

A close-up photograph of several wheat stalks, showing the golden-brown grains and the green awns. The background is a soft, out-of-focus light green, suggesting a field of wheat under bright light. The stalks are arranged diagonally across the frame, creating a sense of depth and texture.

CI-340 Photosynthesis System Training

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CI-340 Handheld Photosynthesis System

- Entire photosynthesis system in hand-held case
- Lightweight and truly portable
- Open and closed system measurements
- Light, temperature, CO₂ and H₂O control
- Chlorophyll fluorescence and soil respiration

CI-340 Features

- Infrared CO₂ gas analyzer
- H₂O/humidity analyzer
- PAR sensor
- Temperature sensors to measure leaf, air, and internal temperature
- Wide selections of leaf chambers to operate as an ***open*** or a ***closed*** system
- Complete set of environmental control modules



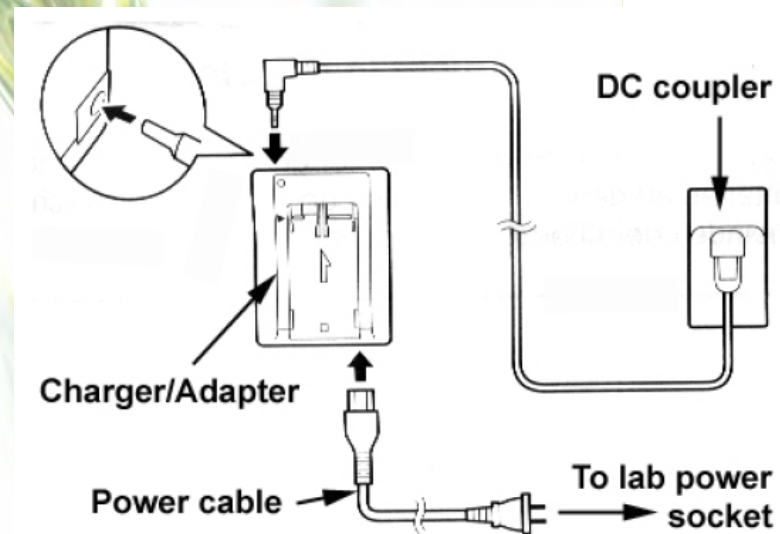
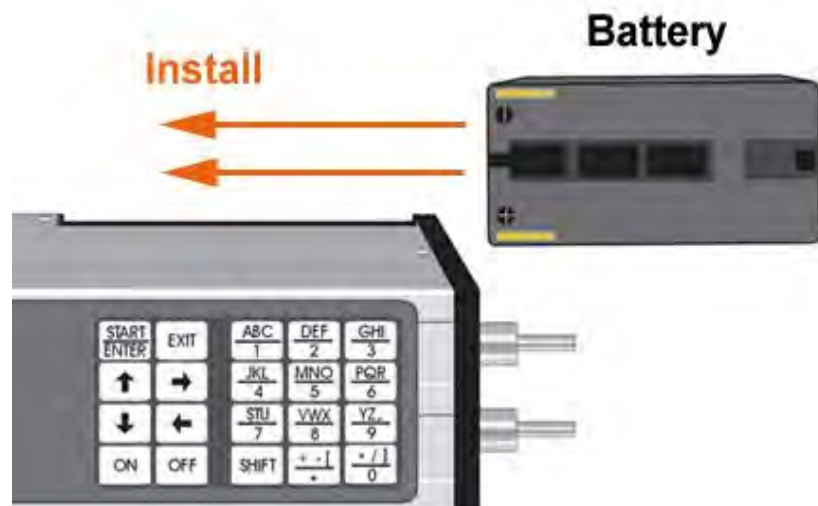
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CI-340 Features - continued

- Three gas concentration measurement modes:
 - Differential (Photosynthesis, P):
Measures CO₂/H₂O concentration differences between inlet and outlet: at least 40 seconds
 - Absolute (Single channel absolute, S):
Measures absolute CO₂/H₂O concentration from a single source (inlet)
 - Continuous (Continuous photosynthesis, C):
Measures gas concentration from inlet once, then measuring from outlet continuously: at least 20 seconds
Only use with standard gas

Powering Up

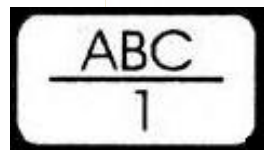
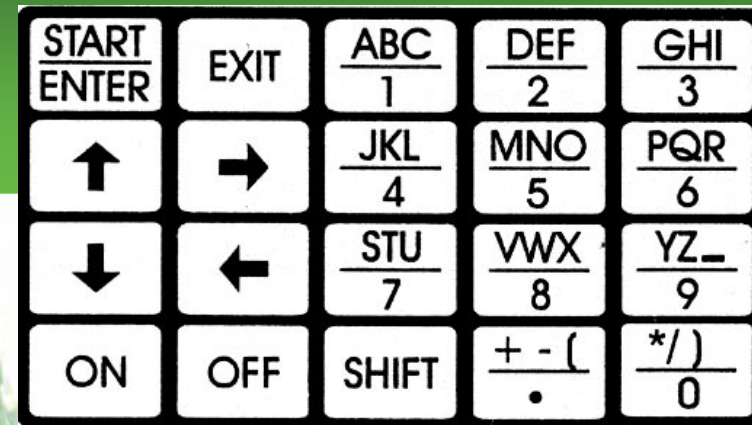
- The CI-340 can be powered by a rechargeable battery or AC power through a DC coupler



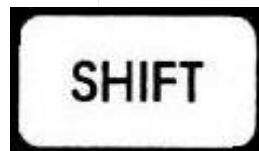
Powering Up

- Press and hold the power key for a couple seconds
- The display will read “Waking Up”
- Allow instrument to warm up for 4 to 30 minutes before using

Using the Keypad



Enters numeric characters (and alpha characters when preceded by )



Switched to upper-level character commands. Pressing several times allows user to enter the various shifted characters.

Keypad Commands



Aborts the operating function or stops measurements



Enters selected operation mode (measurement, calibration, etc) and enters data in the operation



Starts measurements without saving the data

Taking Measurements with an Open System Leaf Chamber

Leaf chambers overview:

- Installing an open-system leaf chamber
- Setting up for a measurement
- Reviewing measurement results

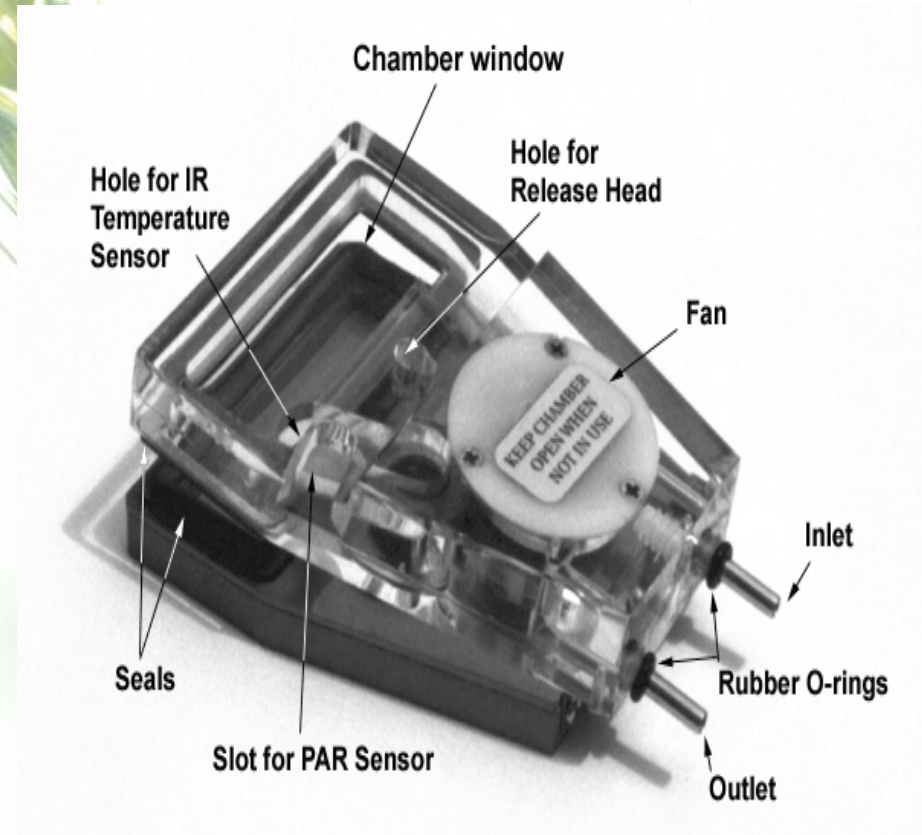
Function of a Leaf Chamber

- Stable environment with fixed leaf area
- Housing for sensors
- Self-contained fan for air circulation



Installing a Leaf Chamber

- Make sure O-rings are on the end tubes
- Insert the end tubes into the CI-340
- Align and tighten the end screw
- Connect the IR Temperature sensor and PAR sensor



Using a Leaf Chamber

- Set up the main console in a stable station (it can be set up on a tripod)
- Place sample in the leaf chamber
- Gently close, and push the latch backward to lock the chamber
- Allow chamber environment to stabilize for 30 seconds before measuring
- Push the latch forward to open the chamber once measurements are complete

Setting up for a Measurement

Press the  key

- Enter the desired file name
 - *If the filename ends with a number, same settings can be used without re-entering for subsequent measurements with incremental filenames as default
- Enter “P”, “S” or “C” for the measurement type
- Enter console-controlled module; “0” if not using any

Setting up for a Measurement

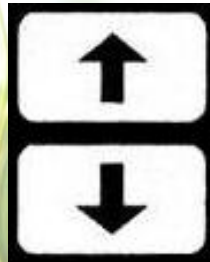
- Enter the area of the leaf sample (in cm^2)
- Enter the intended flow rate (0.2~0.999 lpm)

* 0.3 lpm is generally used unless very active leaves are measured

- For open system, press “enter”

* Press “C” for closed system

Taking Measurements

- Display will read “Warming Up” while the chamber environment stabilizes
- Once the unit is done warming up, the display will read “Working” and count down to 0
- The data will display, use the  keys to view both data displays

Graphic Data Display

- Switch to graphic mode from numerical data
- press “G” (shift, 3)
- upper 1/8th of graph will be erased when switching between modes (a memory limitation with the current hardware)
- best for large data set

Working around Files

- This Lab will cover:
 - Software installation
 - Finding and deleting files
 - File download
 - Saving files on computer
 - Viewing data on computer


Data Storage in CI-340

- Measurement data is stored in the built-in memory of the CI-340
- Once saved, the measurement results cannot be seen on the instrument. The data file(s) has to be transferred to PC via USB connection and viewed on PC

Software Installation

- Load CD into CD drive of computer
- Open the CD
- Visit webpage for downloads:
<https://www.cid-inc.com/support/CI-340/>
- Double-click “Setup.exe” to install
- Follow installation instructions

Finding Files

- Press  key when “Enter → File menu” displays
- Use the “up arrow” and “down arrow” to view the stored files
- Files stored chronologically
- Press “EXIT” to leave the menu.


Deleting Stored Files

- Press “D” (SHIFT + “DEF”) to delete last file saved
- Press “Y” (SHIFT + “YZ_”) to delete all files

File Download

- Connect the USB cable to the CI-340 and a computer
- Start “C340DF.exe” on the computer
- Click “File – Open”
- Select files to download and click “Open”

Saving Files on Computer

- After downloading, select *File, Save* to save the data
- Power down the instrument or press  to take more measurements
- View the files with spreadsheet program before deleting from CI-340

CI-340 Data Summary

Direct Measurement	
Internal T:	Internal temperature for the instrument
Pressure:	Atmospheric pressure
T _{air} :	Air temp.
Flow:	Flow rate
CO _{2in} :	Inlet CO ₂
H _{2Oin} :	Inlet water pressure
H _{2Oout}	Outlet water pressure
PAR:	Photosynthesis Active Radiation
T _{leaf} :	Leaf temp.
CO _{2out} :	Outlet CO ₂
Month:	Current month
H, min and s:	Time experiments conducted
Year:	Current year
Date	Current date

Calculated Measurement	
W:	Mass flow rate
RH _{in} :	inlet relative humidity
RH _{out} :	Outlet relative humidity
P _n :	Net photosynthesis rate
E:	Transpiration rate
C:	Stomatal conductance rate
CO _{2int}	Internal CO ₂

CO₂ Zero and CO₂ Span Calibration

- CO₂ Zero: weekly
- Use soda lime or 0 ppm CO₂ gas
- CO₂ Span: every 6-12 months with standardized CO₂ gas between 200-1000 ppm
- Always use T-connector to relieve excess pressure if using bottled gas

H₂O Zero and H₂O Span Calibration

- H₂O Zero: weekly to monthly
- Use silica gel or 0% RH gas
- H₂O Span: every 6-12 months with moisture generator, need to have **precise** control over temperature to perform H₂O Span
- Always use T-connector to relieve excess pressure if using bottled gas

CI-340 Annual Maintenance

12 Point Maintenance and Calibration Includes:

- Inspect Chamber Seals and replace if necessary.
- Inspect Tygon tubing (hoses) and replace if necessary.
- Set temperature off sets.
- Calibrate CO₂ and H₂O sensors.
- Recalibrate air flow through leaf chamber.
- Test accessory cables for control modules (if applicable) and replace if necessary.
- Test USB cable and replace if necessary.
- Recalculate H₂O/CO₂ compensation.
- Recalculate CO₂ TCAL (temperature calibration).
- Recalibrate PAR Sensor.
- Inspect Rotary Valve for leakage and replace if necessary.
- Replace lithium battery.

**Cost of \$780 USD
includes all parts,
labor and return
shipping**

****first year included
with purchase
(international users
must cover cost of
shipping to/from)**

Using the Light Module, CI-301LA

- Lab will cover:
 - Introduction to CI-301LA
 - Installing CI-301LA
 - Making measurements with CI-301LA

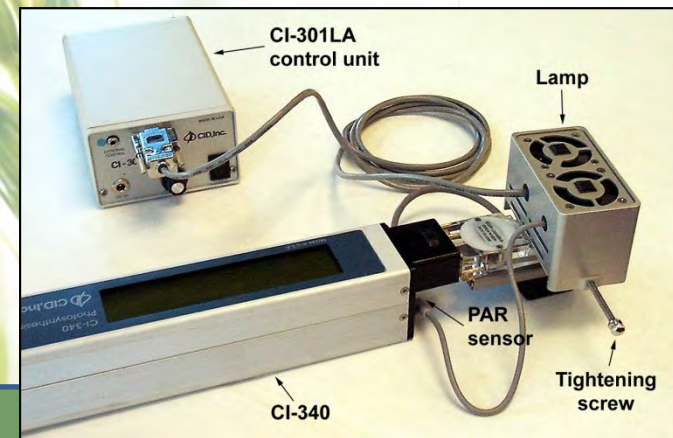
Introduction to CI-301LA

- The CI-301LA is used as an intensity-controlled light source on flat, open leaf chambers
- The light intensity ranges from 0 to 2000 $\mu\text{mol}/\text{m}^2\text{s}$ and can be controlled by the main console or the control unit
- The emitted light covers the photosynthesis wave band

Installing CI-301LA

- Mount the CI-301LA on the leaf chamber
- CI-301LA is equipped with a PAR sensor with a small grey cable. Plug in the grey cable in place of the external PAR sensor
- Connect the eight-pin cable to the control unit. Make sure the control unit is powered off before connecting the cable
- From the Accessory cable, insert the plug with a blue-color band if the light intensity is to be controlled by the main console*

*In order to use the main console to control the light intensity, turn the intensity control knob counter-clockwise all the way down during the setup



Making Measurements with CI-301LA

- Similar procedure as operating the main console
- When using the console to control the light intensity, follow the procedure below
 - In the “Control CS, AD, or LA?”, enter the appropriate number for the module used:
 - CI-510CS – 1
 - CI-301AD – 2
 - CI-301LA – 4. For multiple, add the numbers. Press “Enter”
 - Enter the desired PAR (0 – 2000 $\mu\text{mol}/\text{m}^2\text{s}$). Press “Enter”. The light should come on at this point if the setup is correct
- When using the control unit to control light intensity, turn on the power will turn the light on

Response Curve: Pn vs. PAR

- Press “L” when measuring photosynthesis with CI-301LA being controlled by the CI-340.
- L = shift, shift, shift, 4
- Prompt to enter number of steps for light response
- CI-340 will control CI-301LA and increase the light intensity from very low to very high in that number of steps.
- Make sure the intensity knob on the CI-301LA is turned all the way counterclockwise

Using the Adjustable CO₂ & H₂O Control Module – CI-301AD

- Lab will cover:
 - Introduction to CI-301AD
 - Installing CI-301AD
 - Making measurements with CI-301AD

Introduction to CI-301AD

- The CO₂ concentration can be regulated from 0 to 2000 ppm at flow rates up to 0.5 lpm by a CO₂ cartridge and soda lime
- The H₂O concentration can be regulated from 5% to 20-30% above ambient humidity (up to 95% relative humidity) by water vapor and Silica gel



Installing CI-301AD

- Before operating the CI-301AD, proper consumable materials need to be added and installed at correct positions
- Connect the “Out” port on the CI-301AD to the “Intake” port on the main console
- Turn on the power and purge the system with pure CO₂ for 5-10 min before using
- Adjust the H₂O and CO₂ concentration. If concentration is to be remotely controlled, the CO₂ knob should be turned counterclockwise and the H₂O knob clockwise



Making Measurements with CI-301AD

- Enter a flow rate less than 0.5 lpm
- When using the console to control the CO₂/H₂O concentration, follow the procedure below
 - In the “Control CS, AD, or LA?” enter a proper number corresponding to the modules used. Press “Enter”
 - Enter the desired concentration of CO₂ (0 – 2000ppm) and/or H₂O (5%-95% RH). Press “Enter”

Response Curve: Pn vs. CO2

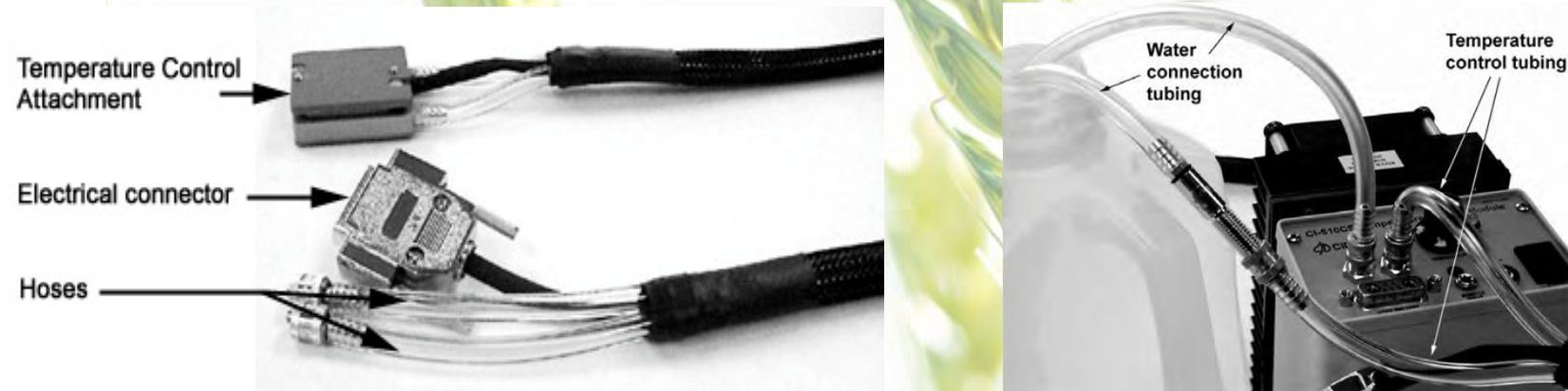
- Press “C” (shift, shift, shift, 1) when measuring photosynthesis with CI-301AD being controlled by the CI-340
- Prompt to enter step size to make the CO2 adjustments
- CI-340 will control CI-301AD and slowly step from the lower limit to the upper limit, using approximately the specified step size.
- Make sure the intensity knob on the CI-301AD is turned all the way counterclockwise

Using the Temperature Control Module, CI-510CS

- Lab will cover:
 - Introduction to CI-510CS
 - Installing CI-510CS
 - Making measurements

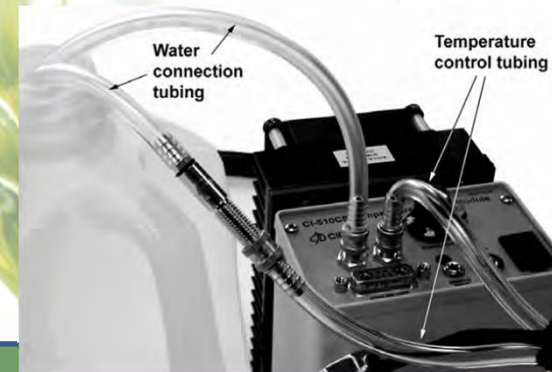
Introduction to CI-510CS

- CI-510CS consists of a peltier thermoelectric heat pump and a cooling water reservoir
- Temperature control range is $\pm 25^{\circ}\text{C}$ from the ambient temperature



Installing CI-510CS

- Fill the reservoir with distilled water
 - Connect a hose to the “IN” fitting on the controller
 - Connect one end of the cooling unit to the “OUT” fitting on the controller, and the other end to the hose with a connector
 - Put both free-end hoses into a distilled water bath
- Turn the power on and observe the water flow. Once no air bubbles in the hoses, turn off the power.



Installing CI-510CS – Continued

- Detach both free end hoses from the “IN” fitting and one end of the cooling unit. Attach the free hose of the cooling unit to the “IN” fitting
- Connect the five-pin electrical connector to the controller
- Attach the cooling unit to the leaf chamber
- Turn the control knob counterclockwise all the way to end before powering on
 - * The peltier heat pump can only be operated when the water reservoir is filled

Making Measurements with CI-510CS

- Turn the power on to allow water circulating through the cooling unit and the reservoir
- When using the console to control the temperature, Turn the control knob counterclockwise all the way down before powering on. Enter the desired temperature

Response Curve: Pn vs. Temperature

- Press “T” (shift, shift, 7) when measuring photosynthesis with CI-510CS being controlled by the CI-340
- Prompt to enter number of steps for light response
- CI-340 will control CI-510CS and increase the light intensity from very low to very high in that number of steps.
- Make sure the intensity knob on the CI-510CS is turned all the way counterclockwise

Using the Chlorophyll Fluorescence Module, CI-510CF

- Lab will cover:
 - Introduction to CI-510CF
 - Installing CI-510CF
 - Making measurements
 - Interpreting CF measurements

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Introduction to CI-510CF

- The CI-510CF is modulated chlorophyll fluorescence measurement module
- Performs two functions:
 - Chlorophyll fluorescence trace data
 - Individual pulse data (calculated)
- Modulation frequency from 8 Hz to 80 Hz

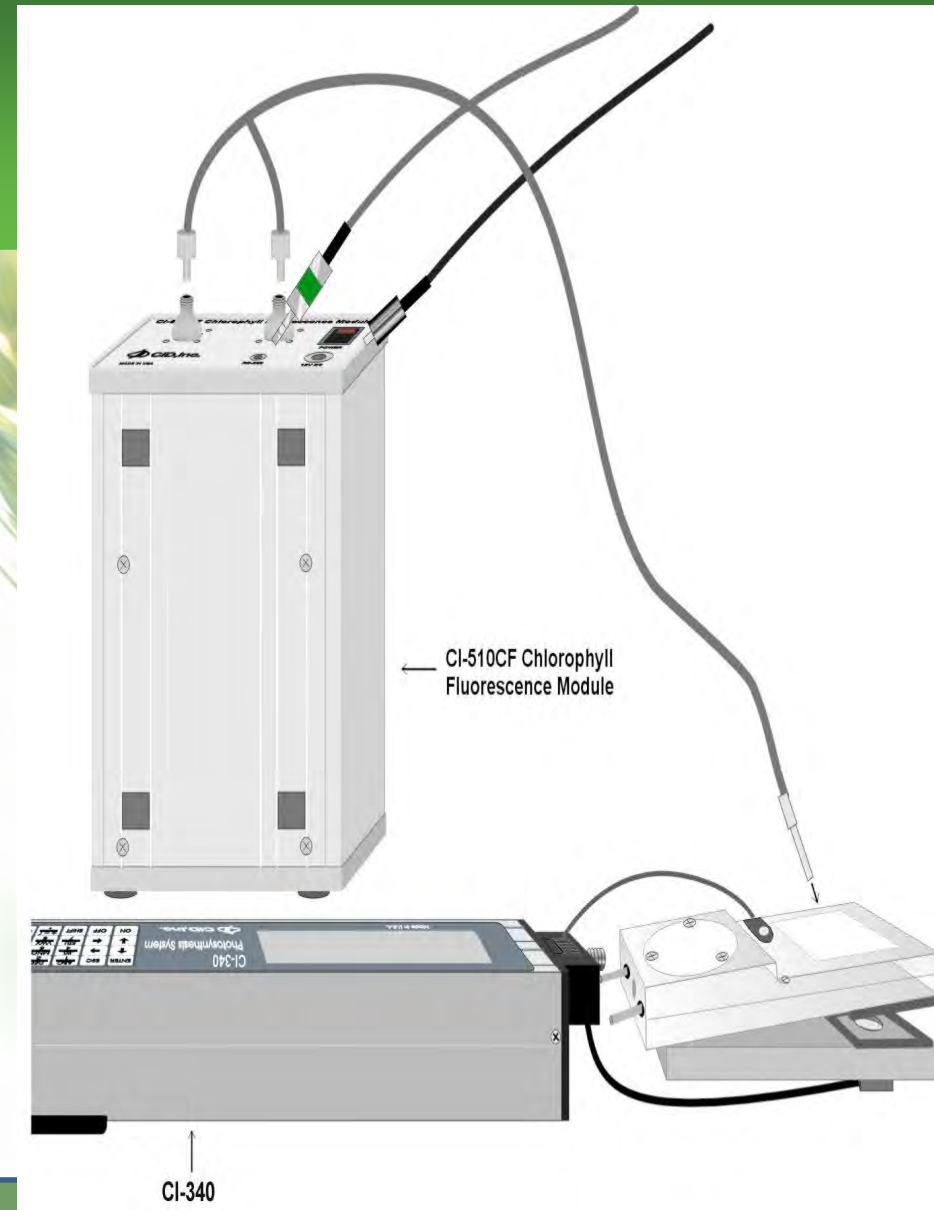
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Installing the CI-510CF

- Screw on the 2 connectors on the “Y” end of the fiber optic cable to the CF Module.
- Insert the end of the cable into the hole in the side of the leaf chamber.
- Insert the power plug for the CF module.
- Connect the 4 and 8-pin accessory control cable to the CI-340 and CI-510CF module.
- Insert the plug with the green color band into the jack on the CI-510CF control unit.

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- Connect the 4 and 8-pin accessory control cable to the CI-340 and CI-510CF module.
- Insert the plug with the green color band into the jack on the CI-510CF control unit.



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Making Measurements with CI-510CF

- Activate the CI-510CF by turning on the CI-340 and CI-510 module.
 - Start the measurement by pressing “SHIFT SHIFT SHIFT 2” for “F” or fluorescence
 - Enter a file name to save data under
 - Enter a pulse length from 0.8 to 3 seconds
 - The default saturation pulse length is 1 second

Interpreting CF Measurements

- Download the CF files to a PC
- Fluorescence numbers represent the chlorophyll fluorescence in A/D (analog to digital converter) counts.
 - Generated at 16 Hz

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CF DATA

- Ratio value should be interpreted as 0.xxx (xxx is the # displayed in table)

- Ex: if the number is 99, the ratio is 0.099

Low Fluor. value	Fo – dark Fs - ambient
High Fluor. value	Fm – dark Fms - ambient
Ratio of DHL:H	Fv/Fm – dark Y – ambient

- Fv = variable chlorophyll fluorescence:
 - $Fv = Fm - Fo$
 - Fv/Fm = Yield: the quantum efficiency of the primary photochemical reaction of photosynthesis