

Chlorophyll Content Meter

CCM-200 plus





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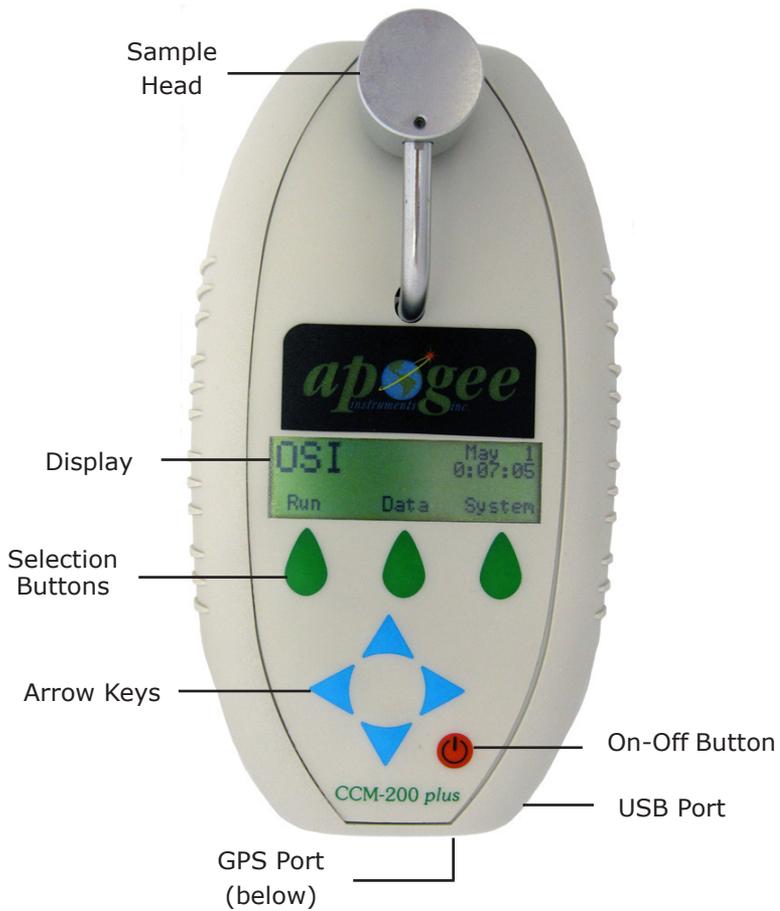
Unit Overview

The CCM-200 plus is a self-contained, handheld device powered by a 9V alkaline battery. The sample head is located at the top of the instrument. A Liquid Crystal Display (LCD) is located near the center of the unit. The power switch is at the bottom of the front panel. Eight menu/control keys are used to access all program functions.

A USB port is located at the bottom right hand side of the case and allows the user to export data to a PC. A RS232 port is included on the bottom for use with GPS, and it can also be used for data transfer.

The three green tear shaped buttons are for selecting software defined choices and will be described as "buttons". The blue arrow keys are used for scrolling and referred to as "arrow keys".

Note: The unit has a four minute auto-off feature. When no key is pressed, or test run for four minutes the unit will shut off automatically in order to conserve battery power.



About the Instrument

The CCM-200 plus Chlorophyll Content Meter is a handheld, battery operated instrument designed for the rapid, non-destructive, determination of chlorophyll content in intact leaf samples. Chlorophyll content is a direct indication of plant health and condition. Obtaining chlorophyll content via non-destructive analysis gives researchers, agronomists, and growers valuable diagnostic information. This data can then be applied to a multitude of crop production and research initiatives such as: nutrient and irrigation management, pest control, environmental stress evaluation, and crop breeding.

Measurements are instantaneous and can be done in the field under normal lighting and growing conditions. Ample on-board data-logging and simple, easy to understand measurements further enhance the user's ability to gather and interpret crop health conditions. The USB cable included with the CCM-200 plus allows for data download to a PC for additional analysis.

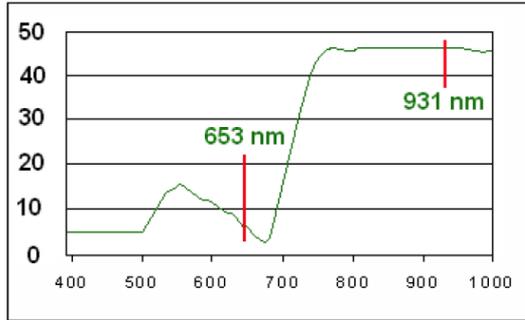
The CCM-200 plus is a remarkable alternative to destructive sampling techniques. It is far less time consuming and allows samples to be monitored multiple times over various stages of an entire growth cycle. The rapid test and data gathering capability is sure to provide a tremendous advantage to all types of research. This innovative pocket-sized instrument is destined to play an important role in improving crop yield and producing higher quality foods.



How It Works

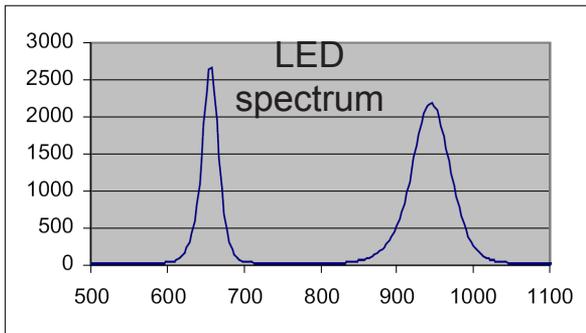
Chlorophyll has several distinct optical absorbance characteristics that the CCM-200 plus exploits in order to determine relative chlorophyll concentration. Strong absorbance bands are present in the blue and red but not in the green or infrared bands.

Figure 1
Chlorophyll
Transmittance



$$\text{CCI} = \% \text{Transmittance at } 931 \text{ nm.} / \% \text{Transmittance at } 653 \text{ nm.}$$

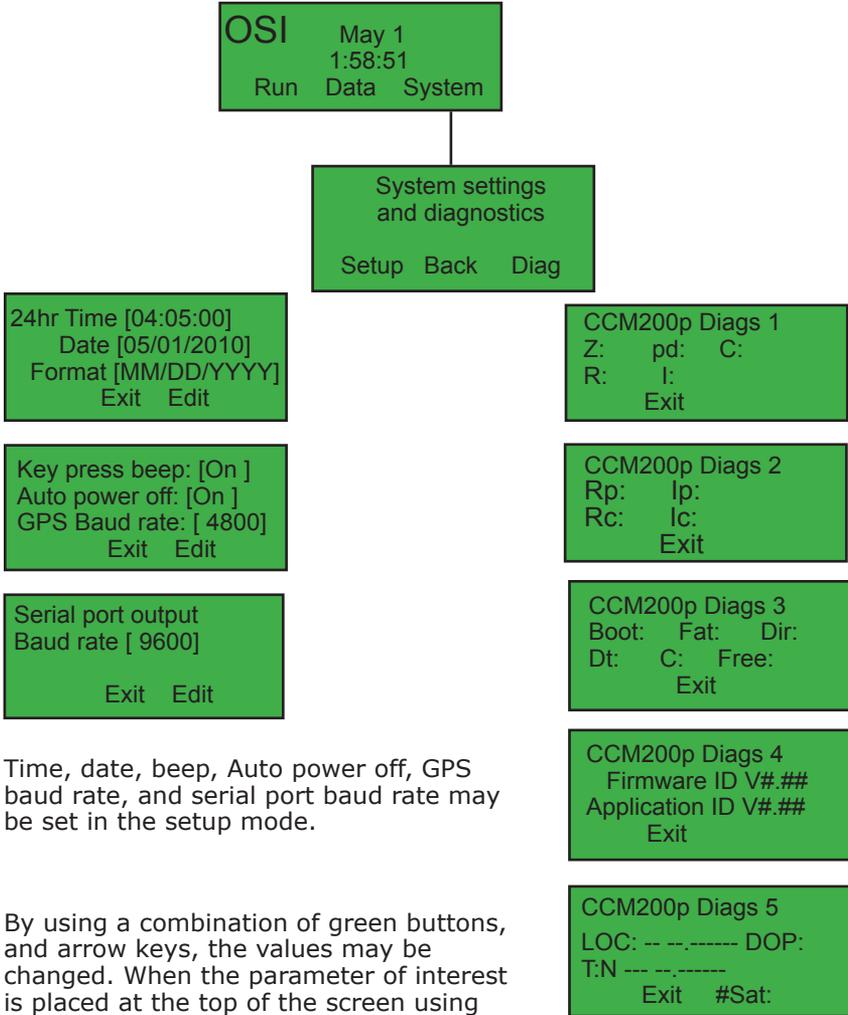
The CCM-200 plus uses absorbance to estimate the chlorophyll content in leaf tissue. Two wavelengths are used for absorbance determinations. One wavelength falls within the chlorophyll absorbance range while the other serves to compensate for mechanical differences such as tissue thickness. The meter measures the absorbance of both wavelengths and calculates a Chlorophyll Concentration Index (CCI) value that is proportional to the amount of chlorophyll in the sample.



Note: CCI value is a relative chlorophyll value. Absolute chlorophyll content per unit area is not computed. CCM-200 measurements, however, can be correlated to ground/solvent analysis.

System Settings

At the main test menu, choose System.



Time, date, beep, Auto power off, GPS baud rate, and serial port baud rate may be set in the setup mode.

By using a combination of green buttons, and arrow keys, the values may be changed. When the parameter of interest is placed at the top of the screen using the arrow keys, select Edit with a green button. Use the arrow keys to select the correct setting, press enter with a green button, and exit the main test menu.

Diagnostics are to be used only with factory assistance

Call 435.792.4700 for support.

Measurement & Operation

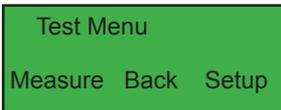
Described on the following pages are the specifics on how to obtain measurements with the CCM-200 plus as well as the overall instrument operation protocols. Calibration, measurements, memory and data storage management and the five operating modes and each key function are outlined in detail.

Measure

Turn on the system with the red on-off button. After a few seconds, the main menu screen appears as below.



Press Run button. The unit will quickly change to:



Before measuring, use setup to select the correct parameters.

Setup

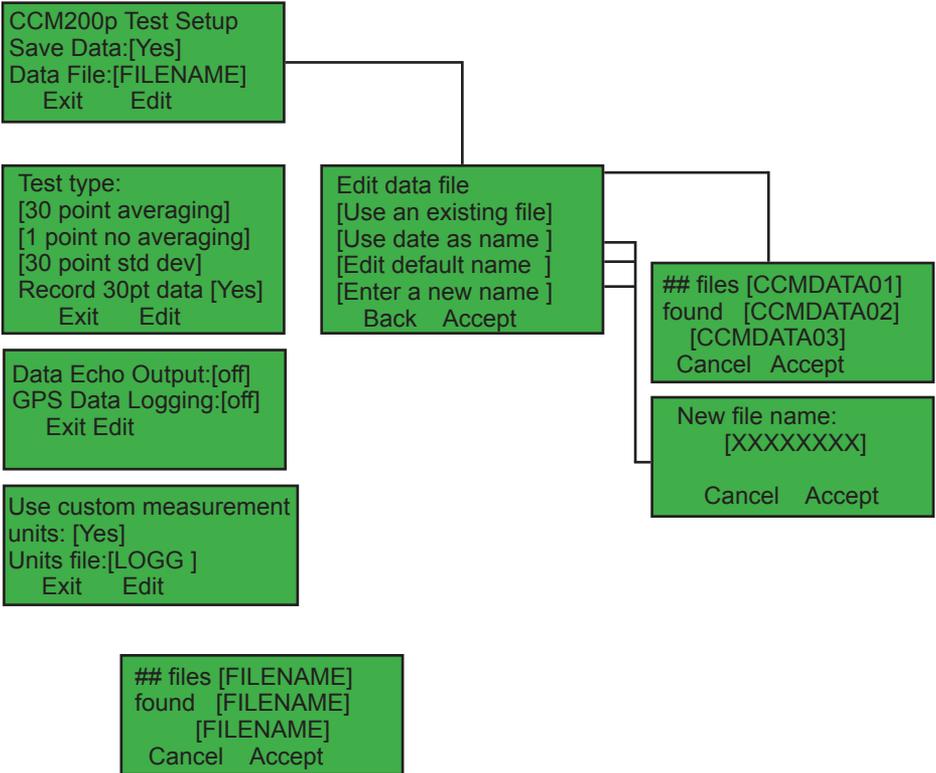
Use the arrow keys to scroll through the options.

When the option of interest is at the top of the screen, select the edit button.

A cursor will appear. Use the arrow keys to highlight your selection.

Press the enter button when finished. Exit to the main test menu.

Measure, Continued



Single point measurement

Sample number: #####
Type
Units
Info Exit

This is the main measuring screen for single point measurement.

Storage info:
Data File: FILENAME
Free Space: #####KB
Back

At this screen, place the leaf to be measured between the CCM body and the silver measuring head. Hold until the beep sounds. Test data will appear as shown to the left

Chlorophyll Content Index

GPS Data
LOC: -- --.----- DOP:
T:N -- --.-----
Back N Sat: --

By pressing info, the information on the left becomes available. If GPS is being used, the second screen is available.

Calibration

Calibration is required every time the unit is turned on. The unit's detection system needs to check its chamber path. The user has to calibrate or "zero" the instrument each time the unit is powered up.

Calibration happens after the unit is powered up, "Run" has been selected on the main test menu, and the "measure" button has been pressed.

To calibrate the unit, close the measuring chamber.

Important: make sure the chamber is clear of any material.

Hold closed until a beep is heard (after about 2-3 seconds), or the release arm message is read on the screen. Once the beep is heard release the chamber arm. The unit will indicate calibration status.

Note: If a "Cal Error" occurs, see following section.

Note: Calibration is not needed between measurements, only when the system is powered up. The unit is ready to take another measurement once information is displayed. This includes after automatic shutdown (no activity after four minutes).

Error Codes

The error code number describes the problem encountered.

"Light is leaking into the sample chamber". Make sure the chamber is closed tightly.

Note: this error may occur if the black gasket material around the chamber gets damaged or worn.

"Low signal error". This error may occur if there is debris or dirt in the chamber. Clean out the chamber and try again.

"Sample too Dense". This error may occur in cases where the sample tissue is too thick.

No data is recorded when these errors occur. Try repositioning the sample in the chamber. Or, try a thinner sample. In rare cases the sample is simply too thick to get an accurate reading.

Thirty Point Averaging

Thirty point averaging is used for some nitrogen management schemes. Please refer to the following papers for more details.- (Shapero 2006) (Francis 1999)

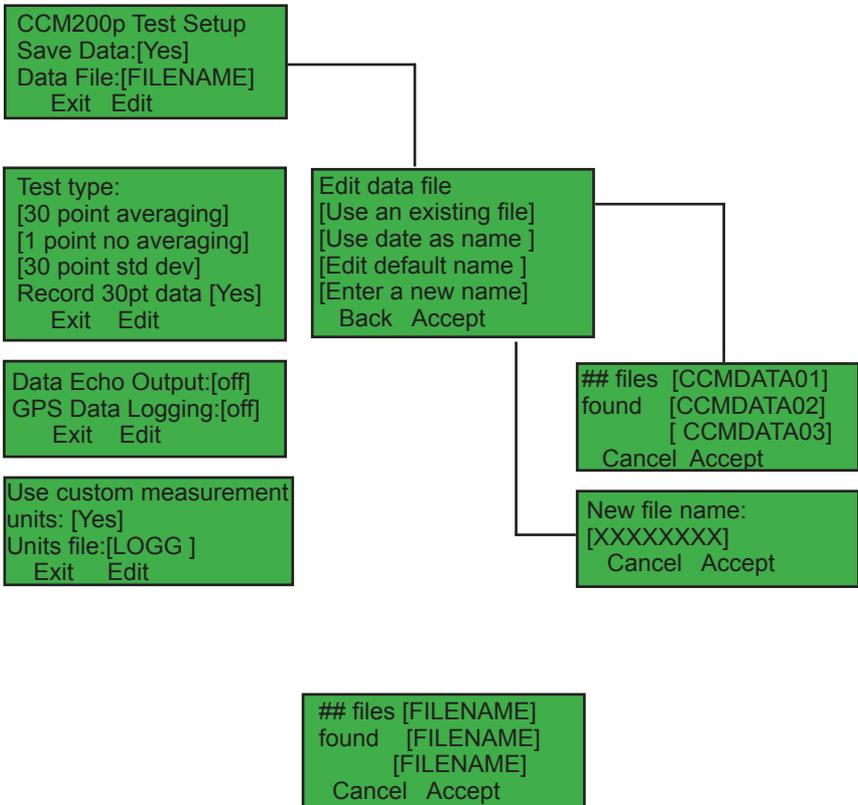
Go to the main Test Menu and select the setup button.

Use the arrow keys to scroll through the various parameters available until the averaging line appears at the top of the page.

Select the Edit button, and this line will become highlighted.

Use the arrow keys to scroll through the options, select 30 point average by pressing the Enter button. Press the Exit button to go to the main test menu.

Return to the main test menu and select measure.



First measuring screen for 30 point averaging



Sample number: ####
Ave ##.#
Info Exit Delete

Second screen for 30 point averaging used for points 2 through 30



Ave Pt:##
##.# Units
Delete Back

As each of the thirty measurements is made the number of measurements, and a graph of the measurements appears on the screen.

Again, place the leaf under the silver measuring head and press. Hold the head down until you hear a beep.

For each measurement point, a line appears on the graph, with the number of measurements made.

When finished, the graph is no longer shown, but the average of the thirty measurements is displayed. All measuring points are stored in the measuring file along with averages. The graphs may be reproduced in Excel if desired.

Thirty Point Averaging, continued

Thirty Point averaging with standard deviation.

This option provides that ability to throw out fliers that do not fall within a two-sigma window. After measuring thirty samples, the unit will throw out measurements that do not conform. Replacement measurements will have to be made to bring the total number of measurements up to thirty.

This parameter is selected just like thirty point averaging. Use the directions for thirty-point averaging, but select "30 point std dev."

Again, a graph is displayed for the measurements.

```
Sample number: ####  
Ave    ##.#  
Info  Exit  Delete
```

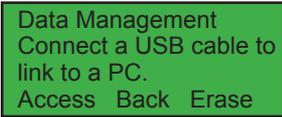
```
Ave Pt:##  
##.# Units  
Delete Back
```

Send Data

To transfer files from the CCM-200 plus by USB cable

This is the recommended way to transfer files because it is the easiest way to do it.

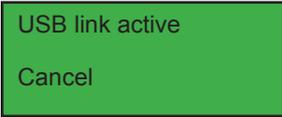
There are some files on the unit that are software files, and they should not be touched. If they are manipulated in any way, a software reload may be required.



Data Management
Connect a USB cable to
link to a PC.
Access Back Erase

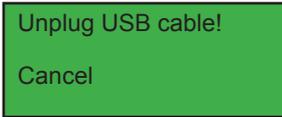
Connect USB Cable.

After connecting the USB cable, a drive window will probably appear on your PC that has a drive letter at the top of the file. The window asks you to select the correct viewing method. Select "Open windows to view files using Windows Explorer". If this window does not appear, then go to Windows Explorer and My Computer. Find the new drive that is usually listed as a letter and then CCM2p. When you see the files on the drive, right click the data files and open the file with Excel. Data may be graphed using Chart Wizard.



USB link active
Cancel

Press cancel before unplugging the USB cable. The message below will appear.



Unplug USB cable!
Cancel

Specifications

Measured Parameters

- Ratio of optical transmission at 931 nm (50 nm half-bandwidth) divided by transmission at 653 nm (25 nm half-bandwidth)

Measurement Area

- 71 mm²
- 0.95 cm diameter

Resolution

- ± 0.1 Chlorophyll Concentration Index (CCI) unit

Range

- 0 to 200

Sample Acquisition Time

- 2 - 3 seconds

Detectors

- Two silicon photodiodes with integral amplifiers

Storage Capacity

- Internal datalogging of over 100,000 measurements

Input & Output

- Mini USB port provided for main data transfer
- RS-232 port can be used as backup data transfer with software
- RS-232 port can also be used with GPS for integrated measurement

Radiation Source

- Two LEDs

User Interface

- 50 mm by 15 mm graphic display screen
- 8 keys for control and data manipulation
- Beep-signal for status and warnings

Operating Temperature

- 0 - 50° C

Temperature Drift

- Temperature compensated source and detector circuitry for minimum drift over full range

Input Power

- Standard 9 V alkaline battery

Dimensions

- 15 by 8.2 by 2.5 cm

GPS Option

- RS-232 port is used for GPS
- GPS location data is saved with measuring data for each measurement in the file

Mass

- 220 g (with battery)

Warranty

- 1 year against defects in materials and workmanship

Notes

Notes



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