO_2-free air through the calibration accessory at a rate of about 0.5 to 1.0 LPM.

Attach the zero gas to the calibration fixture at one of the ports shown in *Figure 9-5* on the previous page. The calibration accessory has quick connect fittings for use with standard 1/8” I.D. Bev-a-line (or other) tubing.

Zero CO_2

Important: Always zero the instrument before spanning (don’t span, then zero).

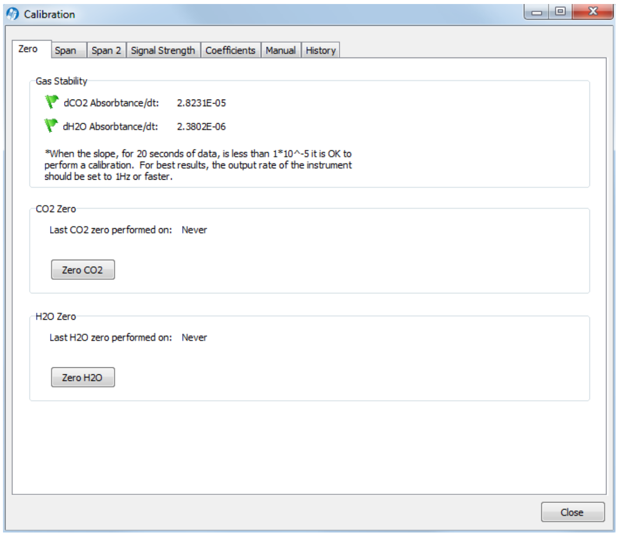
5 In the PC software, click **LI-7500/RS > Calibration**.

Verify that temperature reading looks OK by checking its value in the dashboard.

6 Click on the **Manual** tab and view the value of Z_{co} (CO_2 Zero).

7 Click the **Zero** tab.

When the reading has stabilized in the dashboard, and the **Gas Stability** flag is green, click **Zero CO2** to set the CO_2 zero.



After a brief delay, the displayed CO_2 value should be fluctuating around zero. Check the value of Z_{co} shown on the **Manual** tab. It should be near 1 (typically between 0.8 and 1.2). This value will steadily increase over time (2-3 months) as the internal chemicals lose effectiveness.

Zero H_2O

Now is a good time to check or set the H_2O zero, if you have been flowing dry, CO_2-free air through the optical path.

8 Click the **Manual** tab, and note the present value of Z_{wo} (H_2O Zero).

Wait for the H_2O reading to stabilize in the dashboard (3 or 4 minutes). The **Gas Stability** flag will turn from a red 'X' to a green flag when it is OK to perform the calibration.

9 Click the **Zero** tab, and click **Zero H_2O**. Note the new value of Z_{wo} (typically between 0.8 and 1.2).

Span CO_2

10 Flow a CO_2 span gas through the calibration tube at 0.5 to 1 liter/minute.

11 Click on the Span tab and enter the mole fraction in the **Span gas concentration** field.

12 When stable (1-2 minutes) click **Span CO2**.

Click the **Manual** tab and check the new CO_2 Span value S_c (typically between 0.8 and 1.2).

Span H_2O

13 To set the H_2O span, flow air of known dew point through the calibration tube at about 0.5 to 1.0 LPM.

To prevent condensation, use a dew point temperature several degrees below the ambient temperature.

14 Click the **Manual** tab, and note the present value of the H_2O Span value S_w.

Go back to the **Span** tab and enter the span gas dew point temperature in the **Dew point temperature** field.

15 Observe the H_2O dew point in the dashboard and wait for it to stabilize.

The **Gas Stability** flag will turn from a red 'X' to a green flag when it is OK to perform the calibration. ***This may take up to 15 or 20 minutes.***

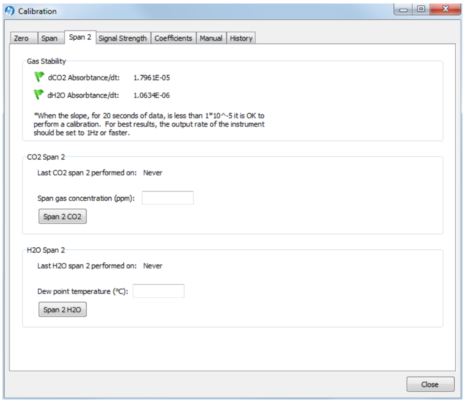
16 When the reading has stabilized, click **Span H2O**.

Click the **Manual** tab again and note the new H_2O Span value S_w (typically between 0.8 and 1.2).

Considerations for setting the secondary span

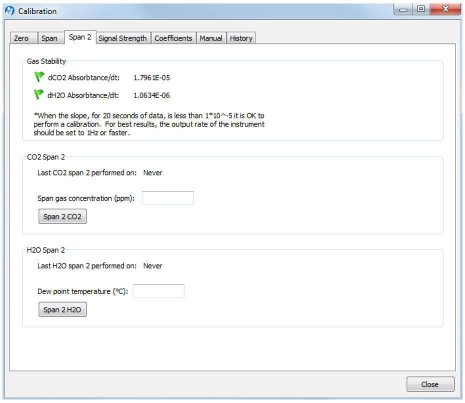
If you find that after zeroing then spanning at one concentration, the instrument is not within specifications at a different concentration, a secondary span may be in order. The most common reason for doing this would be after a change in the chopper housing temperature set point. The two gas concentrations used for the span and secondary span should be as far apart as possible. For example, at the factory, this is typically done for CO_2 using 200 ppm and 3000 ppm. At a minimum, the pair should be at least 500 ppm apart, and bracket your intended operating range (e.g. 300 ppm and 800 ppm). For H_2O, you are constrained by the temperature of the air. You would normally choose a very low dewpoint, such as 5 °C, and something close to (just below) ambient. If the air temperature is 15 °C or less, you should probably avoid doing a secondary water vapor span.

Secondary CO_2 pan



1. Zero the CO_2 reading (see *Zero CO2* on page 9-15).
2. Span the CO_2 reading at a concentration below your normal operating range (something in the 200-300 ppm range, see *Span CO2* on page 9-16).
3. Flow a CO_2 concentration that is at or above your upper operating range (above 800 ppm, for example).
4. Click on the Span 2 tab, and when stable, click **Span 2 CO2**.

Secondary H_2O span



1. Zero the H_2O reading (see *Zero H2O* on page 9-16).
2. Span the H_2O reading at a dew point that is just below the ambient temperature (see *Span H2O* on the previous page).

3 Flow a very low dew point through the tubing.

4 Click on the Span 2 tab, and when stable, click **Span 2 H_2O**.

It may take another 10 minutes or so to ensure equilibrium is reached when changing from one concentration to another, due to water present in the tubing, etc.

> **Note:** For both the CO_2 and H_2O secondary spans, you can reverse the concentrations if you wish. The normal span can be the high concentration, and the secondary the low concentration. Also, multiple secondary spans can follow a normal span. Simply make sure that the concentration difference between the normal span and any secondary span is large.

What actually happens

In the LI-7500RS the zero and span parameters are set in software (see *Manual* on page 10-16). What actually happens when the zero is set is that the value of Z_{c0} (or Z_{w0} for water) is determined. For example, when CO_2-free air is in the optical path of the analyzer, α_c should be 0. From equation 11-17,

$$\alpha_c = 0 = \left(1 - \left[\frac{A_c}{A_{c0}} + X_{wc}\frac{A_w}{A_{w0}}\right](Z_{c0} + Z_c V_d)\right) \qquad 9\text{-}1$$

so

$$Z_{c0} = \frac{1}{\frac{A_c}{A_{c0}} + X_{wc}\frac{A_w}{A_{w0}}} - Z_c V_d \qquad 9\text{-}2$$

Similarly,

$$Z_{c0} = \frac{1}{\frac{A_c}{A_{c0}} + X_{wc}\frac{A_w}{A_{w0}}} - Z_c V_d \qquad 9\text{-}3$$

When the span is set, the value of S_{c0} (or S_{w0} for water) is determined. For example, if there is a known CO_2 density $\rho'c$ in the optical path and the measured absorptance is α'_c, then from equations 11-19 and 11-8, we can write

$$\rho'_c = P_{ec} f_c \left(\frac{\alpha'_c(S_{c0} + S_{c1}\alpha'_c)}{P_{ec}}\right) \qquad 9\text{-}4$$

so

$$S_{c0} = \frac{P_{ec} f_c^{-1}\left(\frac{\rho'_c}{P_{ec}}\right)}{\alpha'_c} - S_{c1}\alpha'_c \qquad \text{9-5}$$

We rewrite this in terms of a known mole fraction m'_c instead of density.

$$S_{c0} = \frac{P_{ec} f_c^{-1}\left(\frac{m'_c P}{P_{ec} RT}\right)}{\alpha'_c} - S_{c1}\alpha'_c \qquad \text{9-6}$$

If we assume that the CO_2 span gas is dry, then $P_{ec} = P$, so

$$S_{c0} = \frac{P_{ec} f_c^{-1}\left(\frac{m'_c}{RT}\right)}{\alpha'_c} - S_{c1}\alpha'_c \qquad \text{9-7}$$

Similarly, for a known H_2O mole fraction m'_w and resulting measured absorptance α'_w,

$$S_{w0} = \frac{P f_w^{-1}\left(\frac{m'_w}{RT}\right)}{\alpha'_w} - S_{w1}\alpha'_w \qquad \text{9-8}$$

Whenever the CO_2 span is set, the instrument saves two values that are used if and when a secondary CO_2 span is performed. These values are

$$I_c = P f_c^{-1}\left(\frac{m'_c}{RT}\right)$$

$$A_c = \alpha'_c \qquad \text{9-9}$$

When a secondary span for CO_2 is performed at a mole fraction m'_c with measured absorptance a'_c, then the span slope term S_{c1} is computed from

$$S_{c1} = \frac{\frac{P f_c^{-1}\left(\frac{m'_c}{RT}\right)}{\alpha'_c} - \frac{I_c}{A_c}}{(\alpha'_c - A_c)} \qquad \text{9-10}$$

A new offset term S_{c0} is then computed using equation 9-7, since the slope term S_{c1} has changed. Similarly, for H_2O, each time a normal water span is set, the instrument retains

$$I_w = P f_w^{-1}\left(\frac{m'_w}{RT}\right)$$

$$A_w = \alpha'_w \qquad \text{9-11}$$

and when a secondary H_2O span is performed at water mole fraction m'_w with measured absorptance a'_w, then the span slope term is computed from

$$S_{w1} = \frac{\frac{Pf_w^{-1}\left(\frac{m'_w}{RT}\right)}{\alpha'_w} - \frac{I_w}{A_w}}{(\alpha'_w - A_w)}$$

and a new offset term S_{w0} is computed from equation 9-8.

Section 10.
Software reference

This section describes the connection options for configuring the instrument, followed by a description of the software features. The LI-7500RS can be configured from a computer that is running Windows 7 or newer.

Connection options

Launch the software to open the **Connect** window, where you set the parameters for communication between the instrument and your computer.

Connect over Ethernet

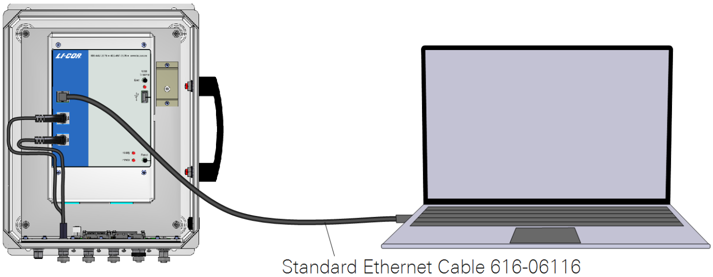


Figure 10-1. Option 1: Plug a standard Ethernet cable into an Ethernet port inside the LI-7550. Plug the other end directly into a computer or computer network.

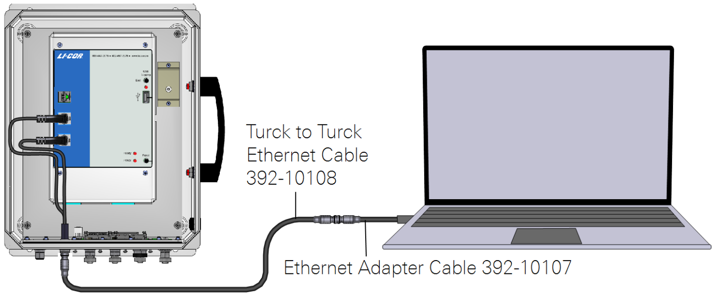
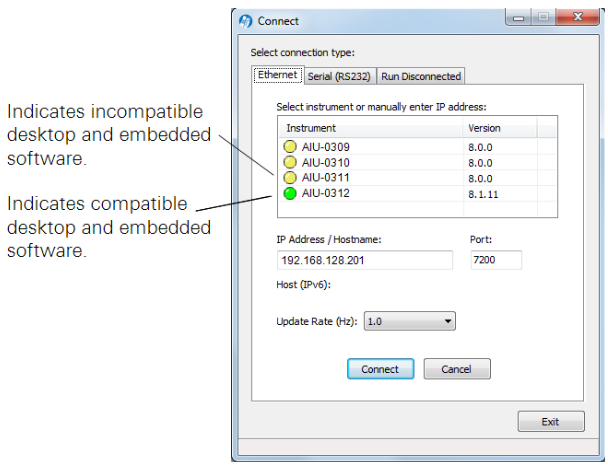


Figure 10-2. Option 2: Connect to the Ethernet port on the exterior of the LI-7550 enclosure. Plug the other end (RJ45 connector) directly into a computer or computer network.

If the instrument is powered on and connected to an Ethernet port on the same subnet as your computer, its name will be displayed in the software. The default instrument name is the serial number of the Analyzer Interface Unit.



- Yellow indicators show that the instrument embedded software is ***incompatible*** with the PC software. You can still connect, but there may be issues.
- Green indicators show that the instrument embedded software is ***compatible*** with the PC software.

Note: We recommend that you always use the most up-to-date software and that your PC software and the instrument embedded firmware are compatible. Go to www.licor.com/env/support to get the latest instrument software.

The **Update Rate** is the communication frequency between the instrument and the computer. Select from 0.1, 0.2, 0.5, 1, 2, 5, 10, or 20 Hz.

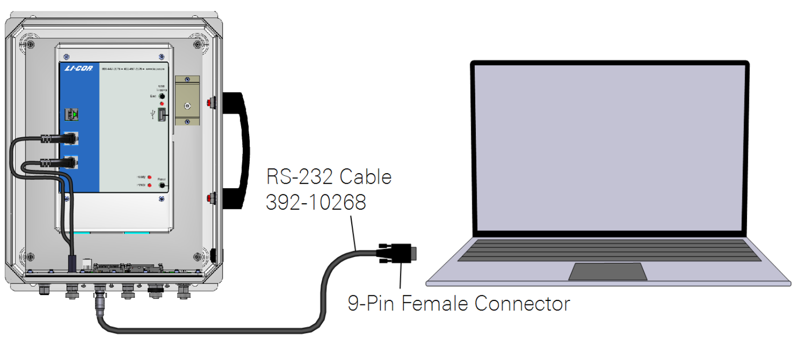
Note: When connecting over satellite or cellular networks that have data limits, connect at a lower update rate (such as 0.1 Hz) to limit the amount of data used.

Click on the **Connect** button to establish communications with the instrument. If something is wrong, it will time out after about 15 seconds. If this happens, make sure you selected the correct instrument and retry.

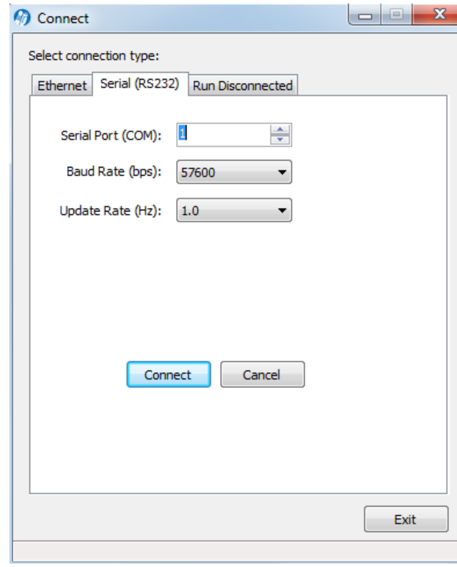
Connect over RS-232 serial

The LI-7550 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.

Note: You may need a USB to RS-232 adapter to use the serial connection. LI-COR part 6400-27 is a suitable adapter.

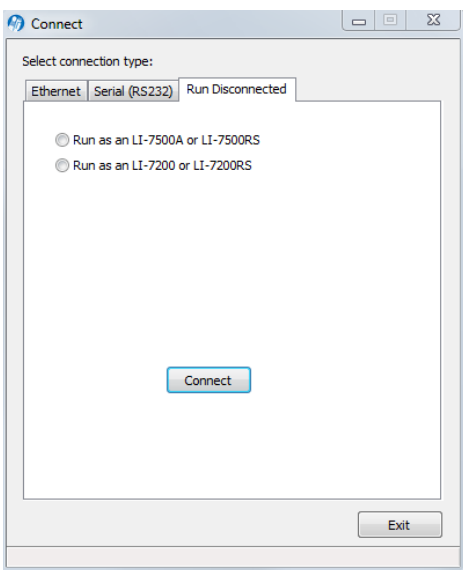


Select the communication baud rate for the serial port. The maximum update rate is dependent upon the rate available with your computer's serial port and the **Update Rate** used while the program communicates with the instrument. Select from 9600, 19200, 38400, 57600, or 115200.



The Update Rate is the communication frequency between the instrument and the computer. Select from 0.1, 0.2, 0.5, 1, 2, 5, 10, or 20 Hz. ***Note that at 9600 baud, the maximum update frequency is 2 Hz; at 19200 baud, 5 Hz; at 38400 baud, 10 Hz; at 57600 baud, 15 Hz; and at 115200 baud, 20 Hz.*** Click the **Connect** button to establish communications with the instrument.

Run disconnected

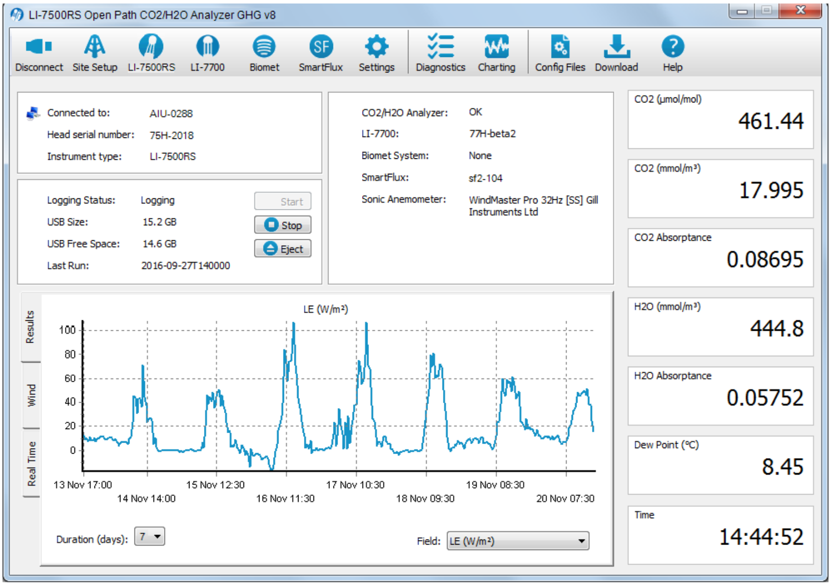


The PC software can be used independently of an instrument by clicking on the **Run Disconnected** tab and selecting the instrument. This can be useful for training purposes, or for creating a configuration file that can then be saved and transferred to instruments in the field. Much of the functionality of the software is disabled in this mode (e.g., data will not appear, so charting is unavailable), but features that do not require an active connection are fully functional.

> **Note:** See *Configuration files* on page 10-38 for more information on creating a configuration file for later use.

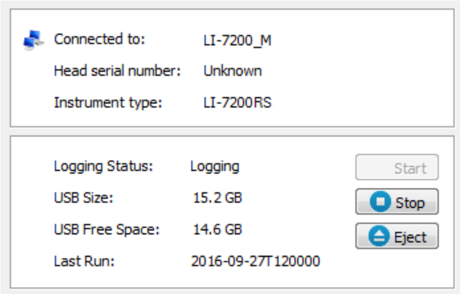
Dashboard

The dashboard provides status and diagnostic indicators, live data values, and graphs of flux results. In addition, it is used to configure the gas analysis settings, set eddy covariance parameters, connect with an LI-7700, connect with a biomet system, and connect with the SmartFlux System.



Instrument information and data logging status

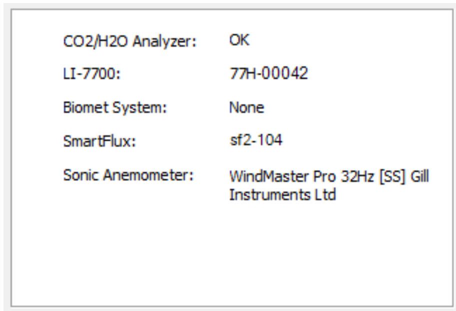
Information about the CO_2/H_2O gas analyzer is presented in this pane.



- **Connected to**: Indicates the network name of the gas analyzer.
- **Head serial number**: Serial number of the CO_2/H_2O analyzer sensor head.
- **Instrument type**: Indicates the model of the CO_2/H_2O analyzer.
- **Logging Status**: Indicates **Logging** or **Not logging.**
- **USB Size**: Total storage capacity of the USB drive inside the LI-7550.
- **USB Free Space**: Available space on the USB drive inside the LI-7550.
- **Last Run**: Last half-hour flux processing run by Eddypro® inside the SmartFlux System. Gives the most recent date and time when data collection began.
- **Start** button: Starts a logging session.
- **Stop** button: Stops a logging session.
- **Eject** button: Stops activity so the USB drive inside the LI-7550 can be safely removed.

Instrument performance and connection status

Instrument status information is presented in the **status pane**.



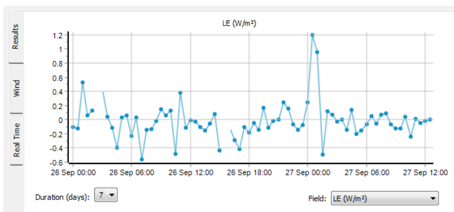
> **Note:** The warning symbol ( ) indicates that the component is in need of attention or that it is not communicating properly.

- **CO2/H2O Analyzer**: Indicates the status of the CO_2/H_2O gas analyzer.
- **LI-7700**: Indicates the status of the LI-7700 Open Path CH_4 Analyzer (optional).
  - **None**: LI-7700 not connected.
  - **Name of LI-7700**: Connected.
- **Biomet System**: Indicates the status of the Biomet Station, if installed.
  - **None**: Biomet not connected.
  - **Name of Biomet System**: Connected.
- **SmartFlux**: Indicates the status of the SmartFlux System
  - **None**: SmartFlux System not connected.
  - **Serial Number of SmartFlux System**: Connected. Note: A warning symbol ( ) indicates "waiting to connect" or that the system has become disconnected.
- **Sonic Anemometer**: Indicates the status of the sonic anemometer if using SmartFlux 2.
  - **None**: Sonic anemometer not connected or not present. Note: If the EC system does not include SmartFlux 2, the anemometer may still be connected.
  - **Name of the sonic anemometer**: Connected.

Graphs

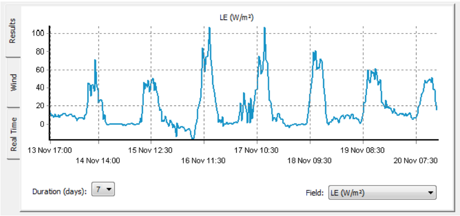
Click on one of the three tabs on the left side of the graphing pane. The **Real Time** tab provides real-time graphing of measured variables. The **Results** tab displays eddy covariance flux results from the SmartFlux System. The **Wind** tab displays a graph of wind speeds by direction.

- **Real Time**: Current data measured by the instrument. Click the button to open the charting.

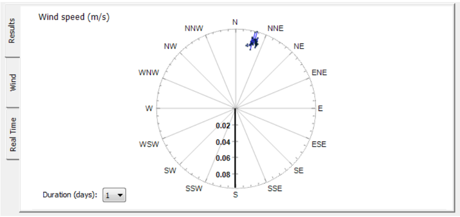


> **Note:** It may take several minutes after you select a tab for data to load into the graph.

- **Results**: Presents fully processed flux results (SmartFlux System required) for the variables that are measured at the site. **Duration** sets how many days of data are displayed (maximum of 7 days). **Field** sets the flux variable that is displayed. The variables available are:
  - H (W/m^2),
  - LE (W/m^2),
  - ET (mm/h),
  - CO_2 Flux ($\mu mol/m^2/s$),
  - CH_4 Flux ($\mu mol/m^2/s$; LI-7700 required),
  - u* (m/s),
  - CO_2 (µmol/mol),
  - H_2O (mmol/mol),
  - CH_4 (µmol/mol; LI-7700 required).

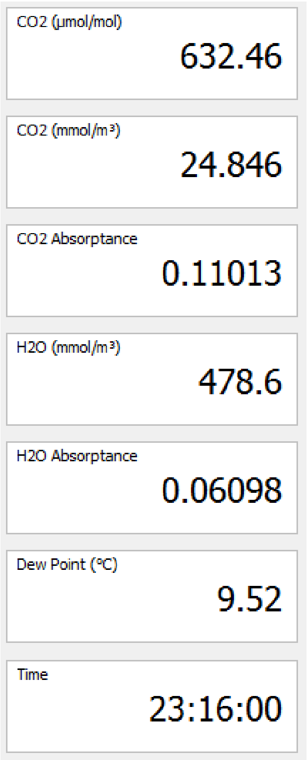


- **Wind speed:** Presents mean wind speed by direction. **Duration** sets how many days of data are displayed.



Data display

Measured variables are displayed on the right of the dashboard. To change a variable displayed click directly on a data value and select a new item from the **Data Items** menu.



The variables available for display are given in *Table 6-2* on page 6-2.

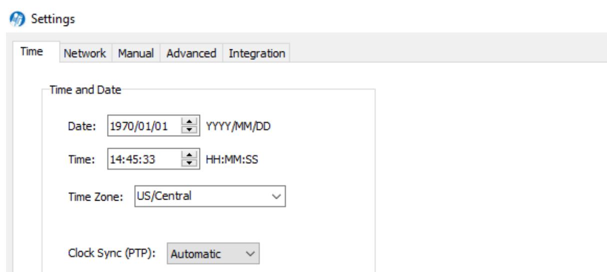
Other software settings

This section describes features that have not been described elsewhere.

Settings

Under **Settings**, you can set the instrument time, network configuration, send commands, change the chopper housing temperature set point, and integrate CO_2 measurements.

Time



This is where you set the instrument time and date. The instrument clock uses the Precision Time Protocol (PTP) time keeping system. PTP is a high precision time synchronization protocol for networked devices. Devices controlled with PTP can maintain accuracy in the sub-microsecond range with a sufficiently accurate master clock. PTP is defined in the IEEE 1588-2002 and 1588-2008 standards, entitled “Standards for Precision Clock Synchronization Protocol for Networked Measurement and Control Systems.” A detailed summary of IEEE-1588 is available at www.ieee1588.com. Full documentation is available for purchase from the Institute of Electrical and Electronics Engineers (IEEE) at www.ieee.org.

The basic principle behind PTP is that the best time keeping can be accomplished with multiple networked devices by synchronizing all device clocks to the most precise clock on the network. Each clock on the network has a rating that indicates its relative accuracy. The IEEE 1588 protocol specifies the use of a Best Master Clock algorithm to determine which clock on the network is the most accurate. On a network, the most accurate clock becomes the master clock and all other clocks sync to the master clock.

The software implementation of PTP provides accuracy in the 10 microsecond range. When used with the SmartFlux System, the GPS clocks will become the master clock for the system.

About time keeping

The LI-7500A/RS/DS and LI-7200/RS are network-based instruments and it is possible for multiple users to log data from a single instrument over multiple TCP/IP connections. Consequently, the analyzer uses Coordinated Universal Time (UTC) for its onboard timekeeping tasks. The default time stamp is therefore UTC based, but local time can be set, if desired.

Generally, we recommend that the system synchronizes its time to the GPS clocks. The instrument uses a time zone database that includes local time zones that are kept as constant offset from UTC. These time zones are listed as 'Etc/GMT' + offset. However, these time zone names beginning with 'Etc/GMT' have their sign reversed from what is commonly used. Thus, zones west of GMT have a positive sign, and those east have a negative sign. For example, US/Central Standard Time is 6 hours behind GMT, and in the database this time zone is listed as 'Etc/GMT-6'.

Unix time is the number of seconds elapsed since the Unix epoch of 00:00 Coordinated Universal Time (UTC) January 1, 1970 (or 1970-01-01T00:00:0Z ISO 8601). For example, the time stamp 1262884605 translates to 01/07/2010 at 05:16:45 UTC. The date and time are converted to a conventional display format (YYYY-MM-DD; HH:MM:SS) and adjusted based on the time zone setting that you select.

The time stamp in each file header shows the instrument time and time zone.

Setting the clock

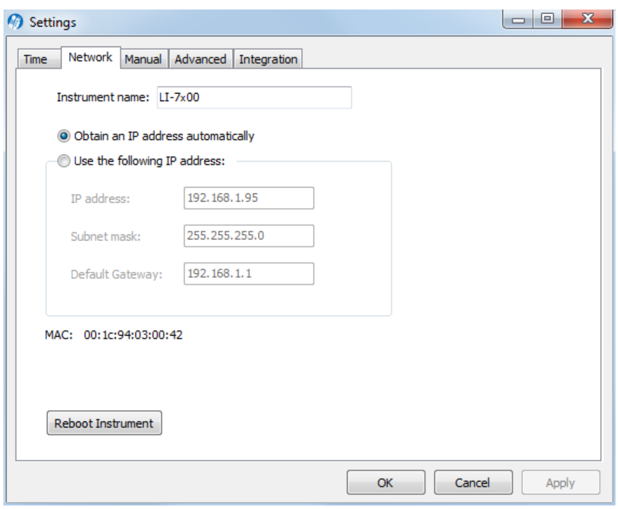
1. Connect to the gas analyzer.
2. Open the Settings window.
3. Set the Clock Sync (PTP).
4. Choose your time zone.
5. Click **Apply** or **OK**.

The PTP clock settings available are:

- **Off**: Turns PTP time keeping system off. Instrument time will be determined by the Date and Time set by the user, even if there is a better clock on the network.
- **Automatic**: The gas analyzer searches the network and syncs to the most accurate clock using the Best Master Clock algorithm (could be the gas analyzer). This setting should be used in most circumstances.
- **Slave Only**: The gas analyzer always syncs to another clock. It will search the network and synchronize to the best clock.
- **Preferred**: The gas analyzer uses its own internal clock unless it finds a better clock on the network.

Network

The instrument name is given in the **Connect** window and **Settings > Network** window. You can change this name in **Settings > Network**. The name can include upper and lower case letters (A to Z; a to z), numbers (0 to 9), dash (-), and period (.). Other characters are invalid and will cause communication errors with the system.



The **IP address** (Internet Protocol) is a numerical identifier that is assigned to devices participating in a computer network. In many cases this address is assigned automatically (Dynamic IP address). In other cases, your network administrator may assign a permanent address (Static IP address) that can be entered manually.

With **Obtain an IP address automatically** selected, the IP address, Subnet mask, and Default Gateway fields are filled in automatically; if you choose to enter the IP address manually, the address fields are editable.

The **Subnet mask** is a set of 4 octets used to separate an IP address into two parts; the network address and the host address. The **Gateway** is a node that routes traffic to another network.

Manual addressing

You can connect to an instrument by manually enter the IPv4 Address or Host-name of the instrument. The IP address can be set automatically by a network or assigned manually in **Settings > Network > Use the following IP address.** If IPv6 (Internet Protocol version 6) addressing is available on the network and enabled on the computer, the instrument's IPv6 address is displayed as well.

Both the LI-7500A/RS/DS and LI-7200/RS use the **Port** number 7200 for Ethernet communications. Therefore, when connecting to the instrument on a network you will enter the IP address of the instrument and port 7200 in the connection window of the software to initiate communication. You can select the instrument from the list of instruments on the same network as your computer or connect your computer directly to the instrument Ethernet port.

Port forwarding

In some network setups it may be necessary to forward communication traffic on a port from a public IP address to a private IP address to gain access to an instrument. For example, assume you have an analyzer installed in the field and the instrument is connected to a wireless gateway such as a cellular modem. The instrument will acquire a **private** IP address from the cellular modem, but this address is only visible to nodes on the private network. On the other hand, the cellular modem is assigned a public IP address that can be accessed from any node on the Internet. For this discussion let's assume the public address is 166.66.77.88. In order to connect to the instrument in the private network, a port forwarding rule must be created in the cellular modem to "forward" all communications on port 7200 coming into the modem to the private IP address of the instrument.

Instrument	Exaple Public IP	Public Port	Private IP	Private Port
1	166.66.77.88	7200	192.168.13.201	7200

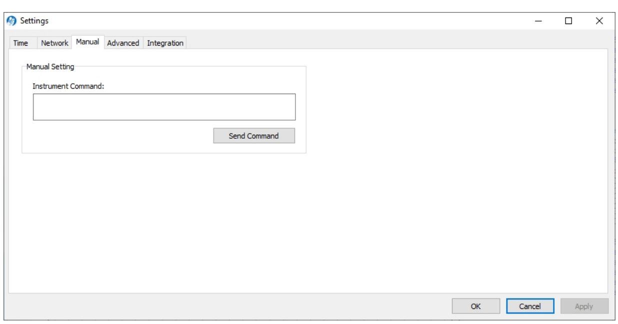
The public port number should be changed when there is more than one LI-7500A/RS/DS or LI-7500/RS instrument in the private network. In this case, to connect to each instrument, two port forwarding rules must be set up, similar to that shown below.

Instrument	Example Public IP	Public Port	Private IP	Private Port
1	166.66.77.88	7201	192.168.13.201	7200
2	166.66.77.88	7202	192.168.13.202	7200

You can run multiple LI-7500A/RS/DS or LI-7200/RS software sessions at the same time to communicate with different analyzers. Simply double-click on the software icon to open another session, and connect to a different instrument.

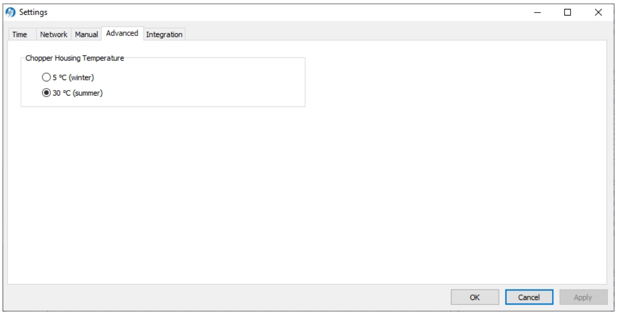
Manual

A command line field is present that allows you to send a command to the instrument. This can be useful for diagnosing problems, as a LI-COR technician can gauge the instrument's response to given commands, and determine if the instrument is functioning properly. Contact LI-COR technical support for details on the grammar.



Advanced—Chopper housing temperature

The chopper motor housing temperature can be set to a lower operating temperature (5 °C) in winter to reduce power consumption and minimize heating by the electronics. We recommend changing the setting only when the average ambient temperature drops below 5 °C. You can change the setting back to 30 °C when the average ambient temperature is above 5 °C. Note, however, that the instrument will still function properly when the chopper motor housing temperature is set to 30 °C, even when temperatures are below 5 °C.



Do not set the chopper housing temperature to 5 °C when ambient temperatures are above 5 °C, however, as the instrument will not function properly.

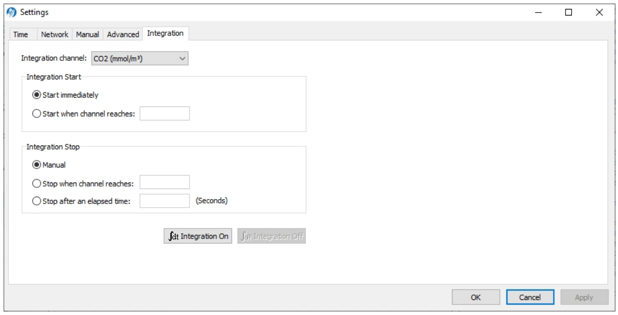
Important: When changing between winter and summer settings, you will need to perform a zero and dual span calibration.

Integration

Allows for the setup of an integration function using a selected CO_2 source (mmol/m^3, µmol/mol, or dry µmol/mol). The integrated value selected can be viewed as a data source in the main software window (choose **Integral** in the Data Items list). To integrate a CO_2 source:

1. Choose a source to be integrated from the Integration Channel list.
2. Choose the method to start the integration; immediately, or using a threshold value.
3. Choose the method to stop the integration; manually, with a threshold value, or after a user-entered elapsed time has expired.
4. Enter the threshold value for the start or stop (or both) of the integration, if either was chosen in Steps 2 or 3 above.
5. Click on the Apply button.

If **Start Immediately** was chosen for the **Start Time**, the integration function is started and/or stopped manually by clicking the **∫dt Integration On** or **∫dt Integration Off** buttons (available on the dashboard, as well).



Example: Start integrating CO_2 (µmol/mol) after it reaches a value of 500 µmol mol^{-1}, and continue integrating for 5 minutes.

6 Choose **CO2 (µmol/m^3)** from the Integration Channel list.

7 Click **Start when channel reaches** button and enter 500 in the text entry field.

8 Click the **Stop after an elapsed time** button and enter 300 (seconds) in the text entry field.

9 Click **Apply**.

10 Click the **∫dt Integration On** button. Click **OK** to dismiss the dialog.

The integration result (area under the curve) can be viewed in the dashboard.

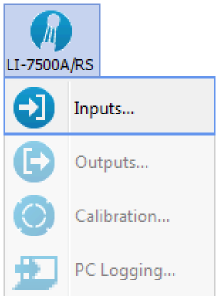
Menu overview

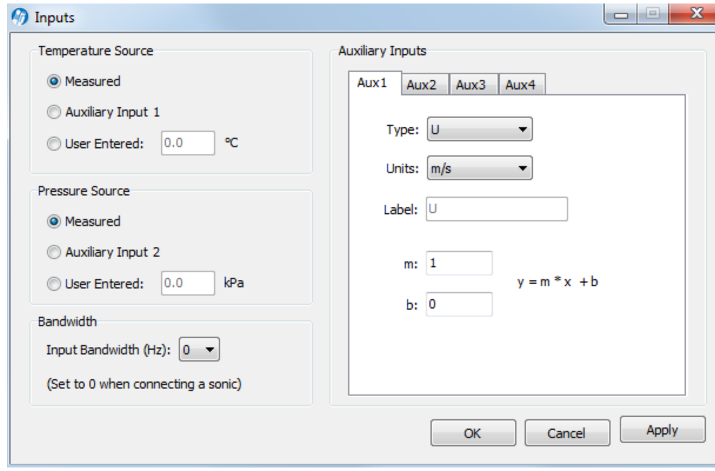
The LI-7500RS menu provides access to **Inputs**, **Outputs**, **Calibration**, and **PC Logging** settings.

Inputs

There are three things to configure under **Inputs:**

- **Auxiliary Inputs:** Can be used for sonic anemometer analog data.
- **Temperature Source**: Specifies whether the temperature source is the instrument, a temperature sensor on Auxiliary Input 1, or a User Entered value.
- **Pressure Source**: Specifies whether the temperature source is the instrument, a pressure sensor on Auxiliary Input 2, or a User Entered value.





Temperature and pressure values are required to convert CO_2 and H_2O density (mmol/m^3) to mole fraction (μmol/mol or mmol/mol). In addition, the analyzer requires a pressure value to compute CO_2 or H_2O mole density, and a temperature value to perform the band broadening correction for H_2O on CO_2.

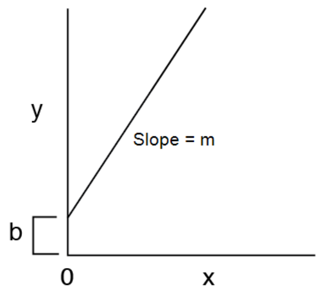
If you use your own temperature and/or pressure sensors, one or two of these channels will be unavailable for anemometric data. If you use the on-board temperature and pressure sensors, all four auxiliary input channels are available for use with other sensors.

Choose **Other** for any sensor input other than a sonic anemometer. The **Units** field describes the data after the coefficients *m* and *b* are applied. The **Label** will appear in the header of the data file.

Each auxiliary input channel has two fields for the multiplier (*m*) and offset (*b*). Linear voltage inputs (0 to 5 V) use the slope-offset equation:

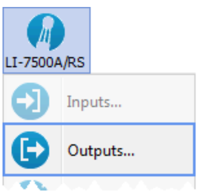
$$y = m*x + b \qquad 10\text{-}1$$

where *y* is the sensor output, *x* is the voltage output of the sensor, *b* is the Y-axis intercept (offset), and *m* is the calibration multiplier, which is the slope of the line representing the sensor's response.



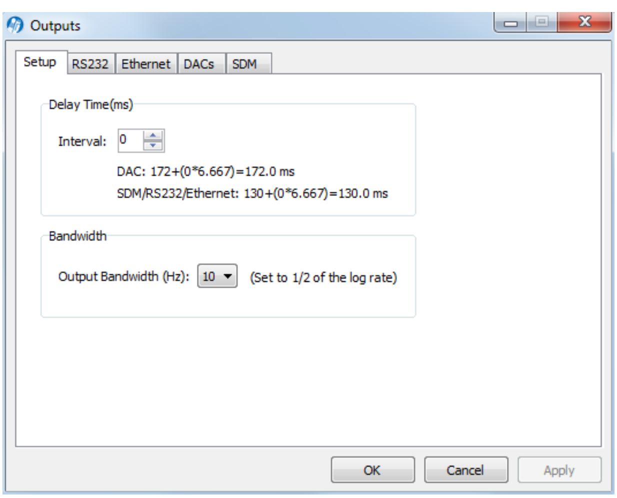
Outputs

Five options are available under the outputs tab: Setup, RS-232, Ethernet, DACs, and SDM..



Setup

The **Setup** tab presents **Delay Time** and **Bandwidth** settings that affect all outputs (RS-232, Ethernet, DACs, and SDM).



Output bandwidth

Bandwidth (5, 10 or 20 Hz) determines the signal averaging done by the digital filter. To avoid aliasing (only a concern for co-spectra, not for fluxes), **one should sample the gas analyzer at a frequency greater than or equal to 2 times the bandwidth**. Thus, if you are sampling at 10 Hz, the bandwidth is 5 Hz.

Bandwidth is the frequency at which the indicated amplitude is 0.707 of the real amplitude (*Figure 10-3* below).

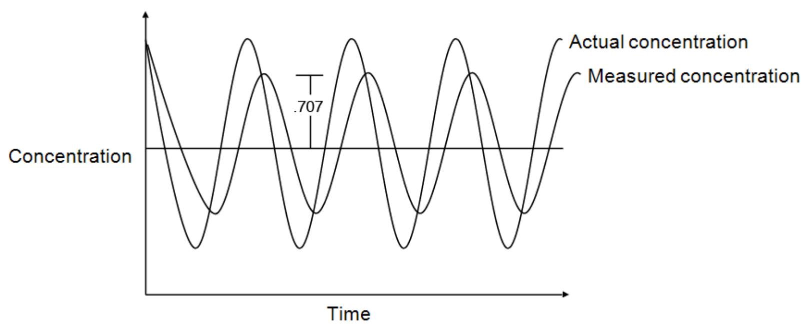


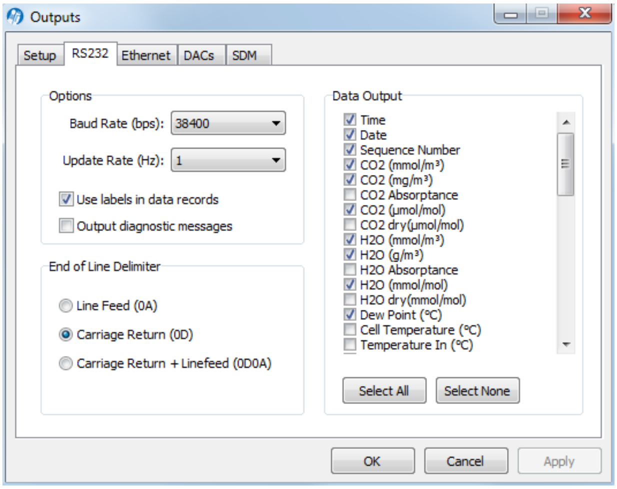
Figure 10-3. Bandwidth = 1/oscillation period.

Bandwidth is a useful indicator for characterizing real-world behavior in which there are fluctuating gas concentrations. Given a sinusoidal oscillation of concentration, the instrument's ability to measure the full oscillation amplitude diminishes as the oscillation frequency increases.

> **Note:** The bandwidth selection has no impact on the system delay. The filters were designed so they have exactly the same delay whether a 5, 10, or 20 Hz signal bandwidth is selected.

RS-232 output

The RS-232 tab is used to set the instrument's RS-232 port configuration for unattended data collection. After configuration, click **Apply**. The instrument will begin to send data out the RS-232 port according to these parameters after you disconnect from the instrument (or immediately if you are connected via Ethernet).



Use the Baud Rate menu to select from 9600, 19200, 38400, 57600, or 115200 baud.

Use the Update Rate menu to select from .1, .2, .5, 0, 1, 2, 5, 10, or 20 Hz. Note that at lower baud rates, you may not be able to output all data items at high frequencies. For example, at 9600 baud, the maximum update rate is 2 Hz, when outputting all 34 data items.

Note on Data Output Rates

When sending data via a serial connection (e.g., RS-232), note that the baud rate selected may limit the number of samples that can be output. A single line of data (all log values selected) consists of approximately 350 bytes (2800 bits), so the maximum output rate at the available baud rates becomes:

Baud Rate	Maximum Output Rate (Samples per Second)
9600	2
19200	5
38400	10
57600	15
115200	20

Under **Options**, you can choose whether or not to output labels with each data record, and whether to output diagnostic text records. An example of a data record sent with and without labels is shown below.

Data format with labels:

(Data (Ndx 87665) (DiagVal 757) (Date 2009-09-10) (Time 14:06:44:140) CO2Raw 0.0332911) (H2ORaw 0.19299) (CO2D 5.20672) (H2OD 755.566) (Temp 15.517) (Pres 99.4361)…

Data format without labels:

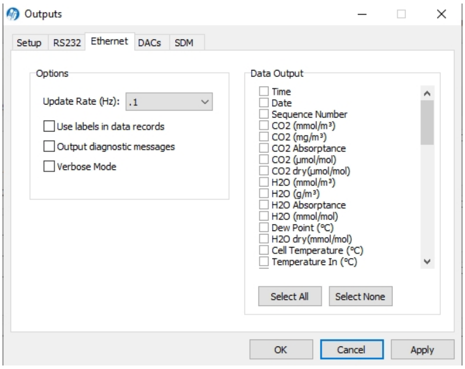
87665 757 2009-09-10 14:06:44:140 0.0332911 0.19299 5.20672…

The End of Line Delimiters determine the character(s) that terminate the data records. Depending on your recording device, a line feed, carriage return, or both may be required to properly parse the data records.

Under **Data Output**, select the data records that you want to output; click **Select All** to choose all, or **Select None** to disable all checked values.

Ethernet output

The **Ethernet** tab is used to set the instrument's Ethernet output. After configuration, click **Apply** and the analyzer will begin to send data out the Ethernet port according to these parameters.



Use the **Update Rate** menu to select from 0.1, 0.2, 0.5, 0, 1, 2, 5, 10, or 20 Hz.

Under **Options**, you can choose whether or not to output labels with each data record, whether to output diagnostic text records, and whether to use verbose mode. An example of a data record sent with and without labels is shown below.

Data format with labels:

```
(Data (Ndx 87665) (DiagVal 757) (Date 2009-09-10) (Time 14:06:44:140) CO2Raw
0.0332911) (H2ORaw 0.19299) (CO2D 5.20672) (H2OD 755.566) (Temp 15.517) (Pres
99.4361)…
```

Data format without labels

```
87665 757 2009-09-10 14:06:44:140 0.0332911 0.19299 5.20672…
```

Under **Data Output**, select the data records that you want to output; click **Select All** to choose all, or **Select None** to disable all checked values.

DAC configuration

The LI-7550 has the capability to output up to 6 variables on DAC channels 1-6. The DACs page allows you to configure the DAC output channels by specifying the source channel (e.g., CO_2 mmol/m^3) that drives the analog signal, the source channel value that corresponds to zero volts, and the source channel value that corresponds to full scale voltage (5V).

For example, to configure DAC #1 to output a voltage signal proportional to CO_2 mmol/m^3, 20 mmol/m^3 full scale, select CO_2 mmol/m^3 under DAC1 'Source', and set 0V = 0, and 5V = 20.

0V → 0(X_o, zero volts corresponds to 0 mmol/m^3)

5V → 20(X_F, full scale corresponds to 20 mmol/m^3)

When a voltage range R is selected, the DAC output voltage V resulting from a CO_2 molar value X is given by

$$V = R\frac{X - X_0}{X_F - X_0} \tag{10-2}$$

where R = 5V.

The DACs are linear, so in the example above, a measured voltage signal of 3 volts would correspond to a CO_2 mmol/m^3 value of 12.

For test purposes, you can also choose **Set Point** for the Source, and enter a Set Point voltage value; the DAC channel will then output that voltage continuously.

SDM output

SDM addressing allows multiple SDM-compatible peripherals to be connected to a single Campbell Scientific® datalogger. Choose an address under the SDM tab between 0 and 14.

SDM communications are enabled in Campbell Scientific dataloggers with one of two instructions, depending on the datalogger. For dataloggers programmed in EdLog (e.g. CR23X) SDM communications are enabled using instruction 189:SDM LI-7500. When using this instruction, parameter two (SDM Address) should be set to match the SDM address of the LI-7500RS. Parameter three (Option) is used to define what variables the datalogger collects from the instrument, and can take on values from 0 to 6 (see *Table 10-1* below for variables included in each option).

Below is a programming example of instruction 189 used to collect data from an LI-7500RS at SDM address 0:

```
1: SDM-LI7500 (P189)
1: 1        Reps
2: 0        SDM Address
3: 6        Get CO2 & H2O molar density, pressure, and cell diagnostic value
4: 49       Loc [ LI75000  ]
```

For dataloggers programmed in CRBasic (e.g. CR5000) SDM communications are enabled using the instruction CS7500. When using this instruction, parameter three (SDMAddress) should be set to match the SDM address of the LI-7500RS. Parameter four (CS7500Cmd) is used to define what variables the datalogger collects from the instrument. Unlike instruction 189, the CS7500 instruction supports a group trigger mode, so it can take on values from 0 to 7 (see *Table 10-1* below for variables included in each option). Below is a programming example of the CS7500 instruction used to collect data from an LI-7500RS at SDM address 0:

```
CS7500 (LI-7500(),1,0,6)
```

Table 10-1. Parameter 3 value definitions.

Mode	Items Sent
0	CO_2 (mmol/m^3) H_2O (mmol/m^3)

Table 10-1. Parameter 3 value definitions. (...continued)

Mode	Items Sent
1	CO_2 absorptance H_2O absorptance
2	Pressure (kPa) Temperature (°C) Aux channel #1 (user units) Cooler signal (Volts)
3	Diagnostic value (see below) Bandwidth (Hz) Delay interval
4	CO_2 (mmol/m^3) H_2O (mmol/m^3) CO_2 absorptance H_2O absorptance Pressure (kPa) Temperature (°C) Cooler signal (Volts) Diagnostic value (see below) Bandwidth (Hz) Delay interval
5	CO_2 (mmol/m^3) H_2O (mmol/m^3) Pressure (kPa)
6	CO_2 (mmol/m^3) H_2O (mmol/m^3) Pressure (kPa) Diagnostic Value (see below)
7	Trigger Mode CO_2 (mmol/m^3) H_2O (mmol/m^3) CO_2 Signal Strength Pressure (kPa)
NOTES:	LI-7500RS Mode 7 requires the Campbell datalogger to broadcast a group trigger to cause data to be registered. The registered data set is held and not updated until the next group trigger. All serial transfers on the SDM bus are bit reversed. This means that the least significant bit is sent first and the most significant bit is sent last. This includes sending the signature.

Delay time

The output signal from the optical bench is sampled by a high-speed analog-to-digital converter and input into a digital signal processor (DSP). This signal is processed digitally and gas densities are computed from it. There is a fixed delay in this process, and an additional user-programmable delay that can be used to make the instrument output occur on even sampling intervals.

The instrument has a fixed throughput delay of 172 milliseconds for the DAC outputs, and 130 ms for the SDM, RS-232, and Ethernet outputs. This delay can be increased in increments of 1/150 seconds (6.667 ms), to minimize offsets between the gas analyzer and other sensors.

For example, suppose you are sampling (via SDM output) the LI-7500A/RS or LI-7200/RS with a Campbell Scientific CR5000 datalogger at 10 Hz (0.1 s). Setting the delay count of the gas analyzer to 25 yields a total delay of 0.297 seconds, which means the data will have a delay of 3 execution intervals (0.297 s/0.1 s), which the logger can allow for when synchronizing the data to the sonic anemometer or other analog measurements made by the datalogger. Thus, the “unaccounted for” lag is 0.003s. Without this extra delay, the lag time would be 0.130 seconds, which is 1 execution interval (0.1 seconds) plus 0.03 seconds unaccounted for.

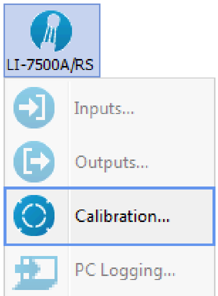
Similarly, if you are sampling the gas analyzer with the DAC outputs, setting the delay count to 19 yields a total delay of 0.299 seconds. The lag will be 0.001s.

Total system delay examples

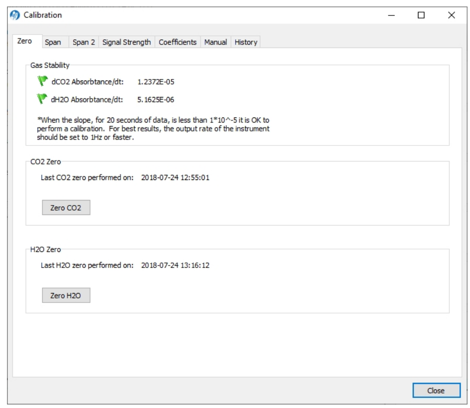
Total System Delay (ms) = Delay Time + (Delay Step × Delay Step Increment)

Output	Delay Time (ms)	Delay Step (ms)	Delay Step Increment	Total Delay (ms)
DAC	172	6.667	19	299
SDM/RS-232/Ethernet	130	6.667	25	297

Calibration window



The **Calibration** window is where you set the zero and span of the instrument. There are entry fields to set the target values for the span gases used to set the span of the instrument; CO_2 span gas target values are in ppm, and H_2O span gas target values are entered in °C dewpoint. The Zero and Span tabs also provide information about the stability of the gas flowing through the optical path:



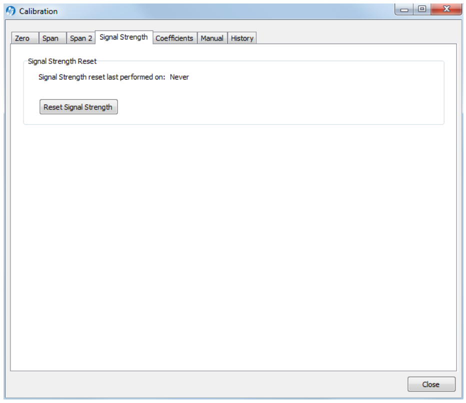
- A green flag indicates that it is OK to perform the calibration
- A red 'X' indicates that it is **not OK** to perform the calibration; wait until the red 'X' changes to a green flag before performing the calibration.

Zero, Span, and Span 2 tabs

Step-by-step instructions for calibrating the gas analyzer can be found in *User calibration* on page 9-11.

Signal strength tab

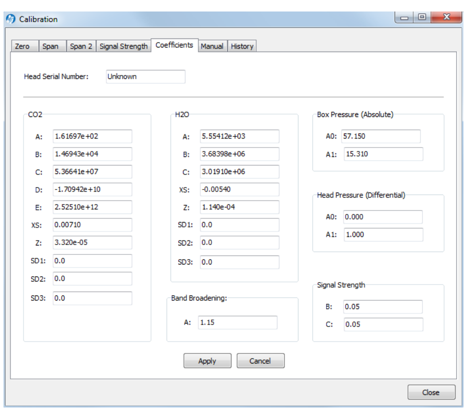
The **Signal Strength** tab has a button labeled **Reset Signal Strength** that you can click if you've decided your instrument optics are as clean as you can reasonably make them, and you want to reset the signal strength to 100.



See *CO2 signal strength* on page 8-8 for more information.

Coefficients tab

The **Coefficients** tab displays factory-determined calibration coefficients, a factor for correcting CO_2 measurements for band broadening due to the presence of water vapor (*A*), and a zero drift correction factor (Z). The coefficient shown as *XS* (cross sensitivity) compensates for slight cross sensitivity between CO_2 and H_2O signals absorbed by the detector.



The calibration coefficients, *XS*, and *Z* values are unique to each sensor head, and may be found on the calibration sheet shipped from the factory. The Band Broadening coefficient is 1.15 for all sensor heads.

The calibration coefficients are stored in the LI-7550 Analyzer Interface Unit, not the sensor head. To change these values, edit them and then click Apply to load these values to the LI-7550.

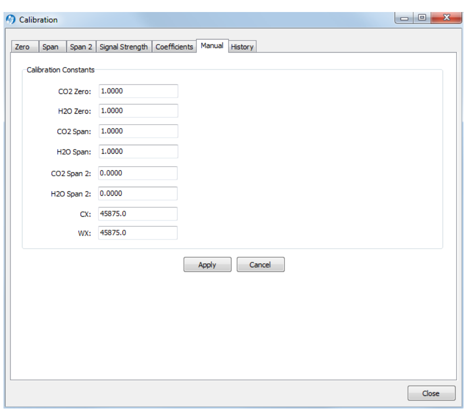
Caution: To avoid undesirable changes to the instrument performance, do not edit values in this window. Click **Cancel** to avoid any undesirable changes.

The *Head Serial Number* displays the serial number of the sensor head that is associated with the coefficients. When exchanging sensor heads, it is necessary to change calibration coefficients, and to redo the zero and span.

Note: The easiest way to get the calibration coefficients, zero, and span updated for a sensor head is to save the configuration (it is a *.7x file) and then upload the file to a different LI-7550 using **Open Configuration.**

Manual tab

The **Manual** tab displays current values for CO_2 and H_2O zero and span; after performing a zero and span calibration, these values should be near 1 (zero is typically between 0.8 and 1.2, and span is typically between 0.8 and 1.2; Z_{wo} and Z_{co}, see equations 11-13 and 11-17). Span 2 values will be near zero.



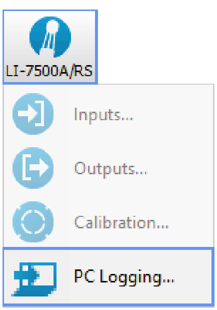
We recommend that you track the zero values over time as you re-zero the instrument. As the internal chemicals lose their effectiveness, this value will increase. The CO_2 zero drift is also somewhat temperature dependent.

In most cases you will never need to manually edit these values. If, for some reason, the instrument calibration becomes unstable (e.g., you accidentally zeroed or spanned the instrument with the wrong gas), you can manually enter a value of 1 for each of these parameters (and zero for Span 2 values), and click **Apply**. This will return the instrument to a more normal state, after which you can perform zero and span calibrations again. Alternatively, if you have performed at least one previous (successful) calibration, you can restore those values using the **History** tab.

History tab

The **History** tab displays a list of previous calibration backup files generated during a zero and/or span calibration of the instrument (when used with the same computer used to connect to the instrument). You can click on any previous calibration in the list to view the details; you can also restore the values from a previous calibration by choosing a file in the list and clicking the Restore button. Click **Delete** to permanently remove calibration files from the list stored on the computer.

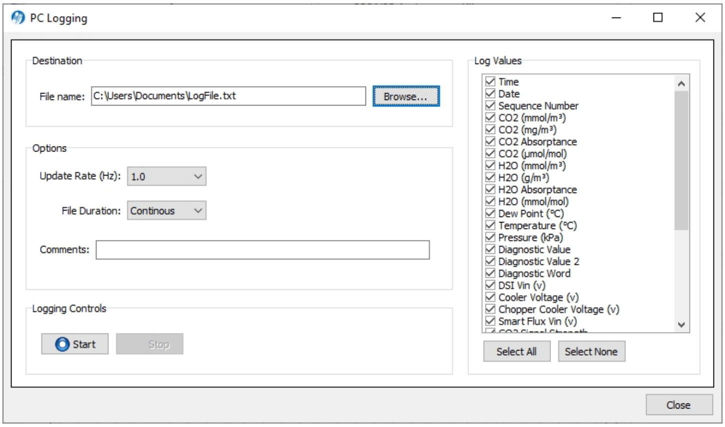
PC logging



The PC Logging window is used to configure the data output parameters used while the LI-7500A/RS/DS or LI-7200/RS Windows software is active. Data are logged to a file on your computer. You can specify the destination file, update rate, file duration, comments, and values to be logged.

Data can be logged at up to 20 Hz. These files can be split into smaller files, at 15, 30, 60 minutes, or 1.5, 2, 4, or 24 hour intervals. The files are split based on fractions of the hour as measured by the system clock. Thus, if you choose to split the files at 15 minute intervals and start logging at 10:22, the file will be split at 10:30, 10:45, 11:00, etc.

Note: File compression and metadata information are not available when logging to a PC; these options are available only when logging to the USB drive.



Under **Log Values**, select the data records that you want to output; click **Select All** to choose all variables.

Click **Start** to begin logging data and **Stop** to quit logging.

Note on data output rates

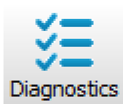
When sending data via a serial connection (e.g. RS-232), note that the baud rate selected will limit the number of samples that can be output. A single line of data (all Log Values selected) consists of approximately 350 bytes (2800 bits), so the maximum output rate at the available baud rates becomes:

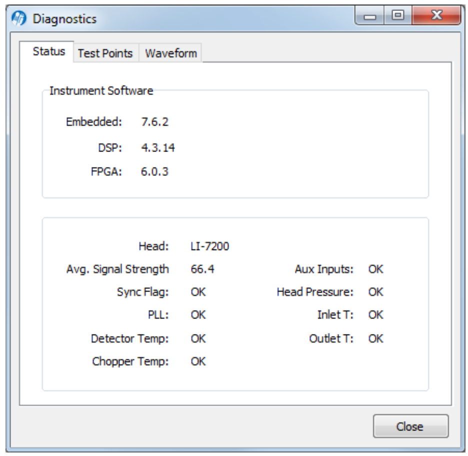
Baud Rate	Maximum Output Rate (Samples per Second)
9600	2
19200	5
38400	10
57600	15
115200	20

Logging 20 samples per second (20 Hz) would result in approximately 384 MB/day data accumulation, or about 1 GB/2.5 days.

Diagnostics

The **Diagnostics** page allows you to view the current operational state of the instrument, including current software versions, diagnostic flags, optical bench properties, and technician test point values.





Status tab

Diagnostic indicators for the Sync Flag, PLL, Detector Temperature, and Chopper Temperature will read either **OK** or **Service**.

Instrument Software: Reports the Embedded version, DSP version, and FPGA version. For diagnostic purposes.

Head: Displays the model of the sensor head currently connected to the LI-7550 Analyzer Interface Unit. The software may display LI-7200 even if an LI-7200RS is connected and LI-7500A even though an LI-7500RS is connected.

Avg. Signal Strength: Average Signal Strength is an indicator of the cleanliness of the optics. A value near 100 indicates clean optics; a value near 0 indicates highly contaminated optics. For the best performance, clean the optics if the signal strength is below the upper 90s. Signal strength is not an indicator of accuracy because contamination on the optics can affect measurements in unpredictable ways, depending upon the optical properties of the contaminants.

Sync Flag: Not used. Will always read **OK**.

PLL: Phase Lock Loop offset, indicates the status of the optical filter wheel for the IRGA. Common causes of a service indication are not having a sensor head connected to the LI-7550, the head cable is not been tightened properly, or the cable has failed.

Detector Temperature: If not OK, indicates the detector cooler is not maintaining the proper temperature. This will happen at temperatures above 50 °C. This does not always indicate a serious problem; the cooler may simply have not yet reached the target temperature during instrument start up, or it may be out of range due to external environmental conditions. Readings may still be OK. Otherwise, this can occur if the sensor head is not be attached to the LI-7550 or if the cable is not tight, causing a bad connection.

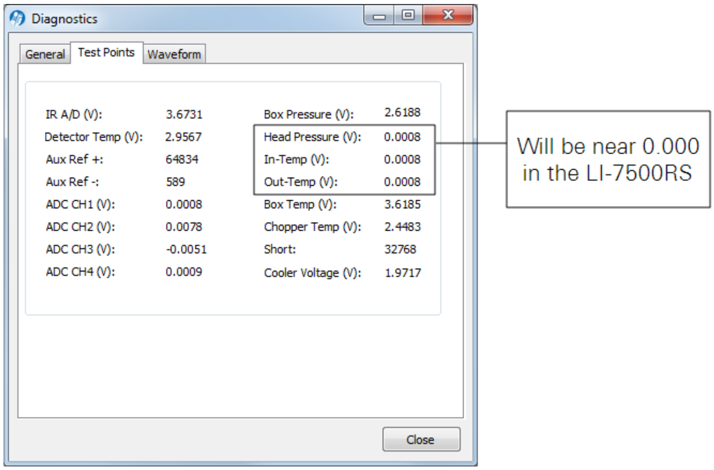
Chopper Temperature: If not OK, indicates the chopper temperature controller is out of range, hot or cold. As with the Detector Temperature indicator above, this may or may not indicate a serious problem. The chopper should be able to temperature control when ambient is between +50 and -25 °C. Check that the sensor head cables to the LI-7550 are tight, and make sure the chopper temperature is not set to Winter when measuring in high ambient temperatures.

Aux Inputs: If not OK, indicates that the two reference voltages on the LI-7550 analog circuit board cannot be checked properly. The LI-7550 needs service.

Head Pressure: If not OK, the pressure reading at the sensor head is outside of its normal range. A service indication can also be caused by a loose or missing cable between the LI-7550 and the sensor head.

Test point values

The **Test Points** tab displays voltages and raw counts of a variety of diagnostic test points. Though primarily for LI-COR technician reference, values outside of the normal range may give you an indication of where problems may be originating.

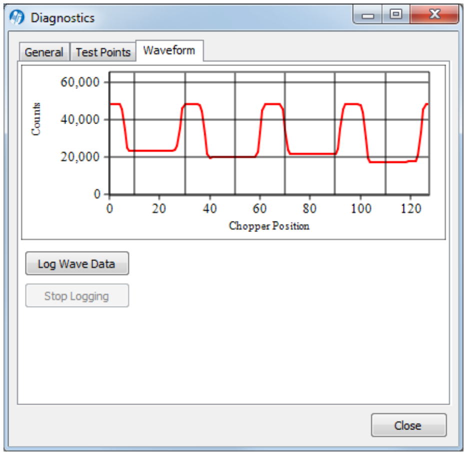


Test Point	Description	Normal range
IR A/D (V)	Voltage from IRGA being sent to A/D converter	0.2 – 4.8 V
Detector Temp (V)	Detector temperature voltage	2.9 V. Readings near +5 V or 0 V are normal for a few seconds after power on.
Aux Ref +	16-bit conversion of positive reference voltage used in Auxiliary Input circuit	~64830
Aux Ref -	16-bit conversion of negative reference voltage used in Auxiliary Input circuit	~600
ADC CH1 (V)	Analog input channel 1	-5 V to +5 V. A reading near 0 is normal for an open input.
ADC CH2 (V)	Analog input channel 2	-5 V to +5 V. A reading near 0 is normal for an open input.
ADC CH3 (V)	Analog input channel 3	-5 V to +5 V. A reading near 0 is normal for an open input.

Test Point	Description	Normal range
ADC CH4 (V)	Analog input channel 4	-5 V to +5 V. A reading near 0 is normal for an open input.
Box Pressure (V)	Absolute pressure	Any value between 0 and 5
Box Temp (V)	LI-7550 temperature	3.5 at room temperature
Chopper Temp (V)	Displays voltage of chopper housing temperature control circuit.	2 is normal. Readings near 0 V or +5 V indicate that the temperature control circuit is unable to control the chopper temperature.
Short (V)	Reference short in auxiliary input circuit	32768
Cooler Voltage (V)	Displays voltage of detector cooler. If this value gets below 0.5V, it may be too cold; the detector may not be temperature controlling. This will typically occur at -30 °C or below.	0 V to +5 V

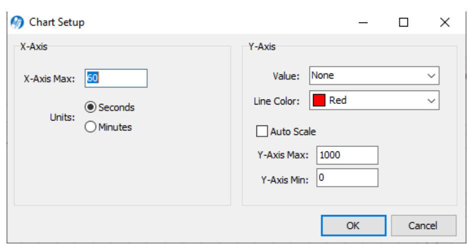
Waveform

The **Waveform** tab displays the current state of the analyzer's chopping shutter disk. Though primarily for LI-COR technician reference, if problems are encountered, it may be useful to log the waveform data for troubleshooting purposes. Waveform data can only be logged when the **Diagnostics** window is open.



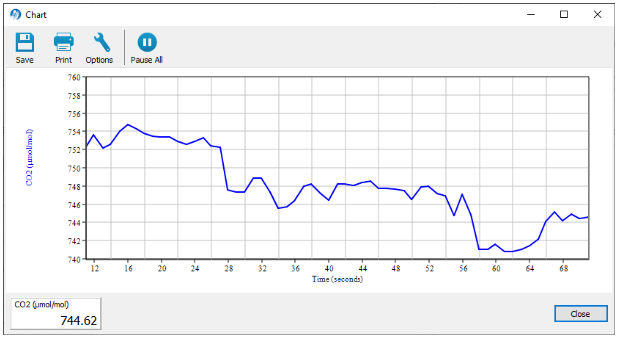
Charting

The **Chart** window allows real time graphics display of one or two variables plotted against time. The Y-Axis displays the value chosen in the respective menu against time on the X-Axis.



Time on the X-Axis can be displayed over user-defined values of seconds or minutes; the X-Axis Max value defines the unit of time displayed in the window before the window starts scrolling the time value off the right edge.

Choose the value for the Y-Axis Left and/or Y-Axis Right in the menu(s), and enter values for the Y-Axis maximum and minimum; choose Auto Scale if you want the chart to scale the Y-Axis automatically to keep data from scrolling off the top or bottom edges. You can also select the color of the line for both Y-Axes values.



When you are finished defining the strip chart(s) parameters, click **OK**. A new chart window will appear. Press **Pause All** to temporarily stop plotting (press Pause All again to resume); press **Save** to save a "snapshot" of the current plot to a bitmap file; press **Print** to print the currently displayed chart window, or press **Options** to open the Chart Setup window again to make changes to the strip chart parameters.

Note: You can rescale both Y-axes of an active strip chart by right clicking on the chart, holding, and dragging up or down. You can also open as many chart windows as you want.

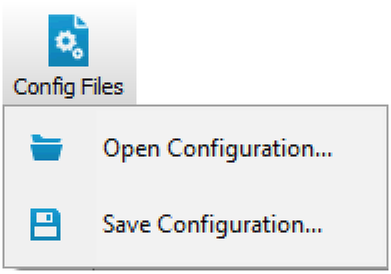
Configuration files

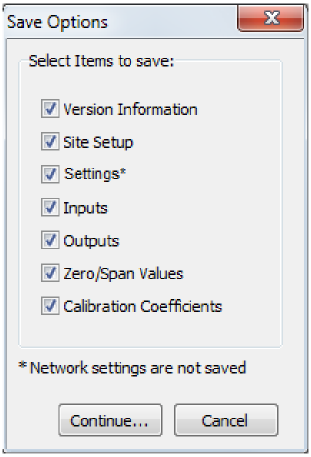
The instrument uses a configuration file to store parameters of the configuration, including the setup information, instrument settings, calibration coefficients, and zero and span values, and logging configuration. Unique configuration files can be set up, saved, and then re-opened to easily change your setup information.

When the software program is started for the first time, a default set of parameters is loaded, which can be modified and saved as a new configuration file with a different name. The analyzer stores its configuration so that it will power on configured just as it was when it was powered off.

To save the current configuration, click **Config File > Save Configuration**. Select the items to include in the file and click **Continue**. Select a directory and save the file. It will have a `.l7x` extension.

To open an existing configuration file, click the **Config Files** button and select **Open Configuration**. Select the file and click **Open**. You are prompted to send the configuration to the instrument; changes are implemented in the instrument when the configuration file is loaded.





Section 11. Theory of operation

Relating absorption to concentration

The scaling law of Jaimeson et. al., (1963) shows the effect of pressure on infrared absorption. If the amount of absorber of some gas u_i (mol m^{-2}) and absorption in a band are related by some function $h_i()$, then

$$\frac{\alpha_{\mathrm{i}}}{P_{\mathrm{ei}}} = h_i\left(\frac{u_i}{P_{ei}}\right) \qquad 11\text{-}1$$

The subscript i denotes a particular (i^{th}) gas. Pressure is denoted as P_{ei} because it is the equivalent pressure for the i^{th} gas. Equivalent pressure is potentially different from total pressure P if there are gases present other than i that affect how the i^{th} gas absorbs radiation.

We rewrite this in terms of number density (mol m^{-3}) by introducing a path length λ, and noting that $u_i = \rho_i\lambda$. Substituting this into equation 11-1, and solving for the number density ρ_i of gas i yield

$$\rho_i = \frac{P_{ei}}{\lambda} h_i{}^{-1}\left(\frac{\alpha_i}{P_{ei}}\right) \qquad 11\text{-}2$$

We rewrite equation 11-2 as

$$\rho_i = P_{ei}\mathrm{f}_i\left(\frac{\alpha_i}{P_{ei}}\right) \qquad 11\text{-}3$$

by combining λ and the inverse $h()$ functions into a new function $f_i()$. The calibration function $f_i()$ is generated by measuring a range of known densities ρ_i and fitting a curve to ρ_i/P_{ei} plotted against $\alpha i/P_{ei}$. Since gas standards are not available in “known densities”, the ρ_i values are computed from known concentrations m_i (moles of gas per mole of air) using the ideal gas law

$$\rho_i = m_i \frac{P}{RT} \tag{11-4}$$

Measuring absorptance

Given a source with radiant power Φ, and a detector some distance away, in the absence of reflection, absorptance by gas i can be determined from

$$\alpha_i = 1 - \tau_i = 1 - \frac{\Phi_i}{\Phi_o} \tag{11-5}$$

where τ_i is transmittance through gas i, Φ_i is transmitted radiant power in the absorption band with some concentration of gas i present, and Φ_o is the transmitted radiant power in the absorption band with zero concentration of i present. The instrument approximates absorptance by

$$\alpha_i = \left(1 - \frac{A_i}{A_{io}}\right) \tag{11-6}$$

where A_i is the power received from the source in an absorbing wavelength for gas i, and A_{io} is the power received from the source in a reference wavelength that does not absorb gas i. The instrument measures A_i and A_{io} alternately 150 times per second.

If we combine equations 11-6 and 11-3, we can write the full equation for computing molar density from absorptance.

$$\rho_i = P_{ei} f_i \left(\left[1 - \frac{A_i}{A_{io}} z_i\right] \frac{S_i}{P_{ei}}\right) \tag{11-7}$$

Note the zeroing term z_i and the span adjustment term S_i in equation 11-7. The span adjustment term is a linear function of absorptance (see *What actually happens* on page 9-19):

$$S_i = S_{i0} + S_{i1} \alpha_i \tag{11-8}$$

Cross sensitivity

Because the instrument uses one detector for measuring A_c, A_{co}, A_w, and A_{wo}, (the absorbed and non-absorbed power for CO_2 and H_2O, respectively), there is a slight cross-sensitivity between gases due to imperfections in the detector's frequency (time) response. This varies from detector to detector, but is measured during calibration, and is corrected in software. Equation 11-6 is written as

$$\alpha_i = \left(1 - \left[\frac{A_i}{A_{io}} + X_{ji}\left(1 - \frac{A_j}{A_{jo}}\right)\right]\right) \qquad 11\text{-}9$$

where X_{ji} is the cross sensitivity response of gas j on gas i (determined during calibration), and A_j and A_{jo} are the absorbed and non-absorbed power for gas j. Equation 11-7 becomes

$$\rho_i = P_{ei} f_i \left(\left[1 - \left(\frac{A_i}{A_{io}} + X_{ij}\left[1 - \frac{A_j}{A_{jo}}\right]\right) z_i\right] \frac{S_i}{P_{ei}}\right) \qquad 11\text{-}10$$

Zero drift

Even though the detector and filters are temperature controlled in the LI-7500A/RS, the detector is subject to slight temperature drift as ambient temperature changes. This error is directly related to the detector cooler control voltage, which is measured, and thus provides a mechanism for a software "fine tuning".

The zero term z_i is computed from

$$z_i = Z_{io} + Z_i V_d \qquad 11\text{-}11$$

where V_d is the cooler voltage, Z_i is the slope of the relationship between V_d and z_i (determined during calibration), and Z_{io} is the zero factor determined when setting the zero.

Equation summary

H_2O

In the atmosphere, the absorption of radiation by water vapor is not significantly influenced by any other gas, so the effective pressure for water vapor, P_{ew}, is simply the total pressure P.

$$P_{ew} = P \tag{11-12}$$

H_2O absorptance, α_w, is

$$\alpha_w = \alpha^*_w \left(1 + b_1 \left(V_c - b_3\right) + b_2 \left(V_c - b_3\right)\alpha^*_w\right) \tag{11-13}$$

where b_1, b_2, and b_3 are constants (**CO_2 SD1**, **SD2**, and **SD3** on the calibration sheet) and V_c is cooler voltage. Uncorrected absorptance, α^*_w, is given by

$$\alpha^*_w = 1 - \left(\frac{A_w}{A_{wo}} + X_{cw}\left(1 - \frac{A_c}{A_{co}}\right)\right)\left(Z_{wo} + Z_w V_c\right), \tag{11-14}$$

where A_w and A_{wo} are the raw signals for the water vapor absorption and reference bands, X_{cw} is the cross sensitivity coefficient for CO_2 on water vapor (**H_2O XS** on the calibration sheet), A_c and A_{co} are the raw signals for the CO_2 absorption and reference bands, Z_{wo} is the zeroing coefficient (**H2O Zero** on the calibration sheet), Z_w is the zero drift coefficient (**H_2O Z** on the calibration sheet), and V_c is the cooler voltage.

Mole density of H_2O, ρ_w, is given by

$$\rho_w = P f_w \left(\frac{\alpha_w S_w}{P}\right) \tag{11-15}$$

The coefficients for the 3rd order polynomial $f_w()$ are given on the calibration sheet. The polynomial has the form $Ax + Bx^2 + Cx^3$, where $x = \alpha_w S_w / P$. S_w is span for H_2O.

CO_2

The absorption of radiation by CO_2 molecules is influenced by several other gases, including O_2 and H_2O. Since the concentration of H_2O is most variable, it must be accounted for in the equivalent pressure of P_e. A method of doing this (LI-COR Application Note #116) is

$$P_{ec} = P\left(1 + \left(\alpha_w - 1\right)m_w\right) \tag{11-16}$$

P is pressure, α_w is the band broadening coefficient, and m_w is the mole fraction of water vapor. α_w has been determined to be 1.15 for the LI-7500A/RS.

CO_2 absorptance, α_c, is given by

$$\alpha_c = \alpha^*_c \left(1 + b_1 \left(V_c - b_3\right) + b_2 \left(V_c - b\right)\alpha^*_c\right) \tag{11-17}$$

where b_1, b_2, and b_3 are constants (**H_2O SD1**, **SD2**, and **SD3** on the calibration sheet) and V_c is cooler voltage. Uncorrected absorptance, α^*_c, is given by

$$\alpha^*_c = 1 - \left(\frac{A_c}{A_{co}} + X_{wc}\left(1 - \frac{A_w}{A_{wo}}\right)\right)(Z_{co} + Z_c T_h) \quad \text{11-18}$$

,

where A_c and A_{co} are raw signals from the CO_2 absorption and reference bands, X_{wc} is the cross sensitivity coefficient for water on CO_2 (**CO_2 XS** on the calibration sheet), A_w and A_{wo} are the raw signals for the water vapor absorption and reference bands, Z_{co} is the zeroing parameter (**CO2 Zero** on the calibration sheet), Z_c is the temperature drift coefficient (**CO_2 Z** on the calibration sheet), and V_c is the cooler voltage.

Mole density of CO_2, ρ_c, is given by

$$\rho_c = P_{ec} f_c\left(\frac{\alpha_c S_c}{P_{ec}}\right) \quad \text{11-19}$$

The coefficients for the 5th order polynomial $f_c()$ are given on the calibration sheet. The polynomial has the form $Ax + Bx^2 + Cx^3 + Dx^4 + Ex^5$, where $x = \alpha_c S_c / P_{ec}$. S_c is the span parameter for CO_2, P_{ec} is equivalent pressure, and α_c is the span-drift corrected absorptance for CO_2.

The value the LI-7550 needs to output for CO_2 absorptance is α_c (equation 11-17), and for H_2O absorptance is α_w (equation 11-13). The span drift correction, implemented in this manner, should leave the span setting algorithms unchanged.

LI-7500RS implementation

Atmospheric pressure, P_g, (kPa) and temperature, T_g, (°C) are measured by sensors in the Analyzer Interface Unit. W_f is the mole fraction of water vapor and $\psi(W_f) = 1 + (\alpha_w - 1)W_f$.

Table 11-1. Fundamental equations used in the LI-7500A/RS calculations.

Label	Description	Equation
H_2O mmol/m^3	H_2O number density	$\rho_w = P_g f_w\left(\frac{\alpha_w S_s}{P_g}\right)$ 11-20
H_2O g/m^3	H_2O mass density	$W_m = \frac{18}{1000}\rho_w$ 11-21

Table 11-1. Fundamental equations used in the LI-7500A/RS calculations. (...continued)

Label	Description	Equation	
H_2O mmol/mol	H_2O mole fraction	$W_f = \frac{\rho_w R(T_g+273.15)}{1000P_g}$	11-22
Dew Point (°C)	Dew point temperature	$T_d = \frac{240.97x}{17.502-x}$	11-23
		$x = \ln\left(\frac{W_f}{613.65}P_g\right)$	11-24
CO_2 mmol/m^3	CO_2 number density	$\rho_c = P_g\psi\left(\frac{W_f}{1000}\right)f_c\left(\frac{\alpha_c S_c}{P_c\psi\left(\frac{W_f}{1000}\right)}\right)$	11-25
CO_2 mg/m^3	CO_2 mass density	$C_m = 44\rho_c$	11-26
CO_2 µmol/mol	CO_2 mole fraction	$C_f = \frac{\rho_c R(T_g+273.15)}{P_g}$	11-27

A note about pressure and temperature

Since the instrument is calibrated for number density, accurate temperature is not required for the calculation, and accurate pressure measurement is not required, either (equations 11-20 and 11-25). For example, if you introduce a 1% error in the pressure sensor on a perfectly calibrated instrument, the resulting CO_2 mole density error would be about 0.25%, and the H_2O mole density error about 0.5% in typical ambient conditions.

When calibrating (specifically when setting spans), temperature and pressure are more important. Calibrating with a 1% pressure error will cause the resulting CO_2 mole density to have a 1% error, but no error in the resulting H_2O mole density (because the water span target is computed from dew point, not mole fraction). A 1% error in temperature (3 °C) will cause a 1% error in both CO_2 and H_2O mole density.

Appendix A.
Sonic anemometer connection options

This section describes how to connect with some anemometers using the optional USB cable. It also describes additional wiring options for anemometers.

USB connections for configuration

You can connect a sonic anemometer to a computer to view the firmware version, settings, and troubleshooting.

WindMaster/Pro

Important: Do not leave the USB cable connected to the anemometer during normal use. Failure to disconnect the cable may result in communication problems and data loss.

Use the suitable version of **Wind** software from Gill or a terminal program such as **Tera Term**. To connect the anemometer to a computer, attach bare leads of the USB-to-RS-422 adapter cable (392-16348) to bare leads on the anemometer cable. You can insert pairs into a single terminal in a terminal strip, twist them together, or connect them with wire nuts. To power the anemometer, connect the black lead from the USB-to-RS-422 adapter cable and the power leads from the anemometer cable to the **Power Out** terminals on the SmartFlux System.

The USB-to-RS-422 adapter cable requires a VCP driver, which you can download from www.ftdichip.com.

Table A-1. Data wire leads to connect together when connecting the USB adapter (part number 392-16348) to the WindMaster/Pro cable.

USB Cable	connects to	Anemometer Cable
White (RX-)	connects to	White/Green (TX-)
Yellow (RX+)	connects to	Green (TX+)
Red (TX-)	connects to	White/Orange (RX-)
Orange (TX+)	connects to	Orange (RX+)

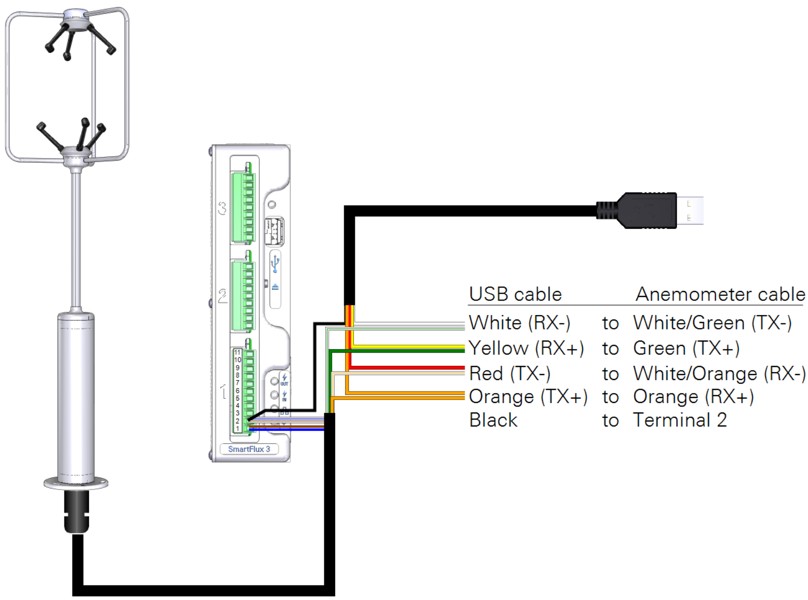


Table A-2. Power to the anemometer can be provide through the SmartFlux System. The black lead from the USB cable must be connected to ground, such as terminal 2 on the SmartFlux System.

USB Cable	Anemometer Cable	connects to	SmartFlux
Black (GND)	White/Blue	connects to	Terminal 2 (Power -)
n/a	White/Brown	connects to	Terminal 2 (Power -)
n/a	Blue	connects to	Terminal 1 (Power +)
n/a	Brown	connects to	Terminal 1 (Power +)

CSAT3B and CSAT3

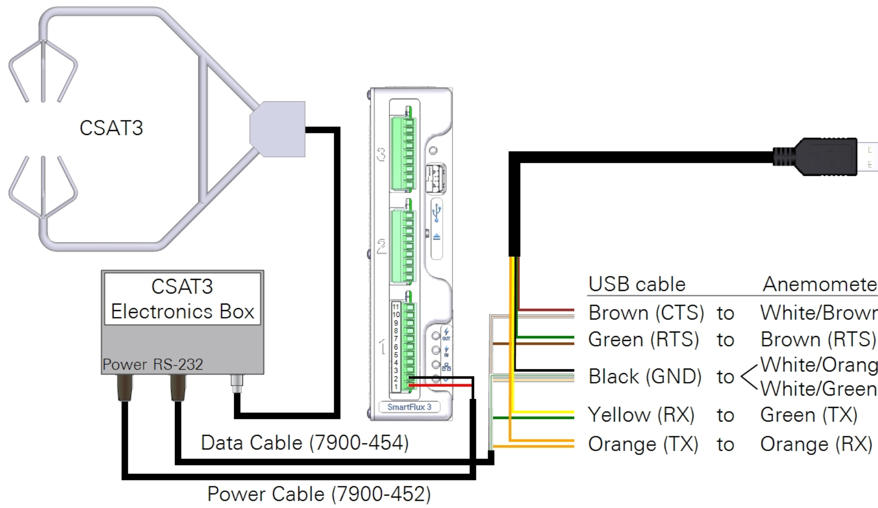
> **Important:** Do not leave the USB cable connected to the anemometer during normal use. Failure to disconnect the cable may result in communication problems and data loss.

Use the **Device Configuration Utility** from Campbell Scientific to configure the CSAT3 and CSAT3B.

- To connect the CSAT3B to a computer, use the cable from Campbell Scientific (30179).
- To connect the CSAT3 to a computer, attach bare leads of the USB-to-RS-232 cable (392-16347) to bare leads on the anemometer cable. You can insert pairs of wires into a single terminal in a terminal strip, twist them together, or connect them with wire nuts. The adapter cable requires a VCP driver, which you can download from www.ftdichip.com.

Table A-3. Data wire leads to connect together when connecting the USB adapter (part number 392-16348) to the CSAT3 cable.

USB Cable	connects to	Anemometer Cable
Brown (CTS)	connects to	White/Brown (RTS)
Green (RTS)	connects to	Brown (CTS)
Black (GND)	connects to	White/Orange White/Green (Signal Return)
Yellow (RX)	connects to	Green (TX)
Orange (TX)	connects to	Orange (RX)



Power to the anemometer can be provide through the SmartFlux System. The black lead from the USB cable must be connected to ground, such as terminal 2 on the SmartFlux System.

HS-50 or HS-100

> **Important:** Do not leave the USB cable connected to the anemometer during normal use. Failure to disconnect the cable may result in communication problems and data loss.

Use the suitable version of **Wind** software from Gill or a terminal program such as **Tera Term**. To connect the HS-50 to a computer, attach the bare leads of the USB-to-RS-422 adapter cable (part number 392-16348) to bare leads on the anemometer cable. You can twist them together, connect them with wire nuts, or insert pairs into a single terminal in a terminal strip. Connect the black lead from the USB-to-RS-422 adapter cable and the power leads from the anemometer cable to the **Power Out** terminals on the SmartFlux System.

The USB-to-RS-422 adapter cable requires a VCP driver, which you can download from www.ftdichip.com.

Table A-4. Data wire leads to connect together when connecting the USB adapter (part number 392-16348) to the HS-50 cable.

USB Cable	connects to	Anemometer Cable
White (RX-)	connects to	Black with white (TX-)
Yellow (RX+)	connects to	White (TX+)
Red (TX-)	connects to	Black with brown (RX-)
Orange (TX+)	connects to	Brown

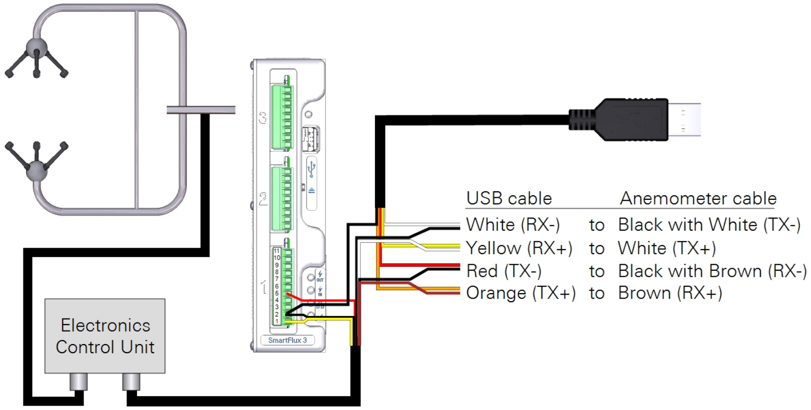


Table A-5. Power to the anemometer is provide through the SmartFlux System power terminals. The black lead from the USB cable must be connected to ground, such as terminal 2 on the SmartFlux System.

USB Cable	Anemometer Cable	connects to	SmartFlux
Red	n/a	connects to	Terminal 5 (Signal Return)
Black	Black	connects to	Terminal 2 (Power -)
n/a	Yellow	connects to	Terminal 1 (Power +)

You can also connect the HS-50 to your PC through the optional Gill Power and Communications Interface (PCI)—not pictured here. Consult the Gill HS-50 instruction manual for more on this method.

RM Young

You can connect the anemometer to a computer to view the firmware version and settings for troubleshooting.

> **Important:** Do not leave the USB cable connected to the anemometer during normal use. Failure to disconnect the cable may result in communication problems and data loss.

Use a terminal program such as **Tera Term** to communicate with the anemometer. To connect the anemometer to a computer, attach bare leads of the USB-to-RS-422 adapter cable (392-16348) to bare leads on the anemometer cable. You can insert pairs into a single terminal in a terminal strip, twist them together, or connect them with wire nuts. To power the anemometer, connect the black lead from the USB-to-RS-422 adapter cable and the power leads from the anemometer cable to the **Power Out** terminals on the SmartFlux System.

The USB-to-RS-422 adapter cable requires a VCP driver, which you can download from www.ftdichip.com.

Table A-6. Data wire leads to connect together when connecting the USB adapter (part number 392-16348) to the 81000 series anemometer.

USB Cable	connects to	Anemometer Cable
White (RX-)	connects to	White/Green (TX-)
Yellow (RX+)	connects to	Green (TX+)
Red (TX-)	connects to	White/Orange (RX-)
Orange (TX+)	connects to	Orange (RX+)

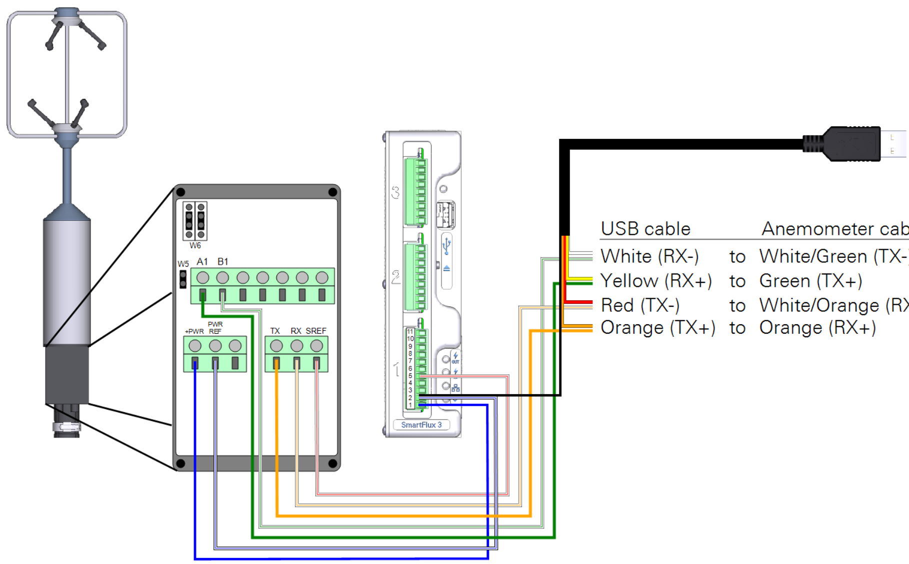


Table A-7. Power to the anemometer can be provide through the SmartFlux System. The black lead from the USB cable must be connected to ground, such as terminal 2 on the SmartFlux System.

USB Cable	Anemometer Cable	connects to	SmartFlux
n/a	White/Red (REF)	connects to	Terminal 5 (Signal Reference)
Black (GND)	n/a	connects to	Terminal 2 (Power -)
n/a	White/Blue	connects to	Terminal 2 (Power -)
n/a	Blue	connects to	Terminal 1 (Power +)

Additional digital data cable options

Here we describe more digital data cable options and details regarding wire colors, pin numbers, and part numbers. The SmartFlux 2 and 3 System features two 9-pin and one 11-pin UART (Universal Asynchronous Receiver/Transmitter) serial ports. The green terminal strips are made by Phoenix Contact.

Serial Port	Terminal Strips	LI-COR Part #	Phoenix Part #
Port 1	11-pin 3.5 mm pitch	331-15378	Phoenix 1840450
Ports 2 and 3	9-pin 3.5 mm pitch	331-15376	Phoenix 1840434

Serial port 1 has pins for RS-232 RTS (Request To Send) and CTS (Clear to Send) signals. Serial ports 2 and 3 do not have these pins. All 3 serial ports are equipped with RS-485 transceivers which allows them to be compatible with either RS-422 or RS-485 signaling. The serial ports support the Campbell Scientific CSAT3, CSAT3B, Gill WindMaster™, WindMaster™ Pro, R3-50, HS-50, HS-100, Metek Cage, Class-A, and RM Young 81000 series sonic anemometers. The current implementation of RS-485 is full duplex only.

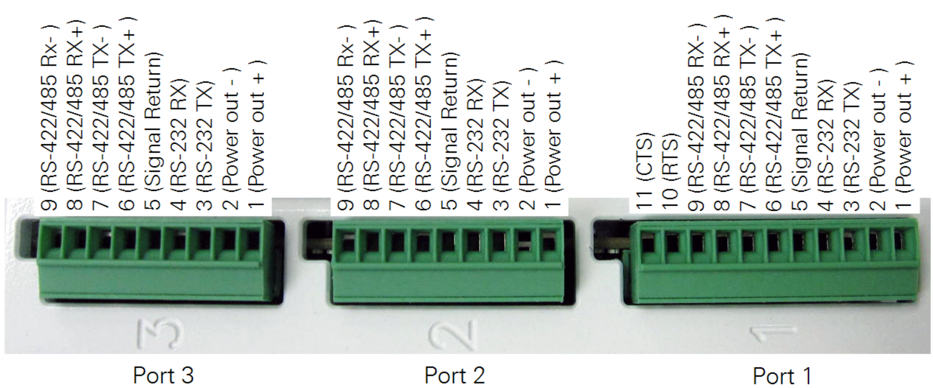


Figure A-1. Serial ports on the SmartFlux 2 or 3 System with pin assignments and numbers.

The serial ports include power out pins to power the sonic anemometer. Using these power out pins also makes it easier to control the amount of voltage drop in the power wires to the sonic anemometer because no other currents flow in the anemometer power wires. This, in turn keeps the potential difference between the anemometer and SmartFlux 2 or 3 System small, which helps ensure trouble-free communication with the sonic anemometer.

3-Amp fuses limit the total power out current to the serial ports. It is best to keep the total current to 2 amps or less so that the fuses will never fail. The lifetime of the fuses will shorten as 3 amps is approached. For many—but not all—sonic anemometers, 2 amps will be more than adequate. If the power in LED for the SmartFlux 2 or 3 System is on, but the power out LED for the serial ports is not lit, then one of the fuses has failed. Two spare fuses are included inside the SmartFlux 2 or 3 System.

Important: Some sonic anemometers (CSAT3/A) have an upper voltage limit of 15 VDC. In this case, supplying an incoming 24 VDC to the SmartFlux 2 or 3 System could damage the sonic anemometer. The same voltage provided to the SmartFlux System is provided to a sonic anemometer that is connected to the **Power Out** terminals.

The following sections describe different methods that can be used to connect a sonic anemometer to the SmartFlux 2 or 3 System. There are multiple methods for some sonic anemometers and the best method might depend on what equipment you already own.

CSAT3

The CSAT3 can be connected to a SmartFlux 2 or 3 System with a LI-COR RS-232 cable and a CSAT3 Power cable.

Option 1

The 7900-454 cable will allow RS-232 signaling to function properly at 50 meters as long as the voltage drop in the power return wire is less than about 1 volt. If the CSAT3CBL3-L must be extended, use 18 or 20 gauge copper wire to easily meet this requirement. CSAT3 sonic anemometers should be wired to serial port 1, which supports the RTS and CTS signals of the CSAT3.

Table A-8. Pin assignments for a CSAT3 sonic anemometer using a CSAT3CBL3-L power cable and LI-COR RS-232 cable.

SmartFlux 2 Port 1	LI-COR 7900-454 RS-232 cable	CSAT3 10-Pin RS-232 Connector	CSAT3CBL3-L power cable	CSAT3 6-Pin Power connector
11 (CTS)	White/Brown	H (RTS)		
10 (RTS)	Brown	G (CTS)		
9 (RX-)				
8 (RX+)				
7 (TX-)				
6 (TX+)				
5 (Signal Return)	White/Orange Green/Orange	E (Gnd)		
4 (RX)	Green	B (Tx)		
3 (TX)	Orange	C (Rx)		
2 (Power -)			Black	B
1 (Power +)			Red	A

See the Campbell CSAT3 Three Dimensional Sonic Anemometer Instruction Manual, (page 9, table 5-1, CSAT3 Power and page 10, table 5-6, CSAT3 RS-232 Output Pin Out).

Note: The mating connector for the CSAT3 RS-232 receptacle is Amphenol PT06E-12-10P(470). This style of connector is often referred to as a MIL-DTL-26482 series of connector.

Option 2

It is possible to connect a CSAT3 to a SmartFlux 2 or 3 System using only Campbell cables. Follow Campbell's recommendation for maximum RS-232 cable length when using Campbell cables. See the Campbell CSAT3 Three Dimensional Sonic Anemometer Instruction Manual, (page 9, table 5-1, CSAT3 Power and page 10, table 5-6, CSAT3 RS-232 Output Pin Out).

Table A-9. Pin assignments for a CSAT3 sonic anemometer (option 2) using a CSAT3CBL3-L power cable and a CSAT3CBL3-L RS-232 cable.

SmartFlux 2 Port 1	CSAT3CBL2-L RS-232 Cable	CSAT3 10-Pin RS-232 Connector	CSAT3CBL3-L Power Cable	CSAT3 6-Pin Power Connector
11 (CTS)	Black	H (RTS)		
10 (RTS)	Brown	G (CTS)		
9 (RX-)				
8 (RX+)				
7 (TX-)				
6 (TX+)				
5 (Signal Return)	Green	E (GND)		
4 (RX)	Red	B (Tx)		
3 (TX)	White	C (Rx)		
2 (Power -)			Black	B
1 (Power +)			Red	A

Note: The mating connector for the CSAT3 RS-232 receptacle is Amphenol PT06E-12-10P(470). This style of connector is often referred to as a MIL-DTL-26482 series of connector.

The CSAT3B has different cabling from the CSAT3. The Campbell-supplied cables should work well for connecting to a SmartFlux 2 or 3 System. There are two options for the power cable, CSAT3BCBL1 and CSAT3BCBL2. For this application, CSAT3BCBL2 will work best as it has heavier conductors and no unused wires. The RS-485 cable is CSAT3BCBL3. These are Campbell cable part numbers. These cables can be ordered in custom lengths from Campbell. These cables can also be supplied by LI-COR.

Table A-10. Pin assignments for a CSAT3B sonic anemometer, using Campbell RS-485 cables.

SmartFLux 2 Port 1, 2, or 3	CSAT3BCL3, 7900-464, CPI/RS-485 Signal Names	CSAT3BCL3, 7900-464, CPI/RS-485 cable	CPI/RS-485 Connector Pin Number	CSAT3BCBL1, CSAT3BCBL2, 7900-462 Power Cables	Power/SDM Connector Pin Number
9 (RX-)	TxB	Blue	1		
8 (RX+)	TxA	Blue/White	6		
7 (TX-)	RxB	Brown/White	2		
6 (TX+)	RxA	Brown	4		
5 (Signal Return)	RGND	Green	5		
4 (RX)					
3 (TX)					
2 (Power -)				Black	2
1 (Power +)				Red	1

See the CSAT3B Three Dimensional Sonic Anemometer Instruction Manual (page 43, Table 7-3, CSAT3B Cable Wire Assignments).

HS-50

Important: At least 13 VDC must be supplied when using a 50 meter power cable because of voltage drops.

There are several ways to connect a Gill HS-50 to the SmartFlux 2 or 3 System. The method chosen will depend on the cables and equipment you might already own, and whether or not you are willing to cut or modify existing cables, and whether or not you would like to continue using existing cables directly with a PC. Another consideration is whether you have an HS-50 PCI (Power and Communications Interface).

Option 1

The first method is to connect directly to an HS-50 without a PCI using an adapter to the Gill 1086-M-043 Anemometer Cable. The Gill 1086-M-043 cable is intended to connect between an HS-50 Electronics enclosure and PCI, but it can be repurposed if the PCI is not needed. Creating an adapter allows the use of an existing 1086-M-043 Anemometer Cable without modifying the cable.

See the Gill HS-50 Horizontally Symmetrical Ultrasonic Research Anemometer User Manual (page 47, Section 13.2, Connector Pin Assignments).

An adapter can be made using a DB-15 cable or plug with pins for short distances (about 5 m). For long distances, use an Ethernet cable such as the Quabbin DataMax 5700 or 5750 or similar. The table here uses two pairs of wire for power.

Table A-11. Pin assignments for a Gill HS-50 sonic anemometer (option 1) using a Gill 1086-M-043 anemometer cable and DB-15 adapter.

SmartFLux 2 Port 1, 2, or 3	Quabbin DataMax Ethernet Cable	HS-50 Db-15 Pin number, plug with pins	HS-50 DB-15; Signal name	HS-50 Hirose 20-Position Connector pin number and signal name
9 (RX-)	White/Green	9	RS-485 Rx-	3 (RS-485 Tx-)
8 (RX+)	Green	2	RS-485 Rx+	2 (RS-485 Tx+)
7 (TX-)	White/Orange	10	RS-485 Tx-	5 (RS-485 Rx-)
6 (TX+)	Orange	3	RS-485 Tx+	4 (RS-485 Rx+)
5 (Signal Return)		4	Signal GND	13 (Digital 0V)
4 (RX)				

Table A-11. Pin assignments for a Gill HS-50 sonic anemometer (option 1) using a Gill 1086-M-043 anemometer cable and DB-15 adapter. (...continued)

SmartFLux 2 Port 1, 2, or 3	Quabbin DataMax Ethernet Cable	HS-50 Db-15 Pin number, plug with pins	HS-50 DB-15; Signal name	HS-50 Hirose 20-Position Connector pin number and signal name
3 (TX)				
2 (Power -)	White/Blue & White/Brown	11	Supply V-	14 (Supply V-)
1 (Power +)	Blue & Brown	5	Supply V+	6 (Supply V+)

Option 2

If you already own or want to continue using a Gill PCI, and you want to use RS-232 signaling, an adapter can be built to accomplish this task. This will work well for short distances. It might be necessary to cycle power on the PCI if communications with the SmartFlux 2 or 3 system are lost in order to re-establish communication. For long distances, build the RS-422/485 adapter described in the next table. You will need to obtain a DB-9 cable or plug with pins to build this adapter. Plug this adapter between the PCI RS-232 port and the SmartFlux 2 or 3 System.

See the Gill HS-50 Horizontally Symmetrical Ultrasonic Research Anemometer User Manual (page 46, Section 13.2, Connector Pin Assignments).

Note: The Tx and Rx labels are not crossed in the wiring table.

Table A-12. Pin assignments for a Gill HS-50 sonic anemometer (option 2) using the RS-232 output on the PCI.

SmartFlux 2 Port 1, 2, or 3	Optional, Colors using Ethernet cable	Gill DB-9 Signal Name	DB-9 with Pins
9 (RX-)			
8 (RX+)			
7 (TX-)			
6 (TX+)			
5 (Signal Return)	White/Orange White/Green	Signal Ground	5
4 (RX)	Green	RXD (Data from Anemometer to PC)	2
3 (TX)	Orange	TXD (Data from PC to Anemometer)	3

Table A-12. Pin assignments for a Gill HS-50 sonic anemometer (option 2) using the RS-232 output on the PCI. (...continued)

SmartFlux 2 Port 1, 2, or 3	Optional, Colors using Ethernet cable	Gill DB-9 Signal Name	DB-9 with Pins
2 (Power -)			
1 (Power +)			

Option 3

Option 3 connects the HS-50 Electronics Enclosure to the SmartFlux 2 or 3 System using RS-422/485 and a modified Gill 1086-M-043, unmodified 1086-10-118 Anemometer Cable, or LI-COR 7900-445 HS-50 RS-485/Power cable (50 m), or 382-16158 HS-50 RS-485/Power Cable (5 meter).

This method will work well if the PCI is not needed, and there is no intent of ever connecting the HS-50 to a computer using the DB-15 connector on one end of the 1086-M-043 Anemometer Cable. In this case, the DB-15 connector can be cut off the cable, or a cable without the DB-15 connector can be ordered from Gill (part number 1086-10-118). The Gill 1086-10-118 cable can be ordered from LI-COR. Strip the insulation back from the conductors of the cable end about 5 mm to connect straight into the SmartFlux 2 or 3 connector. See page 40 of HS-50 Horizontally Symmetrical Ultrasonic Research Anemometer User Manual. The following table is set up using the same wire colors as shown for the Gill 1086-M-043 anemometer cable. It will be necessary to use an ohm meter to figure out the wiring because 6 of the wires in the 1086-M-043 cable are black. The black wires are not interchangeable. The connections must be made according the pin numbers shown for the SmartFlux 2 or 3 connector and the Hirose 20-way plug at the opposite end of the cable.

See the Gill HS-50 Horizontally Symmetrical Ultrasonic Research Anemometer User Manual, page 40, 1086-M-043 Anemometer Cable (Voltage Out).

> **Note:** In this cable, Gill uses the standard convention of Tx+, Tx-, Rx+, and Rx-. The Tx and Rx labels are crossed in the cable diagram.

Table A-13. Pin assignments for a Gill HS-50 sonic anemometer (option 3) using a modified Gill 1086-M-043, unmodified 1086-10-118 (LI-COR 7900-445).

SmartFlux 2 Port 1, 2, or 3	Gill Wire Color	HS-50 DB-15; Signal name	HS-50 Hirose 20-Position Connector pin number and signal name
9 (RX-)	Black	RS-485 Rx-	3 (RS-485 Tx-)
8 (RX+)	Green	RS-485 Rx+	2 (RS-485 Tx+)
7 (TX-)	White/Orange	RS-485 Tx-	5 (RS-485 Rx-)
6 (TX+)	Orange	RS-485 Tx+	4 (RS-485 Rx+)
5 (Signal Return)		Signal GND	13 (Digital 0V)
4 (RX)			
3 (TX)			
2 (Power -)	White/Blue & White/Brown	Supply V-	14 (Supply V-)
1 (Power +)	Blue & Brown	Supply V+	6 (Supply V+)

Option 4

Option 4 connects the HS-50 Electronics Enclosure to SmartFlux 2 or 3 using RS-422/485 and unmodified Gill 1086-M-043 cable and dongle.

This method will work well if you own a PCI but want to bypass it without cutting your cable so it can be connected back to the PCI later. Use a quality Ethernet cable when making this dongle. The wire colors listed here are for using a Quabbin DataMax Ethernet cable.

Note: In this cable, Gill uses the standard convention of Tx+, Tx-, Rx+, and Rx-. The Tx and Rx labels are crossed in the cable diagram.

Table A-14. Pin assignments for a Gill HS-50 sonic anemometer (option 4) using a dongle to a Gill 1086-M-043 anemometer cable.

SmartFlux 2 Port 1, 2, or 3	Quabbin DataMax Ethernet Cable	HS-50 Db-15 Pin number	HS-50 DB-15; Signal name	HS-50 Hirose 20-Position Connector pin number and signal name
9 (RX-)	White/Green	9	RS-485 Rx-	3 (RS-485 Tx-)
8 (RX+)	Green	2	RS-485 Rx+	2 (RS-485 Tx+)
7 (TX-)	White/Orange	10	RS-485 Tx-	5 (RS-485 Rx-)

Table A-14. Pin assignments for a Gill HS-50 sonic anemometer (option 4) using a dongle to a Gill 1086-M-043 anemometer cable. (...continued)

SmartFlux 2 Port 1, 2, or 3	Quabbin DataMax Ethernet Cable	HS-50 Db-15 Pin number	HS-50 DB-15; Signal name	HS-50 Hirose 20-Position Connector pin number and signal name
6 (TX+)	Orange	3	RS-485 Tx+	4 (RS-485 Rx+)
5 (Signal Return)	Brown/White	4	Signal GND	13 (Digital 0V)
4 (RX)				
3 (TX)				
2 (Power -)	White/Blue	11	Supply V-	14 (Supply V-)
1 (Power +)	Blue	5	Supply V+	6 (Supply V+)

Appendix B.
7550-101 Auxiliary Sensor Interface

The optional Auxiliary Sensor Interface (ASI) is an O-ring sealed, weatherproof junction box that can be used to connect analog inputs and/or outputs. It has connections for up to six analog outputs, four general purpose analog inputs, and a constant 5 VDC source (5 mA maximum).

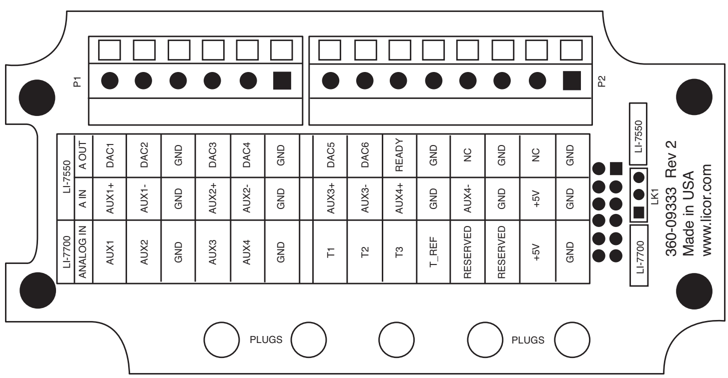


Figure B-1. Interior label of the ASI.

The ASI can also be configured to work with the LI-7700 Open Path CH_4 Analyzer. There is a small jumper located at position LK1 (far right in *Figure B-1* above). When using the ASI with the LI-7700, make sure that the jumper is positioned over the 2 pins nearest the LI-7550 label (the topmost 2 pins).

Mounting the ASI

The ASI mounting bracket can be attached to a 1 to 1½” (2.5 to 4 cm) post. Two U-bolts and hex nuts are included for this purpose. It can be mounted either vertically or horizontally, but to prevent leaks, orient the plugs so they face the ground. If you do not want to use the mounting plate, remove the two screws that hold the mounting bracket and secure it however you want.

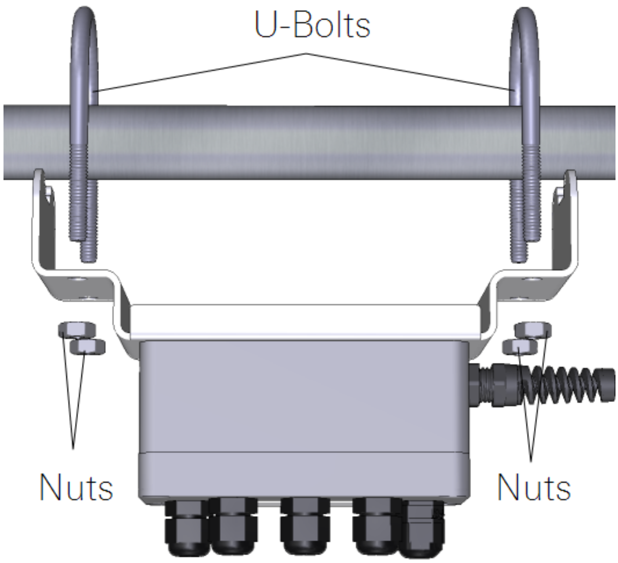
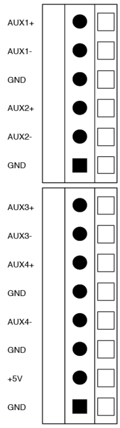


Figure B-2. Orient the gland plugs toward the ground to prevent water ingress.

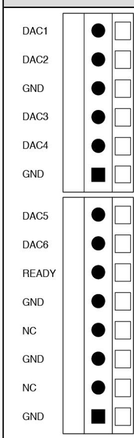
Terminal connections

Terminal positions for **analog inputs** are:



	Terminal	Analog Inputs[1]	Description
	1	AUX1+	Auxiliary Input 1 positive
	2	AUX1-	Auxiliary Input 1 negative
	3	GND	Ground
	4	AUX2+	Auxiliary Input 2 positive
	5	AUX2-	Auxiliary Input 2 negative
	6	GND	Ground
	7	AUX3+	Auxiliary Input 3 positive
	8	AUX3-	Auxiliary Input 3 negative
	9	AUX4+	Auxiliary Input 4 positive
	10	GND	Ground
	11	AUX4-	Auxiliary Input 4 negative
	12	GND	Ground
	13	+5V	+5V supply
	14	GND	Ground

Terminal positions for **analog outputs** are:

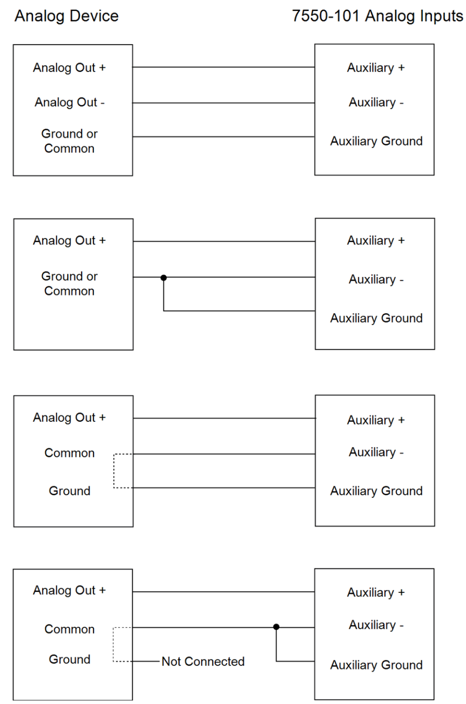


	Terminal	Analog Outputs[2]	Description
	1	DAC1	DAC channel 1 positive
	2	DAC2	DAC channel 2 positive
	3	GND	Ground
	4	DAC3	DAC channel 3 positive
	5	DAC4	DAC channel 4 positive
	6	GND	Ground
	7	DAC5	DAC channel 5 positive
	8	DAC6	DAC channel 6 positive
	9	READY	Analyzer ready
	10	GND	Ground
	11	NC	No connection
	12	GND	Ground
	13	NC	No connection
	14	GND	Ground

[1] Analog Inputs ±5V

[2] Analog Outputs 0-5V

Electrical connections

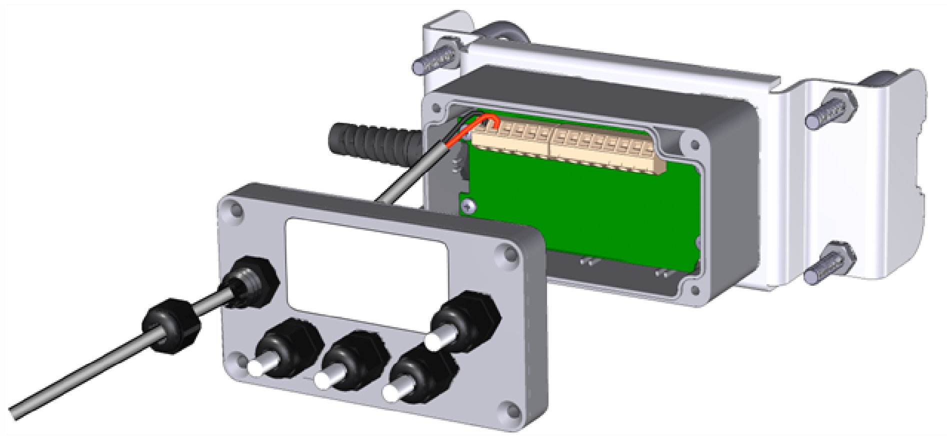


All analog devices connected to the ASI must be referenced to the ground (GND) connection; some examples are shown below.

- All auxiliary analog input ground connections are internally connected together.
- All auxiliary analog output ground connections are internally connected together.
- Analog devices with both ground and common outputs can share these outputs with their power supply ground.
- LI-7550 analog inputs are electrically isolated from the LI-7550 power input.
- LI-7550 analog outputs are electrically isolated from the LI-7550 power input and isolated from the analog inputs.

Connecting sensors

There are gland plugs on the ASI top cover, through which the sensor wires pass, after which they are connected to the appropriate screw terminals. Follow these steps to attach sensors or power to the ASI:



1 Remove the Philips screws from the corners of the ASI and remove the top cover.

2 Remove the cap from a gland plug.

3 Pass the wires through the cap and then through the gland plug.

4 Insert the wire leads into the appropriate terminals. Tighten the terminals to secure the wires.

Make a note of which plug the wires are passing through (e.g., A, B, C), and to which terminals the wires are connected. This information will be needed when you enter the sensor calibration coefficients into software.

5 Pull gently on the wires to remove excess wire from inside the interface. Re-attach the interface top cover and tighten the gland plug cap.

6 Attach the ASI cable connector to the ANALOG IN connection on the Analyzer Interface Unit.

There are 5 EPDM type plugs inside the box that can be inserted into unused gland plugs. The plugs prevent water, insects, and dirt from entering the interface box. Remove the top cover and insert the narrow end of the plug through the back of the gland plug(s) and tighten the plug cap(s). The plugs should be used any time there are gland plugs that do not have wires inserted through them.

There is a length of Santoprene tubing in the ASI spares kit. This tubing can be cut to length and placed around small gauge wires that may not be able to be tightened sufficiently with the gland plug caps. It can also be used for oddly shaped wires that can be difficult to seal with the gland plug caps.

Appendix C. Pin assignments

The LI-7550 pin assignments are given on the case interior label. The label also gives LED blink patterns for the LI-7550 USB port.

LI-7550 Pin Assignments

SDM

PIN 1	BROWN	SDM_EN
PIN 2	WHITE	SDM_CLK
PIN 3	BLUE	SDM_DATA
PIN 4	BLACK	GND
COUPLING	BARE	EARTH GND

POWER

PIN 1	BROWN	BLACK	VIN-
PIN 2	WHITE		VIN-
PIN 3	BLUE	RED	VIN+
PIN 4	BLACK		VIN+

INPUT: 10 - 30VDC

FUSE: 5A F 125/250V

ANALOG IN

PIN 1	WHITE	AUX1+
PIN 2	BROWN	AUX1-
PIN 3	GREEN	AUX2+
PIN 4	YELLOW	AUX2-
PIN 5	GREY	AUX3+
PIN 6	PINK	AUX3-
PIN 7	BLUE	AUX4+
PIN 8	RED	AUX4-
PIN 9	ORANGE	+5V
PIN 10	TAN	GND
PIN 11	BLACK	GND
PIN 12	VIOLET	GND

ANALOG OUT

PIN 1	WHITE	DAC1
PIN 2	BROWN	DAC2
PIN 3	GREEN	DAC3
PIN 4	YELLOW	DAC4
PIN 5	GREY	DAC5
PIN 6	PINK	DAC6
PIN 7	BLUE	READY
PIN 8	RED	NC
PIN 9	ORANGE	NC
PIN 10	TAN	GND
PIN 11	BLACK	GND
PIN 12	VIOLET	GND

USB LOGGING - USE INDUSTRIAL GRADE ONLY!

●	SOLID LED - DRIVE MOUNTED, NOT LOGGING
● ● ● ●	RAPID BLINK - LOGGING
● ●	SLOW BLINK - ERROR. EJECT AND RETRY
○	NO LED - DRIVE NOT MOUNTED, OK TO REMOVE

WARNING! FAILURE TO PRESS EJECT BUTTON BEFORE REMOVING USB DRIVE WILL RESULT IN LOSS OF DATA!

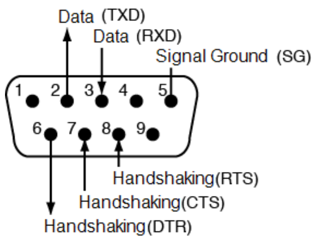
LI-COR®
Biosciences

LI-COR Biosciences
4647 Superior St.
Lincoln, NE 68504

1-800-447-3576 (U.S. & Canada)
402-467-3576
FAX: 402-467-2819
envsales@licor.com ● envsupport@licor.com
www.licor.com

DB-9 connector on RS-232 serial cable

The serial cable (part number 392-10268) has a round connector that attaches to the LI-7550 and a female DB-9 connector that attaches to a computer. Note that not all pins are used for communication between the LI-7550 and a computer.



Appendix D.
Suppliers

The company names, addresses, and phone numbers are the most current we have at the time of this printing. In some cases the information may change without notice.

Chemical sources

Material	LI-COR Part Number
Ascarite II, 500 g	9970-022
Magnesium Perchlorate, 2 kg	9960-078

Fisher Scientific www.fishersci.com 800-766-7000 770-871-4500	VWR Scientific Products www.vwrsp.com800-932-5000 908-757-4045
Thomas Scientific www.thomassci.com 800-345-2100 856-467-2000	GFS Chemicals, Inc. www.gfschemicals.com 800-394-5501 740-881-5501
P.W. Perkins Co., Inc. www.pwperkins.com 856-769-3525	LI-COR Biosciences 4647 Superior Street Lincoln, NE 68504 USA

Internal chemical bottle kit

The internal scrubbing bottles for the gas analyzer can be purchased in a pre-charged kit that is ready to use. The bottles contain magnesium perchlorate and

Ascarite II. The kit can be ordered under part number 7200-950, and contains two small bottles.

Cables

Turck, Inc.
3000 Campus Drive
Minneapolis, MN 55441
Phone: 612-553-7300
FAX: 612-553-0708
www.turck.com

Table D-1. Turck® cables used to connect to the LI-7500RS or LI-7200RS.

LI-COR Part Number	Cable	Cable Connector	Turck Part Number
392-09807 (LI-7200 only)	10-pin head cable	10-pin right angle male-female	RKS-10T-5-WSS 10T
392-10094	Power	4-pin female	RK4.41T-*/S529
392-10093	SDM Interface	4-pin male	RSS 4.4T-*
392-10268	Serial	6-pin female to DB-9 female	RKC 6T-*-DB9F/CS12317
392-10109	Analog In/Out	12-pin male	RSS 12T-*
392-10108	Ethernet	8-pin male-male	RSS RSS841-*M
392-10107	Ethernet Adapter	8-pin female to RJ45	RKC RJ45 840-*M

* = cable length in meters

OCP Group Inc
7130 Engineer Rd
San Diego, CA 92111
Phone: 858-279-7400
www.ocp.com

LI-COR Part Number	Cable	Cable Connector	OCP Part Number
392-13984	19-pin head cable	19-pin male to female	Specify LI-COR 392-13984 and the length you prefer

Industrial rated USB drives

16 GB industrial grade drives are available directly from LI-COR. Contact us for more information. LI-COR Part Number: 616-10723.

NOTE: The USB flash drive listed below has been tested by LI-COR; if you want to use other drives in the LI-7550, please contact LI-COR for more information.

APRO Co., Ltd.
www.apro-tw.com
APRO Part Number: WMUFD016G-ACCMC/3C

Appendix E. Configuration grammar

> **Note:** This grammar supports the core features of the instrument, but some functions are not fully described. Contact us if you have questions.

This section describes the protocol used by the instrument to communicate via RS-232 and Ethernet, for both configuration and data output purposes. Commands sent to the instrument have a certain structure that must be followed, and data sent by the instrument comes packaged in a particular way. For example, to set the Bandwidth to 10Hz, the following string

```
(Outputs(BW 10))
```

should be sent followed by a line feed character (decimal 10). Each command begins with a left parenthesis '`(`', and ends with a right parenthesis '`)`'. Some commands, such as `(BW...)` contain a single value, while other commands, such as `(Outputs...)`, can contain one or more commands. The parentheses mark the start and stop of the command, and extra characters before or after are ignored, as well as white space (spaces and tabs) before or after the parentheses. This string would work equally as well, for example:

```
This is ignored ( Outputs (BW 10 )) and so is this
```

The instrument does not try parsing a command string until a line feed is received. Since "extra" characters are ignored, commands can be terminated with carriage return and line feeds equally as well.

Another example of a command string is

```
(Outputs(RS232(Freq 10)(Pres TRUE))(BW 5))
```

In this case, we are setting the RS-232 output frequency to 10Hz, requesting that Pressure be included in the output records, and that the bandwidth be 5 Hz. Notice the 2 parentheses at the end of `(Pres TRUE))`. This is because `(Pres..)` and `(Freq..)` are `(RS232..)` commands, while `(BW..)` is not. `(BW..)` and `(RS232..)` are both `(Outputs..)` commands, however, and the “extra” parenthesis at the end of `(BW 5))` signals the end of the `(Outputs..)` command.

An illegal command string would be

```
(BW 5)
```

because the `(BW...)` command is only recognized within the context of an `(Outputs...)` command.

The configuration grammar is case sensitive. That is, `(Outputs(BW 10))` will work, while `(outputs(bw 10))` will not.

Who sends what

Not all of the commands in the instrument grammar are really commands. Some are designed to be used by the instrument to package outgoing data. The `(Data..)` command, or record, might look like this

```
(Data (CO2D 2.2083146e1)(H2OD 3.5485935e2)(Temp 2.5886261e1)(Pres
9.8157062e1))
```

This record is showing the latest values of CO_2 and H_2O mole density (mmol m^{-3}), temperature (°C), and pressure (kPa). The fields present in a `(Data..)` record, and how often they are output, is determined by the `(Outputs..)` command.

Once it has established communications with a host computer (discussed in the next section), the instrument’s RS-232 communications is largely made up of outgoing `(Data..)` and `(Diagnostics..)` records. The only other type of records it might send are `(Error..)` and `(Ack..)`. The `(Error..)` record is sent whenever the instrument receives a command it cannot parse or recognize, and the `(Ack..)` record acknowledges a configuration change. It is also used to pass back the new zero or span setting after a `(Calibrate..)` command.

Command summary

In the following sections, some abbreviations are used:

{int} means an integer value, such as 0, 10, 452, etc.
{float} means any integer or floating point value, such as 0, 3.14159, 1E-7, -3.47e-09,

etc.

{string} means anything (< 40 characters) contained by double quotes, such as "Hey, you!"

{ item1 | item2 | item3 } means you must include one of the items in the list.

{bool} - *{* TRUE | FALSE *}*

The (Outputs..) command

`(Outputs..)` is used to configure the items pertaining to data output, including the bandwidth, delay time, DACs (digital to analog convertors), the RS-232 port, Ethernet and USB Logging. The actual RS-232 and Ethernet output uses the `(Data..)` record described in *Table E-2* on page E-8.

Table E-1. The Outputs Command

<table>
<tr><th>Command</th><th colspan="4">Subcommands</th><th>Remarks</th></tr>
<tr><td rowspan="6">(Outputs</td><td colspan="3">(BW {5 | 10 | 20})</td><td rowspan="6">)</td><td>Sets instrument bandwidth to 5, 10, or 20 Hz.</td></tr>
<tr><td colspan="3">(Delay {int})</td><td>Output delay interval (0 to 32), where each interval is 1/150 seconds. This is added to the 220 ms system delay.</td></tr>
<tr><td rowspan="3">(Dac1
(Dac2
(Dac3
(Dac4
(Dac5
(Dac6</td><td>(Source {List})[1]</td><td rowspan="3">)</td><td>The variable that drives the DACs (digital to analog converters)</td></tr>
<tr><td>(Zero {float})</td><td>Value that corresponds to 0 Volts output</td></tr>
<tr><td>(Full {float})</td><td>Value that corresponds to 5 Volts output</td></tr>
<tr><td>(SDM</td><td>(Address {int})</td><td>)</td><td>SDM address (0 thru 14).</td></tr>
</table>

[1]Auxiliary Outputs: { NONE | CO2A | CO2MMOL | H2OA | H2OMMOL | TEMPERATURE | PRESSURE | AUX | AUX2 | AUX3 | AUX4 | CO2MF | CO2MFD | H2OMF | H2OMFD | DEWPT | SETPOINT}

Table E-1. The Outputs Command (...continued)

Command	Subcommands				Remarks
(Outputs	(RS232	(Baud {9600 | 19200 | 38400})	)	)	Baud rate for RS-232
		(Freq {float})			Output frequency of (Data..) records in Hz. Usable values: 0.0 thru 20.0
		(Labels {bool})			
		(DiagRec {bool})			
		(EOL {"hex code(s)"})			User defined termination character(s) for data record in "hex" (e.g. "0D0A" would be carriage return line feed). Default is "0A" = line feed.
		({List[1]} {bool})			These commands determine what is included in the (Data output record
	(ENet	(Freq {float})	)		
		(Labels {bool})			
		(DiagRec {bool})			
		(EOL {"hex code(s)"})			
		({List[1]} {bool})			
	(Logging	(Freq {1|2|5|10|20}	)		
		(Split {0|15|30|60|90|120|240|1440})			
		(Zip {bool})			
		(Full { Delete | DeleteAll | Stop })			
		(7700Status {bool})			
		({List[2]} {bool})			
		(Metadata{see below})			

[1]Data Outputs: Ndx | Time | Date | CO2Raw | H2ORaw | DiagVal | DiagVal2 | CO2D | H2OD | Temp | Pres | Aux | Aux2 | Aux3 | Aux4 | Cooler | CO2MF | CO2MFd | H2OMF | H2OMFd | DewPt | H2OAW | H2OAWO | CO2AW | CO2AWO | CO2SS

[2]Logging Outputs: Ndx | Time | Date | CO2Raw | H2ORaw | DiagVal | DiagVal2 | CO2D | H2OD | Temp | AvgTemp | TempIn | TempOut | Pres | APres | DPres | FlowPressure | MeasFlowRate | VolFlowRate | FlowPower | FlowDrive | Aux | Aux2 | Aux3 | Aux4 | Cooler | CO2MF | CO2MFd | H2OMF | H2OMFd | DewPt | H2OAW | H2OAWO | CO2AW | CO2AWO | FlowPressure | FlowPower | FlowDrive | AvgSS | CO2SS | H2OSS | DeltaSS | SECONDS | NANOSECONDS | CH4 | CH4D | TEMP | PRESSURE | AUX1 | AUX2 | AUX3 | AUX4 |AUXTC1 | AUXTC2 | AUXTC3| RSSI | DROPRATE | AUXTCDIAG | DIAG

Metadata commands

Command	Subcommands		
(Metadata	(Log {bool})		)
	(Site	(site_name {string})	
		(altitude {float})	
		(gpsformat {DDD MM SS.SSS | DDD MM.MMM | Decimal Degrees})	
		(latitude {+|- xxxd xx' xx.xxx"} | {+|- xxxd xx.xxx'} | {+|- xxx.xxxx})	
		(longitude {+|- xxxd xx' xx.xxx"} | {+|- xxxd xx.xxx'} | {+|- xxx.xxxx})	
		(canopy_height {float})	
		(displacement_height {float})	
		(roughness_height {float})	
	(Station	(station_name {string})	)
	(Instruments	(instr_1_manufacturer {string})	
		(instr_1_model {string})	
		(instr_1_height {float})	
		(instr_1_wformat {uvw|polar_w|axis})	
		(instr_1_wref {spar|axis})	
		(instr_1_north_offset {float})	
		(instr_2_manufacturer {string})	
		(instr_2_model {string})	
		(instr_2_height {float})	
		(instr_2_north_separation {float})	
		(instr_2_east_separation {float})	
		(instr_2_vertical_separation {float})	
		(instr_3_manufacturer {string})	
		(instr_3_model {string})	
		(instr_3_height {float})	
		(instr_3_north_separation {float})	
		(instr_3_east_separation {float})	
		(instr_3_vertical_separation {float})	

(EOL "{hex code(s)"})

End of Line character. Enter hex value in double quotes.

Example:

(Outputs(RS232(EOL "0D0A”)))lf

would terminate data strings with a carriage return and a line feed.

(Ndx {bool})

Determines whether an index value is transmitted or not.

Example:

(Outputs(RS232(Ndx TRUE)))lf

would cause the data stream to contain an index value. The index value is incremented approximately every 6.7 milliseconds (e.g. 150 Hz) and ranges from approximately -2.0E8 to +2.0E8.

(DiagRec {bool})

Controls whether independent (Diagnostic) text records are ever sent. If TRUE, operates normally (1/second or on a change). If FALSE, never sends a Diagnostic record.

Transmitted: `(Outputs(RS232(DiagRec TRUE)))lf`

Received: `(Diagnostics (SYNC TRUE)(PLL TRUE)(DetOK TRUE)(Chopper TRUE)(Path 61))`

(DiagVal {bool})

Controls whether or not a 1 byte diagnostic value (0-255) is output (same as SDM diagnostic value) in the (Data stream. "Diag" is used for the label when (Labels TRUE is set.

Example:

Transmitted: `(Outputs(RS232(DiagVal TRUE)))lf`

Received: `(Data... (Diag 249...))`

NOTE: The (DiagRec and the (DiagVal are two separate outputs and are independent of one another.

(Labels {bool})

This command controls whether or not data labels are transmitted with the data stream. Default is TRUE, and this means that data are transmitted in the normal (Data) format record. When (Labels FALSE), however, data output are values only and are tab-delimited. To maximize available bandwidth, when (Labels FALSE), a data record might appear as

```
15.1234<tab>354.123<tab>101.3<tab>249<eol>
```

The following are several examples of data formatting. The command string sent to the instrument is terminated with a line feed character.

EXAMPLE (Labels TRUE) data format

Transmitted to instrument

```
(Outputs(RS232(Freq 1)(EOL "0D0A")(Ndx TRUE)(DiagRec FALSE)(DiagVal TRUE)
(Labels TRUE)))lf
```

Received from the instrument

```
(Data (Ndx 1545)(DiagVal 250)(CO2Raw 1.5386712e-1)(CO2D 3.2183277e1)(H2ORaw
3.5775542e-2)(H2OD 1.9687008e2)(Temp 2.4227569e1)(Pres 9.8640356e1)(Aux 0)
(Cooler 1.5756724))(Data (Ndx 1809)(DiagVal 250)(CO2Raw 1.5380490e-1)(CO2D
3.2162146e1)(H2ORaw 3.5757541e-2)(H2OD 1.9677452e2)(Temp 2.4227569e1)(Pres
9.8543587e1)(Aux 0)(Cooler 1.5750400))
```

EXAMPLE (Labels FALSE) Data format

Notice how this format is much cleaner and reduces the overhead of redundant label transmissions. The data selected for output data record is accomplished with the (Outputs(RS232(CO2Raw TRUE)...)) command.

Transmitted to the instrument

```
(Outputs(RS232(Freq 1)(EOL "0D0A")(Ndx TRUE)(DiagRec FALSE)(DiagVal TRUE)
(Labels FALSE)))lf
```

Received from the instrument

```
252 250 0.15401 32.2167 0.03569 196.703 24.33 98.6 0 1.5730
511 250 0.15404 32.2174 0.03572 196.816 24.42 98.5 0 1.5683
765 250 0.15402 32.2342 0.03579 196.995 24.49 98.6 0 1.5703
1033 250 0.15400 32.2097 0.03571 196.771 24.63 98.5 0 1.5724
1288 250 0.15405 32.2341 0.03578 196.838 24.76 98.5 0 1.5734
1544 250 0.15406 32.2385 0.03575 196.782 24.72 98.5 0 1.5724
```

Examples:

To set the instrument to output only CO_2 and H_2O molar densities once every 2 seconds:

```
(Outputs(RS232(Freq .5)(Pres FALSE)(Temp FALSE)(Aux FALSE)(CO2Raw FALSE)(CO2D
TRUE)(H2ORaw FALSE)(H2OD TRUE)(Cooler FALSE)))
```

To configure DAC #1 to output CO_2 mole density with this scaling: 0V = 12 mmol m^{-3}, and 5V = 15 mmol m^{-3}.

```
(Outputs(Dac1(Source CO2MMOL)(Zero 12)(Full 15)))
```

Data and status records

The `(Data..)` and `(Diagnostics..)` records are the vehicles with which the instrument outputs data through its RS-232 port. The frequency with which it outputs `(Data..)` records is determined by the `(Outputs(RS232(Freq..)))` command. Data and status record formats are determined by the `(Outputs(RS232 (boolean` controlled command structure. `(EOL {"hex codes"})` and `(Labels {boolean})` determine the termination characters and whether or not `(Data` labels are output.

Table E-2. Data and Diagnostic Records

Record	Subcommands		Remarks	
(Data	(Ndx {int})	)	Index value. Increments by 150 every second.	The values included are set by (Outputs (...)). How often this is output is determined by (Outputs (Freq...)).
	(Time {})		Time	
	(Date {})		Date	
	(Temp {float})		Block temperature, °C	
	(Pres {float})		Total pressure, kPa	
	(Aux {float})		Auxiliary input value	
	(Aux2 {float})		Auxiliary input value 2	
	(Aux3 {float})		Auxiliary input value 3	
	(Aux4 {float})		Auxiliary input value 4	

Table E-2. Data and Diagnostic Records (...continued)

Record	**Subcommands**		**Remarks**	
(Data	(CO2AW {float})	)	CO_2 Source	The values included are set by (Outputs (...)). How often this is output is determined by (Outputs (Freq...)).
	(CO2AWO {float})		CO_2 Reference	
	(CO2Raw {float})		CO_2 absorptance	
	(CO2D {float})		CO_2 density (mmol m^{-3})	
	(CO2MF {float})		CO_2 mol fraction (μmol/mol)	
	(H2OAW {float})		H_2O Source	
	(H2OAWO {float})		H_2O Reference	
	(H2ORaw {float})		H_2O absorptance	
	(H2OD {float})		H_2O density (mmol m^{-3})	
	(H2OMF {float})		H_2O mol fraction (mmol/mol)	
	(Cooler {float})		Detector cooler (Volts)	
	(DiagVal {int})		Diagnostic value 0-8191255. Boolean controlled output	
(Data	(DiagVal2 {int})	)	31 bit diagnostic value	The values included are set by (Outputs (...)). How often this is output is determined by (Outputs (Freq...)).
	(AvgSS {float})		Average Signal Strength	
	(CO2SS {float})		CO_2 Signal Strength	
	(H2OSS {float})		H_2O Signal Strength	
	(DeltaSS {float})		CO_2 Signal Strength – H_2O Signal Strength	
Record	Subcommands		Remarks	
(Diagnostics	(Path {float})	)	Average Signal Strength (0-100)	Diagnostics are always output at 1 Hz
	(Synch {bool})		Synch (always true)	
	(PLL {bool})		Phase lock loop status	
	(DetOK {bool})		Detector temperature control	
	(Chopper {bool})		Chopper temperature control	
	(PDif {bool})		Differential pressure	
	(AuxIn {bool})		Auxiliary Inputs	
	(Head {1|0})		Head, 1=7200RS/7500TS	

Table E-2. Data and Diagnostic Records (...continued)

<table>
<tr><th>Record</th><th colspan="2">Subcommands</th><th>Remarks</th></tr>
<tr><td rowspan="2">(Ack</td><td>(Received TRUE)</td><td rowspan="2">)</td><td>Sent by the instrument to acknowledge any incoming command.</td></tr>
<tr><td>(Val {float})</td><td>Only sent after zeroing and spanning commands. Contains the new, computed value of zero or span.</td></tr>
<tr><td colspan="3">(Error (Received TRUE))</td><td>Sent by the instrument when it cannot parse or recognize a command.</td></tr>
<tr><td rowspan="4">(EmbeddedSW</td><td>(Version {string})</td><td rowspan="4">)</td><td rowspan="5">Embedded software version
Instrument model
Embedded DSP software version
Embedded FPGA software version</td></tr>
<tr><td>(Model {string})</td></tr>
<tr><td>(DSP {string})</td></tr>
<tr><td>(FPGA {string})</td></tr>
<tr><td colspan="3">(Command {start_logging | stop_logging | eject_usb | factory_reset})</td></tr>
<tr><td rowspan="3">(Info (USB</td><td>(Size {float})</td><td rowspan="3">)</td><td rowspan="3">0: Drive not present
1: Logging
2: Drive present, not logging
3: Error</td></tr>
<tr><td>(Free {float})</td></tr>
<tr><td>(State {0|1|2|3}</td></tr>
</table>

Examples:

A typical (Data..) output record, with all items present, is shown below:

```
(Data (Ndx 215713)(CO2Raw 1.2831902e-1)(CO2D 2.2083146e1)(H2ORaw 5.5372476e-2)
(H2OD 3.5485935e2)(Temp 2.5886261e1)(Pres 9.8157062e1)(Aux 0)(Cooler
1.0537354))
```

A typical (Diagnostics..) record is shown below:

```
(Diagnostics (Sync TRUE)(PLL TRUE)(DetOK TRUE)(Chopper TRUE)(Path 63))
```

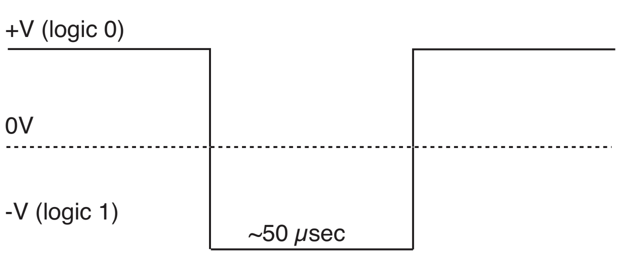
Data polling (software and hardware)

A software command using the ENQ character (0x05) is available to query the instrument for a data record over RS-232. When transmitted to the instrument, via RS-232, the record is built as presently defined (Labels TRUE or FALSE, etc.), and is added to the serial output queue. This software command is normally used when the update frequency is set to zero, as shown in the command below.

```
(Outputs (RS232 (Freq 0)(DiagRec FALSE)))lf
```

The instrument also supports toggling of the Clear To Send (CTS) line to request a data record. This hardware polling would be normally used when the update frequency is set to 0 as described above. Since the CTS line is an input, the host software should toggle the Request To Send (RTS) line from the host computer. This method of transmitting a data record occurs when the CTS line goes from low to high.

Users familiar with programming RS-232 interfaces may already understand that RS-232 logic TRUE (1) is considered a low (or negative) voltage and logic FALSE (0) is considered a high (or positive) voltage. Thus, the CTS toggle sequence would look like:



Data are updated to RS-232 at 20 Hz. If the CTS line is toggled, record will be output the next time one is ready. The CTS line is pin 7 on the LI-COR RS-232 Cable, part number 392-10268. The RS-232 serial pin-out from a DB9 connector on an AT style computer is defined as:

Pin	Signal Description	Function	Signal at Device
1	DCD	Data Carrier Detect	Input
2	RD	Received Data	Input
3	TD	Transmit Data	Output
4	DTR	Data Terminal Ready	Output
5	SG	Signal Ground	
6	DSR	Data Set Ready	Input
7	**RTS**	**Request To Send**	**Output**
8	**CTS**	**Clear To Send**	**Input**
9	RI	Ring Indicator	Input

A possible wiring configuration using the LI-COR RS-232 cable, part number 392-10268 to a computer would be:

LI-COR CABLE	DB9 ON HOST COMPUTER	LI-COR CABLE
Function	**PIN**	**Function**
Ground	PIN 5	Ground
Receive Data	PIN 3	Transmit Data
Request To Send	PIN 8	Clear To Send
Transmit Data	PIN 2	Receive Data
Clear To Send	PIN 7	Request To Send
Data Terminal Ready	PIN 6	Data Set Ready

Note about embedded software RS-232 communication priorities

The RS-232 hardware and software trigger does not tap directly into the same data stream that is output to the DAC's and the SDM. The trigger actually sends a request to the instrument to output a single data record over the RS-232 port. The processing that is incurred to do this is relatively lengthy. The RS-232 task is also a low priority, so considerable latency could occur. If you want to output data that is tightly synchronized to an input stimulus you should use the SDM output or sample a DAC output based on your trigger; don't use RS-232.

The (Inputs..) command

The (Inputs..) command is used to scale the Auxiliary input channel, and to determine how pressure and temperature are measured by the instrument.

Table E-3. The Inputs Command.

Command	Subcommands				Remarks
(Inputs	(Pressure (Temperature	(Source { Aux | Measured | UserEntered })	)	)	How it is determined
		(Val *{float}*)			Fixed value, for “UserEntered”
	(Aux	(A *{float}*)	)		A and B are the Slope and Intercept respectively Name: Used to denote the type of input. For example, U, V, W, Ts. Units: The units of the data after the slope and intercept are applied.
		(B *{float}*)			
		(Name*{string}*)			
		(Units*{string}*)			
	(Aux2	(A *{float}*)	)		
		(B *{float}*)			
		(Name*{string}*)			
		(Units*{string}*)			
	(Aux3	(A *{float}*)	)		
		(B *{float}*)			
		(Name*{string}*)			
		(Units*{string}*)			
	(Aux4	(A *{float}*)	)		
		(B *{float}*)			
		(Name*{string}*)			
		(Units*{string}*)			

Examples:

To make pressure fixed at 92 kPa, send this:

```
(Inputs(Pressure(Source UserEntered)(Val 92)))
```

To measure temperature from a linearized thermistor connected to the Auxiliary input, where 0 volts is 0 °C, and 5 volts is 50 °C, send this:

```
(Inputs(Aux(A 10)(B 0))(Temperature(Source Aux)))
```

To measure pressure and temperature normally, using the built-in sensors, send this:

```
(Inputs(Pressure(Source Measured))(Temperature(Source Measured)))
```

The (Calibrate...) and (Coeffs...) commands

The `(Calibrate..)` and `(Coeffs..)` commands control zeroing, spanning, and factory calibration coefficients. The `(Date` subcommand must be present, and `(Val` must be absent to perform `(ZeroH2O` and `(ZeroCO2`. For `(SpanCO2` and `(SpanH2O`, `(Date` and `(TDensity` must be present, and `(Val` must be absent to trigger a calibration.

Table E-4. Calibration Commands.

<table>
<tr><th>Command</th><th colspan="4">Subcommands</th><th>Remark</th></tr>
<tr><td rowspan="9">(Calibrate</td><td rowspan="2">(ZeroH2O
(ZeroCO2</td><td>(Val {float})</td><td rowspan="2">)</td><td rowspan="9">)</td><td>For setting the zero directly. If not present will trigger a calibration.</td></tr>
<tr><td>(Date {quoted string})</td><td>The date field triggers the instrument to do a zero immediately. The new value will be returned in an (Ack..) record.</td></tr>
<tr><td rowspan="4">(SpanCO2
(Span2CO2
(SpanH2O
(Span2H2O</td><td>(Val {float})</td><td rowspan="4">)</td><td>For setting the span directly. If not present will trigger a calibration.</td></tr>
<tr><td>(Target {float})</td><td>Target value in ppm for CO_2, or °C for H_2O (for reference purposes).</td></tr>
<tr><td>(TDensity {float})</td><td>Target value in mmol m^{-3}. (For computational purposes).</td></tr>
<tr><td>(Date {quoted string})</td><td></td></tr>
<tr><td rowspan="3">(MaxRef</td><td>(CX {int})</td><td rowspan="3">)</td><td>Maximum expected value of raw reference signal Aco at -40 °C.</td></tr>
<tr><td>(WX {int})</td><td>Maximum expected value of raw reference signal Awo at -40 °C.</td></tr>
<tr><td>(Date {quoted string})</td><td></td></tr>
</table>

Table E-4. Calibration Commands. (...continued)

Command	Subcommands					Remark
(Coeffs	(Current	(SerialNo *{quoted string}*)			)	The 72H-xxxx head number.
		(Band (A *{float}*))				The band broadening coefficient (1.15).
		(CO2	(A *{float}*)	)		These values are found on the calibration sheet. SD1, SD2, and SD3 are b1, b2, and b3 in equation 11-17.
			(B *{float}*)			
			(C *{float}*)			
			(D *{float}*)			
			(E *{float}*)			
			(XS *{float}*)			
			(Z *{float}*)			
			(SD1 {float})			
			(SD2 {float})			
			(SD3 {float})			

Table E-4. Calibration Commands. (...continued)

Command	Subcommands				Remark
		(H2O	(A *{float}*)	)	
			(B *{float}*)		
			(C *{float}*)		
			(XS *{float}*)		
			(Z *{float}*)		
			(SD1 {float})		These values are found on the calibration sheet. SD1, SD2, and SD3 are b1, b2, and b3 in equation 11-13.
			(SD2 {float})		
			(SD3 {float})		
		(Pressure	(A0 *{float}*)		
			(A1 *{float}*)		
		(MaxRef	(B *{float}*)		
			(C *{float}*)		

Examples:

1 To set the CO_2 zero right now (with CO_2-free gas flowing though it, of course), send this:

(Calibrate(ZeroCO2(Date “11 Aug 2016 at 2:15”)))

Note 1: The data value can be any string, so “My Birthday” is equally valid.

Note 2: The new value of zero will be sent in the next `(Ack(Val..))` record. (See Table 2).

2 To force the H_2O channel to use the value 0.96 for its zero, send this:

(Calibrate(ZeroH2O(Val 0.96)))

3 To make the instrument set its CO_2 span right now, with 400 μmol mol^{-1} flowing through the calibration tube, first compute the target density (solved for C).

If the temperature is 23°C, and the pressure 98kPa, then the mode density is 15.92 mmol CO_2 m^{-3}. Then send the following:

(Calibrate(SpanCO2(Target 400)(Tdensity 15.92)(Date "14 Sept 2015")))

The Program Reset command

`(Program(Reset TRUE))` is the equivalent of pressing the reset button on the main board. It is generally only used to access lower level software for updating the embedded program, or when the instrument is not responding normally.

Table E-5. Synchronization Commands

Command	Remarks
(Program (Reset TRUE))	Sending this will force the software to reset. This is equivalent to pressing the reset button on the LI-7550 inside panel.

The Network command

The **Name** can only include upper and lower case letters (A to Z and a to z), numbers (0 to 9), the dash character (-), and the period (.). Names that do not comply with this constraint will cause communication problems.

Table E-6. Network Commands

<table>
<tr><th>Command</th><th colspan="4">Subcommands</th><th>Remarks</th></tr>
<tr><td rowspan="6">(Network</td><td colspan="3">(Name {string})</td><td rowspan="6">)</td><td rowspan="6">Hostname
Address type: dhcp | static</td></tr>
<tr><td rowspan="5">(IP</td><td>(Type {dhcp | static}</td><td rowspan="5">)</td></tr>
<tr><td>(Address {xxx.xxx.xxx.xxx})</td></tr>
<tr><td>(Netmask {xxx.xxx.xxx.xxx})</td></tr>
<tr><td>(Gateway {xxx.xxx.xxx.xxx})</td></tr>
<tr><td>(MAC {xx:xx:xx:xx:xx:xx})</td></tr>
</table>

The Clock command

<table>
<tr><th>Command</th><th>Subcommands</th><th>Remarks</th></tr>
<tr><td rowspan="4">(Clock</td><td>(Date {})</td><td>System date</td></tr>
<tr><td>(Time {})</td><td>System time</td></tr>
<tr><td>(PTP {off | automatic | slaveonly | preferred})</td><td>Precision Time Protocol setting</td></tr>
<tr><td>(Zone {[1]})</td><td>Time zone</td></tr>
</table>

The Query command

The Query (?) command is used to query the instrument for any configuration parameter individually, as well as any node in the configuration tree.

[1] Refer to the PC software for list of time zones.

Table E-7. Query Commands

Command	Remarks
(Outputs ?) (Calibrate ?) (Coef ?) (Outputs ?) (Data ?) (Diagnostics ?) (EmbeddedSW ?) (Inputs ?) (Info ?) (Network ?) (MeteoDevices ?) (MeteoSensors ?)	The query for individual parameters works only for configuration parameters and not data or diagnostic information. All commands are followed by a line feed (lf).

Examples:

The query (**Outputs**(**RS232**(**Freq ?**)))**lf** would respond:

```
(Outputs (RS232 (Freq 5)))
```

whereas the query (**Calibrate ?**)**lf** causes a Calibrate record to be put in the output queue.

Example Response:

```
(Calibrate (ZeroCO2 (Val 0.8945)(Date 26 08 2009 10:37))(SpanCO2 (Val 1.0068)
(Target 597.2)(Tdensity 23.154)(Date 26 08 2009 11:00))(Span2CO2 (Val 0.0)
(Target )(Tdensity )(ic 0.106207)(act 0.105489)(Date 4Cal))(ZeroH2O (Val
0.791075)(Date 26 08 2009 11:20))(SpanH2O (Val 1.00585)(Target 12.00)(Tdensity
447.421)(Date 26 08 2009 11:37))(Span2H2O (Val 0.0)(Target )(Tdensity )(iw
0.059434)(awt 0.0590885)(Date 4Cal)))
```

(**Coef ?**)**lf** causes a Coefficients record to be put in the output queue.

Example Response:

```
(Coef (Current (SerialNo 75H-Beta6)(Band (A 1.15))(CO2 (A 1.56704E+2)(B
2.15457E+4)(C 4.33894E+7)(D -1.24699E+10)(E 1.75102E+12)(XS 0.0023)(Z 0.0002))
(H2O (A 5.24232E+3)(B 3.91896E+6)(C -2.33026E+8)(XS -0.0009)(Z 0.0185))
(Pressure (A0 56.129)(A1 15.250))(DPressure (A0 1.0)(A1 0.0))))
```

(**Outputs ?**)**lf** causes a Outputs record to be put in the output queue.

Example Response:

```
(Outputs (BW 10)(Delay 0)(SDM (Address 7))(Dac1 (Source NONE)(Zero -5e-2)(Full
4e-1))(Dac2 (Source PRESSURE)(Zero -1e-1)(Full 4e-1))(RS232 (Baud 38400)(Freq
0)(Pres TRUE)(Temp TRUE)(Aux TRUE)(Cooler TRUE)(CO2Raw TRUE)(CO2D TRUE)(H2ORaw
TRUE)(H2OD TRUE)(Ndx TRUE)(DiagVal TRUE)(DiagRec FALSE)(Labels FALSE)(EOL
"0D0A")))
```

(**Data ?**)**lf** causes a Data record to be put in the output queue. (Note that an ENQ (0x05) will do the same thing...)

Example Response:

```
(Data (Ndx 2471)(DiagVal 250)(CO2Raw 1.6319131e-1)(CO2D 3.5119712e1)(H2ORaw
3.1672954e-2)(H2OD 1.7067077e2)(Temp 2.3874512e1)(Pres 9.8735609e1)(Aux 0)
(Cooler 1.5630015))
```

(**Diagnostics ?**)**lf** causes a Diagnostics record to be put in the output queue.

Example Response:

```
(Diagnostics (SYNC TRUE)(PLL TRUE)(DetOK TRUE)(Chopper TRUE)(Path 65))
```

(**EmbeddedSW ?**)**lf** causes an EmbeddedSW record to be put in the output queue.

Example Response:

```
(EmbeddedSW (Version 4.0.0)(Model LI-7x00RS CO2/H2O Analyzer)(DSP 4.0.0)(FPGA
4.0.0|))
```

(**Inputs ?**)**lf** causes an Inputs record to be put in the output queue.

Example Response:

```
(Inputs (Pressure (Source Measured)(UserVal 9.8000002e1))(Temperature (Source
Measured)(UserVal 2.5000000e1))(Aux (A 1)(B 0)))
```

The MeteoDevices command (biomet station)

Command	Subcommands		Remarks
(MeteoDevices	(DevList {string:string...})	)	Colon delimited list of devices on the network (subnet)
	(Device {string})		Current connected device
	(DeviceState {0|1})		0=not connected 1=connected
	(SyncClock {bool])		When TRUE, the clock on the 9210B will get updated with the time of the LI-7550

The MeteoSensors command (biomet sensors)

Command	Subcommands		Remarks
(MeteoSensors(Sensor	(Name {string})	)	Name of sensor, Defined in Coms Tag
	(Type {int})		Type of sensor
	(Units {int})		Units

The connection protocol

The purpose of this section is to describe the protocol used to establish communications with the instrument when it is operating in an “unknown” mode. That is, when the baud rate is not known, nor are any other details about the instrument’s configuration.

For simple data collection, the instrument can be configured with the PC software, and you will not have to deal with this protocol at all. If you want to write your own interface program or driver for the instrument, and you want to get the instrument to send its configuration to you, then this protocol must be used.

1. Set a break condition on the RS-232 line. 500 ms should be sufficient.

   The instrument will cease normal activity, change its baud rate to 9600 baud, and begin to send ASCII ENQ characters (decimal 05) at a rate of 2 Hz for up to 10 seconds. Before 10 seconds are up, the host should:

2. Send an ASCII ACK character (decimal 06) to the instrument.

   Upon receipt of an ACK, the instrument will output its current configuration, terminated with a line feed (decimal 10). After this is sent, the instrument will resume its normal operation, except it will remain at 9600 baud.

3. The host can then send the desired configuration changes, if any, to the instrument.
4. If the configuration change involves a baud rate change, the instrument will send its (Ack..) record before changing baud rates.

Appendix F. Specifications

CO_2 Measurements

Calibration Range: 0 to 3000 μmol mol^{-1}

Accuracy: Within 1% of reading

Zero Drift (per °C):

±0.1 ppm typical

±0.3 ppm maximum

RMS Noise (typical @ 370 ppm CO_2):

@5 Hz: 0.08 ppm

@10 Hz: 0.11 ppm

@20 Hz: 0.16 ppm

Gain Drift (% of reading per °C @ 370 ppm):

±0.02% typical

±0.1% maximum

Direct Sensitivity to H_2O (mol CO_2 mol^{-1} H_2O):

±2.00E-05 typical

±4.00E-05 maximum

H_2O Measurements

Calibration Range: 0 to 60 mmol mol^{-1}

Accuracy: Within 1% of reading

Zero Drift (per °C):

±0.03 mmol mol^{-1} typical

±0.05 mmol mol^{-1} maximum

RMS Noise (typical @ 10 mmol mol^{-1} H_2O):

@5 Hz: 0.0034 mmol mol^{-1}

@10 Hz: 0.0047 mmol mol^{-1}

@20 Hz: 0.0067 mmol mol^{-1}

Gain Drift (% of reading per °C @ 20 mmol mol^{-1}):
±0.15% typical
±0.30% maximum

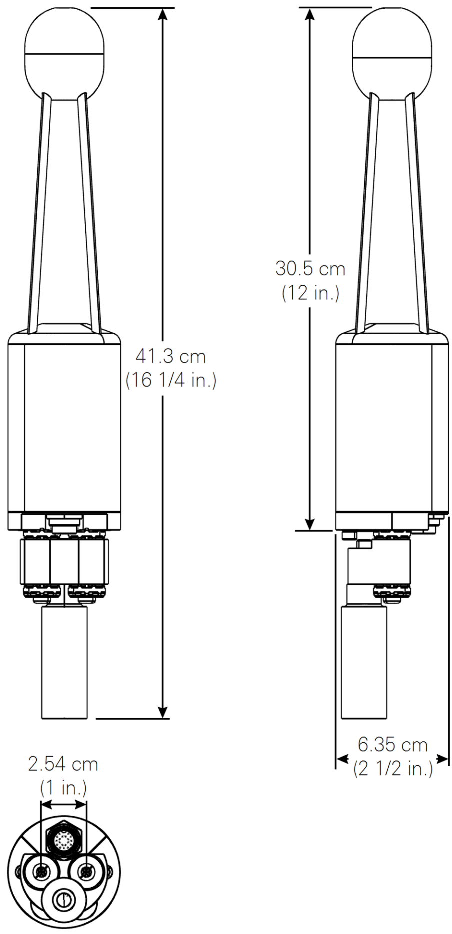
Direct Sensitivity to CO_2 (mol H_2O mol^{-1} CO_2):
±0.02 typical
±0.05 maximum

General

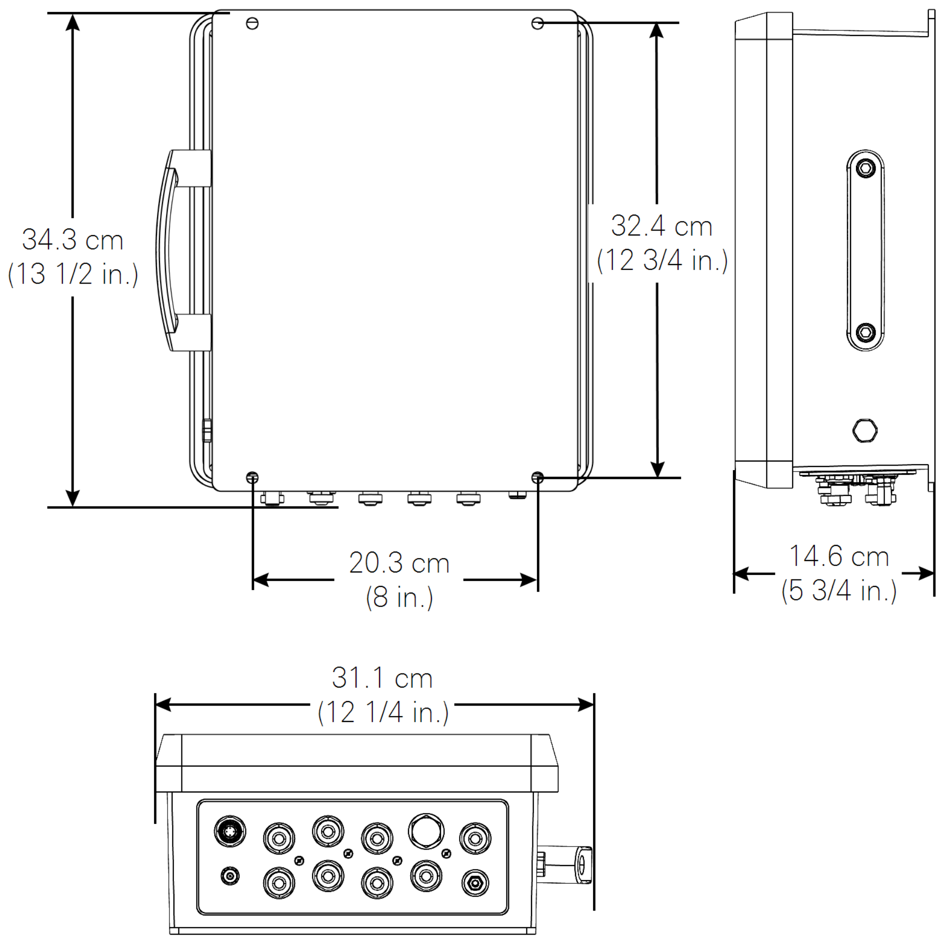
Fundamental Gas Sampling Rate: 150 Hz
Bandwidth: 5, 10, or 20 Hz; software selectable
Type: Absolute, open-path, non-dispersive spectroscopy
Detector: Thermoelectrically cooled lead selenide
Path Length: 12.5 cm (4.92")
Air Temperature Thermistor: 10K ohm @ 25 °C thermistor; Accurate to ±0.5 °C
Pressure Sensor:
Range: 65 to 115 kPa absolute
Accuracy: ± 0.1% of full scale
Resolution: 0.002 kPa
Signal Noise (peak-to-peak): 0.002 kPa typical
Inputs: Ethernet, 4 analog input channels (±5 V, 16 bit)
Outputs: RS-232 (20 Hz Maximum); SDM (User selectable to 50 Hz); Ethernet; 6 user-scalable 16 bit DACs (0-5 V range, single-ended)
Operating Temperature Range: -25 to 50 °C (-40 to 50 °C verification on request)
Relative Humidity Range: 0-95% (non-condensing)
Data Storage: Removable industrial grade USB flash storage
Data Communication: Ethernet, Synchronous Device for Measurement (SDM; User-selectable to 50 Hz), RS-232 (115200 baud); 20 Samples/Sec. max., 6 DACs (single ended; 0-5 V)
Weatherproof Rating: Tested to IEC IP65 standard
User Interface: Windows® PC software
Power Requirements: 10.5 to 30 VDC
Power Consumption: Typically 30 W during warm-up (maximum 37 W at -40 °C), 8 to 18 W steady state (depending on ambient temperature)
Dimensions:
Head: Diameter 6.5 cm, Length 30 cm.
LI-7550 Analyzer Interface Unit: 35 × 30 × 15 cm
Cable: 5 meters. Head cable can be extended to 10 meters.
Weight:
Head: 0.75 kg

LI-7550 and Cables: 4.8 kg

Gas analyzer head dimensions

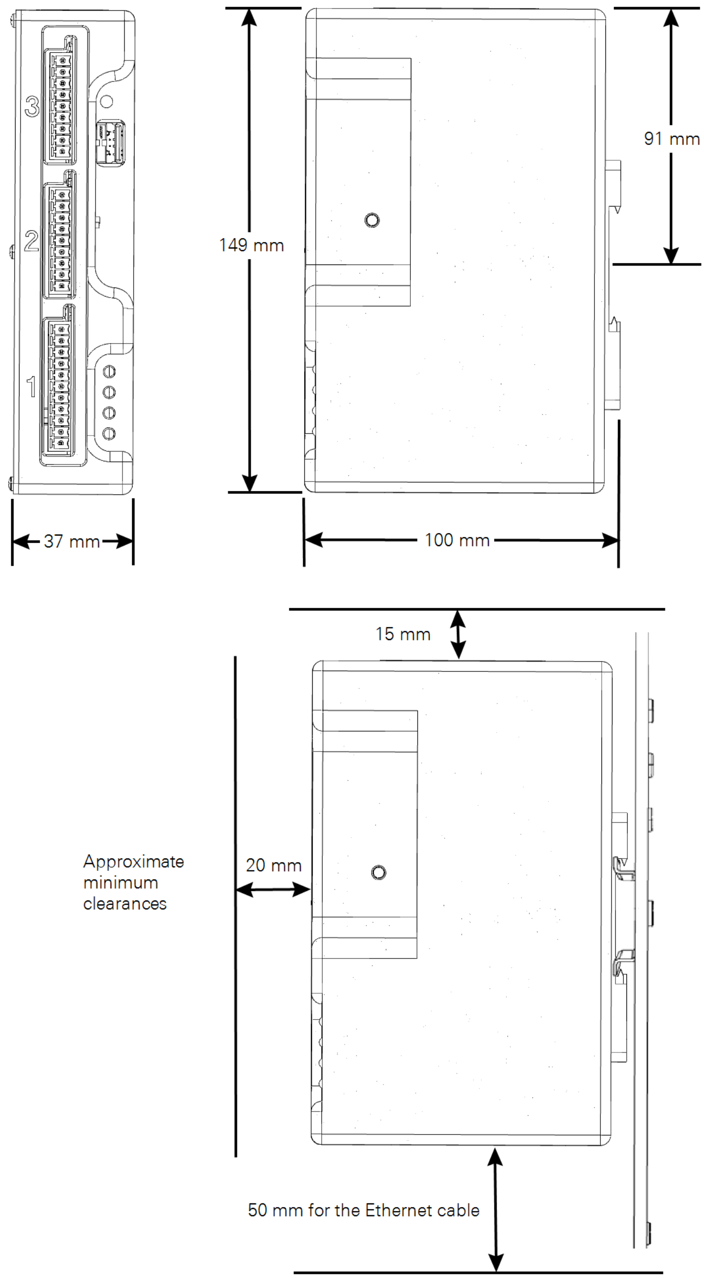


LI-7550 dimensions



SmartFlux 2 System

Data Inputs: Three RS-232/422/485 serial ports
Network Communication: Ethernet (TCP/IP)
Data Storage: USB port for 16 GB industrial grade flash drive
Operating Temperature Range: -25 to 50 °C (-40 to 50 °C verification on request)
GPS Antenna Operating Temperature Range: -30 °C to 80 °C
Relative Humidity Range: 0 to 95% (non-condensing)
Input Voltage: 10 to 30 VDC
Power Consumption: 1.5 watts typical (3.5 watts maximum; excluding pass-through power)
Max Current Passed Through to the Anemometer: 2 A
Dimensions with DIN Clip: 149 x 100 x 37 mm (L×W×H)
Weight with GPS Antenna: 1.32 lb. (0.59 kg)
GPS Antenna Diameter: 61 mm (2.4 in.)
GPS Cable Length: 5 m
GPS Accuracy:
  GPS Standard Positioning Service: <15 m; 95% typical
  WAAS: <3 m; 95% typical


3
2
1
37 mm
149 mm
100 mm
91 mm
15 mm
Approximate
minimum
clearances
20 mm
50 mm for the Ethernet cable

Appendix G.
Warranty

Each LI-COR, Inc. instrument is warranted by LI-COR, Inc. to be free from defects in material and workmanship; however, LI-COR, Inc.'s sole obligation under this warranty shall be to repair or replace any part of the instrument which LI-COR, Inc.'s examination discloses to have been defective in material or workmanship without charge and only under the following conditions, which are:

1. The defects are called to the attention of LI-COR, Inc. in Lincoln, Nebraska, in writing within one year after the shipping date of the instrument.
2. The instrument has not been maintained, repaired or altered by anyone who was not approved by LI-COR, Inc.
3. The instrument was used in the normal, proper and ordinary manner and has not been abused, altered, misused, neglected, involved in an accident or damaged by act of God or other casualty.
4. The purchaser, whether it is a DISTRIBUTOR or direct customer of LI-COR or a DISTRIBUTOR'S customer, packs and ships or delivers the instrument to LI-COR, Inc. at LI-COR Inc.'s factory in Lincoln, Nebraska, U.S.A. within 30 days after LI-COR, Inc. has received written notice of the defect. Unless other arrangements have been made in writing, transportation to LI-COR, Inc. (by air unless otherwise authorized by LI-COR, Inc.) is at customer expense.
5. No-charge repair parts may be sent at LI-COR, Inc.'s sole discretion to the purchaser for installation by purchaser.
6. LI-COR, Inc.'s liability is limited to repair or replace any part of the instrument without charge if LI-COR, Inc.'s examination disclosed that part to have been defective in material or workmanship.

There are no warranties, express or implied, including but not limited to any implied warranty of merchantability of fitness for a particular purpose on underwater cables or on expendables such as batteries, lamps, thermocouples, and calibrations.

Other than the obligation of LI-COR, Inc. expressly set forth herein, LI-COR, Inc. disclaims all warranties of merchantability or fitness for a particular purpose. The foregoing constitutes LI-COR, Inc.'s sole obligation and liability with respect to damages resulting from the use or performance of the instrument and in no event shall LI-COR, Inc. or its representatives be liable for damages beyond the price paid for the instrument, or for direct, incidental or consequential damages.

The laws of some locations may not allow the exclusion or limitation on implied warranties or on incidental or consequential damaged, 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 state to state. 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 date the instrument is shipped to a user who is a customer or eighteen months from the date of shipment to LI-COR, Inc.'s authorized distributor, whichever is earlier.

This warranty supersedes all warranties for products purchased prior to June 1, 1984, unless this warranty is later superseded. To the extent not superseded by the terms of any extended warranty, the terms and conditions of LI-COR's Warranty still apply.

DISTRIBUTOR or the DISTRIBUTOR's customers may ship the instruments directly to LI-COR if they are unable to repair the instrument themselves even though the DISTRIBUTOR has been approved for making such repairs and has agreed with the customer to make such repairs as covered by this limited warranty.

Further information concerning this warranty may be obtained by writing or telephoning Warranty manager at LI-COR, Inc.

Appendix H.
Index

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