MAHLE

Particle Counter measuring tool

Multi language digital user manual

1. General instructions

1.1 Introduction

Counting particles: The new frontier in emissions control

The emission of particulate matter in motor vehicles exhausts (both diesel and petrol) has a negative impact on Air Quality and Health. The nanoparticles emitted can easily enter human body thru breath, and the long-term effects of exposition to such particles are alarming.

Modern motor vehicles are fitted with Particulate Filters (de facto mandatory from Euro 5 Diesel and Euro 6.2 Petrol engines) in order to reduce at least by a factor of 1000, the count of particles emitted at tailpipe.

The adoption of Particulate Filters has a proven positive impact on public health. This is threatened by the lack of check on former emission control devices used during Periodic Test Inspections. In fact, it has been proven that in most Diesel Euro 5 and Euro 6 cars with faulty or tampered DPF, the opacity of the smoke emitted during a free acceleration is far below the legal limit, and this makes the opacimeter ineffective in testing this new generation of vehicles.

This dangerous behavior ends with the introduction in Emission Stations of Particulate Counter.

Reading carefully this user manual will let you understand how it works and how to maintain properly the device.

MAHLE is proud to be part of this emissions revolution, and made all possible efforts to design, industrialize and produce a reliable and easy to use measurement instruments, that will help you in your daily work for long time.
Thanks for choosing MAHLE garage equipment.
For more information on our products please visit our web site:

www.mahle-aftermarket.com

1.2 General notes

and operators of the equipment to which it refers.

MAHLE and the resources used for the drawing up of this manual will not be held responsible for the incorrect use of the manual while they guarantee that information in the manual have been duly checked.

The product can be subject to changes and improvements. MAHLE reserves the right to change without notice the information contained in the manual.

1.3 General instructions

PMU 400 has been designed to count concentration of nanoparticles emitted at the tailpipe from motor vehicles.

PMU 400, as every metrological instrument, undergoes checks before commissioning (initial verification) and periodical checks during operation (subsequent verifications) in compliance with rules and law provisions in force in the country where the tool is used.

The operator is responsible for operating the device in conformity with local legislation.

The equipment is intended to be used in periodic test inspection stations, roadside inspections and automotive repair and service workshops.
This equipment is intended solely for use by professionally trained operators, familiar with exhaust gas measurement. A careful reading of the present manual by the owners, the users and the operators is required for a correct and safe use of the tool.
The user shall not be entitled to open the product since maintenance operations are reserved to the authorised service center.
Furthermore, in the event of breakage of the seals required by the approval body, the device cannot under any circumstances be used during official tests, until it is restored by an authorized service center.

Unauthorized personnel or animals, since they don't have any personal protection equipment, must not be standing within the operating range of the station.

1.4 Manufacturer identification

The device is manufactured by:

MAHLE Aftermarket Italy S.p.A.
Via Diesel, 10/A - 43122 Parma, (Italy)
Tel. +39 0521 954411 – Fax +39 0521 954490
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internet www.mahle-aftermarket.com

1.5 Marking

PMU 400 is manufactured in compliance with the EU Directives being relevant and applicable to its placing on the market. The characteristic data of the equipment are described in its technical label. The equipment complies with the requirements of Directive, 2014/30/EU.

1.6 Protection from electromagnetic disturbances

The electromagnetic environment for which the equipment PMU 400 is intended to be used is the basic electromagnetic environment, defined by standard EN 61326-1:2013-01 as environment existing at locations characterized by being supplied directly at low voltage from the public mains network.

As example: light industrial locations, workshops, laboratories, service centres.

In case of intense electromagnetic disturbances, in order to restore the correct device operation, the device may autonomously interrupt the test in progress and reset after showing a message to the user. If this procedure takes place, the operator is responsible to manually restart the measurement.

2. Safety conditions

2.1 Definitions

Dangerous areas	Any area within or close to the equipment implying risk for the safety and health of exposed persons
Exposed person	Any person completely or partially standing in a dangerous area
Operator	The person/s charged with operating the machine for its intended purpose
User	Body or person legally responsible for the equipment

2.2 Classification of operators

The operator can be classified according to two main categories, which, in some cases, refer to one single person:

The operator charged with the equipment operation has the duty to:

- Start and check the machine automatic operation
- Carry out simple setting operations
- Remove the causes of equipment stop not implying breakings of members but simple operation anomalies

Maintenance technician: a technician trained by a MAHLE authorised service centre, capable of working on the machine's mechanical and electrical components with its guards open to adjust and to service and repair it

2.3
Personal safety information

The PMU 400 Automotive Particulate Counter is particularly simple and reliable due to its adjustments and functions. When used correctly it presents no hazard for the operator, on condition that he observes the following general safety instructions, and that the device is regularly serviced (incorrect maintenance/use compromise the equipment's safety).

Before operating the device for the first time, read these instructions carefully. If any part of the instructions is unclear, contact your reseller.

General Precautions

- All the operators shall not be under the effect of tranquillizers, drugs or alcohol when performing their job
- Before starting their job, operators shall be perfectly aware of the position and operation of all the controls indicated on the user manual
- Always pay attention to any danger sign affixed on the installation and within the company of the user
- The employer is responsible for the spreading of this document to the whole personnel that is going to work on the equipment
- Besides the obligation to strictly comply with the instructions contained in this manual, the operators shall inform their heads on any deficiency or potentially dangerous situation that might occur
- In case of machine malfunctioning, check the procedures outlined in the various chapters
- Always refer to the safety standards adopted by the company employing the equipment with a view to avoiding useless risks

Risk of Asphyxia

Gasoline Engines: Exhaust gases of gasoline vehicles contain carbon monoxide, a colourless and odourless gas which, if inhaled, can cause serious physical problems.
Special attention is always required when working within pits, as exhaust gases components are heavier than air and consequently deposit on the bottom of the pit.

Attention shall be paid to natural gas vehicles as well.

Diesel Engines: Diesel engine exhaust gas composition is not always the same. It can change according to: type of engine, intake, and conditions of use and fuel composition.
Diesel exhaust is made up of gases (CO, CO_2, NOx and HC) and particulate (soot, sulphates, etc.); the small particles of carbon making up soot remain suspended in the air and can thus be breathed. Toxic components, albeit in small quantities, are present as well.

Safety Measures:

- Always ensure good ventilation and air aspiration (especially in the pits)
- In closed premises, always start the exhaust gas aspiration system

Risk of Burn

When intervening on the engine, protect face, hands and feet with suitable protective devices, avoid contact with hot surfaces, such as sparking plugs, radiators, pipings of the cooling system and electromechanic sensors. Catalytic mufflers reach extremely high temperatures and can cause burns or fires.
Attentions shall thus be paid to avoid touching these objects without suitable precautions.

Safety Measures:
Wear protective gloves.

- Let cool down the engine and other independent accessories, if any
- Do not install testing tools connection cables over or close to hot parts
- Do not keep the engine turned on once checks have been completed

Risk of Fire or Explosion

When carrying out operations on the fuel system (injectors, fuel and gasoline pump, etc.) there is risk of fire or explosion due to the fuels employed and/or vapours formed by them.

Safety Measures:

- Disable start
- Let the engine cool down
- Do not use open flames or sparks sources
- Do not smoke
- Collect the out flowing fuel
- Start the aspiration units in closed premises

Risk of Intoxication

The pipes that are used for exhaust gases sampling if subject to high temperatures (exceeding 250°C or due to fires) release a highly toxic gas which, in case of inhalation, can be harmful for health.

Safety Measures:

- In case of inhalation, immediately contact a doctor
- To remove combustion residues, wear neoprene or PVC gloves
- Fire residues can be neutralized with a calcium hydroxide solution. This leads to the formation of calcium fluoride that can be removed with water

Electrical Connection

Connect the power cord solely to a mains supply which conforms to the ratings on the device external power supply (included in the scope of delivery). Make sure the mains socket is grounded.

Maximum impedance allowed in the point of connection to the mains shall comply with standard EN 61000-3-11. Starting currents can cause short voltage drops, which may affect other equipments under unfavourable conditions. If impedance in the point of connection to the mains is not compliant, this may lead to interference so please consult the electrical power network operator before connecting the equipment.

Never use the device with a defective power cord or other than the manufacturer part. If damaged, replace it immediately with an original spare or equivalent by a MAHLE Aftermarket service centre. Before opening the device (authorized service only), disconnect the supply cable from the plug.

Do not tamper with or bypass the safety equipment and settings.

Do not leave the machine powered on when not in use; shut off the power supply before leaving the equipment unused for a long time. Do not forget that the equipment (pressure equipment) must always be protected.

Working Fluid: Isopropyl alcohol (IPA)

The PMU 400 requires the use of Isopropyl alcohol as a working fluid. An internal pump draws IPA from an external tank to the measurement chamber. The 250ml tank is designed to last for 80 hours of operation which is sufficient for 1000-2000 official tests. As IPA is hygroscopic, measures must be taken to prevent water or water vapor from entering the IPA tank. For this reason, MAHLE designed a specific tank (described later).

Isopropyl alcohol is a flammable liquid. The vapor of IPA does not create an explosive atmosphere according to the ATEX regulations. Nevertheless, device has been designed to ensure a safety operation with the equipment.

Isopropyl alcohol (IPA) is defined (by ECHA European Chemical Agency) as:

 Flammable

 Health hazard

Danger! According to the harmonised classification and labelling (CLP00) approved by the European Union, this substance is a highly flammable liquid and vapour, causes serious eye irritation and may cause drowsiness or dizziness.

Updated information/requirements on Isopropyl alcohol (IPA) safety are available on the official website of ECHA European Chemicals Agency.

Websites:
https://echa.europa.eu

Substance information:
https://echa.europa.eu/substance-information/-/substanceinfo/100.000.601

For Isopropyl alcohol (IPA) in particular, requirements are available on the following topics:

- First aid measures
- Fire-fighting measures
- Accidental release measures
- Handling and storage
- Exposure controls / personal protection

Please review the safety data sheet of Isopropyl alcohol for all safety information.

Workplace: PMU 400 operates internally with Isopropyl alcohol (IPA).

IPA is a flammable liquid.
Use the equipment away from heat sources or hot surfaces. The equipment must not be used in explosion risk environments (ATEX - potentially explosive atmospheres).
Do not smoke near the equipment and during the operation (keep at a distance of at least 2 m).
Before using it, put the equipment on a levelled plane and secure position.
Do not expose the equipment to direct sunrays, heat sources, rain and jets of water.
The work area must be monitored by the operator while the equipment is operating.

Attention

Ensure good ventilation in the premise during use.

First aid measures: IF exposed or if you feel unwell: Call a POISON CENTRE or doctor/physician. If unconscious place in recovery position and seek medical advice. Never give anything by mouth to an unconscious person or a person with cramps. Change contaminated, saturated clothing. Do not leave affected person unattended.

After inhalation: Remove peron from danger area. Supply the person with fresh air and culsult a doctor according to the symptoms. If the person is unconscious, place in a stable side position and consult a doctor. If respiratory arrest – artificial respiration apparatus necessary.

In case of skin contact: Remove polluted, soaked clothing immediately, wash thoroughly with plenty of water and soap. In case of irritation of the skin (flare), consult a doctor.

After eye contact: Remove contact lenses. In case of contact with eyes flush immediately with plenty of flowing water several minutes holding eyelids apart using copious water. Consult a doctor immediately.

In case of ingestion: If accidentally swallowed rinse the mouth with plenty of water (only if the person is conscious). Do NOT induce vomiting. Give copious water to drink. Consult a doctor immediately.

Maintenance / General cleaning: The device maintenance has to be performed according to the procedures described in this manual and to the current safety regulations.

Use only original parts.

Always replace the HEPA filters and the working fluid bottle of the unit when required by the equipment.

Maintenance on PMU 400 can be carried out exclusively by an authorized service center.
Do not use chemical agents for the service station cleaning as they could attack the material or the surface.

Stop for long period: Before turning off the device, please do a dryout procedure (from main menu select “Settings and Controls” and then “Dryout procedure”) in order to dry the Isopropilic Alcohol inside the unit. This allows for a quicker restart of the device operation. In case of doubts, contact your local Technical Service to run a safe shutdown of the equipment.

Store the equipment in a safe place, disconnected from the mains, away from excessive temperatures, direct sun light, humidity and the risk of damaging impacts.

If scrapping the unit, follow local legislation.

To resume operation later, provided that service interval is not elapsed, it’s sufficient to repeat the installation sequence (described later) and regular operational checks as required by local legislation.

In case of periodic verification period is elapsed, as per local legislation, please contact your local Technical Service for the necessary maintenance and verification tasks.

2.4 Important information on equipment safety

When using the equipment, the following operations are not allowed as they might cause, under certain circumstances, danger for persons and cause permanent damage to the equipment itself.

	Do not remove or make unreadable labels, signs and/or dangers signs placed on the equipment and in the area nearby

	Do not disable the unit's safety equipment
	If the power supply is known or can be expected to vary beyond the limits specified for the service equipment, immediately disconnect it
	The electrical system to which the service equipment is connected must be configured as provided by local legislation
 	Only operators or qualified staff instructed or certified for the equipment maintenance can open the equipment. The equipment contains parts which can cause electrocution: shut off power to the equipment before servicing/repairing it
	Use only original spare parts, consumables and accessories

2.5 Safety devices

PMU 400 is equipped with the following safety devices:

Power supply	Position the unit so that the power plug is easy for the operator to access. It is advisable to pull the power cord plug out of the mains socket in any case before starting maintenance work
Temperature electronic control	To prevent all risk situations, the device is equipped with intrinsic safety devices. The unit recognizes the fault condition and goes into standby mode, stopping any measurement in progress. The user is alerted by means of an error message on the device display

Any tampering with the above-mentioned safety devices is prohibited.

Failure to observe any of the above safety instructions voids the equipment's warranty.

2.6 Hot parts

Burn hazard! Only service network should open the unit!

For metrological reasons, inside PMU 400 is embedded an evaporation tube, that is heated to more than 200°C. It's enclosed in a special high efficiency insulation material, but the fittings and inside of the insulating case, may be extremely hot.

3. Layout of the manual

3.1 Use of the manual

This manual is an integral part of the equipment and must be kept in the equipment's immediate vicinity by the purchaser.

- This manual shall accompany the equipment in case this is passed on to a new user
- The content of this manual has been drawn up in compliance with the guidelines of the UNI standard 10893:2000
- Diffusion, modification or use of this manual for own aims is forbidden
- The manual uses symbols which call the reader's attention to specific points to facilitate its use
- It includes all technical, operating, shutdowns, maintenance, spare parts and safety information
- In case of doubts on the correct interpretation of the instructions, please contact our technical service to obtain the required clarifications

	Operations representing a situation of potential danger for operators are highlighted using the symbol shown alongside. Such operations can cause serious injury
	Operations requiring particular attention are highlighted using the symbol alongside. Such operations shall be performed correctly in order to avoid damaging objects or the surrounding environment. This symbol also highlights information special attention shall be paid to
	Operations which require careful reading of the manual's instructions are highlighted with this symbol

3.2 Symbols

This paragraph describes the safety-related symbols that might be present on the external part of the equipment.

Safety

	Alternating current
	Safety grounding
	Consultant the instructions manual
	Caution! Electrocution hazard
	Caution! Do not remove the cover (maintenance technicians only)
	Use protective gloves
	Wear safety glasses
	Use anti-smash safety shoes
	Flammable
	Health hazard
	No open flame, fire, open ignition source and smoking prohibited
	No smoking
	Burn hazard

Marking

	CE mark

4. Product description

4.1 General description

The PMU 400 particulate counter is a metrological instrument that can measure the particle number concentration in the exhausts of vehicles with installed particle filters. The result is expressed in particles number per cubic centimeter (shortened to "#/cm^3" or "#/ccm").

Measurement of the particle number concentration in the exhausts enables the control of emissions not only for the compulsory inspections but also for maintenance or repair of vehicles.
The measurement may be carried out by withdrawing gas from the exhaust pipe through a probe.

Just to give a rough indication, a good particulate filter is reducing particles concentration in exhausts by a factor of 1000.
So, if particulate filter is working properly, the device will show a concentration between 0 #/ccm and few thousand #/ccm, while in case of defective of tampered particulate filter, the measured value will likely be in the range of millions #/ccm. For this reason, at the moment of writing this manual, different international studies and test campaings, are indicating 250.000#/ccm as the limit value in order to define if DPF filter on Euro 6 diesel vehicles is defective. Please note that it's mandatory to refer to your local legislation for more details and current limits.
The device has been designed to answer the requirements of the Netherland Ministry of Infrastructure and Housing regulation number IENW/BSK-2019/202498.

Both the mechanical and electronic parts are made from state-of-the-art materials and components. The provisions of EMC standards, required by the CE mark, have also been complied with right from the initial design stage to obtain a fully conforming product.

An important feature of this particulate counter is measurement precision combined with great reliability, to be sure of high-precision measurement even in difficult environments. During the design stage, the engineers of MAHLE Aftermarket Italy Spa paid special attention to ease of use and low maintenance, so that even non-experts can perform fast and precise measurements.

4.2 Scope of delivery

Description
PMU 400
3,5m sampling line with probe
Filter for daily clean air test
Power supply (external)
Schuko mains cable (CEE 7/4)
User manual

4.3 Accessories & Consumables

Only accessories and consumables sold by MAHLE are allowed to use with the PMU 400. Any misuse will compromise the safety and operation of the equipment.

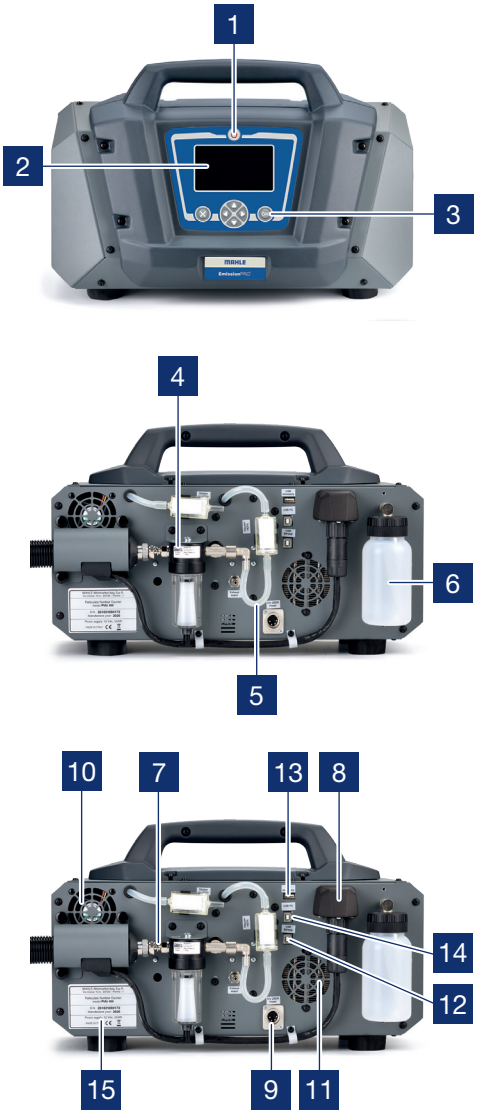
Description	Details / Material number
USB Bluetooth Dongle	1010450000XX
Isopropyl alcohol kit	1010450001XX
Small Hepa filter	1010450002XX

Using non-original or unapproved accessories and consumables, can compromise safety and performances of the device.

Warranty is void if non-original consumables or accessories are used.

4.4
Unit description

Unit description	
1	Power button
2	LCD Display
3	Keypad
4	HEPA 1 / dilution air
5	HEPA 2 / pump protection
6	Working fluid / isopropyl alcohol
7	External probe sample connection
8	External probe electrical connection
9	12V power supply connection
10	Hot area fan
11	Cold area fan
12	Service USB port
13	PC USB port
14	Accessory USB port
15	Metrological data label



Do not use the unit unless the sampling hose is connected correctly.

The status of the device is displayed on the LCD screen **(2)**. The menu selection and the necessary entries are selected by using the keypad **(3)** integrated in the panel. The interaction with user menu and the keypad is described in a dedicated chapter.

5. Technical features

General	
Model name	PMU 400
Display and user interface	PC or internal

Measuring ranges	
Particle size range	10 to 200nm
D50	23nm
Concentration (metrological)	0 to 5,000,000 #/ccm
Concentration (diagnostic purpose)	0 to 30,000,000 #/ccm
Warm-up time 20°C	<15 minutes
Response time (T0 – T95)	<15 seconds

Tank size	
Isopropyl Alcohol	250ml

Filter	
Filter type	HEPA filter
Brand	MAHLE Aftermarket Italy

Sampling line	
Net lenght of sampling line	3,5 m

User interface	
Display	LCD 4.3”
Keypad	Membrane
Software updating	Through USB type-B (service only)

Functions and features	
Automatic measurement cycle	Auto
Daily clean air test	Semi-Automatic

Logic board	
Battery type for internal real time clock	Lithium CR-2032

Dimensions	
WxDxH	470 x 300 x 280 mm
Weight	approx. 14 kg

External power supply output specifications	
Voltage	12VDC ±0,5V
Maximum power	250W

Operating conditions	
Ambient temperature	0-40°C
Relative humidity	Up to 85% R.H. (non condensing)
Atmospheric pressure	75 kPa until 106 kPa

Storage conditions	
Temperature	-32°C to 55°C

6. Installation

6.1 Unpacking the PMU 400

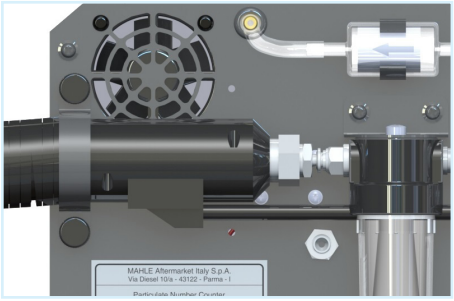
The PMU 400 is supplied in a carton box, enclosed in a special protection, together with 2 smaller boxes, for external heated line and accessories.
Open carefully the box, remove the top protection shell and place the PMU 400 on a suitable support.
We suggest to keep the box and the protections for later use.

The manufacturer disclaims all responsibility for damage to objects and/or persons resulting from the equipment being wrongly removed from the packaging, or from the operation being made by unsuitable personnel, with improper means/protections and without complying with the existing laws on manual handling of loads and with the operations described in this manual.

6.2 Commissioning

The unit has to be positioned on a horizontal surface to ensure the correct operation.
Please use the power supply which is part of the delivery scope. The power supply must be connected to the electric mains following instructions on its identification plate, mainly as to applicable voltage and power.

The external sampling line must be connected to the PMU 400 as shown on next figures.



Please note that the mechanical is connection is obtained thru a quick coupling connector. In order to attach the probe, it's sufficient to push it in, and lock the probe with the dedicated bracket (with 4x M4 screws) to the back of the device.

While in order to detach the probe, it's sufficient to remove the bracket, press the female part of the quick coupling and pull the probe.

Important: always install the bracket! Otherwise, the weight of the external probe may damage the quick coupling and the water trap assembly.

Please connect the probe connector and lock it rotating the dedicated ring.

Handling: During handling, the minimum devices required for correct handling shall be ensured, as provided for by accident prevention provisions.

Positioning: Place the unit in a stable and suitable place. The equipment shall be positioned in premises with adequate ventilation and/or change of air. The unit must be located at least 10 cm from any potential obstacles to its internal ventilation. Protect the unit from rain and excessive humidity to avoid irreparably damage to the equipment, and besides, the equipment must never be directly exposed to the sunrays or to excessive dust.

Installation: the unit must be installed by a specialised technician in strictly complying with the instructions contained in this manual. The use of the equipment in explosive atmosphere is forbidden.

Connections: since the unit is connected to the main power supply, it must be properly grounded with its power plug GND pin. Failure to the ground of the unit can damage it and constitutes

a risk of fatal injury to the operator. Position the unit so that the power plug is easy for the operator to access.

6.3 Language selection

When switched on for the first time, the user interface of the device will be in English.
The language can be changed in the “Setting and controls” section in the main menu.

7. PMU 400 Operation

MAHLE Aftermarket Italy reserves the right to add new parameters to make the equipment increasingly versatile and adaptable to market's needs.

7.1 Personal safety measures

The PMU 400 Automotive Particulate Counter is particularly simple and reliable due to its adjustments and functions. When used correctly it presents no hazard for the operator, on condition that he observes the general safety instructions described in this manual. The main safety instructions are summarized in following list:

- Check the instrument for any damage
- Always ensure good ventilation and air aspiration (especially in the pits)
- In closed premises, always use an exhaust gas aspiration system
- Do not use open flames or sparks sources near the equipment
- Do not smoke
- When intervening on the engine, protect face, hands and feet with suitable protective devices; avoid contact with hot surfaces, such as sparking plugs, radiators, pipings of the cooling system and electromechanic sensors. Catalytic mufflers reach extremely high temperatures and can cause burns or fires

7.2 User interface

All settings, controls and service functions are shown in the LCD display using the keyboard to select and insert data.
The LCD displays the service equipment's status, the progress of the system service and any alarms and error messages.

The following keys are available:

	To move up in the menu options or data field
	To move down in the menu options or data field

	To move left in the menu options or data field
	To move right in the menu options or data field
	To confirm the selection and continue
	To interrupt or stop the operation in progress. To go back in the menu
	Power ON/OFF button

To select a function in the menu, the up/down arrows have to be used. The selected function will be highlighted, then press the OK button to confirm the selection. To go back in the upper menu level please press the “X” button.

If there are descriptions that need more space on the screen page, or in case of setup, it is possible to display the different entries pressing the down arrow key. By pressing up/down arrows, the menu selection moves one line up or down.

In the test procedure the operator is asked to insert customer data e.g., license plate number. To insert a letter or a number the up/down arrows are used. If the operator presses the “up button” 0 is shown. This is continued till number 9. Then the selection starts again at 0. The same procedure is applicable for the alphabet. To select the next digit or letter the right or left arrow needs to be pressed. When pressing the right error, the cursor changes its position to the next data field on the right.

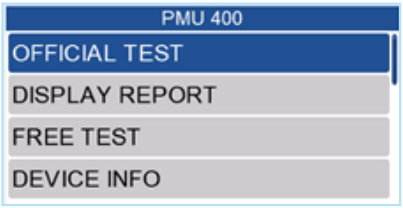
7.3
Menu layout

Please refer to the “Software Menu structure” section of this manual in order to see a graphical view of the menu structure.

The main menu sections are:

- Official test
- Display report
- Free test
- Device Info
  - + Consumables
  - + Service Info
  - + Info
- Setting and Controls
  - + Set Language
  - + Time adjustment
  - + Consumables Counter
  - + Clean air check
  - + Sample needle purge
  - + Shut down procedure
  - + Dry out procedure
  - + All data
- Service

The main functions will be described in detail in the next chapters.

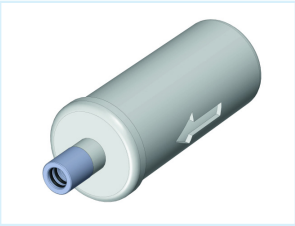


8. Clean air test

The clean air test procedure must be performed daily. This is mandatory in order to unlock the official test.

The instrument will ask the operator before starting an official test to perform a clean air test. However, the end user can also start the clean air test procedure indepentently in the “Setting and Controls” section.

It’s necessary to use a dedicated adapter with filter, which is part of the scope delivery, like shown in the following figure.



Please note that it may be necessary periodically to grease the o-rings in the adapter with a thin layer of vaseline or lithium grease, in order to facilitate the match with the probe tip (as described in the following procedure).

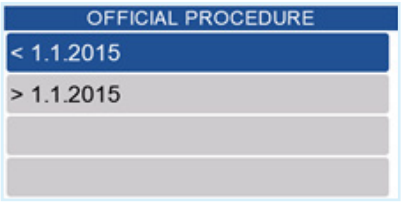
When starting the clean air test the instrument will measure the particle concentration in ambient air first.

After finishing the ambient air measurement, the operator is asked to insert firmly the probe tip in the “Clean air test adapter” and confirm. In this condition the device will aspire Hepa filtered air, with very low particles concentration, close to 0 #/ccm.

Then the PMU 400 will measure the particle concentration again. If the measured value is low enough to be below a fixed limit, the clean air test procedure is passed.

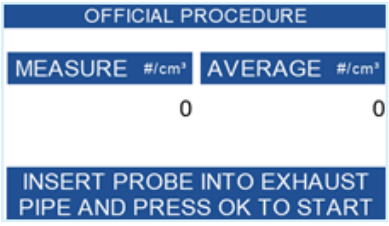
9. Official PTI test

To start an official PTI test the operator must select the “Official test” menu.
When this procedure is selected the operator is asked for the category of the vehicle under test.

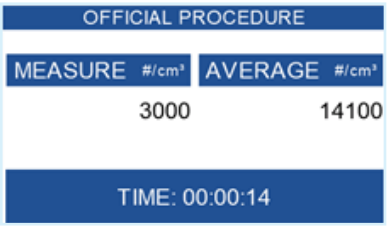


This selection sets the limits for the official test, according to local legislation.
Afterwards the unit is performing several self tests, in order to ensure correct operation.

To continue with the official test the operator is asked to “insert the probe into the exhaust” and confirm this action.

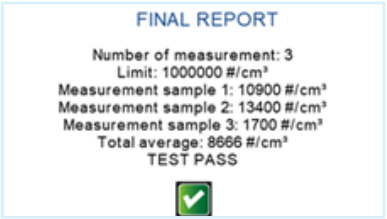


Then the official test starts. The vehicle is running at idle speed. The PMU 400 shows the real measured value and the calculated average over the testing period.



After the official test procedure, the operator is asked to remove the sampling probe from the tailpipe.
Then the PMU 400 is performing post-test procedures for example flushing the device.

The following report will be displayed. The user can note the measured values and the overall result of the test.



In the next step the vehicle license plate can be added to the report.

The results of official tests will be stored in an internal memory, for durable recording purpose.

These recordings can be accessed thru “Display Report” function, from main menu.

10. Preparation for transport + shipment

Specific measures must be taken in order to prepare the PMU 400 for transport and/or shipment.

These procedures are performed to protect the measurement device for any unforeseen handling during transport.

10.1 Preparation for transport

If the PMU 400 needs to be carried to other locations in e.g., the trunk of a car which ensures that the measurement device isn't tilted the shutdown procedure must be executed.

To perform the shutdown procedure the IPA bottle at the back of the device must be connected!

After this is checked please go to the "Settings and Control" menu and select shutdown procedure. The shutdown procedure is performed automatically, and the device is shut down afterwards.

10.2 Preparation for shipping

If the PMU 400 needs to be shipped to a service partner or to the manufacturer the dry out procedure must be executed.

To perform the dry out procedure the IPA bottle at the back of the device must be connected!

This procedure will take some time. You will not be able to use the instrument for tests.

After the IPA bottle was connected to the device please go to "Settings and Control" menu and select dry out procedure. The dry out procedure is performed automatically, and the device is shut down afterwards.

11. Maintenance

PMU 400 is a remarkably reliable unit, manufactured using the highest quality components, making use of the most advanced production techniques.
Please contact an authorized technical service centre for purchasing original spare parts.

11.1 Periodical checks

The PMU 400 service stations must undergo periodical checks to comply with the governmental requirements. The periodical checks will be performed every year or after 500 hours of operation (sufficient for at least 5000 official tests) to ensure the performance of the service equipment.

According to the local legislation contact the technical customer service or the competent body for the following checks.

- Check that connection cables and connector are in good order and undamaged. In case of damaged cables, stop using PMU 400 and contact technical customer service for the related spare part
- Check the condition of the filter used during clean air check. Replace HEPA filters when it's damaged or it's not possible to pass Clean Air Test
- Check performance of the instrument

11.2 Consumable's replacement

To ensure a long lifetime of the PMU 400, consumables must be replaced after a defined time:

- External HEPA filters life is managed in relation to the operation time. It has to be replaced after 200 hours of operation or once per year, or in case of error shown by the instrument, it may be replaced earlier
- The working fluid (Isopropyl alcohol) lasts 80 hours of operation or one year, which is sufficient for more than 1000 official test procedures

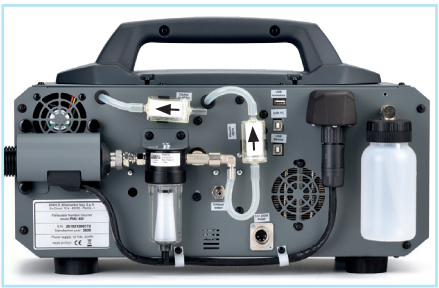
When servicing the device after one year, the residual Isopropyl Alcohol (that have not been used in one year) must be disposed and replaced with fresh, original consumable. This is necessary to ensure the performances of the device over long periods.

11.3 Filters exchange procedure

The HEPA filters must be replaced when the according counter has expired or when the filters are clogged due to too high concentrations in the sampling gas. In both cases a warning message is shown on the display.

To replace the HEPA filters the instrument must be turned off.

The HEPA filters are placed in the back of the instrument as shown in the following image highlighted with yellow circles. Disconnect the filter from the tubing. Remember the flow direction of the installed filter. It is indicated by the arrow on the filter.
Connect the new part in the same way to the tubing.



Using non-original or unapproved accessories and consumables, can compromise safety and performances of the device.
Warranty is void if non-original consumables or accessories are used.

After exchanging the filter, the service counter must be reset. Therefore, select the “SETTING AND CONTROL” menu and go to “Consumables Counter”. Choose the according HEPA filter and confirm the exchange.

11.4 Isopropyl Alcohol tank refilling

Think about safety first! Isopropyl alcohol is FLAMMABLE!

Please put attention when handling Isopropyl Alcohol. Avoid sparks, free flames and smoking during operation.
In case of IPA spill on clothes, floor or surfaces be very careful! IPA evaporates quickly so it’s necessary to ventilate the room, until completely

dry. Avoid breathing the IPA vapours.

Important note
Please be sure to use original Mahle Isopropyl Alcohol kit 1010450001XX in order to ensure it's the high purity, necessary to have a long life of your device.

Warranty is void if non-original consumables or accessories are used.

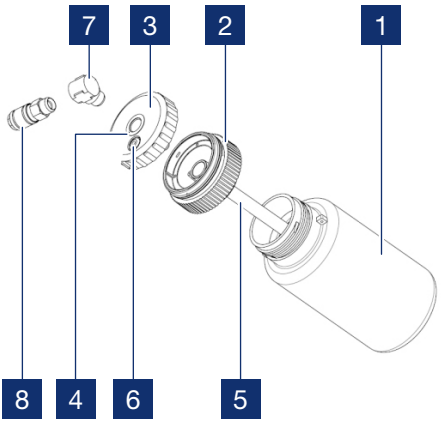
Moreover, during filling procedure, please work on a clean desk and use clean protective gloves in order to avoid contamination of the fluid. Any moisture or dirt that contaminates the fluid may shorten the life of your device.

The IPA tank is located at the back of the device. When replacing the Isopropyl Alcohol (IPA), handle the IPA tank with care so that dropping and damaging the tank is avoided.

The liquid must be filled in the tank from a new original consumable bottle, purchased thru official service network. To fill the tank, it must be removed from the PMU 400 by slightly pressing the quick coupler connector on top of the container. The cap can be opened by unscrewing with hands.

To ensure performances and longer life of the PMU 400 the care cap has to be exchanged as well (included in Isopropyl Alcohol kit). Since the IPA is hygroscopic, it's necessary to regularly replace the care cap, to adsorb the moisture naturally present in the air.

The care cap is shown in the below exploded view as number 2.



Description	
1	IPA bottle 250ml
2	Care cap
3	External cap
4	Washer
5	Silicon tube
6	Check valve
7	Connector
8	Quick coupler male

Using non-original or unapproved accessories and consumables, can compromise safety and performances of the device.
Warranty is void if non-original consumables or accessories are used.

The operator MUST wear personal protective equipment.

During the replacement procedure the unit has to be turned off.

After filling the IPA and replacing the oil care cap, the tank can be put in place, by just pushing the quick coupling back on.
Then the service counter must be reset. Therefore, select “SETTING AND CONTROL” from main menu and go to “Consumables Counter”. Choose IPA tank and confirm the replacement.

11.5 Water trap

Water trap is a safety device that prevents the carry-over of bulk liquids into the device. It has a float valve to shut off the flow when collected liquids reach a certain level.

The water trap must be serviced, only if necessary. It can be found on the back of the device. To empty the water trap please unscrew the black plastic screw on the bottom of the bowl. The transparent bowl body can be unscrewed also in order to allow cleaning.

Since these parts are made of plastic material, when reassembling, please be sure to tighten without applying excessive torque.

11.6 Service (only for service technicians)

In the main menu select SERVICE and press “Ok”.
The Service page is protected by password with access limited to technicians of Service Centres authorised by MAHLE.

11.7 System info

In the main menu select DEVICE INFO and press “Info”.
In the System Info page, at any time, the software version and the serial number are displayed.

11.8 System update

If a homologated software update is available your authorized service partner will install it on your device.

12. Disposal

12.1 PMU 400 disposal

At the end of its work life, the equipment must be disposed of as follows:

- deliver the unit to an authorised collection centre according to local legislation

12.2 Disposal of working fluid IPA

Exhausted Isopropyl alcohol should be disposed of in compliance with existing laws.

Keep out of the reach of children and away from heat sources and fire.

As a further information, please note that the residual IPA can be used as generic surface cleaner and sanitizer, so it's not necessary to throw it away. This will make it useful and environmentally friendly.

12.3 Disposal of HEPA filter

Exhausted HEPA filters should be disposed of in compliance with existing laws.

12.4 Packaging disposal

Electronic and electrical service equipment must never be disposed of with domestic waste but recycled appropriately. The packaging must be disposed of in conformity with local legislation. This contributes to protecting the environment.

13. Spare parts

The necessary components for routine and extraordinary maintenance can be ordered at MAHLE.

Routine maintenance includes the replacement of components subject to wear, such as filters, or subject to use, such as gaskets, cables.

Extraordinary maintenance includes the replacement of other components, for example electronics parts, pumps, pressure sensors, etc.

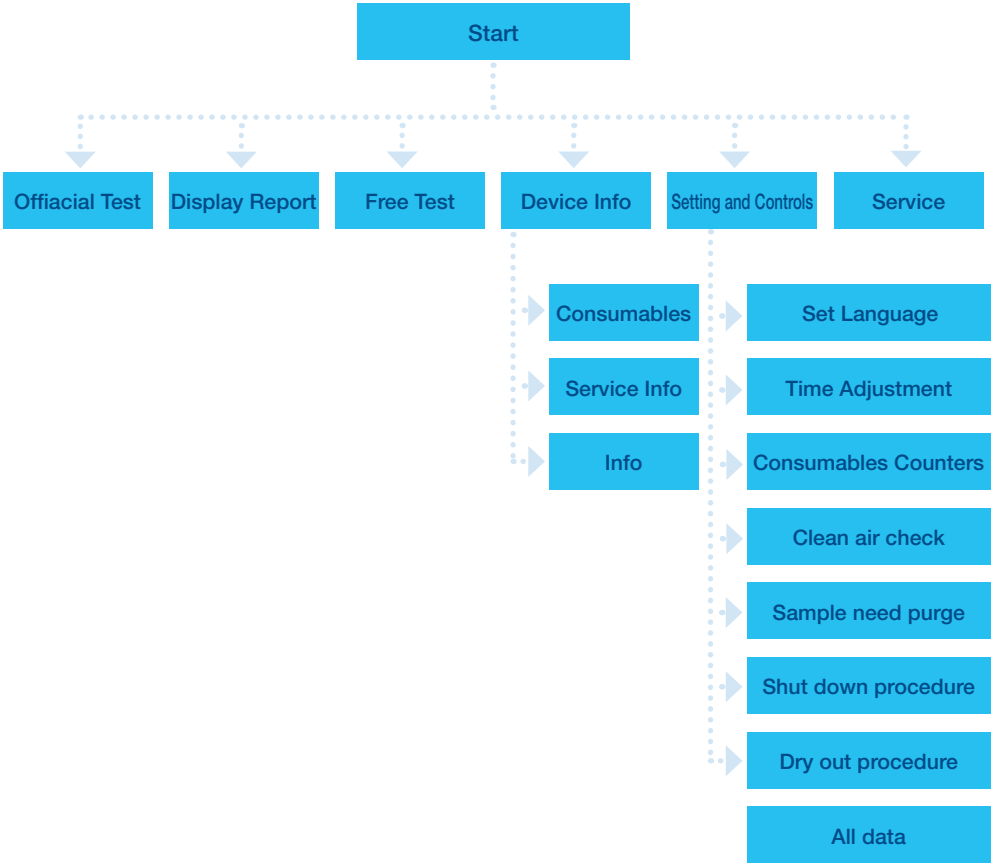
Accessories & Consumables available to the user are listed on Accessories & Consumables section of this manual.

Further spare parts are available through your reseller or through Service Centres authorised by MAHLE.

Using non-original or unapproved accessories and consumables, can compromise safety and performances of the device.
Warranty is void if non-original consumables or accessories are used.

Spare part	
Power supply MAHLE Aftermarket Italy – Original	14381030003500
Heated sampling line (samling line only) MAHLE Aftermarket Italy - Original	141250600098XX
Inox probe with braided hose (probe tip only) MAHLE Aftermarket Italy - Original	145630150400XX
Complete external heated line (inox probe + handle + heated sampling line) MAHLE Aftermarket Italy - Original	141255400015XX

14. Software Menu Structure



15. Error list

If an error is present, in some case, the system cannot be used for regulatory testing. The control software will inform the user, and prevents automatically the execution of the Official Test, while the Free Test in some case may be still available.

Code	Name	Description	Solution
10001	CPC VERSION MISMATCH WARNING	This warning is set when the applications stored CPC library version fails to match the actual CPC library version. When active, the system cannot be used for regulatory testing	The unit requires a service event, please contact your service center
10002	CONFIGURATION TAMPER WARNING	This warning is set when the configuration fails to match its stored checksum	The unit requires a service event, please contact your service center
10003	CONFIGURATION WARNING	This warning is set when the configuration (or a portion of the configuration) has not been set. The system will instead use default values for the missing configuration	The unit requires a service event, please contact your service center
10004	SELF TEST WARNING	The system failed to pass a power-on self-test	The unit requires a service event, please contact your service center

10005	WARMUP TIME-OUT WARNING	This warning is set when the unit fails to warm up in a timely manner	Power cycle the unit. If the same error occurs, the internal measurement bench requires a service event, please contact your service center
10006	FILL TIMEOUT WARNING	This warning is set when the fill pump has timed out trying to fill the internal tank from the external reservoir. The most common cause of this warning is an empty external IPA tank	Check if the external IPA tank is empty, fill it with new working fluid thru the use of an original Isopropyl Alcohol kit (see consumables section), and cycle power. If tank is not empty, please do not operate the device and contact your service center
10007	PHOTOMET-RIC VOLTAGE WARNING	This warning is set when the photometric voltage is outside the acceptable threshold	The unit requires a service event, please contact your service center
10008	COINCIDENCE FACTOR WARNING	This warning is set when the coincidence factor is outside the acceptable threshold. This might also happen when measuring very high concentrations, over maximum possible range. In this case there's no problem on the device	If this happens when measuring low concentrations. the unit requires a service event, please contact your service center

10009	TANK LEVEL WARNING	The system has detected that the tank level voltage is outside the acceptable threshold	The unit requires a service event, please contact your service center
10010	TILT WARNING	This warning is set when the unit is tipped past a certain threshold	Please place the device on a flat and perfectly horizontal surface. If it does not fix the problem, please contact your service center
10011	CPC MIXING RATIO WARNING	This warning is set when the CPC Mixing Ratio measures outside the acceptable threshold	The unit requires a service event, please contact your service center
10012	CPC SAMPLE DP WARNING	This warning is set when the CPC Sample DP measures outside the acceptable threshold	This may happen during a long recording in free measurement. In this case exit and re enter the free measurement (causes a zeroing of pressures). In all other cases, the unit requires a service event, please contact your service center

10013	CPC EXTRACT PRESS WARNING	This warning is set when the CPC Extract Pressure measures outside the acceptable threshold	This may happen during a long recording in free measurement. In this case exit and re enter the free measurement (causes a zeroing of pressures). In all other cases, the unit requires a service event, please contact your service center
10014	CPC PUMP WARNING	This warning is set when the CPC Pump is being driven to a duty cycle outside the acceptable threshold	Please check the exhausts output at the back of device. It must be free to blow out and not blocked by anything. In all other cases, the unit requires a service event, please contact your service center
10015	PND2 DILUITION RATIO WARNING	This warning is set when the PND2 Dilution Ratio measures outside the acceptable threshold	Check and replace HEPA1 filter if it is clogged. Exit and re enter free test. If this is unsuccessful, the unit requires a service event, please contact your service center
10016	PND2 SAMPLE DP WARNING	This warning is set when the PND2 Sample DP measures outside the acceptable threshold	Check and replace HEPA1 filter if it is clogged. Exit and re enter free test. If this is unsuccessful, the unit requires a service event, please contact your service center

10017	PND2 DILUI-TION PRES-SURE WARN-ING	This warning is set when the PND2 Dilution Pressure meas-ures outside the acceptable threshold	Check and replace HEPA1 filter if it is clogged. Exit and re enter free test. If this is unsuccessful, the unit requires a service event, please contact your service center
10018	PND2 PUMP WARNING	This warning is set when the PND2 Pump is being driven to a duty cycle outside the acceptable threshold	Check and replace HEPA1 filter if it is clogged. Exit and re enter free test. If this is unsuccessful, the unit requires a service event, please contact your service center
10019	PND1 DILU-ITION RATIO WARNING	This warning is set when the PND1 Dilution Ratio meas-ures outside the acceptable threshold	Check for clogging of the exter-nal probe. Check the water trap, empty it if necessary. Check and replace HEPA1 filter if it is clogged. Exit and re enter free test. If this is unsuccessful, the unit requires a service event, please contact your service center

10020	PND1 SAMPLE DP WARNING	This warning is set when the PND1 Sample DP measures outside the acceptable threshold.	Check for clogging of the external probe. Check the water trap, empty it if necessary. Check and replace HEPA1 filter if it is clogged. Exit and re enter free test. If this is unsuccessful, the unit requires a service event, please contact your service center
10021	PND1 DILUITION PRESSURE WARNING	This warning is set when the PND1 Dilution Pressure measures outside the acceptable threshold.	Check for clogging of the external probe. Check the water trap, empty it if necessary. Check and replace HEPA1 filter if it is clogged. Exit and re enter free test. If this is unsuccessful, the unit requires a service event, please contact your service center

10022	PND1 PUMP WARNING	This warning is set when the PND1 Pump is being driven to a duty cycle outside the acceptable threshold	Check for clogging of the external probe. Check the water trap, empty it if necessary. Check and replace HEPA1 filter if it is clogged. Exit and re enter free test. If this is unsuccessful, the unit requires a service event, please contact your service center
10023	MAIN BLOCK TEMPERATURE WARNING	The Main Block Temperature is outside of its acceptable control limits	The unit requires a service event, please contact your service center
10024	TANK TEMPERATURE WARNING	The Tank Temperature is outside of its acceptable control limits	The unit requires a service event, please contact your service center
10025	EXTRACT TEMPERATURE WARNING	The Extract Temperature is outside of its acceptable control limits	The unit requires a service event, please contact your service center
10026	CONDENSER TEMPERATURE WARNING	The Condenser Temperature is outside of its acceptable control limits	The unit requires a service event, please contact your service center

10027	VPR Temperature Warning	The VPR Temperature is outside of its acceptable control limits	The unit requires a service event, please contact your service center
10028	Fill Period Warning	The total sample time since last tank fill exceeds limit	The unit requires a service event, please contact your service center
20001	ERROR SENSOR TEMPERATURE PROBE 1	The value of the temperature sensor 1 of the external heated line is outside the acceptable limits	Check the connection of the external heated line, and power cycle the unit. The sensor may have failed. Since the external probe is not serviceable, it's necessary to replace it
20002	ERROR SENSOR TEMPERATURE PROBE 2	The value of the temperature sensor 2 of the external heated line is outside the acceptable limits	Check the connection of the external heated line, and power cycle the unit. The sensor may have failed. Since the external probe is not serviceable, it's necessary to replace it
20003	ERROR SENSOR TEMP VPR 1	The value of the temperature sensor of the evaporation tube is outside the acceptable limits	The unit requires a service event, please contact your service center
20004	ERROR SENSOR TEMP VPR 2	The value of the temperature sensor of the evaporation tube is outside the acceptable limits	The unit requires a service event, please contact your service center

20005	ERROR EXTERNAL PROBE HEATING TIMEOUT	This warning is set when the Externl Probe fails to warm up in the maximum time. It can be defective or not connected properly	Check the connection of the external heated line, and power cycle the unit. The sensor may have failed. Since the external probe is not serviceable, it's necessary to replace it
20006	ERROR VPR HEATING TIMEOUT	This warning is set when the internal VPR fails to warm up in the maximum time. It can be defective	The unit requires a service event, please contact your service center
20007	ERROR FAN 1	This warning is set when the speed of Fan 1 is low. This typically indicates a faulty fan	Please be sure the fan can spin freely and no object from the outside is blocking the fan. If this doesn't solve the issue, the unit requires a service event, please contact your service center
20008	ERROR FAN 2	This warning is set when the speed of Fan 2 is low. This typically indicates a faulty fan	Please be sure the fan can spin freely and no object from the outside is blocking the fan. If this doesn't solve the issue, the unit requires a service event, please contact your service center

20009	ERROR POWER SUPPLY VOLTAGE	This warning is set when the power supply of the electronic board is outside the acceptable voltage limits	The unit or the external power supply adapter, requires a service event, please contact your service center
20010	ERROR RTC	This warning is set when the real time clock isn't responding to commands or has a generic error	The unit requires a service event, please contact your service center
20011	ERROR RTC BATTERY	This warning is set when the real time clock battery is out of power or during initialization the RTC wasn't set up correctly	The unit requires a service event, please contact your service center
20012	ERROR ENV SENSOR	This warning is set when the ambient sensor is broken, or the communication failed	The unit requires a service event, please contact your service center
20013	ERROR SD CARD	This warning occurs when the internal durable recording memory is not present or defective	The unit requires a service event, please contact your service center
20014	ERROR APB COM	This warning is set when the communication to the APB bench failed	The unit requires a service event, please contact your service center

20015	ERROR CLEAN AIR CHECK	This warning occurs when the clean air check wasn't passed	Please redo a clean air check procedure (automatically requested once per day before official test). For better insertion of probe tip into clean air check adapter please consider, from time to time, it may be useful to lubricate orings with vaseline or lithium grease. If it cannot be passed, please check clean air test adapter, external probe and water trap for leaks, and repeat test. Please also replace HEPA1 filter (supplies dilution air). If it's still not possible to pass the clean air test, please contact your service center
20016	ERROR SERVICE HEPA1	This warning is set when the service interval of the HEPA filter 1 expired	Replace the HEPA filter 1 with an original consumable
20017	ERROR SERVICE HEPA2	This warning is set when the service interval of the HEPA filter 2 expired	Replace the HEPA filter 2 with an original consumable

20018	ERROR SERVICE ALCOHOL	This warning is set when the IPA external tank is almost empty. When it's completely empty the device stops working	Please obtain from your service center an original consumable kit for IPA. Please refill the external tank, following the instructions described in this manual
20019	ERROR SERVICE INTERVAL	This warning is set when the overall service interval expired	The unit requires a service event, please contact your service center
20020	ERROR TOTAL SYSTEM OVERCURRENT	This warning is set when the total current drawn by the system, exceeds the allowed limit	The unit requires a service event, please contact your service center
20021	ERROR EXTERNAL PROBE OVERCURRENT	This warning is set when the current drawn by the external probe exceeds the allowed limit	This can be caused by internal electronics or external probe. The unit requires a service event, please contact your service center
20022	ERROR VPR OVERCURRENT	This warning is set when the current drawn by the internal Volatile Particles Remover exceeds the allowed limit	The unit requires a service event, please contact your service center

2023	ERROR AMBIENT TEMPERATURE TOO LOW	This warning is set when the ambient temperature is too low	Please be sure that the device is operated according to it's limits for temperature. If this doesn't solve the issue, the unit requires a service event, please contact your service center
2024	ERROR AMBIENT TEMPERATURE TOO HIGH	This warning is set when the ambient temperature is too high	Please be sure that the device is operated according to it's limits for temperature. If this doesn't solve the issue, the unit requires a service event, please contact your service center
2025	ERROR EXTERNAL PROBE TEMPERATURE TOO LOW	This warning is set when the temperature of the external probe is too low	Please be sure that the device is operated according to it's limits for temperature. If this doesn't solve the issue, the unit requires a service event, please contact your service center

Maintenance form | HEPA Filter replacement

Date	Maintenance technician identification	Maintenance technician signature and stamp

Maintenance form | HEPA Filter replacement

Date	Maintenance technician identification	Maintenance technician signature and stamp

Maintenance form

Date	Result of check (pass / fail)	Maintenance technician identification	Maintenance technician signature and stamp

Maintenance form

Date	Result of check (pass / fail)	Maintenance technician identification	Maintenance technician signature and stamp

Maintenance form | Other checks/maintenance/repairs

Job	Date	Result of check (pass / fail)	Maintenance technician identification	Maintenance technician signature and stamp

Maintenance form | Other checks/maintenance/repairs

Job	Date	Result of check (pass / fail)	Maintenance technician identification	Maintenance technician signature and stamp