



PTM-48M PHOTOSYNTHESIS MONITOR

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Automatic four-channel open-type system for monitoring CO₂ exchange and transpiration of leaves

Operating Instructions



PhyTech Ltd.
www.phytech.com

Before Initial Use

It is extremely important that you take the time to review this operator's manual prior to installation and operation of the PTM-48M Photosynthesis Monitor. Otherwise, damage may be caused which is not covered under our normal warranty policy.

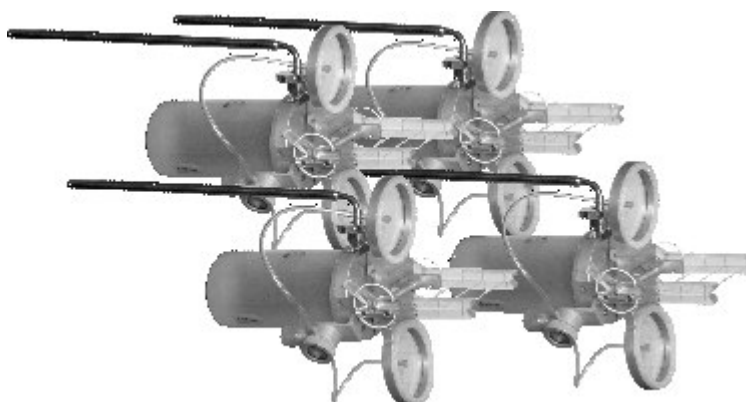
Before powering-up the PTM-48M Photosynthesis Monitor, check and, if necessary, adjust the power supply to available supply-line voltage. Switching diagram is located on the internal side of the power supply's lid.

System Composition and Accessories

TYPICAL SYSTEM COMPOSITION	1 x System console
	4 x LC-4A Leaf chambers with holders
	8 x 6m PVC hose
	2 x one-meter stainless steel tripods for holding leaf chambers and optional phytomonitoring sensors
	Optional sensors



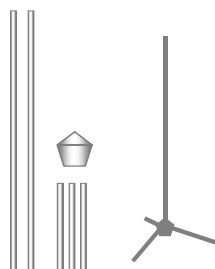


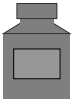



SYSTEM CONSOLE

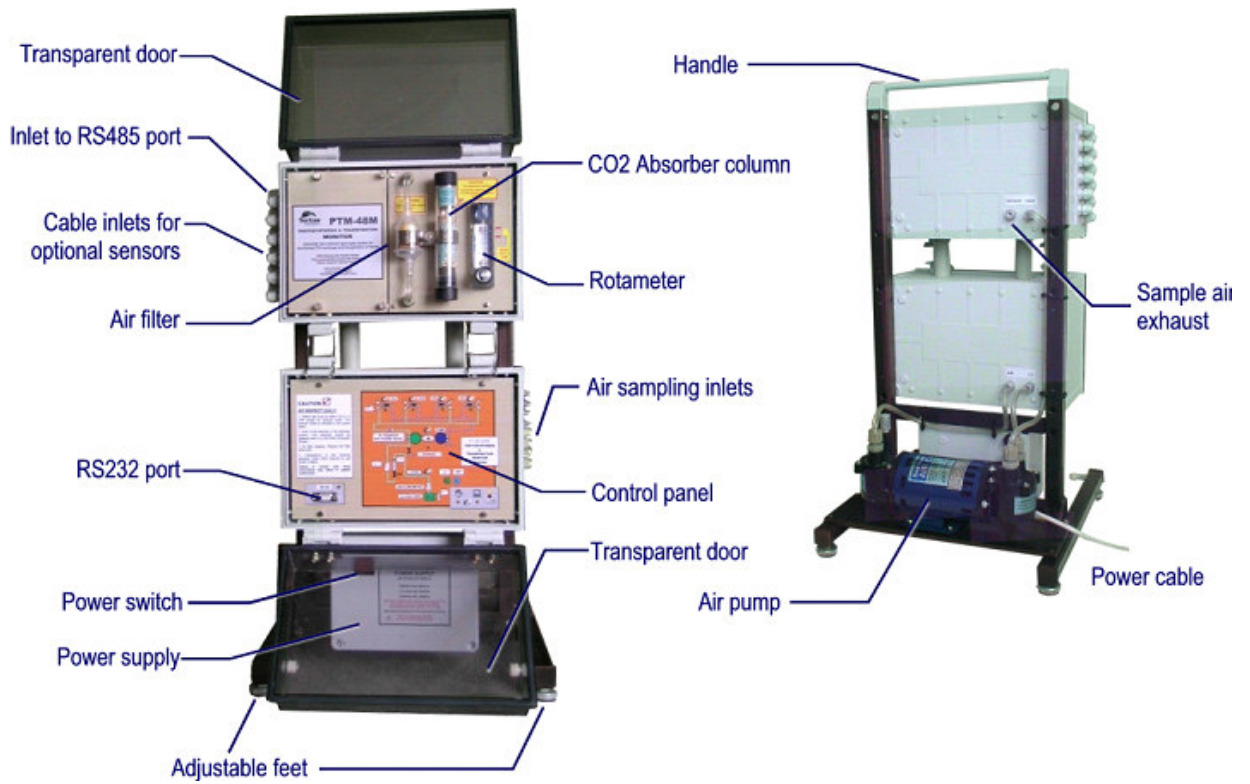


LC-4B LEAF CHAMBERS

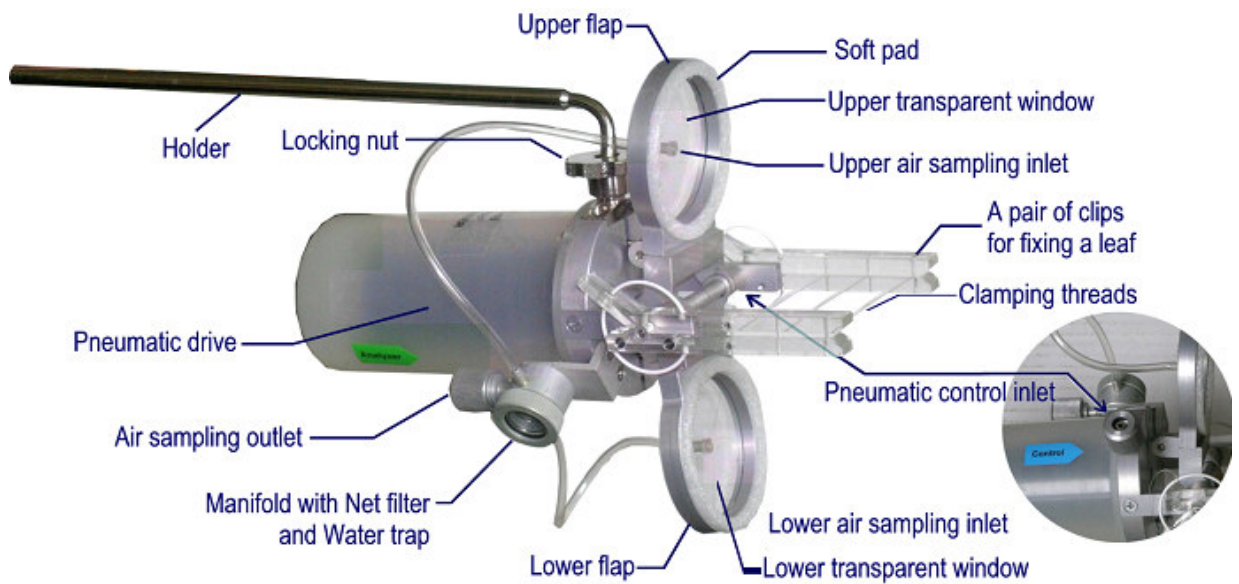
ACCESSORIES

<p>HOLDER FOR LEAF CHAMBER (4 pcs)</p> 	<p>PVC HOSE (2 x 6 x 4 m)</p> 	<p>STAINLESS STEEL TRIPOD (1 m height, 2 pcs)</p> 
<p>CABLE FOR PC</p> 	<p>SOFTWARE SETUP CD</p> 	
<p>CO2 ABSORBER</p> 	<p>SPARE AIR FILTER</p> 	

SYSTEM CONSOLE



LC-4B LEAF CHAMBER



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Principles of Operation

The PTM-48M Photosynthesis Monitor is a four-channel automated system for monitoring CO₂ exchange and transpiration of leaves. The system is equipped with a set of four original self-clamping leaf chambers, which operate one-by-one in such a manner that one of leaf chambers is closed at a time while the others remain open.

The automatic self-clamping design enables keeping a leaf open for more than 90% of the time. Thus, the leaf environment is not disrupted considerably.

In the open photosynthesis system, the CO₂ exchange is determined on the basis of the depression of CO₂ concentration at the outlet (C_{out}) of the leaf chamber in comparison with the incoming ambient air (C_{in}). The CO₂ exchange rate is calculated as follows:

$$E = k \times (C_{in} - C_{out}) \times F,$$

where F is the air flow rate and k is a dimension factor, which depends on air temperature and pressure and is calculated by the system automatically.


Transpiration rate is determined in much the same way as

$$Tr = (H_{out} - H_{in}) \times F,$$

where H is absolute concentration of water vapor in the air. To shorten the measurement cycle, the H_{out} is computed during transient period between 20th and 30th second after closing the chamber. The calculation algorithm also takes into account the rising humidity inside the chamber and, hence, allows determining the initial transpiration rate at the ambient air humidity.

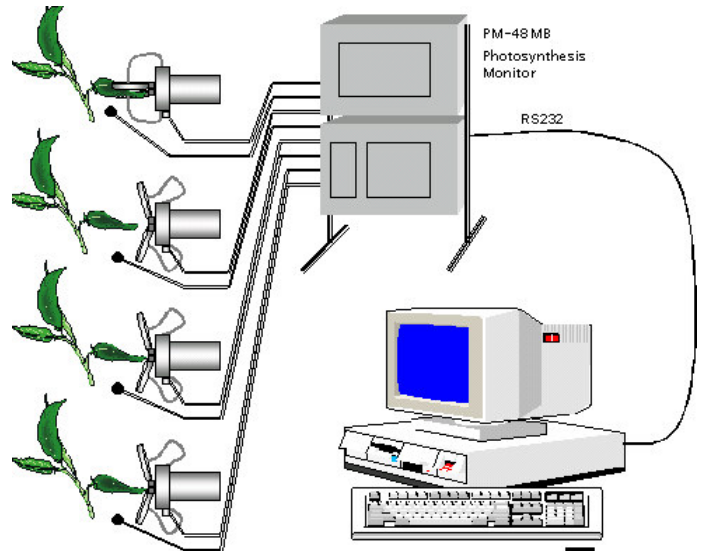
The measurement sequence with two leaf chambers is illustrated below:

TIME SCALE	120 sec	Until steady-state concentration. Upper limit: 60 sec	30 sec	Until steady-state concentration. Upper limit: 60	30 sec	Until the next measurement cycle	
STAGE	AIR PURGE	REFERENCE CHAMBER 1	MEASUREMENT CHAMBER1	REFERENCE CHAMBER 2	MEASUREMENT CHAMBER2	PAUSE	
CHAMBER 1	OPEN		CLOSED	OPEN		OPEN	
CHAMBER 2		OPEN			CLOSED	OPEN	
SENSORS	MEASUREMENT						



 CALCULATION OF AVERAGES AND RECORDING

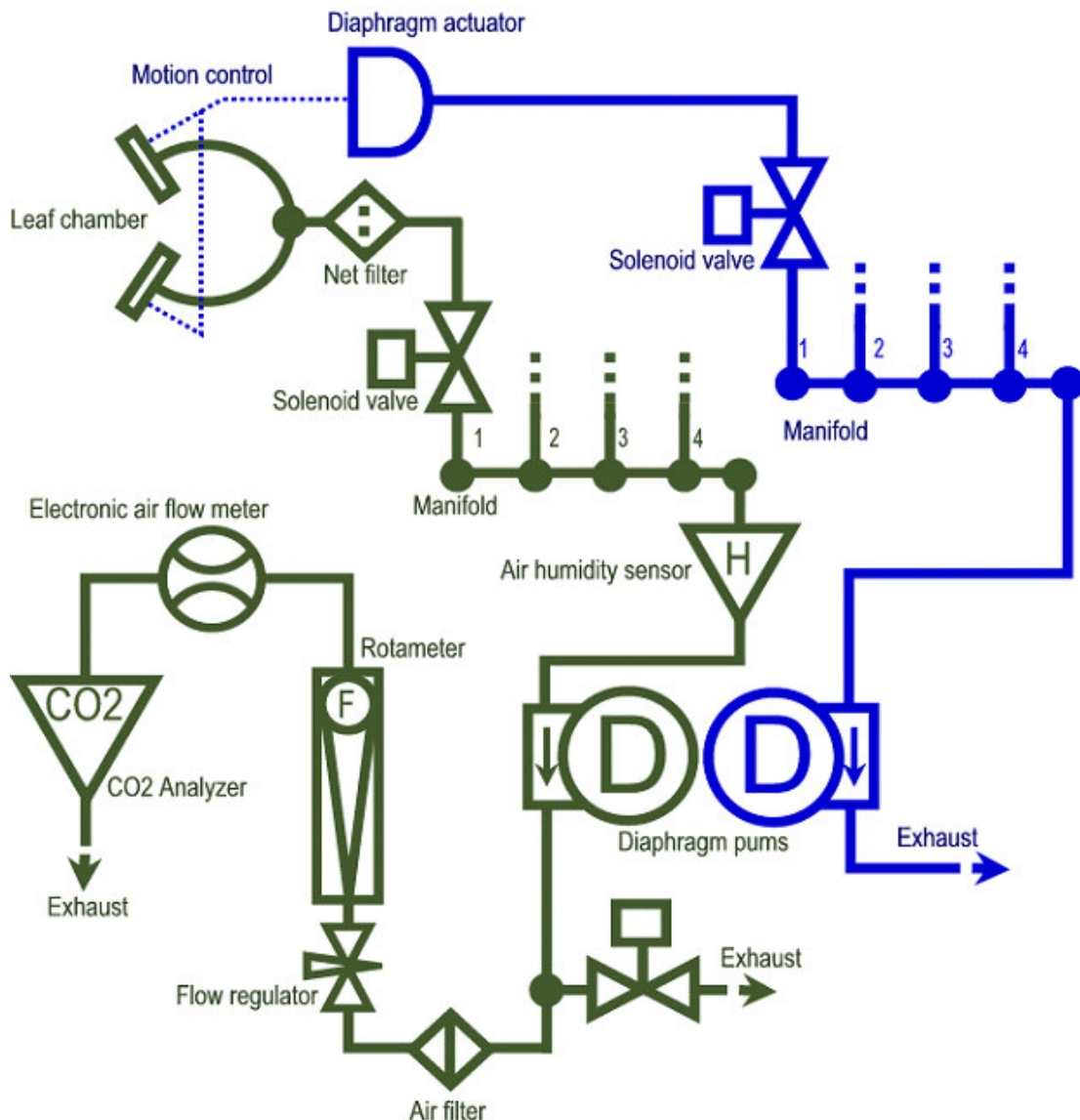
The cycle starts from the purging the system that continuous 120 seconds. All chambers are open and purged at this stage. Then, during the reference stage, only the chamber No. 1 is connected to the measuring system. This stage continues until the steady-state concentration has been reached. In any case the reference stage



stops after 60 seconds and the chamber No. 1 closes. At the end of 30-second measurement stage the records for Chamber # 1 are ready. Then, the second chamber repeats both reference and measurement cycles. If optional sensors are connected to the system, their readings are collected during operation of all leaf chambers. At the end of the measurement cycle, the average values are recorded.

The typical duration of operational cycle with 4 leaf chambers is about 6 minutes while each chamber is closed only 30 seconds. Typical (recommended) time interval between cycles is 30 minutes.

Pneumatic Diagram of the PTM-48M Monitor



The leaf chamber channel is drawn in green and the pneumatic control channel is drawn in blue. All controls are described in the *Location of Controls* section.

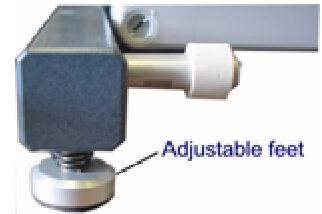
Installation Directions

Positioning

System console

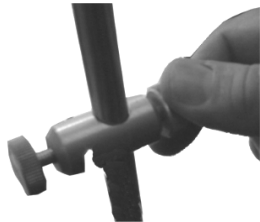
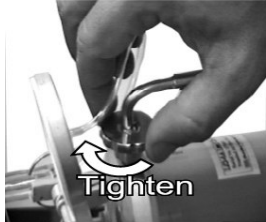
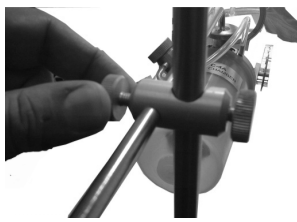

After the system console has been placed in the desired location, level it by means of the adjustable front feet.

Warning: if the system console is not perfectly leveled, it will be unstable, noisy and may lead to malfunctions and broken parts.

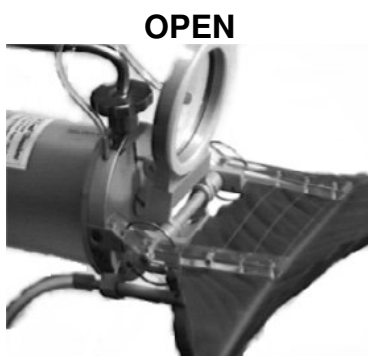


Leaf chamber

Mount a leaf chamber on a tripod as shown below:

<p style="text-align: center;">1</p>  <p>Assemble a tripod. Mount the angle clip to the tripod and tighten the locking bolt.</p>	<p style="text-align: center;">2</p>  <p>Attach the holder to leaf chamber and slightly tighten its locking nut.</p>	<p style="text-align: center;">3</p>  <p>Insert the holder into the angle clip and tighten the appropriate locking bolt.</p>	<p style="text-align: center;">4</p>  <p>Adjust position of the camber. Open the leaf chamber clips and secure the leaf in the desired position. Then, fasten all locking bolt and nuts.</p>
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Position of a leaf chamber flaps in operation is shown below:



Pneumatic Connection

Connect the desired number of leaf chambers (1 to 4) to air sampling and control inlets using twin PVC hoses. Follow the instructions below.



Choose an inlet for connection. All air-sampling and control inlets are located at the right side of the system console. Sampling inlets are green and control ones are blue. To avoid mismatching, both sampling and control PVC hoses are marked with the appropriate color.

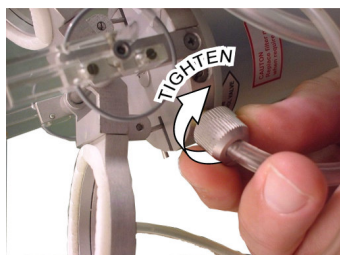


Unscrew the ring nut.

Put the end of PVC hose through the ring nut.

Connect the hose to the air-sampling inlet and tighten the ring nut.

Connect a control end of the hose to the appropriate control inlet.



Locate an opposite end of the hose for connecting to leaf chamber.

Put the ends of PVC hose through the ring nuts

Connect sampling (Analyzer) and control hoses to the appropriate inlets of the leaf chamber.

Tighten the ring nuts.

Electrical Connection

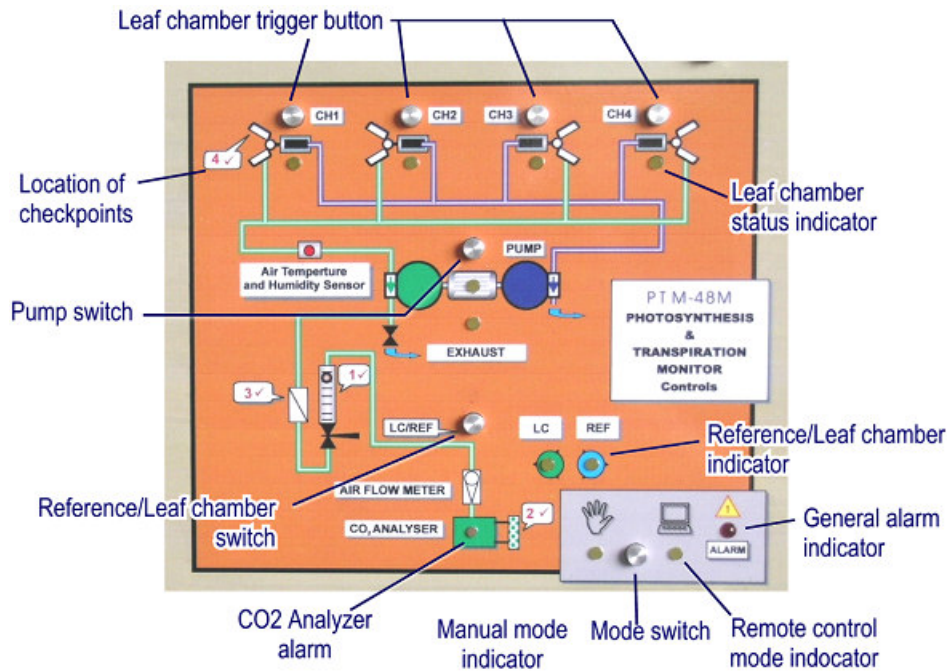
The PTM-48M Photosynthesis Monitor should be connected to the electrical grounded outlet. Make sure that the supply-line voltage matches the working voltage indicated on the power supply front panel.

If necessary, adjust the power supply to available supply-line voltage. Switching diagram is located on the internal side of the power supply's lid.

Location of Controls

Control panel

Most of manual controls are located at the Control panel. Control buttons and appropriate LED indicators are shown in the picture below.



IMPORTANT NOTE: All control buttons (except for the Mode switch) are active in the manual mode only.

Remote Control panel

The Control panel is duplicated in the Terminal emulator interface. You can use the same on-screen control buttons by clicking the left mouse button on any of them. The light indicators are also duplicated on screen.



Air flow control



There is only one Rotameter equipped with the air flow regulator, located on the front panel of the System console. The normal range of air flow rate is between 0.8 and 1 LPM. Adjust if necessary.

Preparation for Use

Software Setup

1. Insert the installation CD into CD-ROM drive in your computer. The software installation Setup wizard starts.
2. Follow the on-screen instructions.

The default location of the program is following:

C:\Program Files\Phytech\PTM-48M Photosynthesis Monitor

The executable file is **phsmon.exe**

Operation Modes

Manual Mode

Manual mode is used only for testing and tuning the system. In manual mode, the system may be controlled either by Control panel, located at the front panel of the System console, or by its duplication in the Terminal emulator screen. Location of controls and indicators are the same. See also page 9.

Automatic Mode

This is the main mode of operation. In automatic mode, the system operates according to settings specified in the current Project descriptor (see Page 13). The data logging session can be initialized only via computer interface (Terminal emulator). Then, the system operates automatically and does not require permanent connection to the computer. After occasional power interruption, the system continues operation in previous mode.

Optional Sensors

The PTM-48 Photosynthesis Monitor has 11 inputs for optional sensors. The following excitation voltages are available: + 15 Vdc, -15 Vdc, +5 Vdc. The maximal current load is 0.3 A. Input: 0 to 2.5 Vdc.

The following phytomonitoring sensors are recommended for use¹:

- PIR-1 Photosynthesis Radiation Sensor;
- TIR-4 Total Irradiance Sensor;
- ATH-2 Air Temperature and Humidity Sensor;
- SMS-2 Soil Moisture Sensor;
- LT-2M Leaf Temperature Sensor;
- SF-4M, SF-5M Sap Flow Relative Rate Sensors;
- SD-5M or SD-6 Stem Microvariation Sensors;
- DE-1M Electronic Point Dendrometer;

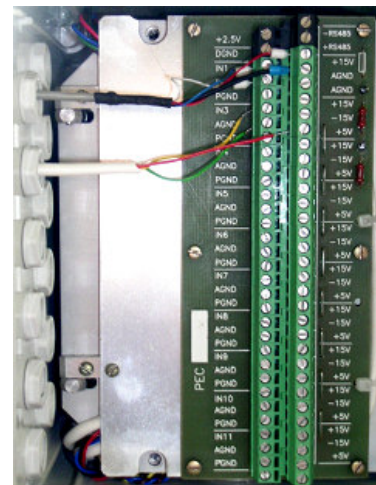
¹ Commercially available worldwide from Phytech Ltd. and authorized dealers. Refer to www.phytech.com for further information.

- FI-LM, FI-MM, FI-SM and FI-XSM Fruit Growth Sensors;
- SA-2 or SA-20 Stem Auxanometers.

Connection



Run sensors' cables through the cable glands located at the left side of the system console upper box. Open the box's door before and remove left front panel.

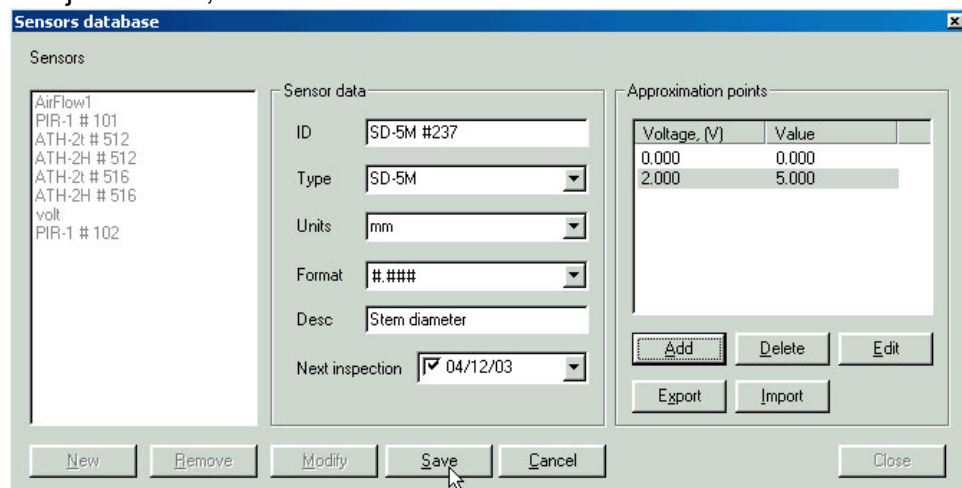


Connect sensors according to their connection diagram. Use inputs 1-8. Note down an input number, used for each sensor.

Entering calibration data

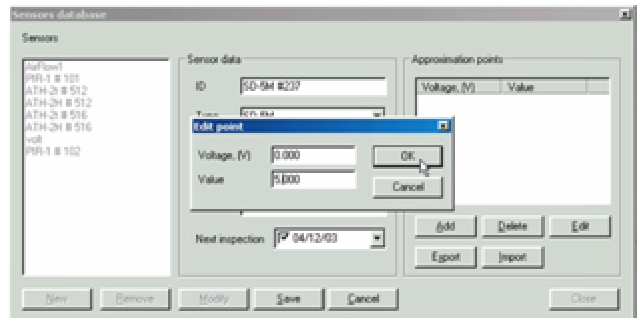
At first, every sensor, which is assigned for use in the PTM-48M Photosynthesis Monitor, is to be included into the sensors database. To do this, run the program (phsmon.exe file, see also Software Setup section on Page 10.). Then, follow the instructions below:

1. In the Project menu, select Sensors database



2. Click New button.
3. Type in the sensors's ID – its type and a serial number (SD-5M #2347, for instance).
4. Enter the sensor's type (SD-5M, for instance).
5. Specify measurement units (mm, for instance).

6. Select data decimal format (###.###, for instance)
7. Type in the sensor's description (Stem diameter, for instance)
8. In necessary, enter the next inspection date for the sensor (04/12/03, for instance)
9. Click Add button for entering the calibration data to the database.
10. Enter the first approximation point specified in the sensor's calibration table (0.000 and 5.000, for instance)
11. Click OK and continue to enter approximation points.
12. Click Save when finished. The new sensor ID appears in the Sensors list.


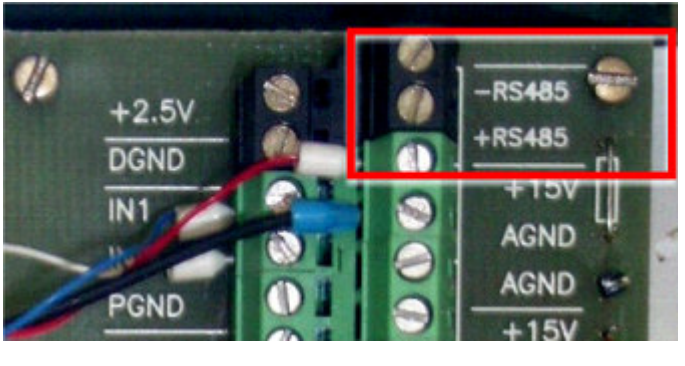


Functioning

Data logging

Communication with PC

PM-48M Photosynthesis Monitor has two communication ports:

RS 232	RS 485
	
<p>Use a 1.5 m communication cable enclosed in the system accessories. Connect it to the available serial COM port in your PC.</p>	<p>Requires a standard RS485/RS232 converter at the PC side. Allows to arrange communication at the distance up to 1200 m.</p>

IMPORTANT NOTE: Do not forget to specify the used COM port number in the PTM-48M-Link Setup menu.

The following commands are available for communication in the Terminal Emulator interface:

Connect

to make connection between PTM-48M Photosynthesis Monitor and a PC.

Disconnect

to break connection between PTM-48M Photosynthesis Monitor and a PC.

Download data records

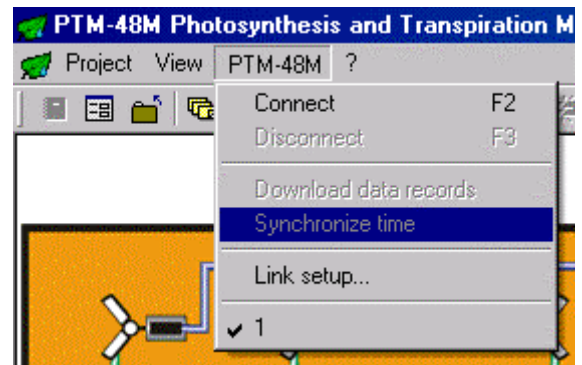
to download the collected data to a PC.

Synchronize time

synchronization of system time with PC.

Link setup

to select a COM port for connection.

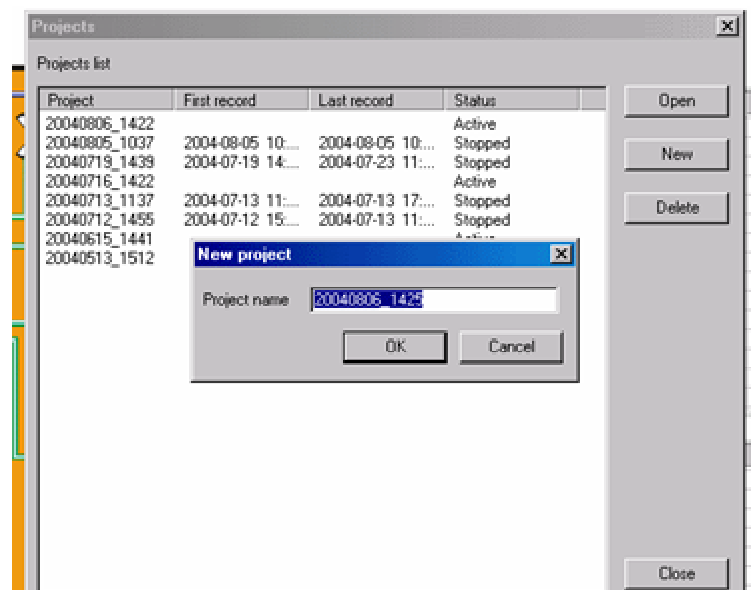


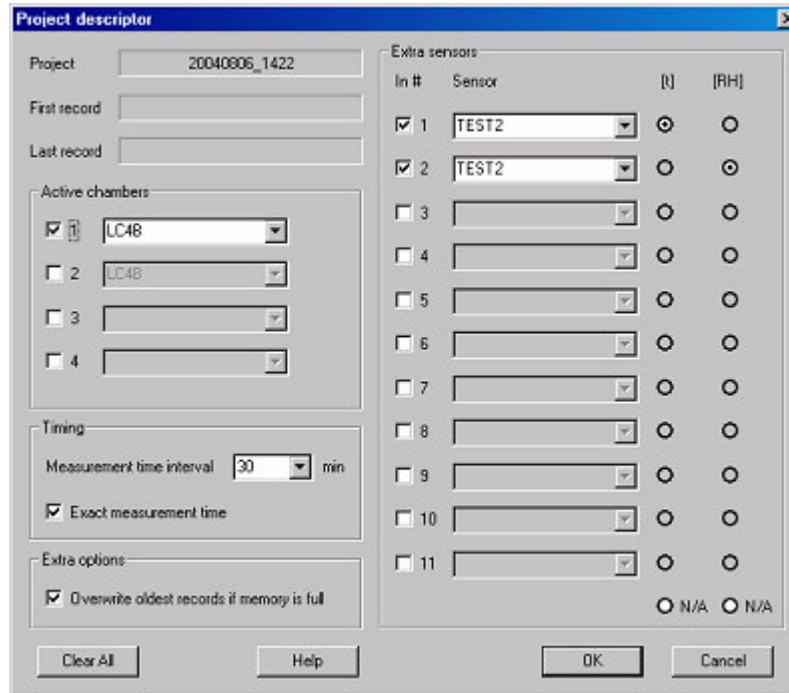
Opening and closing a measurement session

The PM-48M Photosynthesis Monitor logs data in a named data file created by a user. A separate measurement session and an associated data file are determined under the common Project name.

To create a new project, follow these steps:

1. In the menu, select the Project | Open/New option. You will see a list of Projects.
2. Click New button and enter a desired name of the new Project. By default, the program offers the name composed as a start date and time: YYYYMMDD_TIME. For instance, 20040716_1418 means that Project starts at 14:18, July 16, 2004. You may type in another name of the project as well.
3. Click OK.
4. In *Project descriptor* window, select required options and setting.





At first, select the *Active chambers* channels and chambers types.

5. Enter the required *Timing values* of the measurement cycle.

Measurement time interval

Includes exhaust time, reference time, exposition time and pause.
By default: 30 min.

Exact measurement time

In case of selected *Exact measurement time* checkbox, the system starts measurement cycles in round points of time. For instance, if you initiate the system at 9:37 and the *Measurement time interval* is 30 minutes, the system starts at 10:00, then 10:30, 11:00, 11:30, etc. If the checkbox is blank, the system starts immediately, and measurement time will be 9:37, 10:07, etc. It is recommended to select this checkbox.
By default: on.

6. *Extra options*

Overwrite oldest records

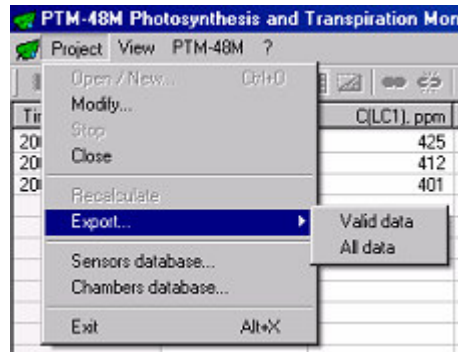
The *Overwrite oldest records if memory is full* checkbox determines the behavior of the system in case of memory overflow. The maximal number of readings, which can be stored in the system memory, is 240. If the cycle time is 30 minutes, the memory will be filled up during 120 hours or 5 days. Please note that it may happen only if you never downloaded the data from the system to your PC during this period. After each data downloading, the memory is cleaned and it can accumulate another 240 readings.

If you select this checkbox, the system will continue data logging even with full memory. The new data replace the oldest ones.

In case of blank checkbox, the system stops data logging when memory is full and switches to Pause mode. In this case, the general alarm indicator lights up. This mode is recommended because of common assumption that absence of data downloading sessions associates with unforeseen lack of maintenance and, therefore, it is better to stop the system operation and to save the data.

7. Enter the connected optional sensors in the *Extra sensors* panel. Select an input and choose appropriate sensor from the list.
8. Select temperature [t] and relative humidity [RH] sensors for the calculating [VPD](#) and [Tr corr.](#)
9. Click OK, when finished.
10. If PC is not connected to PTM-48M software will offer to connect.

To close the current project in your PC, select Project-Close option in the menu. However, all information about the project is still saved in the system memory. In order to stop the project completely and to clean the system memory, click Stop button or select Project-Stop option. The system must be on-line when executes this command.



Project | Open / New | Open

opens Project descriptor of the project selected in the Projects window. A project may be deleted, if necessary, by clicking Delete.

Project | Modify

allows making changes in project configuration.

Project | Stop

stops measurement session of the project.

Project | Close

closes data file, associated with the selected project.

Project | Recalculate

allows recalculating the recorded data in case of modification of sensors calibration data.

Project | Export

creates a data file with *.txt or *.csv format, for importing to Excel or other data processing software.

All data exports all the data;

Valid data exports data marked by asterisk (conditionally rejected)

On-screen indications

Control panel

Control panel represents the pneumatic diagram of the system.

It contains the following **LED indicators and control buttons:**

Automatic Mode

the system operates in automatic mode. Manual controls are disabled.

Manual Mode

the system operates in manual mode. All manual controls are enabled. Data logging is stopped.

Alarm

emergency stop in Automatic Mode.

Channel 1 ... Channel 4

active air sampling channel.

Pump

pump on/off indicator.

REF (Reference)

reference values are measured (Leaf Chamber is open).

LC (Leaf Chamber)

leaf values are measured (Leaf Chamber is closed).

Air Flow Meter Alarm

the readings of the Airflow Meter are out of the normal range.

CO₂ Analyzer Alarm

error message, generated by the CO₂ Analyzer.

Buttons:

Mode

Manual / Automatic mode switch.

Channel 1 ... Channel 4

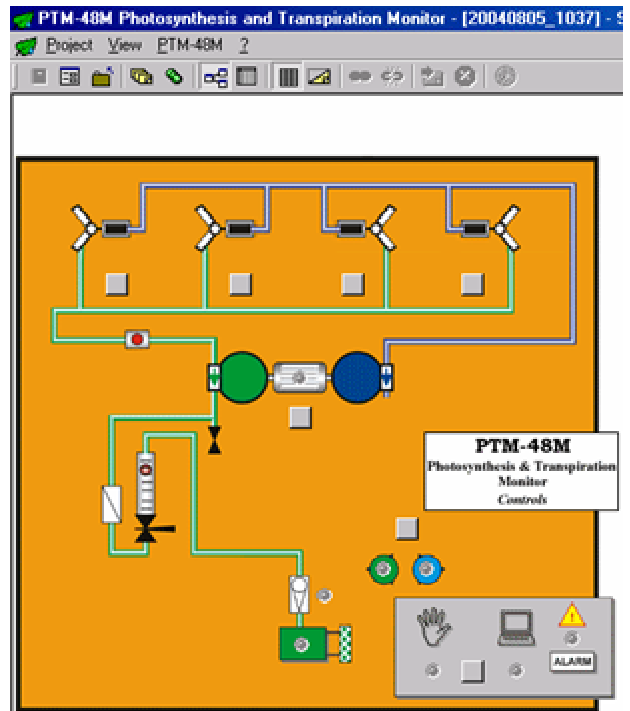
channel switch.

Pump

pump on/off switch.

LC / REF (Leaf Chamber / Reference)

data source selection.



Operation mode

Param	Value
Current Time	11.08.04 10:21:33
PTM-48M	ON-LINE
GA Status	Measure
Mode	Auto
Cycle Phase	Ch 1 - Reference
Recording State	ON

The *Operation mode table* is located at the right lower corner of the screen. It includes the following rows:

CURRENT TIME

PTM-48M ON LINE/OFF LINE

connection status between the system and a PC.

GA STATUS

status messages, generated by CO₂ Analyzer: INITIALIZATION, WARMING, ZERO, etc.

MODE

MANUAL/AUTO

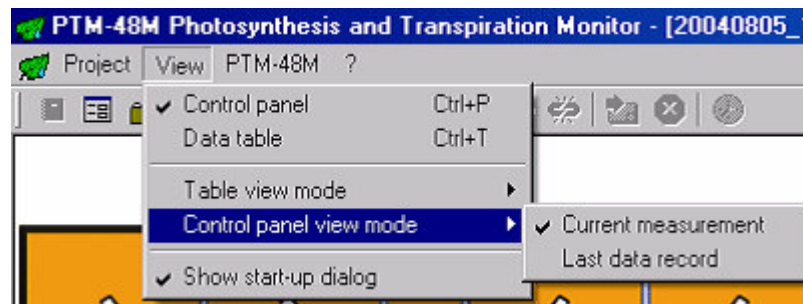
CYCLE PHASE

EXHAUST, REF1, LC1, REF2, ... LC4, PAUSE.

RECORDING STATE

ON/OFF, alarm cause: MEMORY FULL, etc.

The upper table can be selected from two available: *CURRENT MEASUREMENT* or *LAST DATA RECORD*. Select a required table in *View* menu.



CURRENT MEASUREMENT

represents current readouts of all measuring channels. Updated every second.

Current measurement

Param	Value	Units
CO2 Concentration	349	ppm
Atm. Pressure	1018	mb
Abs. Humidity	13.53	g/m3
Air Flow	0.97	lpm
S1 (Air Temp.-ATH-3T)	22.9	C
S2 (Rel.Hum.-ATH-3H)	57.4	%RH
S3 (Tot. Irrad.-TIR-4)	401	W/m2

LAST DATA RECORD

represents the last record in the database.

Last data record

Param	Value	Units	
Time	2004-07-13 17:15		
C(Ref1)	343	ppm	
CO2 Exch1	1.67	mcmol/m2*s	
H(Ref1)	13.69	g/m3	
Tr(1)	12.2	mg/m2*s	
S1 (Air Temp.-ATH-3T)	22.8	C	
S2 (Rel.Hum.-ATH-3H)	58.1	%RH	
S3 (Tot. Irrad.-TIR-4)	206	W/m2	
S1 (ATH-3T)	16.1		
S2 (ATH-3H)	86.2		
S3 (TIR-4)	*0		

In Pause mode (Pump off) there are no records in the table which are related to air analysis (concentration, airflow, pressure).

Select DATA TABLE in *View* menu to open the data file for viewing.

Viewing data file

Each column contains data corresponding to a specific characteristic or parameter. Each row contains readings corresponding to a time of a record.

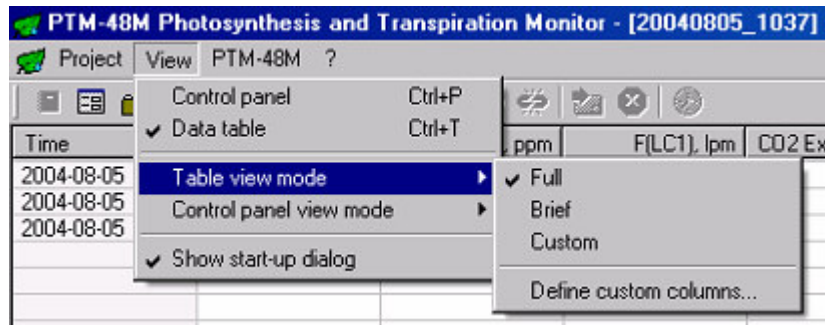
Every row includes:

- Time of data filing (recording) - cycle start time.
- C(Ref#) - Reference CO₂ concentration (Leaf Chamber is open) - channel #.
- C(LC#) - Leaf Chamber CO₂ concentration (Leaf Chamber is closed) - channel #.
- F(LC#) - Airflow rate in Leaf Chamber - channel #
- CO2 Exch# - CO₂ exchange rate - channel #
- H(Ref#) - Reference absolute humidity (Leaf Chamber is open) - channel #.
- Tr(#) - Transpiration - channel #
- S# - Readings of extra sensors
- Atmospheric Pressure

The following additional calculating values are present if temperature and relative humidity sensors are selected in the current Project:

- VPD - Vapour Pressure Deficit.
- Tr corr(#) - Calculated transpiration value at the assumption, that humidity of air in the chamber is equal to humidity of air outside of the chamber.

There are three modes of data table view:



Full

includes the following columns:

- Time of data filing (recording)
- C(Ref#) - Reference CO₂ concentration (Leaf Chamber is open) - channel #.
- C(LC#) - Leaf Chamber CO₂ concentration (Leaf Chamber is closed) - channel #.
- F(LC#) - Airflow rate in Leaf Chamber - channel #
- CO₂ Exch# - CO₂ exchange rate - channel #
- H(Ref#) - Reference absolute humidity (Leaf Chamber is open) - channel #.
- Tr(#) - Transpiration - channel #
- S# - Readings of extra sensors

Brief

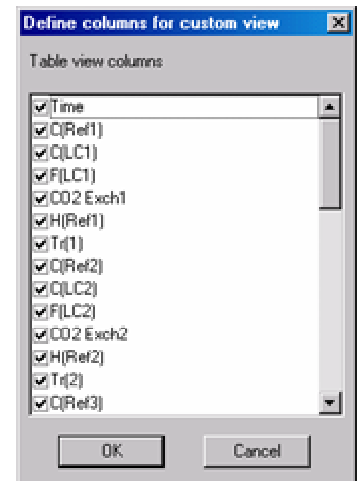
includes the following columns:

- Time of data filing (recording)
- C(Ref1) - Reference CO₂ concentration (Leaf Chamber is open) - channel 1.
- CO₂ Exch# - CO₂ exchange rate - channel #
- H(Ref#) - Reference absolute humidity (Leaf Chamber is open) - channel #.
- Tr(#) - Transpiration - channel #
- S# - Readings of extra sensors

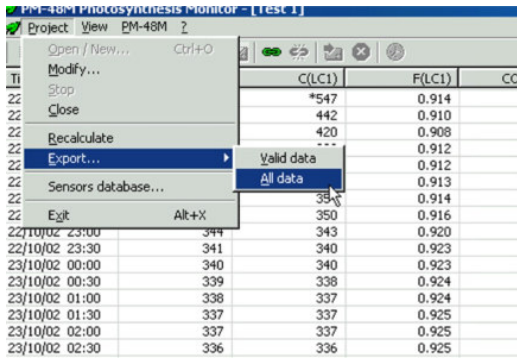
Custom

includes columns selected by a user in Define columns for custom view (*View / Table view mode* menu)

Some of the data may be marked by asterisk. Those values are rejected because there was no steady-state reading of CO₂ Analyzer or Humidity sensor at the moment of measurement or extra sensor reading is out of bounds.



Export data file for further processing



	C(LC1)	F(LC1)	CO ₂
	*547	0.914	
	442	0.910	
	420	0.908	
	...	0.912	
		0.912	
		0.913	
		0.914	
		0.916	
		0.920	
		0.923	
		0.923	
		0.923	
		0.924	
		0.924	
		0.925	
		0.925	
		0.925	

1. Open the data file view (View-Data table)
2. Select Project-Export submenu. Choose between two options:
 - To export all data in the data file;
 - To export the valid data only. The records with asterisk (see above) will be excluded.
3. Choose the file format. Two formats are available: *.txt and *.csv. Name and save the file.

Terminal Emulator

To learn more about the Terminal Emulator read the help file associated with the program.

Specifications

Number of leaf chamber inputs: 4

Leaf chamber area: 20 cm²

Leaf chamber type: pneumatically powered, normally open

Hose connection: 4 mm (inner diameter)

CO₂ measurement principle: non-dispersive infrared analyzer (SBA-4, PPSystems, USA)

CO₂ concentration measurement range: 0-1000 ppm

Signal noise: 2 ppm pk-pk @ 350 ppm (with signal averaging)

H₂O measurement principle: integrated air temperature and humidity sensor (SHT75, Sensirion AG, Switzerland)

Air temperature measurement range: 0 to 50 °C

Repeatability: ± 0.1 °C

Air relative humidity measurement range: 0 to 100 % RH

Repeatability: ± 0.1 % RH

Air flow measurement range: 0.1 to 1.0 LPM

Accuracy: ± 0.02 LPM

Normal range of airflow rate in the air measurement channel: 0.8 to 1.0 LPM

Rated measurement range of CO₂ exchange: -20 to 20 μmolCO₂m⁻²s⁻¹

Rated measurement range of H₂O exchange: 0 to 50 mgH₂O m² s⁻¹

Number of inputs for optional sensors: 11

Input range: 0 to 2 Vdc

Sampling rate: 15, 30, or 60 min (selectable)

Duration of active measurement cycle (when leaf chamber is closed): 30 s

Power supply for optional sensors: +15 Vdc, -15 Vdc, and +5 Vdc @0.3A

Power requirements: 220/110/100 VAC; 50/60 Hz@150W.

Interface: RS232 and RS485 (optional).

Terminal Emulator software for Windows 98,2000,ME and XP.

Specifications are subject to change without notice

Maintenance

Objects of routine inspection

1. Airflow rate in sampling channel. Adjust if required.
2. Color of the absorber in the absorber column. This absorber should be replaced when it is two-thirds exhausted (brown).
3. Air filters clogging. Replace filter when required.
4. Transparency of leaf chamber windows. Clean when required by soft brush or tissue.

Failure to comply with these instructions may result in system malfunction.

The inspection points are marked on the Control panel and labeled on the System console and leaf chambers.

CO₂ Absorber and Air Filter



Both Air filter and CO₂ Absorber column are located at the front side of the System console (see Page 3).

For CO₂ Absorber column:

1. Check the color of the absorber.
2. If about two-thirds are brown, go to the next step.
3. Switch the pump off.
4. Remove the clamp.
5. Pull out the tube
6. Replace absorber medium according to the instruction below and then put the column back.

For Air filter:

Replace the Air filter when required to avoid clogging.

The following Section is quoted from the SBA-4 Operator's Manual (Version 1.0, ©2000 PPSystems, UK)

Absorber Column

We recommend monthly inspections of the absorber column foam pads, filter disks and "O" rings. Also check for cracks on the clear plastic column itself. The absorber column is fitted with 2 black end caps containing 2 white plastic disks, 2 "O" rings and 2 foam pads at each end. The black end fitting(s) can then be removed and the contents emptied when required. Columns are fitted with foam pads at each end to stop the contents spilling out if the ends are inadvertently pulled off during removal. When replacing the contents, the columns should be tapped to ensure tight packing and the foam replaced as found. The "O" rings on the end fittings should be occasionally lightly smeared with silicone grease to aid ease of fitting.

Take care when replacing the end fittings as the "O" rings can roll up and out of the groove.

This will give rise to leaks and the SBA-4 will not work properly.

There can be a very tight fit between the tubes and end fittings. Pushing the end fittings on without proper care can cause the absorber column to crack. Again this will allow air to leak in and out of the column.

It is sensible to examine the absorber column each time the contents are replaced as any leakage of ambient air into the gas circuit generally causes errors during "Autozero" operation or fluctuating reference CO_2 concentration during measurement.

There are three items that should be checked after re-filling a column:

Absorber Column Foam Pads

The foam pads become worn over time and should be inspected regularly and replaced when torn or reduced in size. The foam must be open cell type, such as packing foam.

Absorber Column Filters

Each absorber column black end cap contains a white plastic filter disk. Generally these do not need to be replaced. However, they must be present to prevent any of the column contents being drawn with the gas stream into the instrument.

Absorber Column "O" Rings.

The "O" Rings on the end caps of the columns should be very lightly smeared with silicone grease to aid

ease of fitting and improve the seal. Once sealed, end fittings should be checked to ensure that the O-rings

are seated correctly in their groove and that they are not trapped or pinched.

There is also a small "O" ring on each of the absorber end cap fittings. These should be in good condition. Replacement "O" ring and filter sets can be ordered from PP Systems if required. See figure below for location of "O" rings and foam pads. The white plastic filter disks are located on the black end caps inside the absorber column.

Soda Lime

Soda Lime is supplied as self-indicating granules (1-2.5mm) which turn from green to brown as it becomes exhausted. This desiccant should be replaced when it is two-thirds exhausted (brown). Soda Lime cannot be regenerated and should be discarded when exhausted. Frequent replacement should not be required under normal circumstances. The amount of change is highly dependent on the "Auto-Zero" frequency and flow rate. Under normal operating conditions, this desiccant is changed approximately 1 time per month.

For accurate measurements and calibration, it is absolutely critical that the SBA-4 absorber column is not exhausted. If the soda lime is becoming exhausted, it will cause the ZERO to be performed on non-ZERO air causing an error in the calibration.

! CAUTION !

**WASH YOUR HANDS AFTER HANDLING SODA LIME
MATERIAL SAFETY DATA FOR SODA LIME**

MATERIAL SAFETY DATA FOR SODA LIME

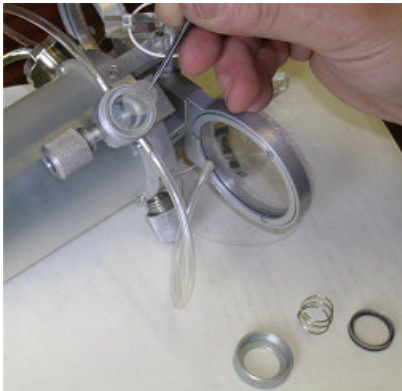
CHEMICAL COMPOSITION	
Components	% W/W
Calcium Hydroxide	(Ca(OH) ₂) > 75.5%
Sodium Hydroxide	(NaOH) < 3.5%
Water	< 21.0%
Indicator (Inorganic Salt)	< 0.2%
PHYSICO-CHEMICAL DATA	
Form	Granules
Color	Green (Exhausted : Brown)
Odor	None
Bulk Density	0.9 g/cm ³
Solubility in Water	None
pH in Water	12-14
Incompatible Substances	Acids, Chloroform, Trichlorethylene
Hazardous Decomposition	
Products	None
PROTECTIVE MEASURES, STORAGE AND HANDLING	
Storage Conditions	Clean dry environment
Preferred temperature range	0 - 35 °C. Store away from direct heat/sun.
Protective Measures	Avoid inhaling dust. Wash hands after handling
Industrial Hygiene	Keep containers closed. Keep contents dry.
MEASURES IN CASE OF ACCIDENTS AND FIRES	
Spillage	Contain material. Sweep or vacuum up. Transfer solids to metal or plastic container for disposal. Wash down spillage with water.
Suit. Extinguishing Media	Water, CO ₂ , Powder, Foam, Halon.

FIRST AID	
Inhalation	Remove from exposure. Obtain medical attention if discomfort persists.
Skin Contact	Drench with clean water. Obtain medical attention if skin becomes inflamed.
Eye Contact	Irrigate thoroughly with clean water. Obtain medical attention.
Ingestion	Wash out mouth thoroughly. Drink water. Obtain medical attention.
HAZARD LABELLING	
Transport Codes	None required.
Hazard Classification	None.

Contact Information on CO₂ Absorber

PP Systems PP Systems
 241 Winter Street Unit 2, Glovers Court, Bury Mead Road
 Haverhill, MA 01830 U.S.A. Hitchin, Hertfordshire, SG5 1RT, U.K.
 Tel: +1 978.374.1064 Tel: +44 (0) 1462.453411
 Fax: +1 978.374.0972 Fax: +44 (0) 1462.431090
 Email: support@ppsystems.com

Leaf Chamber Filter



1. Check visually the state of the net filter. In case of clogging (dust, particles), go to the next step
2. Open a screw-top
3. Take out the net and remove foreign particles. Wash the net in the mild solvent if required.
4. Replace the net filter and the screw-top. Screw on tight!

CONTACT INFORMATION

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