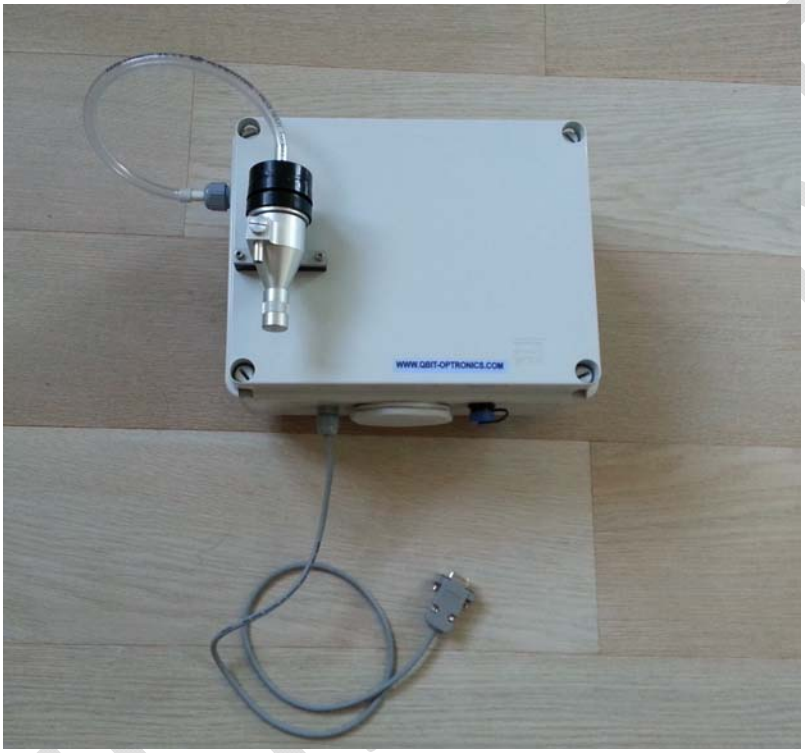
LCT-12N

INSTRUCTION MANUAL



NOTICE

The functionality of the instrument may be impaired if the system is used in a manner not specified in this manual.

NOTICE

The present manual is an accessory part of the LCT-12N. Please retain these instructions for future reference.

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GENERAL NOTICES

QBIT s.r.l. is responsible of safety, reliability and performance only if:
. the system is used according to the instructions reported in this manual – regarding both safety precautions and use;
. any change, adjustment and maintenance operation is performed by qualified personnel duly authorized by QBIT s.r.l. ;
. the instrument is connected to an electrical system which is consistent with both IEC and local directions;

The system LCT-12N is a Particulate Matter (PM) detector. The field of use is air quality monitoring, in industrial plants, working stations or residence buildings.
It may be used both in "indoor" and "outdoor" applications. In the latter case, it must be placed in protected areas, in order to prevent exposure to strong rainfall, snow or hail.

FOREWARD

The following instructions must be carefully read and observed in order to properly install the system and avoid any damage risk.

1. UNPACKING AND INITIAL CHECKS

When you receive the instrument, please unpack it promptly and make a visual inspection to make sure that no damage has occurred during shipment and that all the ordered items have been received. If damage was found, immediately file a claim with the carrier.
N.B.: by law, any good is shipped at buyer's risk and, if not clearly stated, without insurance.
QBIT is not responsible of any damage following dispatch, freight, unloading and unpacking.

2. OPERATION ENVIRONMENT

The operation environment must be consistent with local directives regarding the electrical system and human working area.

3. LIABILITY

The LCT-12N system is an OEM device, to be included in a complete measurement station (produced for final user). It has been designed following high quality standards. Anyway, consistency with European Directives (e.g. Electromagnetic Compatibility or Electrical Safety) is required for the measuring apparatus produced for final user.

The responsibility of use, safety in the working area and any other action rests entirely with the employer, following local laws and European Directive N° 89/391/CEE.
The manufacturer is not responsible for any impairment due to installation, use and maintenance not consistent with the instructions reported in the present manual.
The manufacturer is not responsible for the lack of any care and safety precaution necessary to avoid every damage or prejudice.

4. WARRANTY

QBIT s.r.l. warrants that, at the time of delivery, this product is free from defects or malfunctions, and it conforms substantially to the specifications reported in the present manual. QBIT's liability is limited to the repair or replacement, at QBIT's option, of this product or parts thereof returned to seller and shown to QBIT's reasonable satisfaction to have been defective; provided that written notice of the defect shall have been given by Buyer to QBIT within one (1) year after the date of delivery of this product by QBIT.

The warranty does not apply to parts the instruction manual designates as having a limited shelf-life or as being expended in normal use (e.g. filters).

Excepting those parts subject to maintenance, disassembly, change or modification to the instrument will void the warranty. Any control, adjustment or procedure different from those reported in the present manual will also void the warranty.

CHAPTER I

SAFETY

Safety is essential in the use and maintenance of the equipment. Therefore the present chapter provides important safety information concerning the operation and maintenance of the system.

I.1. SAFETY PRECAUTIONS

Even if the system has been produced in agreement with safety directives, a proper and careful use is very important for safe operation.

IN ORDER TO CORRECTLY OPERATE THE SYSTEM, IT IS STRICTLY REQUESTED TO FOLLOW THE SPECIFICATIONS REPORTED IN THE NEXT PARAGRAPHS.

I.1.1. Instrument safe location:

Locate the equipment on a flat surface, far from heat sources or strong air flows. For the best operation in outdoor applications, the instrument should be placed in protected areas, in order to prevent exposure to strong rainfall, snow or hail. During summer at noontide, it is suggested to avoid exposure to direct sun light.

I.1.2. DC power:

The LCT-12N should be connected to a standard low voltage DC power supply (12/24 Volts).

I.1.3. Proper use:

Do not operate this instrument in the presence of flammable liquids, vapors or aerosols.
Both when the equipment is working and when it is not in use, avoid to lean the instrument on the floor, or anywhere it risks to be hit, crushed and thus damaged.
During system operation avoid to obstruct the cyclone inlet.
CAREFULLY PREVENT ANY LIQUID TO BE SUCKED UP IN THE CYCLONE FILTER;THE INSTRUMENT MAY BE SERIOUSLY DAMAGED.

I.1.4. In case of malfunction:

Do not continue to use this equipment if there are any symptoms of malfunction or failure. In the case of such occurrence, unplug the DC power cord, refer to Chapter VI of the present manual and contact technical service.

I.1.5. Cleaning:

Use a dry cloth to clean the outside of the case. Do not use soap and water. Do not use blast of compressed air.
When the system is not in use, it is suggested to set the equipment in a dry, dust free place.

CHAPTER II

SPECIFICATIONS

II.1. OPERATING PRINCIPLE

The Particulate Matter (PM) monitor system LCT-12N by QBIT is based on "Laser Scattering" principle. A sample of air flows through an optical cell, and the laser light scattered by micron-sized particles is measured. This system allows to reconstruct a real-time estimation of the PM present in the sampled air. Anyway, this quantity is not a direct measurement of the PM weight. The amount of scattered light is proportional to PM density, given certain physical, chemical and granular properties of the PM itself. The obtained optical signal is then to be calibrated with reference to a primary system which correctly measures the PM mass. Consequently, in order to guarantee the best accuracy, air sampled during calibration should be as similar as possible to that surrounding the measuring station.

II.2. ACCURACY AND RESOLUTION – Table II.1

Quantity	Value	Units	Notes
PM signal resolution	1/4096	full scale	(1)
PM signal accuracy	<1%	full scale	full range of measurement times (2)
Maximum PM range	10000	$\mu g/m^3$	factory adjustable (3)
Temparature resolution	0.01	°C	
Temperature accuracy	0.3	°C	(4)
Pressure resolution	0.01	kPa	
Pressure accuracy	0.5	kPa	
Relatve humidity resolution	0.04	%	
Relative humidity accuracy	+/- 2	%	20% < R. H. < 80%

(1) As previously specified, PM resolution and accuracy refer to the optical signal produced by the scattered light. The corresponding specs in terms of PM mass are derived from a calibration process affected by the properties of PM itself (carbon based dust produced by heating - typical of winter season – gives a conversion coefficient larger than that of silicon based dust – summer season).
Thus it is important to compare the measurements in a given place and time interval with a gravimetric instrument (primary system).

(2) The longer the measurement time, the higher the accuracy will be. With measurement interval larger than 10 seconds, the accuracy may be better than 10^{-3}.

(3) The factory selected standard range corresponds to 1500 $\mu g/m^3$ full scale. Following (2), this implies a sensitivity better than 2 $\mu g/m^3$ with measurement interval lasting 10 seconds or more.

(4) Temperature, pressure and RH measuring head is optional.

II.3. GENERAL SPECIFICATIONS – Table II.2

Quantity	Value	Units	Notes
Supply voltage	12/24	V_{dc}	From 220 V_{ac} power supply or battery
Average power absorption	<5	W	2.2 l/min flow rate
Peak power absorption	15	W	During calibration, with 3 l/min flow rate
Flow rate range	0 - 3	l/min	SW Adjustable
PM2.5 cyclone flow rate	2.2	l/min	Factory adjusted
PM10 cyclone flow rate	1.6	l/min	Factory adjusted
Measurement interval	1-120	sec	SW adjustable
Calibration interval	1-600	min	SW adjustable
Single measure dimension	64	Byte	
Dimensions	25x20x10	cm	
Weight	2	Kg	

II.4. TECHNICAL TERMS

MAIN UNIT: main case equipped with 12/24V DC input connector.

POWER SUPPLY/BATTERY CHARGER: external 220 Vac power supply, with two color led and connection for main unit and battery (optional).

CYCLONE FILTER: PM inertial selector at the air inlet. Plastic material for PM2.5, aluminum for PM10.

II.5. DISPOSAL

At the end of lifetime, the system is to be disposed as electronic material, following European Directives 2002/95/EC e 2003/108/EC. The Buyer will contact QBIT s.r.l. to get any instruction about disposal or return of the equipment.

CHAPTER III

FUNCTIONAL OVERVIEW

The system LCT-12N is a device for real-time detection of Particulate Matter (PM- also called micro-dust) which allows air quality control. The instrument is based on an optical measurement. A sample of air flows through an optical cell, and the laser light scattered by micron-sized particles is measured. Without input pneumatic filter, the LCT-12N is sensitive to any kind of fine dust (with dimensions ranging from fraction of micron to some tens of microns). The class of detected PM (typically PM2.5 or PM10) then depends on the selecting input filter placed at the sample air inlet. The LCT-12N adopts cyclone filters (inertial selection principle). The state-of-the-art detection method, based on laser light scattering, leads to high sensitivity, short response time, reduced ownership costs and long lifetime.

The system consists of a main box and a group of accessories, depending on the chosen configuration. The case may be powered from different sources (AC line, batteries and also photovoltaic units). Through USB, RS232 or Blue-Tooth interfaces it may be connected to several control devices: computer, tablet or smartphone.

The LCT-12N is excellent for any application in air quality control, and for installation and maintenance of large industrial plants. In these fields, the LCT-12N allows monitoring of dust emissions, thus contributing to the control of environmental pollution.

III.1. MAIN UNIT

In Fig. III.1 the main box (standard configuration) is shown. The PM10 cyclone selector is mounted on the left side. In the bottom side from left to right: the RS232 cable, the Gore-Tex fitting for internal volume compensation and the plug connector of DC power supply.

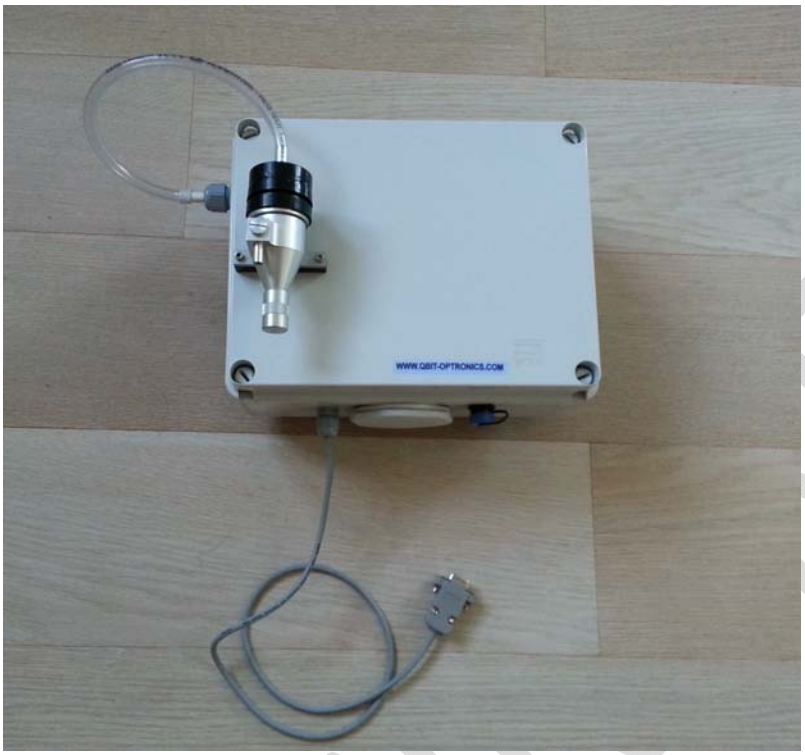

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Figure III.1. Main unit. In this figure is shown the LCT-12N in standard configuration, with PM10 cyclone filter and RS232 interface.

III.2. CYCLONE FILTER

The LCT-12N system is designed for automatic PM measurement and presents few external connections. On the left side of main unit there is the sample air inlet. It is connected by a soft tube to the cyclone filter placed on the front face.

Figure III.2. Cyclone filter (PM10).

Figure III.2 shows the cyclone filter mounting details. The filter is secured to the mounting bracket with the M3 screws indicated by white arrows. It is connected to the main unit with a soft tube (6 mm internal diameter) as shown by red arrows.

III.3. ELECTRICAL CONNECTIONS

The next step consists in connecting the RS232 cable (green arrow in Fig. III.3) to the control unit, PC or any microprocessor interface board. The power plug (12 V_{DC} o 24 V_{DC}) is indicated in the figure with the yellow arrow. The DC external power supply should satisfy the following specs. Current availability: 1.5A (@12V) or 0.75A (@24V); residual ripple max 10mV. In Figure III.3 is also shown the internal air compensation fitting. It consists in a Vent-Gore protected with Gore-Tex that both allows the air exchange and avoids penetration of micro-sized water droplets.

Figure III.3. Electrical connections.

III.4. ACCESSORIES

In Figure III.4 the $LiFePO_4$ (24 V – 5Ah) battery is shown. It allows system operation for more than 15 hours in standard conditions (air flux set to 2.2 l/min for PM2.5 selector).
The battery box presents two connectors; the first to be connected to main unit, the second to be connected to the charger. Thus, the LCT-12N can be supplied also by the AC 220V line, through the battery and the charger. In such configuration the measurements continue in presence of black-out, thanks to the battery. Anyway, it is always suggested to start measurements with fully charged battery.

Figure III.4. Battery and battery charger.

III.5. MANUAL

The present operating manual is an accessory of LCT-12N. Retain these instructions for future reference. Electronic version of any technical document is also available at the URL www.qbit-optronics.com/ .

CHAPTER IV

PREPARING FOR OPERATION

NOTICE:

ANY CONTROL, ADJUSTMENT OR PROCEDURE DIFFERENT FROM THOSE REPORTED IN THE PRESENT MANUAL MAY CAUSE ERRORS AND/OR INSTRUMENT IMPAIRMENT.

IV.1. LOCATION

Locate the equipment on a flat surface, far from heat sources or strong air flows. For the best operation in outdoor applications, the instrument should be placed in protected areas, in order to prevent exposure to strong rainfall, snow or hail. During summer at noontide, it is suggested to avoid exposure to direct sun light.

IV.2. INITIAL OPERATION

Unpack the instrument and accessories. Connect the RS232 cable to a PC and the power connector to a DC 12/24 V power supply. Let the system supplied until the battery (if present) is fully charged (the led light on the battery charger switches from red to green).

NOTICE

Do not operate this instrument in the presence of flammable liquids, vapors or aerosols.
Both when the equipment is working and when it is not in use, avoid to lean the instrument on the floor, or anywhere it risks to be hit, crushed and thus damaged.
During system operation avoid to obstruct the cyclone inlet and the sample air exhaust on the rear panel.
CAREFULLY PREVENT ANY LIQUID TO BE SUCKED UP IN THE CYCLONE FILTER;THE INSTRUMENT MAY BE SERIOUSLY DAMAGED.

IV.3. MOUNTING BRACKETS

The instrument is equipped with two mounting brackets on the rear face of the main box (Figure IV.1). They allow fixing the LCT-12N without opening the sealed box. Opening the sealed box by non authorized people may cause serious damage to the instrument and will immediately void the warranty.
Mounting brackets may be released by un-screwing the external nuts. Do not release the internal nuts that fix the bolts to the box.

Figure IV.1. Mounting brackets.

CHAPTER V

SYSTEM FUNCTIONALITY

V.1. CYCLONE FILTER MOUNTING

The class of detected PM (PM2.5, PM10) depends on the selecting input filter placed at the sample air inlet. The LCT-12N adopts cyclone filters (inertial selection principle) that are calibrated for a given air flow rate, so that heavier particles are not allowed to enter the measuring chamber. Although the correct flow rate is factory adjusted, the user is committed to change this setting (both in case of any flow derating and if a different input filter is adopted) by using the software commands described later in this manual (V.5.3).

For the correct mounting, fix the cyclone filter to the main box by the two M3 screws shown by white arrows in Figure III.2. The soft plastic tube should be connected to the filter and to the main case, respectively (Fig. III.2, red arrows).

V.2. ELECTRICAL CONNECTIONS

V.2.1. DC power supply

The link to an external DC power supply is obtained through the male and female black/blue connectors, tightening the safety nut (Fig. III.3, yellow arrow). .

V.2.2. External battery

When an external battery is present, connect it to the case through the black/blue connector. The battery may also be powered by means of the battery charger (Figure III.4).

V.2.3. RS232 interface

Connection to an external control and data acquisition unit is performed by the RS232 cable indicated by the green arrow in Fig. III.3. The serial port is configured for a 9600 baudrate protocol: (9600,8,N,1). Data and commands are in ASCII standard format.

V.3. MAIN UNIT TURN-ON

The LCT-12N is software configured to start measurements automatically as soon as power is turned on (also in case of black-out). Initially the instrument performs a reset procedure followed by some hardware and software functional tests; the message “rok” confirms that no errors have been detected.
Next the LCT-12N starts working automatically, performing real-time PM concentration measurements and calibration cycles (that is auto-zero detection over a filtered and clean air sample).

V.4. AUTOMATIC MEASUREMENT MODE

At the beginning of automatic measurement mode the LCT-12N sends few messages (“startok” followed by the serial number and FW release) and performs the first calibration cycle. Next measurements are automatically produced (in the format “PM: <Value>”) .
Here below is reported a typical record:

```
********************************************************************************
rok
startok
1D-019
Rel 1.04 - 02/10/2016
c..cok
PM:    5.6
PM:    5.0
PM:    3.8
PM:    1.8
PM:    1.9
PM:   10.8
PM:  120.1
PM:  155.0
PM:  163.0
PM:   69.9
PM:   46.7
PM:   39.5
PM:   41.8
PM:   59.8
PM:   68.4
PM:   77.7
PM:   77.0
. . . . . .
PM:   18.7
PM:   17.2
PM:   15.9
PM:   16.5
PM:   18.1
PM:   15.7
PM:   17.3
PM:   19.9
PM:   23.8
c..cok
PM:   14.5
PM:   13.6
PM:   14.9
PM:   14.3
PM:   14.6
PM:   10.7
```

```
PM:   10.2
PM:   10.8
PM:   11.4
PM:   12.4
PM:   12.3
PM:   12.7
PM:   13.7
PM:   14.6
PM:   14.6
PM:   15.0
......
*************************************************************************
```

In correspondence with "c..cok" messages, the instrument performs auto-zero measurements on filtered and clean air sample, in order to re-calibrate the laser signal.
The measurement time interval is usually factory set to 10 sec, while calibrations (lasting 3 times the measurement, that is 30 seconds) are performed every 10 minutes.
All these time settings can be changed by the user following the simple software commands described in the next paragraphs.

V.5. SOFTWARE COMMANDS

All software commands to control the LCT-12N by the interface are described in this section. The user may set the measuring time intervals, as well as change functional and calibration parameters. Any command sent to LCT-12N by the interface should be ended by <CR> <LF> ("Carriage Return" & "Line Feed"). This is done with the "enter" key if commands are sent from a PC keyboard with a "serial terminal" kind program (for example SimpleTerm). If an external micro-processor board is used to control the LCT-12N, <CR> <LF> should always be used to end any command string.
In the following description of software commands, it will be avoided to repeat such requirement; the user is informed that any command will be accepted by the instrument on <CR> <LF> arrival.

V.5.1. *"stop" command*

The ASCII string "stop" is used to turn off the automatic measurement mode. **During the automatic measuring mode the LCT-12N is ready to accept only the "stop" command and it will ignore any other string from the external control unit.**
When the "stop" command is sent, the instrument concludes the last operation (measurement or calibration) and it stops with the acknowledge answer "**stopok**".
After such message the user is allowed to interact with the LCT-12N and change settings and working times with the commands described in the following.

V.5.2. *"pon / poff" commands*

The two commands "pon" and "poff" allow the user to turn on and off the pump, respectively. When the pump is on, it is possible to calibrate the air flow with the help of any external meter connected to the main box air inlet. This operation is required if a different input filter (cyclone or impactor) is used. Unplug the soft plastic tube from the main box air inlet and connect a flow-meter in the range 0-4 l/min. Follow the instructions of the following command to set the correct flow value suited for the selected filter.

V.5.3. *"speed / speedc" commands*

The "speed" and "speedc" commands allow to set the pump speed during PM measurements and calibration, respectively. These commands have the same syntax that is here described for the "speed" command only.

When sending the command "speed", the LCT-12N answers "speed XX", XX being the present value of the pump speed during measurements (XX represents the percentage of the maximum pump speed, and thus is in the range 0 – 100). In order to modify this value, the user should type "speed VAL" (speed <space> VAL), VAL being the new setting (again in percentage of the maximum speed). The new flow rate is to be verified with an external flow meter and it depends on the instrument and on the length and dimension of the tube used to connect the LCT-12N and the filter (Fig. III.2 red arrow).

The setting of the pump speed during calibration ("speedc" command) is used to obtain an optimal cleaning of the laser scattering cell, especially if the flow in measuring mode is small. It is generally suggested to calibrate with the same pump speed as used in measurement, whenever the pump speed exceeds 40% of the max. This reduces pressure transients when switching from measurement to calibration and vice versa. On the contrary, do not reduce below 40% the pump speed in calibration when in measurement a lower value is set. This is suggested to obtain an optimal cleaning of the interaction cell during calibration.

If the cyclone filter is supplied by QBIT, the LCT-12N flow rate is factory set. In case of PM10 cyclone by QBIT, the required flow rate is 1.6 l/min, and it is obtained with pump speed in the range 30% ÷ 35%. In case of PM2.5 cyclone by QBIT, the required flow rate is 2.2 l/min, and it is obtained with pump speed in the range 40% ÷ 45%. If a different filter is adopted, the flow rate should be properly tuned.

V.5.4. *"timing" command*

The "timing" command allows the user to set the measurement time intervals (in seconds) and the calibration time intervals (in minutes). If the "timing" command is typed, the LCT-12N fist displays the present time interval between two successive calibrations (Tcal, in minutes). Such value can be confirmed with *"enter" (<CR><LF>),* or changed typing the new value followed by "enter". Next the LCT-12N displays the measurement time interval (Tmeas, in seconds), that can be confirmed or changed with the same syntax. Finally the LCT-12N acknowledges the new setting with the message "Timingok" (see the example below).

```
*****************
Tcal = 10
Tmeas = 10
Timingok
*****************
```

In order to always obtain a correct calibration value, the time duration of calibration process is fixed to three times the value Tmeas.

V.5.5. *"scale" command*

The "scale" command is used to re-calibrate the measurements by means of suited amplification (*g* parameters) and offset (*off* parameters).
The firmware allows to change four gain and four offset parameters for each of the physical quantities that LCT-12N can measure; 1=PM (PM concentration), 2=T (temperature – *optional*), 3=P (pressure – *optional*), 4=rH (relative humidity – *optional*). The default values are 1 for the amplification coefficients and 0 for the offset coefficients. The pressure amplification factor is set to 0.01 when the **millibar** unit is used instead of the **Pascal** unit. The "**g1**" amplification factor for PM measurement is chosen depending on the particulate class selected by the cyclone filter. If the filter is supplied by QBIT, this value is factory set (as the corresponding flow rate).
The parameter values can be changed or confirmed with the same syntax as for the "timing" command. The last parameter NEG_ON is a binary flag that allows to turn off (0=default) or on (1) the displayment of negative PM concentration values. Negative PM concentration values are obviously not physical measurements, but they can be shown to perform noise/stability checks of the LCT-12N or to look for drifts due to any system malfunction.
The message "scaleok" acknowledges the correct parameter setting (see the example below).

```
******************
g1 = 1.6
off1 = 0
g2 = 1
off2 = 0
g3 = 0.01
off3 = 0
g4 = 1
off4 = 0
NEG_ON = 0
scaleok
******************
```

V.5.6. *"start" command*

After any setting of LCT-12N parameters, the "start" command allows the user to turn on the automatic measurement mode (as when the power supply is connected). The acknowledge message "startok" is followed by serial number and firmware release, and a new automatic measurement session is started; any parameter change is recorded and maintained in the system memory.

CHAPTER VI

TROUBLESHOOTING

VI.1. TROUBLESHOOTING

In Table VI.1, the most frequently occurring errors and malfunctions are reported, together with any user countermeasure. In case malfunction persists, contact technical service.

Table VI.1

Malfunction	What to do
Main unit turn-on failure	Verify that the power cord is connected and DC required specifications are met. Check the warning light on the power supply. If light is off the power supply is damaged.
Software commands are ignored	Verify the correct selection of the COM port (V.2.3) and the cable connection. If the problem persists turn off the instrument and restart it.
Temperature too high	Turn off the system and wait at least 30 minutes to allow cooling. Reduce the working place temperature or move the instrument to a cooler location.
Temperature, pressure and humidity measures do not match other external instruments	Verify that the aperture of the external probe is not obstructed.
The internal pump is too noisy	Verify that the cyclone is correctly connected. Verify the flow rate with external meter.
PM measures are irregular	Verify the flow rate and that cyclone filter is correctly connected.

CHAPTER VII

MAINTENANCE

For a long and reliable operation of the LCT-14 system, a few maintenance operations are suggested to be performed by the user and by qualified personnel.

VII.1. USER MAINTENANCE

VII.1.1. Cleaning suggestions

Daily cleaning
- remove dust and solid particles from the instrument;
- do not use abrasive products;
- wipe with soft and clean cloths.

Precautions
- avoid dust or grease get into the cyclone filter;
- avoid moisture or liquids get into the cyclone filter;
- avoid dust get into the main case apertures;
- do not use chemical solvents and/or abrasive detergents;
- do not use alcohol for cleaning.

ALWAYS DISCONNECT THE DC POWER BEFORE ANY MAINTENANCE OPERATION.

When the system is not in use, it is suggested to set the equipment in a dry, dust free place.

VII.1.2. Cyclone filter cleaning

This maintenance operation can be performed by the user, at time intervals which depend on working conditions and external environment.
Disconnect the cyclone filter from main unit. Open the conical filter cap unscrewing the circular nut. Clean out the dust from the internal chamber and verify that the air inlet is not obstructed. Remount the cap. Remove and clean the cap placed below the filter.

VII.1.3. Flow rate setting

The user is committed to change the flow rate setting, both in case of any flow derating and if a different input filter is adopted.
Disconnect the cyclone filter from the main unit and connect the flow meter to the soft plastic tube. Turn on the pump by the “pon” command (V.5.3) and tune the flow rate to the desired using the “speed” command(V.5.). Disconnect the flow meter and reconnect the cyclone filter.

VII.2. QUALIFIED PERSONNEL MAINTENANCE

IN ORDER TO ENSURE SYSTEM ACCURACY AND RELIABILITY, THE FOLLOWING MAINTENANCE OPERATIONS ARE TO BE PERFORMED BY QUALIFIED PERSONNEL AT REGULAR INTERVALS (PREFERABLY ONCE A YEAR):

- internal zero-pass filter replacement;
- laser scattering sensor calibration;
- flow rate calibration;
- electric insulation check.