C-SENSE User's Manual

Warranty

1-YEAR LIMITED WARRANTY ON C-SENSE HARDWARE

Precision Measurement Engineering, Inc. (PME) warrant that the C-sense Logger shall be free of defects in workmanship and materials, under normal use, for a period of one year from the date of shipment. This warranty is made only to the original purchaser. In the event a C-sense Logger covered by this warranty fails to operate according to our published specifications, then return it freight pre-paid to PME or an authorized Service Provider. PME will repair the unit at no charge to the customer and bear the cost of return shipment. Carefully pack all components, as the customer is responsible for any freight damage.

This warranty does not apply to services or consumable / expendable items (such as batteries, fuses and ropes) required for general maintenance. Equipment manufactured by other companies (such as meteorology sensors, solar panels, etc) are warranted only to the limit of the warranties provided by their original manufacturer.

PME makes no warranty, either expressed or implied, that the sensors will be operable after they are exposed to adverse environmental conditions, such as bio-fouling, oil fouling, freezing temperatures or others.

This warranty is void if, in our opinion, the C-sense Logger has been damaged by accident, mishandled, altered, or repaired by the customer, where such treatment has affected its performance or reliability. In the event of such treatment by the customer, costs for repairs plus two-way freight costs (no COD shipments will be accepted) will be borne by the customer. In such cases, an estimate will be submitted for approval before repair work is started. Items found to be defective should be returned to PME carefully packed, as the customer will be responsible for freight damage.

Incidental or consequential damages or costs incurred as a result of the product malfunction are not the responsibility of PME.

For all warranty or non-warranty returns please obtain, complete, and submit a RMA to PME. This RMA form may be obtained at

http://www.pme.com/HTML%20Docs/RMAform.html.

After submission of this form, then PME will respond with a RMA number. Please place this number on all shipments and related communications.

Safety Information

BURSTING HAZARD

Should water enter the C-sense Logger and come into contact with the enclosed batteries, the batteries may generate gas causing the internal pressure to increase. This gas will likely exit via the same location where the water entered, but not necessarily.

CONTENTS

Chapter 1: Quick Start

1.1 The Quickest Start Possible

Your C-sense Logger has arrived ready to go. It is set to measure and record time, battery voltage, temperature, and CO2 sensor output once every 10 minutes and write 1 file of measurements daily. You need only to plug on the sensor cable and sensor and the C-sense Logger will start recording files. In this condition the C-sense Logger will record measurements for 1400 samples at 10 intervals before the internal rechargeable battery is drained.

At the end of the deployment period you need only to disconnect the sensor cable and connect it to a host device via the USB plug. The C-sense Logger will appear as a 'thumb drive'. Your temperature, battery voltage, and CO2 concentration measurements, together with a time stamp indicating the time the measurement was made, are recorded in text files in the folder having the serial number of your C-sense Logger. These files can be copied onto any Windows or Mac host computer.

This Manual and other software is also recorded on the C-sense Logger "thumb drive".

- **CsenseCO2Control** allows you to see the state of the logger as well as set the recording interval.
- **CsenseCO2Plot** allows you to see plots of the recorded measurements.
- **CsenseCO2Concatenate** gathers all the daily files into one CAT.txt file.

Follow these steps to start the deployment, logging CO2 & T once each 10 minutes:

1) Spray or apply silicone lubricant to connectors. Wipe off any excessive lubricant from the metal part of the pins. **NOTE: The sensor to logger cable should never be plugged in dry**. See section 3.3 of this document for more information.

2) Connect the sensor cable onto the C-sense CO_2 sensor. Secure the locking sleeve. **Remove the black cap on the end of the sensor before deployment. Do NOT touch the sensor face.**

3) Connect the sensor and sensor cable onto the C-sense Logger and secure the locking sleeve. This will start the recording of CO_2 measurements. (**Note** that the cable connection to the C-sense Logger controls logging. Logging will occur if the cable is connected to the C-sense Logger even if there is no sensor connected to the other end of the cable.)

Follow these steps to end the deployment

1) Disconnect the cable from the C-sense Logger. This will halt measurements.

2) Connect the USB cable to the C-sense Logger.

3) Connect the USB end of this cable to a Windows or Mac host computer. C-sense will appear as a 'thumb drive'.

4) Copy the folder having the same serial number as the C-sense Logger (example 3200-0001) to the host computer.

5) (Suggested, but optional) Delete measurement folder, but NOT CsenseCO2Control or the other .jar programs.

6) (Optionally) Run the CsenseCO2Control program to see the state of the C-sense Logger such as battery voltage or to select a different recording interval.

7) (Optionally) Run the CsenseCO2PLOT program to see a plot of measurements.

8) (Optionally) Run the CsenseCO2Concatenate program to gather together all the daily files of measurements into one CAT.txt file.

9) Recording is halted when no cable to sensor is connected. If no more recording is desired, simply disconnect the USB cable.

10) Recharge the battery.

Sample Interval Minutes	Days of Sampling	Number of Samples
1 minute	7	10,000
10 minutes	20	3,000
60 minutes	120	3,000

NOTE: The above table lists estimated numbers. Actual numbers will depend on the deployment environment and the individual C-sense sensor power demand. Letting the battery discharge below 9 Volts can lead to permanent damage of the battery pack.

1.2 A Few Details

The previous section gives instructions for sampling at 10-minute intervals. However there are a few additional details that will enhance use of the C-sense Logger.

Recording Interval – The C-sense Logger measures and records time, battery voltage, temperature, and dissolved CO_2 concentration at equal time intervals. The default time interval is 10 minutes. However, it is also possible to instruct the C-sense Logger to record at different intervals. This is accomplished by running the CsenseCO2Control.jar program supplied with the C-sense. Recording intervals must be 1 or more minutes and must be less than or equal to 60 minutes. Intervals outside this range will be rejected by CsenseCO2Control. (Contact PME for other recording intervals.)

Please refer to Chapter 2 for instructions on operating the CsenseCO2Control program.

Time – All C-sense times are UTC (formerly known as Greenwich mean time (GMT)). C-sense measurement files are named by the time of the first measurement within the file. Each measurement within files has a time stamp. Both these times are UTC. The time stamp format is Unix Epoch 1970, the number of seconds that have passed since the first moment of 1970. This is inconvenient. The CsenseCO2Concatenate software not only concatenates measurement files but also adds more readable statements of the time stamp.

The C-sense Logger internal clock will drift in the <10 ppm range (< about 30 seconds/month) so you should plan to connect it occasionally to a host having an internet connection. The CsenseCO2Control program will automatically set time based on an internet time server.

Please refer to Chapter 2 for instructions on operating the CsenseCO2Concatenate and CsenseCO2Control program.

File Information – The C-sense Logger software creates 1 file daily. The number of measurements in each file will depend upon the sample interval. Files are named by the time of the first measurement within the file based on the logger's internal clock and expressed in YYYMMDD HHMMSS.txt format.

Rechargeable Battery Life – The C-sense Logger consumes battery power mostly from the measurement of dissolved CO_2, but also slightly from simply keeping track of time, writing files, sleeping, and other activities. Battery life will depend upon deployment temperature, battery wear, and other conditions.

Based on customer feedback, the battery should be checked every month. Letting the battery discharge below 9 Volts can lead to permanent damage of the battery pack.

Coin Cell Battery Life – The C-sense Logger uses a coin cell for backup of the clock when the power is switched off.   This coin cell will supply many years of clock operation. Should the coin cell discharge it must be replaced.   Contact PME.

Chapter 2: Software

2.1 Overview and Software Installation

The C-sense arrives with these files:

- **CsenseCO2Control** allows you to see the state of the logger as well as set the recording interval.
- **CsenseCO2Plot** allows you to see plots of the recorded measurements.
- **CsenseCO2Concatenate** gathers all the daily files into one CAT.txt file.
- **Manual.pdf** this manual**.**

These files are located on the root directory of the C-sense 'thumb drive' within the logger.

PME suggests you leave these programs where they are on the C-sense, but you may copy them to any folder on your computer's hard drive.

CsenseCO2Control, CsenseCO2Plot, and CsenseCO2Concatenate are Java language programs that require the host computer to have the Java Runtime Engine V1.7 (JRE) or later installed. This engine is commonly required for internet applications and will likely already be installed on the host computer. You can test this by running CsenseCO2Plot. If this program displays its graphical user interface then the JRE is installed. If not then the JRE can be downloaded via internet from
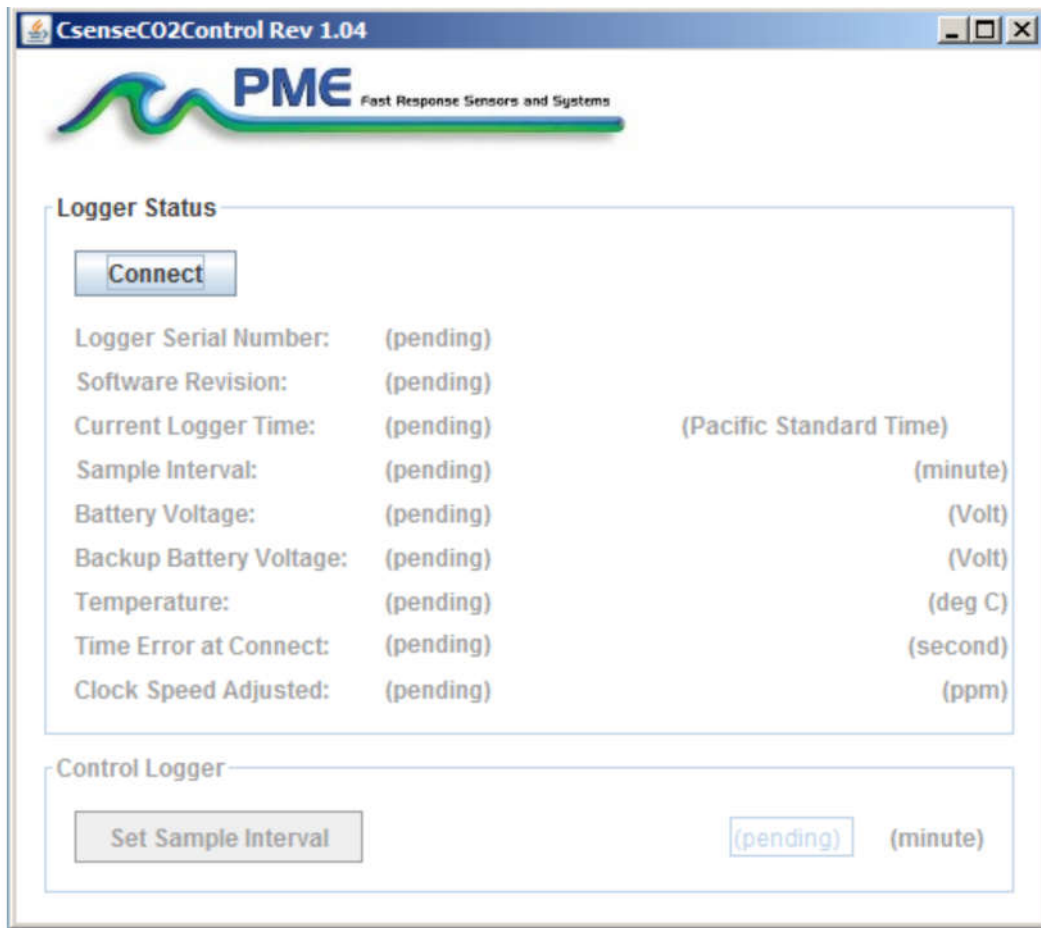
http://www.java.com/en/

At this time C-sense Logger is supported on Windows operating systems, but may also operate on Macintosh and perhaps Linux.

2.2 CsenseCO2Control

Begin program operation by clicking on CsenseCO2Control.jar. Software presents the screen shown below:

The C-sense must be connected to USB at this time.

Click the Connect button. The software will contact the logger. If the connection is successful, the button will turn green and display "Connected". The Serial Number and other parameters will be filled in from information taken from the C-sense.

If the host computer is connected to the internet, the current difference between an internet time server's time and the C-sense Logger internal clock will be displayed. And, if more than a week has passed since time was last set, the C-sense clock will be set and check mark icon will appear. If the host computer is not connected to the internet no time services will occur.

The current C-sense Logger sample interval will be displayed next to the Set Sample Interval button. If this interval is acceptable the interval need not be set.
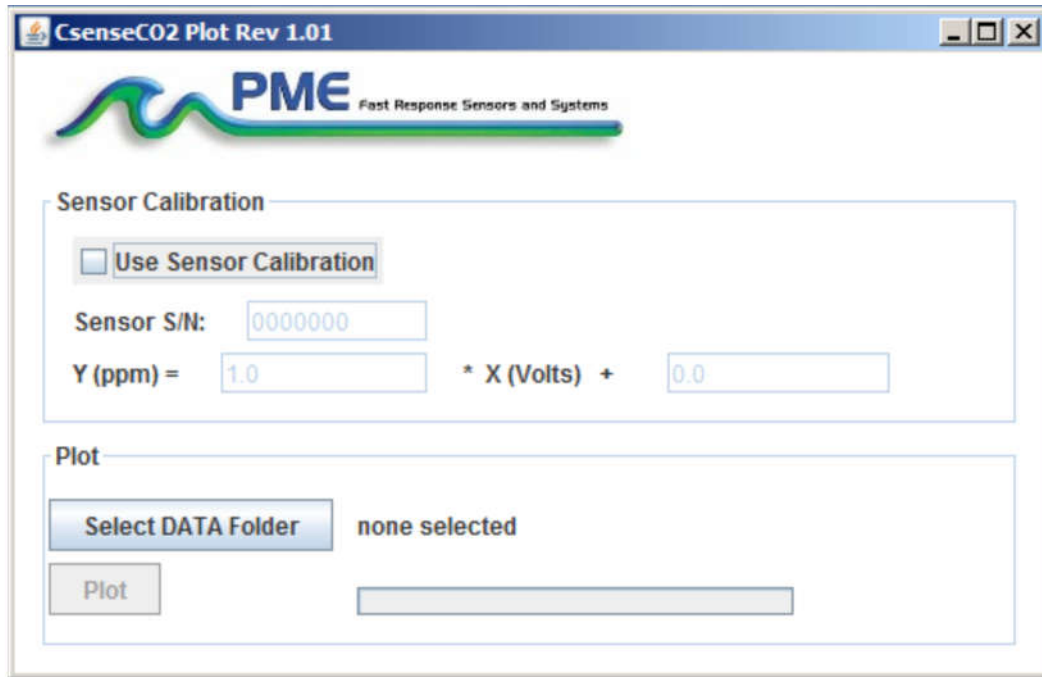
To set the interval, enter an interval not less than 1 minute and not greater than 60 minutes. Click the Set Sample Interval button. Shorter and faster intervals are available. Contact PME.

End CsenseCO2Control by closing the window. Unplug C-sense USB connection.

Upon disconnection of the USB cable the C-sense will begin logging when the cable to the sensor is connected. The logger will halt logging when this cable is disconnected.

2.3 CsenseCO2Plot

Begin program operation by clicking on CsenseCO2Plot.jar. Software presents the screen shown below.
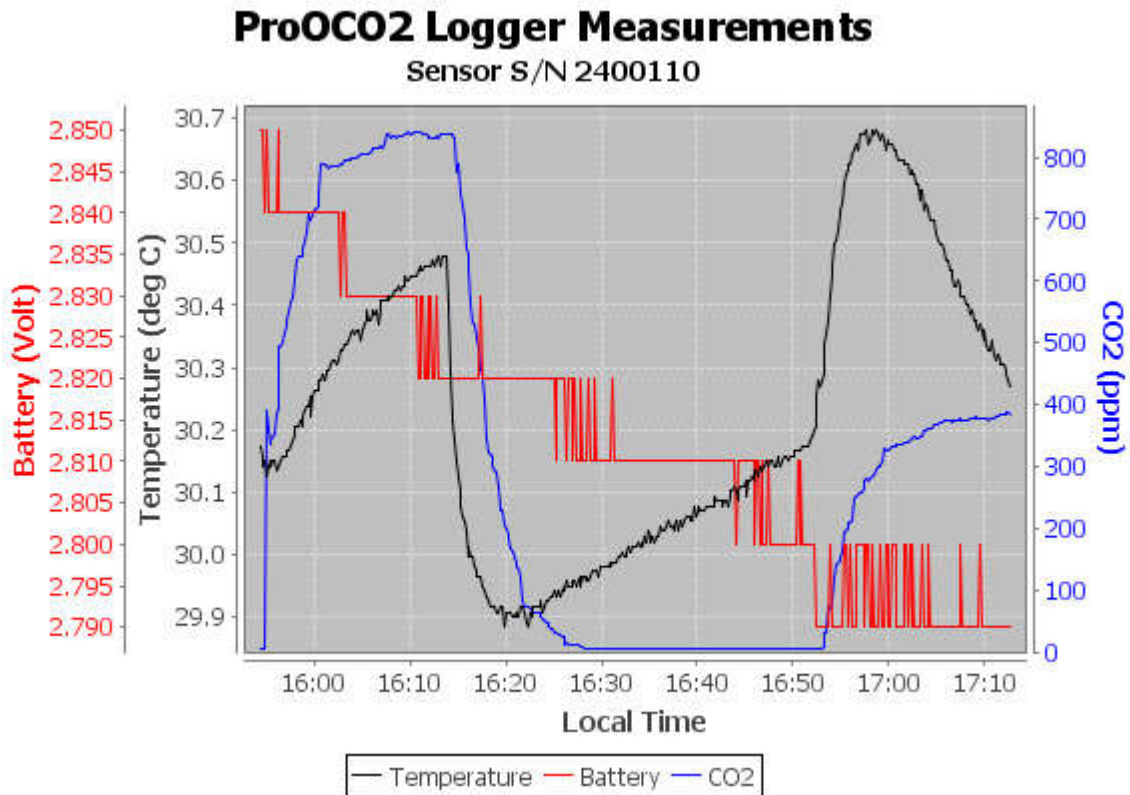

CsenseCO2Plot plots the files recorded by the C-sense Logger. The software reads all C-sense files in a folder, except the CAT.txt file. The software will also compute CO2 saturation from the voltage measured of the sensor. To do this software must be given the sensor calibration. The sensor manufacturer supplies the sensor calibration. If the Use Sensor Calibration is checked the plot will display calibrated values. If not checked the plot will display sensor output in Volts.

Select the folder that contains the files recorded by C-sense. If CsenseCO2Plot is run directly from the C-sense the program will suggest the folder located on the C-sense. You may accept this by clicking on Process, or you may click on Select Data Folder to browse to your computer's hard drive. If the number of measurements recorded is small, say a few thousand, these can conveniently be plotted directly from C-sense storage. However it is best to copy large measurement sets to the host computer and select them there since file access to the C-sense Logger is slow.

C-sense measurement folders must NOT contain any files besides those C-sense records and the CAT.txt file.

Press Plot to begin plotting.

The software reads all C-sense Logger data files in the selected folder. It concatenates these and presents the plot shown below

ProOCO2 Logger Measurements
Sensor S/N 2400110

You may zoom this plot by drawing a square from upper left to lower right (click and hold left mouse button) that defines the zoom region. To zoom completely out, attempt to draw a square from lower right to upper left. Right click on the plot for options such as copy and print. The plot can be scrolled with the mouse while the Control key is held depressed. Copies of the plot can be obtained by right clicking on the plot and selecting Copy from the pop-up menu.
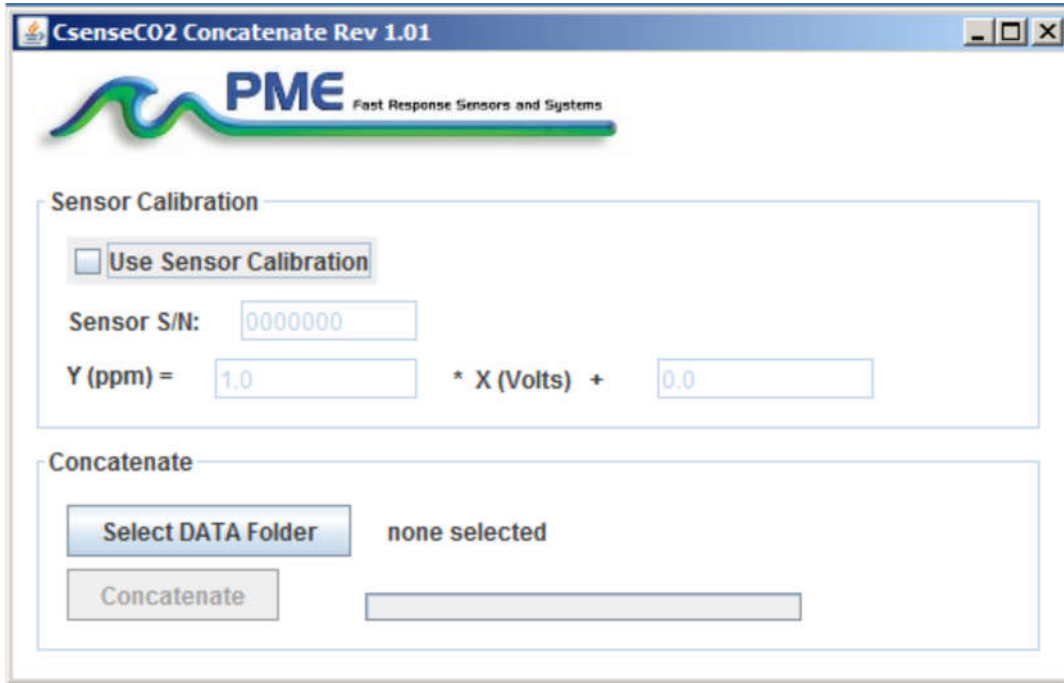
Different DATA Folders can be selected during one session of the program. In this case the software produces multiple plots. Unfortunately the plots are presented exactly on top of each other and so when a new plot appears it is not obvious that the old plot is still there. It is. Just move the new plot to see it.

The software can be re-run at any time.

End CsenseCO2Plot by closing the window.

2.4 CsenseCO2Concatenate

Begin program operation by clicking on CsenseCO2Concatenate.jar. Software presents the screen shown below.

CsenseCO2Concatenate reads and concatenates the files recorded by the C-sense Logger. Software produces CAT.txt in the same folder as selected for the data. CAT.txt contains all the original measurements and contains two additional statements of time. If the Use Sensor Calibration is checked the CAT file will contain an additional column of CO_2.

Select the folder that contains the files recorded by C-sense. If CsenseCO2Plot is run directly from the C-sense the program will suggest the folder located on the C-sense. You may accept this by clicking on Process, or you may click on Select Data Folder to browse to your computer's hard drive. If the number of measurements recorded is small, say a few thousand, these can conveniently be plotted directly from C-sense storage. However it is best to copy large measurement sets to the host computer and select them there since file access to files on the C-sense logger is slow.

C-sense measurement folders must NOT contain any files besides those C-sense records and the CAT.txt file.

Press Concatenate to begin concatenating files and create the CAT.txt file.

The CAT.txt file will resemble the following:

```
1  CsenseCO2 Logger Concatenated Data File
2  Logger:         3200-434068
3  Sensor:         2400110
4  Concatenation Date: 2014Jul14 09:19:28 PDT
5
6
7         Unix Timestamp,          UTC_Date_&_Time,      Pacific Standard Time,      Battery,
8            (Second),                    (none),                    (none),        (Volt),
9         1405119262,       2014-07-11 22:54:22,       2014-07-11 15:54:22,       2.850000,
10        1405119272,       2014-07-11 22:54:32,       2014-07-11 15:54:32,       2.850000,
11        1405119282,       2014-07-11 22:54:42,       2014-07-11 15:54:42,       2.850000,
12        1405119292,       2014-07-11 22:54:52,       2014-07-11 15:54:52,       2.840000,
13        1405119302,       2014-07-11 22:55:02,       2014-07-11 15:55:02,       2.850000,
14        1405119312,       2014-07-11 22:55:12,       2014-07-11 15:55:12,       2.840000,
15        1405119322,       2014-07-11 22:55:22,       2014-07-11 15:55:22,       2.840000,
16        1405119332,       2014-07-11 22:55:32,       2014-07-11 15:55:32,       2.840000,
17        1405119342,       2014-07-11 22:55:42,       2014-07-11 15:55:42,       2.840000,
18        1405119352,       2014-07-11 22:55:52,       2014-07-11 15:55:52,       2.840000,
19        1405119362,       2014-07-11 22:56:02,       2014-07-11 15:56:02,       2.840000,
20        1405119372,       2014-07-11 22:56:12,       2014-07-11 15:56:12,       2.850000,
21        1405119382,       2014-07-11 22:56:22,       2014-07-11 15:56:22,       2.840000,
22        1405119392,       2014-07-11 22:56:32,       2014-07-11 15:56:32,       2.840000,
23        1405119402,       2014-07-11 22:56:42,       2014-07-11 15:56:42,       2.840000,
24        1405119412,       2014-07-11 22:56:52,       2014-07-11 15:56:52,       2.840000,
25        1405119422,       2014-07-11 22:57:02,       2014-07-11 15:57:02,       2.840000,
```

End CsenseCO2Concatenate by closing the window.

Chapter 3: C-sense Logger

3.1 Overview

All of the C-sense Logger measurements pass from the sensors into files on the SD card C-sense contains. Files are transferred to a host computer via USB connection where C-sense appears as a "thumb drive". Measurements may be plotted by CsenseCO2Plot and files concatenated by CsenseCO2Concatenate. The C-sense Logger itself is controlled by CsenseCO2Control software. Logging begins when the sensor cable is connected to the logger and ends when this cable is disconnected.

3.2 Recharging The Battery

Connect the battery charger. The charger will require power from a power supply. The charger has a LED light indicating the status of the charging.

The following table with shows the LED light indications:

LED Indication	Status
Off	No battery detected
Power-up	Red-Yellow-Green off

Green flashing	Fast Charging
Green Solid	Fully Charged
Yellow Solid	Out of temperature range
Red/Green flashing	Shorted terminals
Red flashing	Error

NOTE: To prevent the battery voltage from discharging to an unrecoverable state, PME recommends to re-charge the battery every month after use, if not sooner based on sample rate.

3.3 Connector Maintenance

The plugging and unplugging of the sensor to logger cable can cause wear and tear over time if done dry. The cable manufacturer, Teledyne Impulse, recommends cleaning any debris from the connector pins and a quick spray of silicone lubricant for each mating cycle. It is recommended that only 3M non-food grade silicone lubricant be used. Avoid using any silicone lubricant that contains acetone. Wipe away an excessive lubricant on the metal part of the pins.

The cable manufacturer recommends buying the following 3M spray:
https://www.mscdirect.com/product/details/33010091?item=33010091

Smaller 1 oz. spray bottles are also available for packing on board planes as a carry-on item from Teledyne Impulse.

If the rubber is starting to peel back from the metal pin on any of the connector pins, please contact PME about replacing the cable. Further use could lead to a compromised seal and damage to the logger and/or sensor.

3.4 Battery Replacement

Please do not open the logger. This will void PME's warranty. Please contact PME for battery replacement.

End of Manual.