INSTRUMENTS

OWNER'S MANUAL

CHLOROPHYLL CONCENTRATION METER

Model MC-100, *U.S. Patent No. 9,733,179*

Rev: 1-May-2026

APOGEE INSTRUMENTS, INC. | 721 WEST 1800 NORTH, LOGAN, UTAH 84321, USA
TEL: (435) 792-4700 | FAX: (435) 787-8268 | WEB: APOGEEINSTRUMENTS.COM

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CERTIFICATE OF COMPLIANCE

EU Declaration of Conformity

This declaration of conformity is issued under the sole responsibility of the manufacturer:

Apogee Instruments, Inc.
721 W 1800 N
Logan, Utah 84321
USA

for the following product(s):

Models: MC-100
Type: Chlorophyll Concentration Meter

The object of the declaration described above is in conformity with the relevant Union harmonization legislation:

2014/30/EU	Electromagnetic Compatibility (EMC) Directive
2011/65/EU	Restriction of Hazardous Substances (RoHS 2) Directive
2015/863/EU	Amending Annex II to Directive 2011/65/EU (RoHS 3)

Standards referenced during compliance assessment:

EN 61326-1:2013	Electrical equipment for measurement, control, and laboratory use – EMC requirements
EN 63000:2018	Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

Please be advised that based on the information available to us from our raw material suppliers, the products manufactured by us do not contain, as intentional additives, any of the restricted materials including lead (see note below), mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBB), polybrominated diphenyls (PBDE), bis (2-ethylhexyl) phthalate (DEHP), butyl benzyl phthalate (BBP), dibutyl phthalate (DBP), and diisobutyl phthalate (DIBP). However, please note that articles containing greater than 0.1 % lead concentration are RoHS 3 compliant using exemption 6c.

Further note that Apogee Instruments does not specifically run any analysis on our raw materials or end products for the presence of these substances, but we rely on the information provided to us by our material suppliers.

Signed for and on behalf of:
Apogee Instruments, July 2024

Bruce Bugbee
President
Apogee Instruments, Inc.

CE

CERTIFICATE OF COMPLIANCE

UK Declaration of Conformity

This declaration of conformity is issued under the sole responsibility of the manufacturer:

Apogee Instruments, Inc.
721 W 1800 N
Logan, Utah 84321
USA

for the following product(s):

Models: MC-100
Type: Chlorophyll Concentration Meter

The object of the declaration described above is in conformity with the relevant UK Statutory Instruments and their amendments:

2016 No. 1091	The Electromagnetic Compatibility Regulations 2016
2012 No. 3032	The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012

Standards referenced during compliance assessment:

BS EN 61326-1:2013	Electrical equipment for measurement, control, and laboratory use – EMC requirements
BS EN 63000:2018	Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

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Bruce Bugbee
President
Apogee Instruments, Inc.

UK CA

INTRODUCTION

Chlorophyll is a green pigment found in plant cells, algae cells, and cyanobacteria. The primary function of chlorophyll molecules is radiation absorption, which provides energy essential for photosynthesis. Chlorophyll concentration in plant leaves is typically expressed in units of quantity per area of leaf surface, micromoles per square meter (µmol m^{-2}); mass per area of leaf surface, milligrams per square meter (mg m^{-2}), has also been used.

Hand-held chlorophyll meters typically provide a relative indication of chlorophyll in plant leaves. The patented Apogee model MC-100 chlorophyll concentration meter measures relative chlorophyll content and outputs an estimate of actual chlorophyll concentration in units of µmol per m^2 of leaf surface, which is closely correlated to the relative measurement. The MC-100 provides an alternative to destructive sampling techniques for determining chlorophyll concentration. It is less time consuming and labor intensive and allows for leaves to be measured and monitored over an entire growth cycle. It also allows for rapid replicate measurements of the same leaf, or rapid measurement of multiple leaves.

Typical applications of chlorophyll meters include chlorophyll concentration determination for plant nutrient status assessment, environmental stress impact, and fertilizer requirement.

Apogee Instruments MC-100 chlorophyll concentration meters consist of two light emitting diodes (one emitting red radiation and one emitting near infrared radiation) with paired detectors, liquid crystal display (LCD), operation buttons, 9 V alkaline battery, and signal processing circuitry mounted in a plastic housing. The meter also includes a USB port for data download to a computer and an internal GPS feature to track where measurements were taken. The meter is hand-held and designed for instantaneous, non-destructive, direct determination of leaf chlorophyll concentration. The meter measures the ratio of radiation transmittance from two different wavelengths (red and near infrared) and outputs chlorophyll concentration, which is calculated internally from the transmittance ratio measurement and then displayed on the LCD.

METER MODELS

The MC-100 chlorophyll concentration meter is the only chlorophyll meter model offered by Apogee Instruments. It includes custom coefficients to determine chlorophyll concentration for over 35 different plant species (with more being added upon popular request; see complete list on page 15). It also includes a generic equation for use with all plant species, where the equation was derived from the data from all twenty-two species measured. Custom coefficients for additional species can be added, once established from measurement of chlorophyll content index (CCI) and *in vitro* determination of leaf chlorophyll concentration, which requires chemical digestion of leaf samples and subsequent chlorophyll extraction, then optical analysis for chlorophyll determination. The method is detailed and equations for twenty-two different plant species are provided in Parry et al. (2014).

Parry, C., J. M. Blonquist Jr., and B. Bugbee, 2014. In situ measurement of lead chlorophyll concentration: analysis of the optical/absolute relationship. *Plant, Cell and Environment* 37:2508-2520.

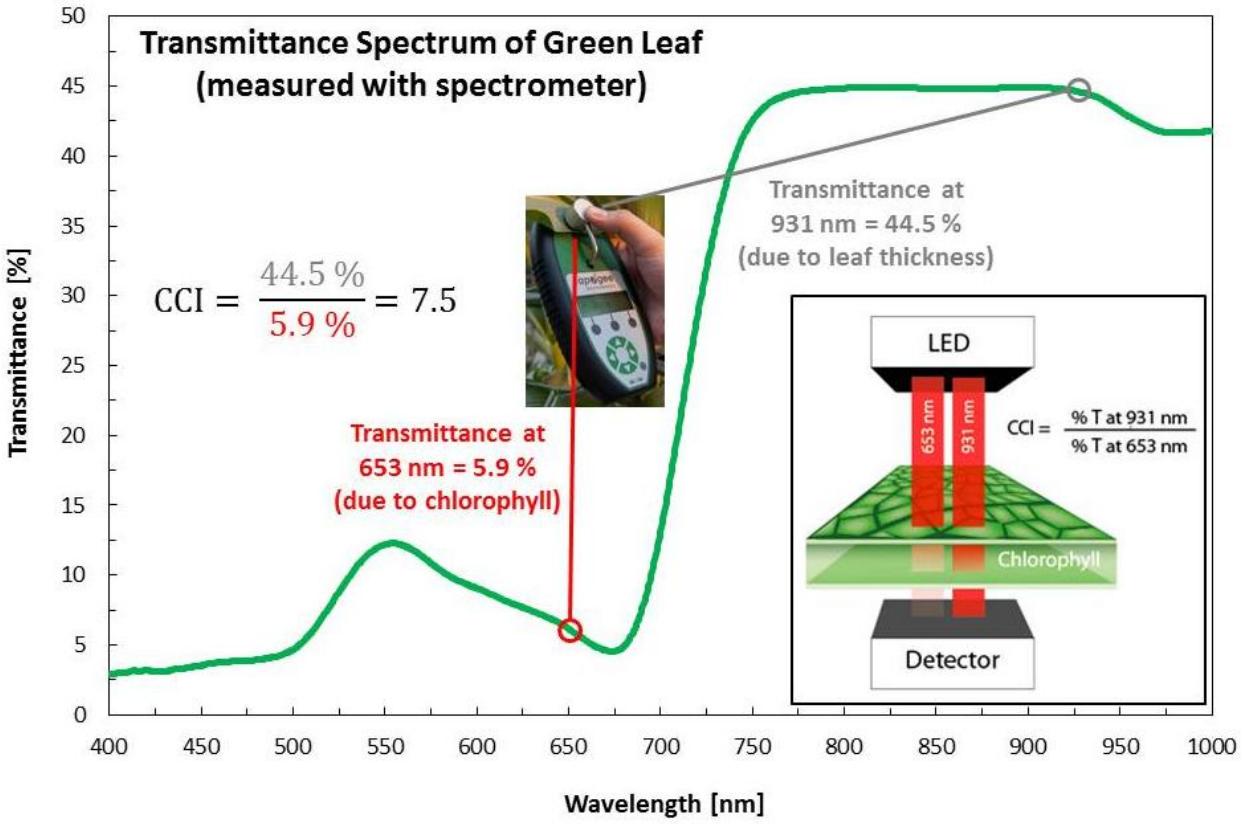
A meter's model number, serial number, and production date are located on a label on back of each meter.

SPECIFICATIONS

	MC-100
Displayed Output Unit	µmol of chlorophyll per m^2 of leaf surface
Measurement Area	63.6 mm^2 (9 mm standard diameter), 19.6 mm^2 (5 mm diameter with reducer)
Resolution	± 10 µmol m^{-2} chlorophyll concentration for generic equation (less for specific species), 0.1 Chlorophyll Content Index (CCI) Unit
Linearity	± 1 %
Repeatability	± 1 %
Sample Acquisition Time	Less than 3 s
Storage Capacity	8 MB for up to 160,000 data measurements; 94,000 data measurements with GPS data entries
User Interface	50 mm by 15 mm graphic display screen; 8 push buttons for control and data manipulation
Data Output	Mini-B USB port provided for main data transfer; RS-232 port can be used with GPS for integrated measurement
Measured Variables	Ratio of optical transmission at 931 nm to optical transmission at 653 nm
GPS Options	Serial # 1-1520: External GPS, RS-232 port (GPS location data is saved with each measurement) Serial # 1521 and Above: Internal GPS
GPS Satellite	GLONASS, 72 channels
Operating Temperature	0 to 50 C
Temperature Drift	Temperature compensated source and detector circuitry over full range
Power Requirement	Standard 9 V DC alkaline battery
Auto-Off Interval	4 minutes (with no key press or download)
Dimensions	152 mm length, 82 mm width, 25 mm height
Mass	210 g

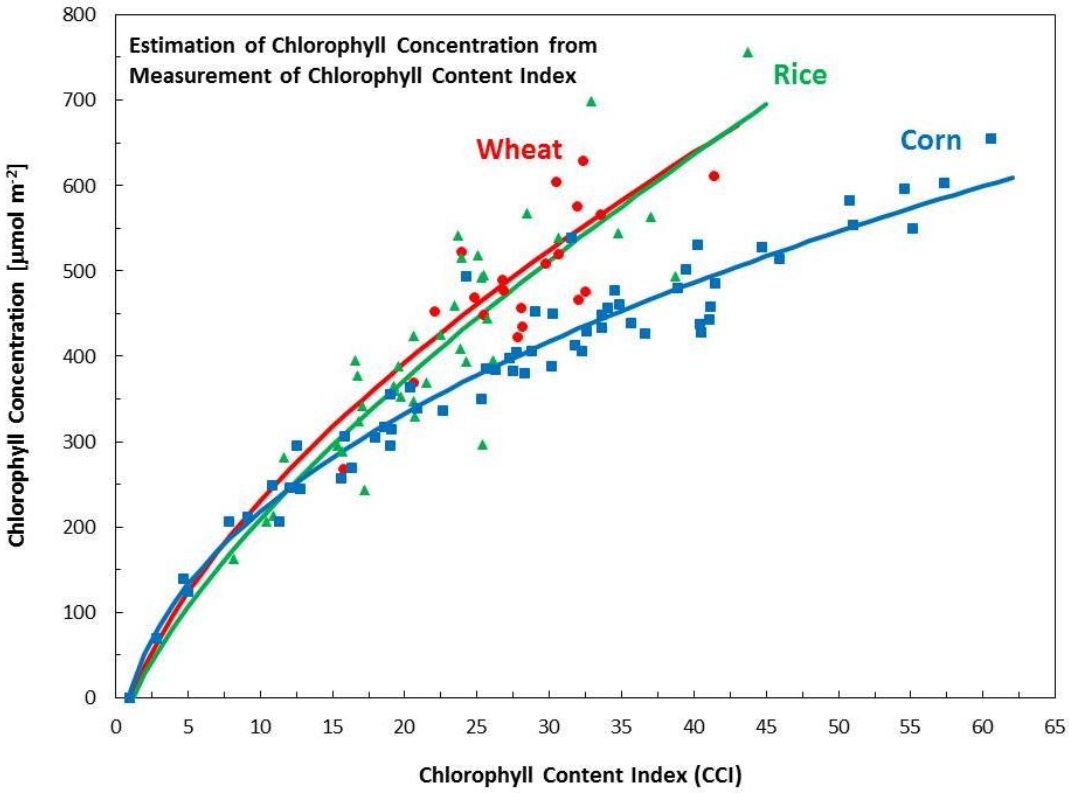
THEORY OF OPERATION

Radiation that drives photosynthesis in plants is called photosynthetically active radiation (PAR). PAR is typically defined as radiation in the 400-700 nm range, the visible wavelengths. Chlorophyll has distinct radiation absorption characteristics and is a strong absorber of all photosynthetically active wavelengths. However, it does not absorb quite as much green radiation as it does blue and red radiation, thus more green radiation is reflected from or transmitted through leaves. This is what gives leaves their green color, and this feature shows up as a characteristic hump near 550 nm in a leaf transmittance spectrum (or reflectance spectrum; leaf reflectance and transmittance spectra are very similar). Chlorophyll absorbs very little radiation at wavelengths greater than 700 nm, thus there is a sharp transition from low to high transmittance near 700 nm (see leaf transmittance spectrum in figure below). This characteristic feature of a leaf transmittance spectrum is called the red edge, where radiation of wavelength greater than approximately 700 nm, termed near infrared (NIR), is not used for photosynthesis.



The Apogee Instruments MC-100 chlorophyll concentration meter exploits the different absorption characteristics of chlorophyll at different wavelengths to determine relative chlorophyll content. Radiation from two light emitting diodes (one centered at 653 nm and one centered at 931 nm) is passed through a leaf sample and intensity is measured by paired detectors to determine transmittance (see inset in lower right-hand corner in graph above). The ratio of transmittance at 931 nm to transmittance at 653 nm provides a measure of relative chlorophyll content because 653 nm is a photosynthetically active wavelength within the chlorophyll absorption range and 931 nm is a near infrared wavelength outside the chlorophyll absorption range, which serves as a reference measurement to compensate for mechanical differences between leaves (e.g., tissue thickness). The ratio of transmittance at 931 nm to 653 nm is termed chlorophyll content index (CCI). A CCI measurement near one indicates similar transmittance of red and NIR radiation, thus little to no chlorophyll in the leaf sample. A CCI measurement greater than one indicates less transmittance of red radiation relative to near infrared radiation (for example, see CCI value calculated from leaf transmittance spectrum in graph above), with larger ratios indicating more chlorophyll.

The MC-100 chlorophyll concentration meter is unique in that it converts CCI, a relative measure of chlorophyll content, to an estimate of actual chlorophyll concentration. There is a non-linear relationship between CCI and chlorophyll concentration, and the relationship is different for different plant species (see relationship for three different crop species in figure below). The MC-100 includes equations with species-specific coefficients for twenty-two different species (see table below), an equation with generic coefficients derived from data for all twenty-two species, and an equation to convert CCI to SPAD units (SPAD is the output from a similar chlorophyll meter manufactured by Minolta). As custom coefficients for additional species are generated, they can be added to the database in the meter by Apogee.

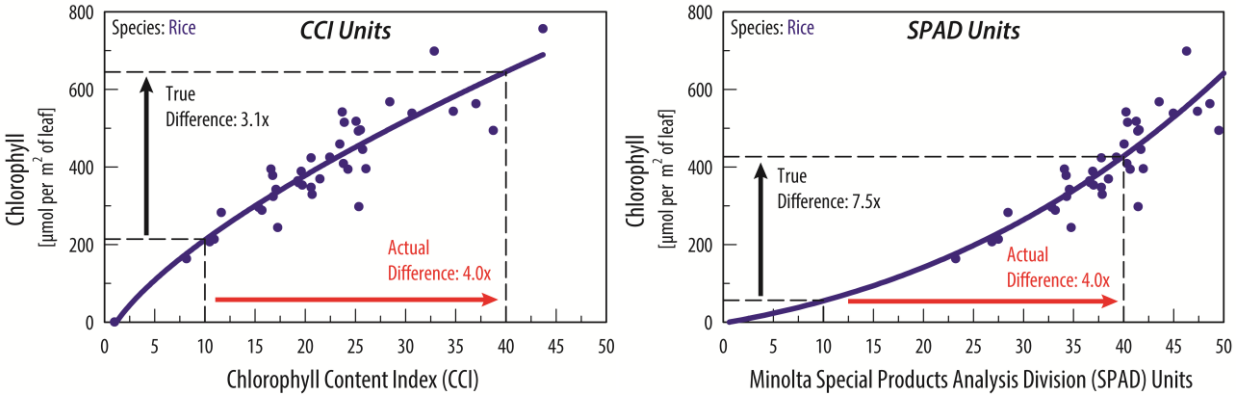


Species for which chlorophyll concentration can be directly determined with MC-100

All Species	
	Generic Equation (used for species not listed below)
Annual Crop Species	
	Arugula (New!)
	Barley
	Blackberry
	Cannabis
	Cherry
	Coffee
	Collard Greens (New!)
	Corn
	Kale (New!)
	Kohlrabi
	Lettuce, cultivar Buttercrunch
	Lettuce, cultivar Romaine (New!)
	Lettuce, cultivar Waldman's Green
	Peas
	Peppers
	Rice
	Sorghum
	Soybean
	Spinach
	Strawberry
	Swiss Chard (New!)
	Tomato
	Wheat
Deciduous Species	
	Boxelder
	Crab Apple
	Crimson King Maple
	European Birch
	Forsythia
	Grapevine*
	Hops
	Japanese Maple
	Lilac
	Norway Maple
	Paper Birch
	Purple Leaf Sand Cherry
	Quaking Aspen

* Coefficients for grapevine were derived from data collected and supplied by Everard Edwards and Tarita Shiraishi Furlan, CSIRO Agriculture & Food.

A major advantage of the Apogee Instruments model MC-100 over other hand-held chlorophyll meters is conversion of relative chlorophyll content to actual chlorophyll concentration (i.e., linearization of the output). Chlorophyll meters typically output an index that is non-linearly related to chlorophyll concentration (e.g., CCI or SPAD). The MC-100 outputs an estimate of actual chlorophyll concentration in units of µmol per m^2 of leaf surface, thus changes in the displayed output are true changes in chlorophyll concentration. For example, a doubling of measured chlorophyll concentration represents an actual doubling in a plant leaf, whereas a doubling of a relative index does not necessarily represent a doubling of actual chlorophyll concentration in the leaf. This concept is illustrated for CCI and SPAD index measurements on rice leaves in the graphs below.



OPERATION AND MEASUREMENT

Apogee Instruments model MC-100 chlorophyll concentration meters consist of two light emitting diodes with paired detectors located in the sampling head, liquid crystal display (LCD), operation buttons, 9 V alkaline battery, and signal processing circuitry mounted in a plastic housing. The meter also includes a USB port for data download to a computer.

Note: Instructions specific to older MC-100 units (serial numbers 1-1521) are found at the end of this Operation and Measurement Section.

The operational buttons consist of three menu selection keys and four arrow keys to adjust menu functions.

Press the power button to turn on the MC-100. After a few seconds the main menu screen appears. Program flow is organized into three menu groups. The selectable options are **Run** – used to set up and take measurements, **Data** – allows access and downloading of data files, and **System** – used to set up functional features of the meter and view system diagnostics.

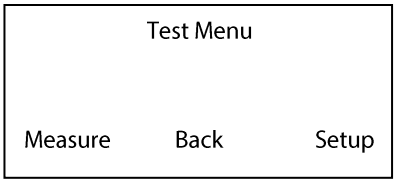
Adjusting Contrast

To adjust the contrast on the screen, press and hold the up arrow button (darker) or the down arrow button (lighter) until the desired contrast level is reached.

MEASUREMENTS

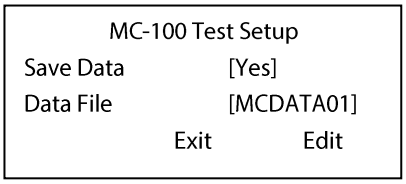
Below is a graphic of what you would see on the LCD display after turning it on. The three words at the bottom of the display correspond to the buttons you can press to navigate to different pages.

From the main menu select **Run**.



Select **Measure** to perform measurements with the MC-100 and **Setup** to make adjustments to data files, test types, and measurement parameters. Select **Back** to return to the main menu.

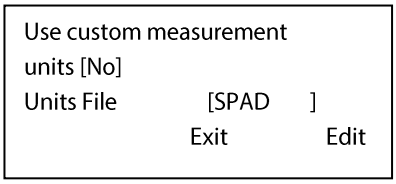
Run → Setup: Data Files



The user can choose to save a data file to memory in addition to naming the file. Select **Edit** to highlight the **Save Data** option. Pressing the up and down arrows will toggle between **Yes** and **No**.

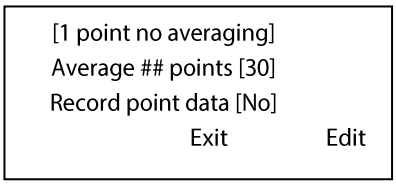
While still highlighted, press the right arrow to enter the File Name Manager. This feature allows the user to select, rename, or create a new data file. Press the up and down arrows to rotate through the following menu options: Use an existing file, Use date as name, Edit default name, Enter a new name. Select **Accept** while the appropriate option is highlighted. A default file will already exist (i.e., MCDATA01), but additional files may be designated using uppercase letters A-Z and/or numbers 0-9. Note that a newly created data file will not appear in the list of existing data files until a measurement is saved to it. The total number of data files is indefinite, as the limit is dependent on available memory.

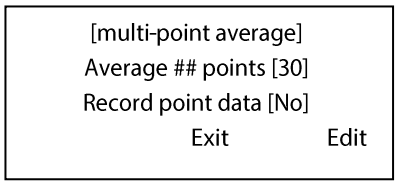
Run → Setup: Custom Measurements

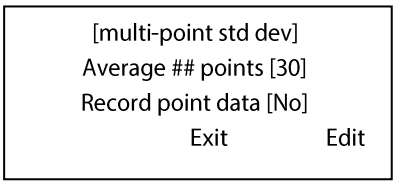


As detailed above, the MC-100 is capable of measuring in both units of CCI (relative chlorophyll content) and in µmol m^{-2} (actual chlorophyll concentration). The default is to measure in units of CCI whereby the **Use custom measurement** units is set to **No**. For measurements reported in units of µmol m^{-2}, select **Edit** to highlight the **Use custom measurement** units. Use the up or down arrow to change the setting to **Yes** and then press the right arrow to select the appropriate species-specific file.

Run → Setup: Test Types



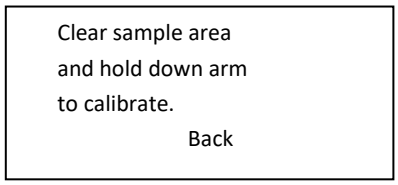


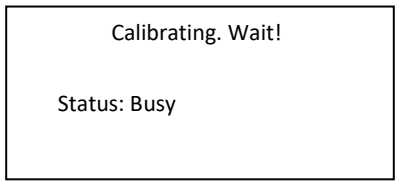


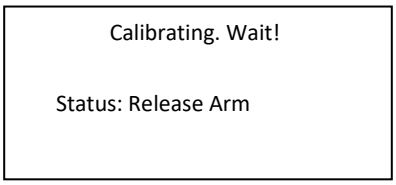
There are three test types to select for measurements: 1 point no averaging, multi-point average, and multi-point std dev. A **1 point no averaging** will save every data point to the data file (the parameters Average ## points and Record point data are not applicable with the single point option). **Multi-point average** will record an average of 2 to 30 samples, depending on the Average ## points selected. Selecting **No** under **Record point data** will only save the averaged value, while selecting **Yes** will save all data points in addition to the average value. **Multi-point std dev** will only allow averaging from 10 to 30 samples and will record the standard deviation from these samples. Selecting **No** under **Record point data** will only save the standard deviation value, while selecting **Yes** will save all data points in addition to the standard deviation value. Note that if the difference between measurements is greater than two standard deviations, the instrument automatically eliminates the outlier and requires an additional measurement.

Select **Edit** and use the up and down arrows to toggle to the appropriate test type and test type options. Pressing the right arrow will advance the highlighted option to the next.

Run → Measure: Calibration

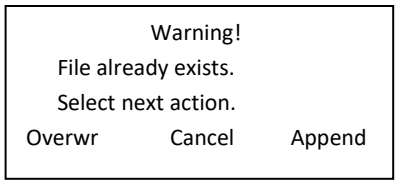






The MC-100 requires a calibration when taking the first measurement after powering on the unit. ***Calibration is not required between measurements.*** Verify the sample chamber's optical path is clear and hold down the measuring arm until the **Release Arm** message is displayed.

When saving the first measurement to a data table, one of the above three screens will appear, depending on the test type selected. If the data file already holds existing data, the following message will appear. Select **Overwr** to overwrite the existing data in the data file or **Append** to add the next set of measurements to the existing data file. Select **Cancel** to close the menu and start over.



Place the sample under the measuring head making sure the entire measuring area is covered by the sample. Hold down the arm until the screen displays **DONE**. Release the arm and the screen updates with the measured value. When taking measurements in multi-point average or multi-point std dev, a vertical bar will appear on a graph for each data point. The total number of measurements made and the latest measurement value will also display.

An alphanumeric comment, up to 20 characters in length, may be entered for each measurement. After taking the measurement, select **Info** and then **Comment**. Use the arrow keys to customize the field. **Info** can be used to check your current GPS location.

GPS SETTINGS

Run → Setup: RS-232 Echo Option

Click the down arrow twice, which should lead to this screen:

Data Echo Output	[Off/On]
GPS Data Logging	[On/Off]
GPS Data Format	[DEC/DDM]
Exit	Edit

Press the button under Edit. The right and left arrows will navigate to the setting you want to change. The up and down arrows will toggle the setting on or off. Once settings are updated, press the button under "Enter" to save.

The MC-100 includes an USB connection that can be used for mirroring collected data files on a computer.

Run → Measure: Perform Measurement

GPS: -	Sample number:	
1 pt	###.#	
Info	Exit	

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

GPS: X	Sample number: ####	
StDev	###.#	
Info	Exit	Delete

The measurement screen has an icon in the upper left corner of the screen to indicate the status of the GPS signal and location logging ability.
"GPS:-" = GPS enable, no signal acquired, searching.
"GPS:+" = GPS enabled, signal acquired.
"GPS:X" = GPS disabled.

System → Checking GPS Information in the Diag Menu

1. Make sure GPS logging is enabled: See the Run → Setup instructions above.
2. Go back to home screen, press System → Diag, then navigation to screen 5
    a. Location is given in latitude and longitude
    b. DOP: degrees of precision
    c. N Sat: number of satellite signals detected

The following tables provide names of specific species and the corresponding file name that appears in menu. The subsequent data file will also include a four-letter notation to help track the species selected during measurement. The generic option will calculate chlorophyll concentration from an equation that was fit to CCI and chlorophyll measurements from all species combined. There is also an option that converts CCI to SPAD, where SPAD units are the output from chlorophyll meters manufactured by Minolta.

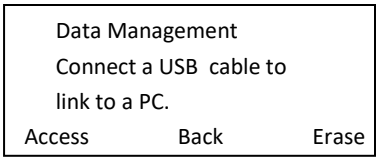
	Function	**Menu Name**	**Data File Notation**
Conversion to SPAD	Converts CCI to SPAD	SPAD	Spad
Combined Species	Generic (equation fit to all data)	GENERIC	Gnrc

	Species Name	**Menu Name**	**Data File Notation**
Annual Crop Species			
	Arugula	ARUGULA	Argl
	Barley	BARLEY	Baly
	Blackberry	BLACKBRY	Blkb
	Cannabis	CANNABIS	Cnbs
	Cherry	CHERRY	Chry
	Coffee	COFFEE	Cofe
	Collard Greens	COLLAR	CGrn
	Corn	MAIZE	Maze
	Kale	KALE	Kale
	Kohlrabi	KOHLRABI	Klrb
	Lettuce – Buttercrunch	BCLETTUC	BcLt
	Lettuce – Romaine	ROMAINE	Rman
	Lettuce – Waldman's Green	WGLETTUC	WGLt
	Pea	PEA	Pea
	Pepper	PEPPER	Pepr
	Rice	RICE	Rice
	Sorghum	SORGHUM	Srgm
	Soybean	SOYBEAN	SyBn
	Spinach	SPINACH	Spnc
	Strawberry	STRWBRY	Strw
	Swiss Chard	SWISSC	SwCd
	Tomato	TOMATO	Tomt
	Wheat	WHEAT	Whet
Deciduous Species			
	Boxelder	BOXELDER	BxEl
	Crab Apple	CRBAPPLE	CbAp
	Crimson King Maple	CKMAPLE	CKMp
	European Birch	EUBIRCH	EuBr
	Forsythia	FRSYTHIA	Frsy
	Grapevine*	GRAPE	Grap
	Hops	HOPS	Hops
	Japanese Maple	JPMAPLE	JpMp
	Lilac	LILAC	Lilc
	Norway Maple	MWMAPLE	NwMp
	Paper Birch	PABIRCH	PpBr
	Purple Leaf Sand Cherry	PLSCHERR	PLSC
	Quaking Aspen	QKASPEN	QkAp

* Coefficients for grapevine were derived from data collected and supplied by Everard Edwards and Tarita Shiraishi Furlan, CSIRO Agriculture & Food.

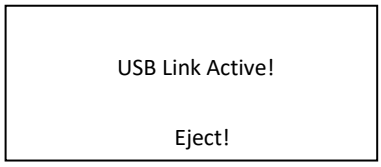
DATA

From the main menu select Data.



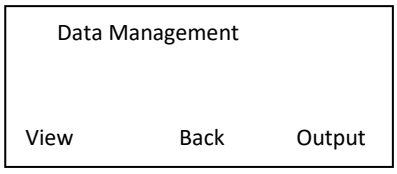
Connect MC-100 to a PC via USB cable or select **Access** to view data points on screen. **Erase** to delete data files.

Data → Connect to PC



Connect the included USB cable from the MC-100 to a PC (note that any USB cable may be used that has a standard A plug to Mini-B plug). The built-in uSD memory of the MC-100 acts as a flash drive so a storage device window will likely pop up once the connection is made. Select Open folder to view files using Windows Explorer. If the window does not appear, go to My Computer and select the MC-100 drive. Locate the appropriate data files (saved as a .txt file) and copy to the computer's hard drive. ***Select Eject before unplugging the USB cable. Do not turn off the PC until the USB cable has been disconnected.***

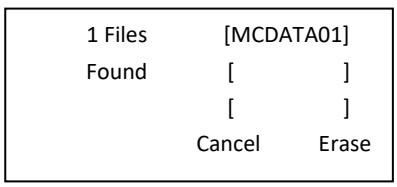
Data → Access: View Data On Screen



Each data point of each data file may be viewed on screen. Select **View** and use the up and down arrows to select the appropriate data file from the list. Once highlighted, select **View** to enter the file. Use the up and down arrows to sequentially traverse through each data point.

Selecting **Output** provides the option of sending data over RS-232 communications with the use of a custom serial cable. *NOTE: Transferring data files over a USB connection is highly recommended. If USB connection is not available please contact Apogee Instruments technical support for more information on transferring files over RS-232. Select **Back** to return to the main menu.

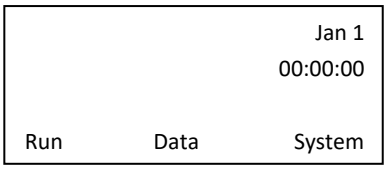
Data → Erase: Delete Data Files



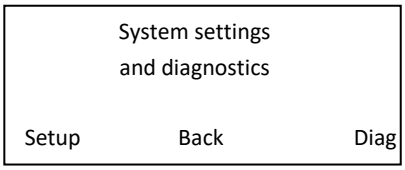
To delete a data file from the MC-100 memory, use the up and down arrows to highlight the appropriate file. Select **Erase** to delete (note there will be no additional check to verify that highlighted file should be deleted).

SYSTEM

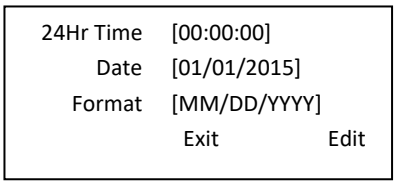
From the main menu select **System**.



Select **Setup** to make adjustments to basic meter functions and **Diag** to view system diagnostics.

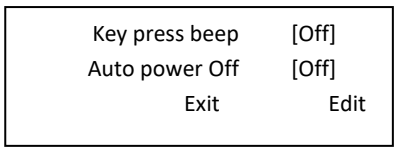


System → Setup: Time Stamp



Since a time stamp is recorded with each data point it is important to maintain the correct date and time. Select **Edit** to highlight the hour and use the up and down arrows to adjust setting. Use the right arrow button to advance to minutes, seconds, months, and so forth. Select **Enter** when set.

System → Setup: Operational Functions



By default, the MC-100 will beep every time a key is pressed, in addition to a four-minute auto-off feature to help conserve battery power. To turn these features off, select **Edit** to highlight the **Key press beep**. Pressing the up and down arrows will toggle between **Yes** and **No**. Use the right arrow to advance to the next setting.

System → Setup: Baud Rate Output

This setup option is no longer available.

Using the Field of View Reducer for Small Leaf Applications:

The field of view reducer (FOVR) accessory reduces the sample chamber area from 63.6 mm^2 to 19.6 mm^2, roughly 30 % of the original size. Field of view reduction errors were less than 5 % for all leaves tested using the steps below.

1. To use the reducer, you must calibrate the meter without the reducer installed. Installing the reducer prior to calibration results in the error message:

   !! Warning !!
   Clean Sample Chamber!

2. Install the FOVR carefully by gently pressing it into place on the meter body side of the sample chamber.

3. You are now ready to make measurements on smaller leaves. Important note: If the meter turns off (preset Auto-off in 4 minutes), you will need to remove the FOVR to repeat steps 1 and 2.

4. To remove the FOVR, carefully use a needle to depress the foam washer and pick out the FOVR from the sample chamber (see image below).

Converting from µmol per m^2 to mg per m^2:

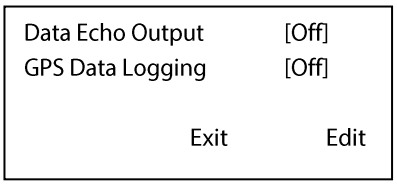
The leaves of higher plants include a mix of both chlorophyll a and b in about a 3 to 1 ratio (Parry et al., 2014). Chlorophyll a has a molar mass of 893.5 grams (g) per mole; chlorophyll b is slightly heavier at 907.5 grams per mole. The typical weighted average mass of both types of chlorophyll in plant leaves is very close to 900 grams per mole (this is equivalent to 900 micrograms per micromole or 0.9 milligrams per micromole).

The reading(s) in µmoles per m^2 can be converted to units of mg per m^2 by multiplying by 0.9. For example, a reading of 400 micromoles per m^2 is approximately 360 mg per m^2.

The reverse conversion from mg per m^2 to micromoles per m^2 can be done by multiplying by 1.11 (1/0.9). For example, a reading of 350 mg per m^2 is approximately 388.5 µmol per m^2.

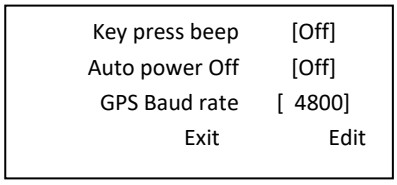
INSTRUCTIONS FOR METERS SERIAL NUMBERS

Run → Setup: RS-232 Option Serial Numbers 1-1520



The MC-100 includes an RS-232 (serial) output that is primarily used for GPS connection. Compatible GPS devices must be capable of RS-232 communications and have a 9-pin connector output. Additionally, although the transferring of data files over USB connection is recommended, it is possible to transfer using the MC-100's serial output with a custom serial cable. Contact Apogee technical support for more information on connecting to a GPS device or transferring files over RS-232.

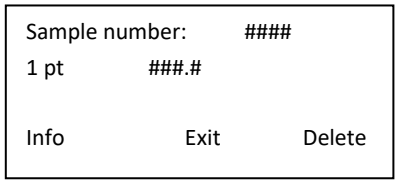
System → Setup: Operational Functions Serial Numbers 1-1520

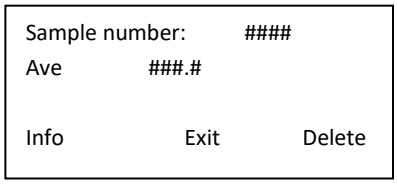


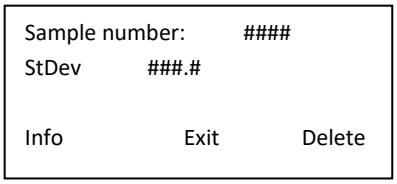
By default, the MC-100 will beep every time a key is pressed, in addition to a four-minute auto-off feature to help conserve battery power. To turn these features off, select **Edit** to highlight the **Key press beep**. Pressing the up and down arrows will toggle between **Yes** and **No**. Use the right arrow to advance to the next setting.

A specific GPS baud rate is required when communicating with a compatible GPS device. Contact Apogee Instruments technical support for more information on connecting to a GPS device.

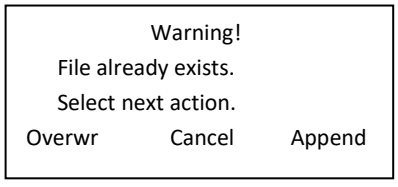
Run → Measure: Perform Measurement Serial Numbers 1-1520







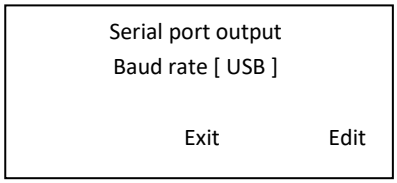
When saving the first measurement to a data table, one of the above three screens will appear, depending on the test type selected. If the data file already holds existing data, the following message will appear. Select **Overwr** to overwrite the existing data in the data file or **Append** to add the next set of measurements to the existing data file. Select **Cancel** to close the menu and start over.



Place the sample under the measuring head making sure the entire measuring area is covered by the sample. Hold down the arm until the screen displays **DONE**. Release the arm and the screen updates with the measured value. When taking measurements in multi-point average or multi-point std dev, a vertical bar will appear on a graph for each data point. The total number of measurements made and the latest measurement value will also display.

An alphanumeric comment, up to 20 characters in length, may be entered for each measurement. After taking the measurement, select **Info** and then **Comment**. Use the arrow keys to customize the field.

System → Setup: Baud Rate Output Serial Numbers 1-1520



For communication over RS-232 the appropriate baud rate will need to be set, otherwise USB should be selected. Select **Edit** to highlight the baud rate and use the up and down arrows to adjust.

System → Diag: Meter Diagnostics

The diagnostics section consists of five screens that detail system operation and overall performance. The information provided in the diagnostics section is intended for troubleshooting and/or repair.

INSTALLING NEW CROP-SPECIFIC SETTINGS

When Apogee released the MC-100, it came with 22 different crop specific coefficients plus a generic setting for all other crops. Since then, we have added some species and will continue to do so upon popular request. For the current list of available species, please check our website. If your meter does not have all of the settings loaded, you can download them from our website and add them to your meter by following these instructions or by watching the video on our website. ***Please note that MC-100 meters with a serial number less than 1402 were only programmed to be able to hold up to 27 crop specific coefficients at a time*.** This can be a limiting factor as we build the library of available species. If you have a unit with this limitation, you can easily upgrade the software by following the instructions linked **HERE >**.

How to Install New Coefficients on Your MC-100

1. Go to https://www.apogeeinstruments.com/chlorophyll-meter-support/#coefficients.
2. Click on one of the the "New Coefficient Zip Files" links to download.
3. Connect the micro-USB end of a micro-USB to USB cable (included with your meter) to your MC-100's USB port. Connect the other end of the USB cable to your computer.
4. Turn the meter on and press the "Data" button. The meter should now read "USB Link Active!"
5. On the connected computer, go to the location of the downloaded zip file and extract its contents.
6. Select the files extracted and copy them. (Right click > Copy, or Ctl + C)
7. Navigate to and open the MC-100's file directory.
8. Paste the two new files into the MC-100's memory. (Right click > Past, or Ctl + P)

Confirming and Selecting New Custom Units

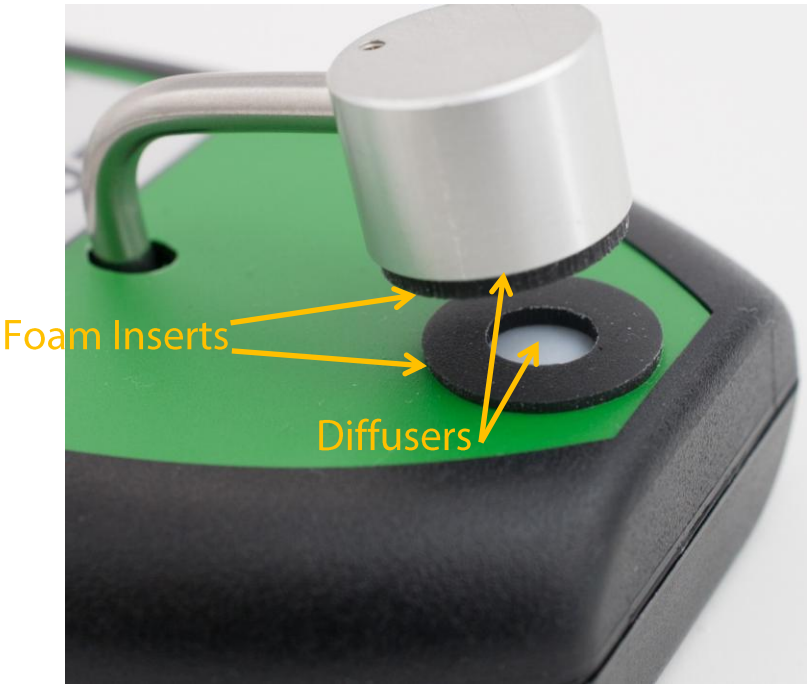
1. Press the "Eject" button and disconnect the USB cable.
2. From the home menu, press the "Run" button to access the Test Menu.
3. Press the "Setup" button to access the MC-100 Test Setup menu.
4. Press the "Up" arrow button to reach the Custom Measurement menu.
5. Press the "Edit" button. Make sure the units' heading is highlighted.
6. Press the "Right" arrow button to go to the unit's selection menu.
7. Scroll through the selection of units to confirm your new species coefficients.
8. Highlight a coefficient and press the "Accept" button to begin using it.

For more detailed instructions including images, click the link below.
https://www.apogeeinstruments.com/content/MC-100-installing-new-coefficients.pdf

MAINTENANCE AND RECALIBRATION

Moisture or debris on the MC-100 diffusers is a common cause of inconsistent readings. If cleaning is required, organic deposits are best removed using water or isopropyl alcohol and a soft cloth or cotton swab. **Never use an abrasive material or cleaner on the diffusers.**

Over time, the foam insert may become worn or damaged, in which case the unit will need to be returned for repair. Contact Apogee Instruments technical support for more information.



TROUBLESHOOTING AND CUSTOMER SUPPORT

FAQs

What do I do when the Apogee logo displays, but the screen then goes completely dark or light?
After the screen goes completely dark or light, try holding down the up or down arrows to adjust the contrast.

What do I do when the meter powers on and beeps, but nothing is showing on the screen?
Perform an extended power cycle by removing the battery from the unit and letting it sit out overnight. Try reinserting the battery and powering the unit on the next day.

Error Codes and Fixes

Apogee model MC-100 chlorophyll concentration meters are powered by a 9 V battery. If a meter loses functionality or will not power on try replacing the battery first. Many error codes can be cleared by performing a master reset by removing the 9 V battery, holding down the power switch for 30 seconds, reinserting the battery and powering on the unit. If any of the fixes listed below do not rectify the problem, contact Apogee Instruments technical support.

Error Code	Fix
"SD init error Continue"	Perform master reset.
"SD error #xx on command #xx"	
"NV load error Continue"	
"! Error Warning ! File System Corrupt! Perform Format on Unit Continue"	Reconnect the meter to the computer. Go to My Computer, find the MC-100 drive, and right click the drive. Left click Format, and then left click Start. This will reformat the drive and subsequently erase all saved data in uSD memory.
"! nvRAM Init !"	Error code may follow a drive reformat, indicating the system defaults are being restored. Message should clear automatically, otherwise perform a master reset.
"Custom file not found! CCI units will be used"	Message appears if the "Use Custom Measurement Units [Yes]" setting is selected and there are no lookup tables available in uSD memory. Turn feature off to clear the message.
"Warning! Average must be>=10 pts for std dev mode. A setting of 10 points will be used."	Message appears in standard deviation test mode when number of samples is less than 10. Value must be 10 or greater.
"!! Warning !! Drive is Full"	Clear uSD memory by deleting or downloading data to computer.
"Sample too dense"	Indicates the amount of signal absorbed by the sample is too great for reliable measurements. Try locating to a different part of the sample.
"Hold arm down for whole test!"	Keep sample chamber closed for the duration of the measurement.
"Light Leak!"	Indicates too much light present in the sample chamber. Error may be due to non-flat samples or worn/damaged gaskets surrounding sample chamber.
"Chamber Light Leak!"	Indicates too much light present in the sample chamber. Error may be due to non-flat samples or worn/damaged gaskets surrounding sample chamber.

Error Code	Fix
“Clean Sample Chamber!”	Indicates the light through the chamber is below a certain level and may be due to dirt on the diffusers or debris in the sample area. Clean chamber as described in section MAINTENANCE AND RECALIBRATION.
“Source/Detector Fail!”	Indicates the unit has detected a fault with one of its sensing components. Perform master reset.
“File is Corrupt!”	Error code may occur after aborting a file transfer to a computer or by removing the 9 V battery instead of using the power switch to turn off the unit. Perform master reset.

RETURN AND WARRANTY POLICY

RETURN POLICY

Apogee Instruments will accept returns within 30 days of purchase as long as the product is in new condition (to be determined by Apogee). Returns are subject to a 10 % restocking fee.

WARRANTY POLICY

What is Covered
All products manufactured by Apogee Instruments are warranted to be free from defects in materials and craftsmanship for a period of four (4) years from the date of shipment from our factory. To be considered for warranty coverage an item must be evaluated by Apogee.

Products not manufactured by Apogee (spectroradiometers, chlorophyll content meters, EE08-SS probes) are covered for a period of one (1) year.

What is Not Covered
The customer is responsible for all costs associated with the removal, reinstallation, and shipping of suspected warranty items to our factory.

The warranty does not cover equipment that has been damaged due to the following conditions:

1. Improper installation, use, or abuse.

2. Operation of the instrument outside of its specified operating range.

3. Natural occurrences such as lightning, fire, etc.

4. Unauthorized modification.

5. Improper or unauthorized repair.

Please note that nominal accuracy drift is normal over time. Routine recalibration of sensors/meters is considered part of proper maintenance and is not covered under warranty.

Who is Covered
This warranty covers the original purchaser of the product or other party who may own it during the warranty period.

What Apogee Will Do
At no charge Apogee will:

1. Either repair or replace (at our discretion) the item under warranty.

2. Ship the item back to the customer by the carrier of our choice.

Different or expedited shipping methods will be at the customer's expense.

How To Return An Item

1. Please do not send any products back to Apogee Instruments until you have received a Return Merchandise Authorization (RMA) number from our technical support department by submitting an online RMA form at www.apogeeinstruments.com/tech-support-recalibration-repairs/. We will use your RMA number for tracking of the service item. Call (435) 245-8012 or email techsupport@apogeeinstruments.com with questions.

2. For warranty evaluations, send all RMA sensors and meters back in the following condition: Clean the sensor's exterior and cord. Do not modify the sensors or wires, including splicing, cutting wire leads, etc. If a connector has been attached to the cable end, please include the mating connector – otherwise the sensor connector will be removed in order to complete the repair/recalibration. ***Note:*** *When sending back sensors for routine calibration that have Apogee's standard stainless-steel connectors, you only need to send the sensor with the 30 cm section of cable and one-half of the connector. We have mating connectors at our factory that can be used for calibrating the sensor.*

3. Please write the RMA number on the outside of the shipping container.

4. Return the item with freight pre-paid and fully insured to our factory address shown below. We are not responsible for any costs associated with the transportation of products across international borders.

Apogee Instruments, Inc.
721 West 1800 North Logan, UT
84321, USA

5. Upon receipt, Apogee Instruments will determine the cause of failure. If the product is found to be defective in terms of operation to the published specifications due to a failure of product materials or craftsmanship, Apogee Instruments will repair or replace the items free of charge. If it is determined that your product is not covered under warranty, you will be informed and given an estimated repair/replacement cost.

PRODUCTS BEYOND THE WARRANTY PERIOD

For issues with sensors beyond the warranty period, please contact Apogee at techsupport@apogeeinstruments.com to discuss repair or replacement options.

OTHER TERMS

The available remedy of defects under this warranty is for the repair or replacement of the original product, and Apogee Instruments is not responsible for any direct, indirect, incidental, or consequential damages, including but not limited to loss of income, loss of revenue, loss of profit, loss of data, loss of wages, loss of time, loss of sales, accruement of debts or expenses, injury to personal property, or injury to any person or any other type of damage or loss.

This limited warranty and any disputes arising out of or in connection with this limited warranty ("Disputes") shall be governed by the laws of the State of Utah, USA, excluding conflicts of law principles and excluding the Convention for the International Sale of Goods. The courts located in the State of Utah, USA, shall have exclusive jurisdiction over any Disputes.

This limited warranty gives you specific legal rights, and you may also have other rights, which vary from state to state and jurisdiction to jurisdiction, and which shall not be affected by this limited warranty. This warranty extends only to you and cannot by transferred or assigned. If any provision of this limited warranty is unlawful, void or unenforceable, that provision shall be deemed severable and shall not affect any remaining provisions. In case of any inconsistency between the English and other versions of this limited warranty, the English version shall prevail.

This warranty cannot be changed, assumed, or amended by any other person or agreement.

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