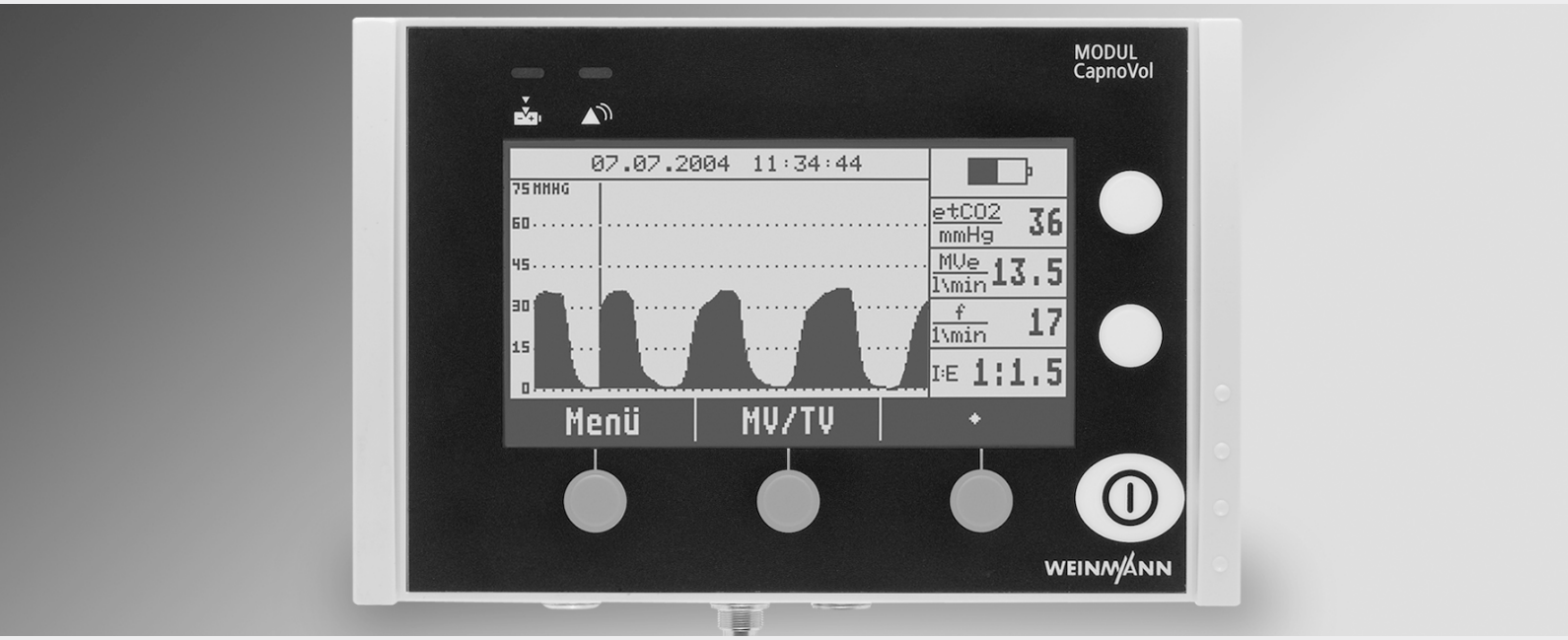
emergency



MODUL CapnoVol

Device for measuring respiratory parameters

WM 22400
WM 22440
WM 22460

Servicing and repair instructions

WEINMANN
medical technology

Content

Introduction

WEINMANN has been developing, manufacturing and selling devices for emergency medicine, for oxygen therapy and for inhalation therapy for decades.

The objective of these servicing and repair instructions is to make you, **an expert**, familiar with the function, technology and repair of MODUL CapnoVol. In conjunction with the training session you have already received from WEINMANN, you are now considered a "trained expert specialist", so can properly instruct your customers, eliminate faults independently and perform the function checks specified in the instructions for use and any repairs in accordance with these servicing and repair instructions.

In the event of a claim under warranty, send MODUL CapnoVol to WEINMANN.

Please enclose the end-customer's proof of purchase (invoice) to enable us to process warranty or goodwill claims.

Repairs and servicing work may only be performed by WEINMANN or by trained specialists.

You are responsible for repairs carried out yourself and for guaranteeing them!

Use only genuine WEINMANN replacement parts for repairs.

Please remember:
your customer trusts you and is relying on your capability in the same way as you rely on WEINMANN.

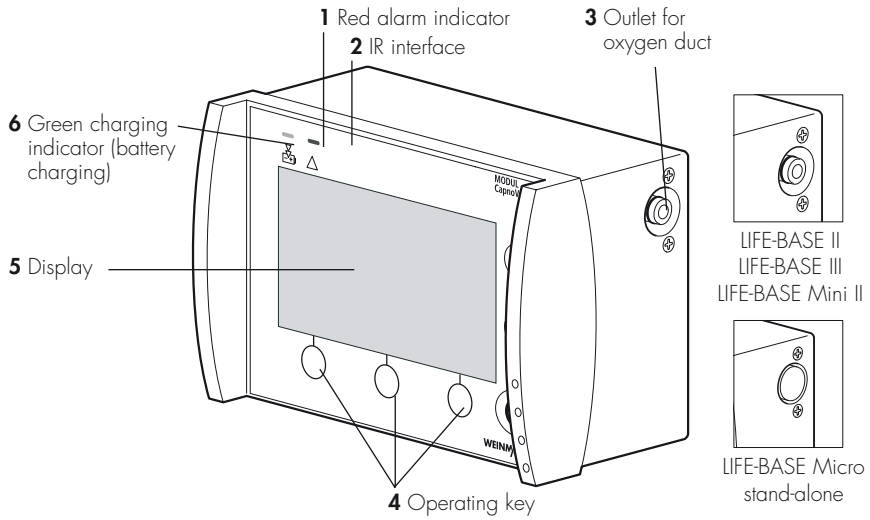
Note

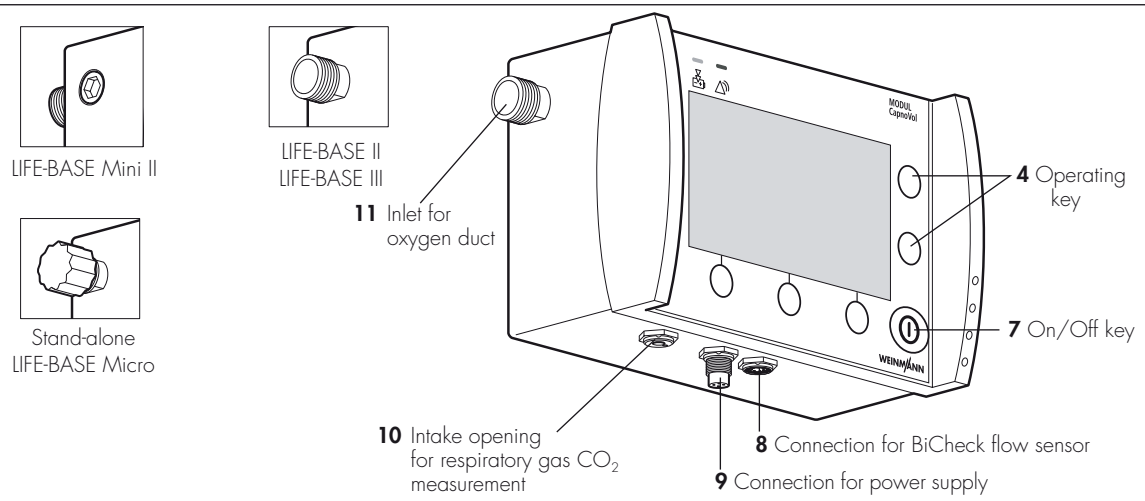
The following information can be found in the instructions for use for MODUL CapnoVol:

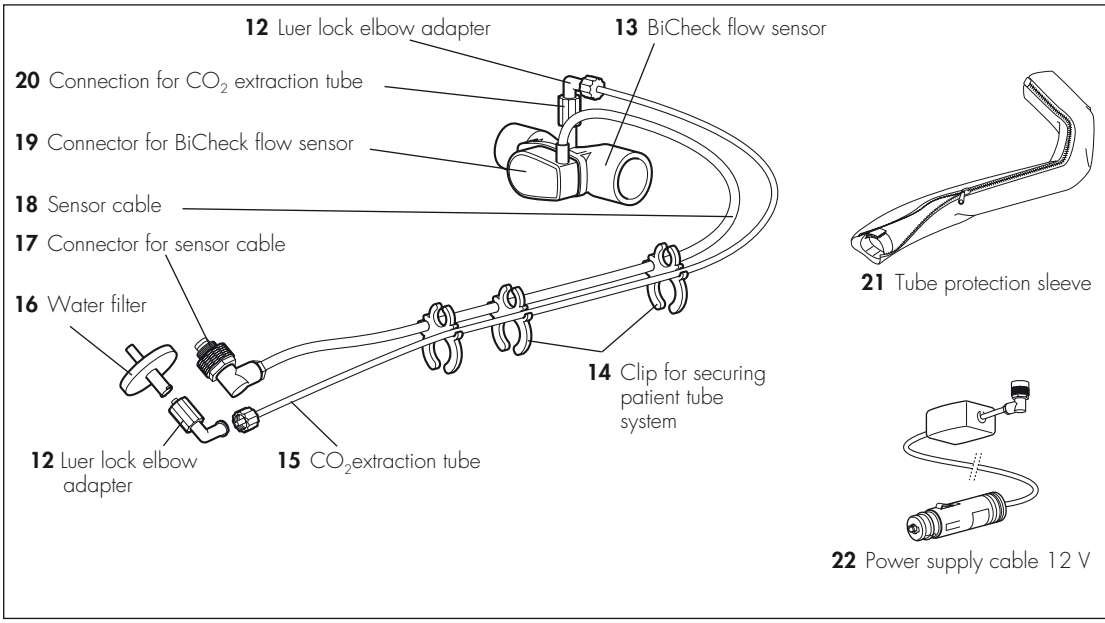
- safety instructions
- assembly of accessories
- operating MODUL CapnoVol
- hygiene treatment
- function check
- warranty

1. Overview

MODUL CapnoVol







2. Description of device

2.1 Intended purpose

MODUL CapnoVol is a device for measuring respiratory parameters on exhalation.

The following are shown as figures:

- tidal volume (TVe)
- minute volume (MVe)
- respiratory frequency (AF)
- ratio of inspiration to exhalation (I:E)
- carbon dioxide concentration at the end of exhalation ($etCO_2$)

The following is shown in the form of a graph:

- current carbon dioxide concentration (capnogram).

MODUL CapnoVol can be used in a permanent location or on a mobile basis both indoors and outdoors.

2.2 Description of function

Measuring volume flow

Volume flow is measured on the principle of heat energy transmission (hot-wire method). This method measures the time taken to transfer heat from one central transmission wire to the lateral reception wires. Tidal volume (TV), minute volume (MV), respiratory frequency (AF) and the ratio of inspiration to exhalation (I:E) are determined from the values measured.

Sampling and gas analysis

A small pump inside the device extracts respiratory gas from the patient's respiratory flow at an adjustable gas flow rate (secondary flow method). The respiratory gas is fed to a measuring cell via a water filter. The CO_2 concentration of the dry gas is determined in the measuring cell. The measuring method used in the process is based on infrared absorption spectrometry.

CO_2 measurement and display of measured values

The patient's exhalation gas is dried for technical reasons before it enters the measuring device. So that the measured values still reflect actual conditions in the moist respiratory air, MODUL CapnoVol incorporates the water vapor partial pressure of moisture-saturated air in its calculation. The value displayed thus includes the water vapor in the exhaled gas (water vapor correction).

Several measured values are determined for each breath. The CO_2 concentration measured can be displayed in vol %, in mmHg or in kPa. Barometric altitude pressure is taken into account and compensated accordingly.

The CO_2 concentration determined is shown in the form of a capnogram. The maximum value at the end of exhalation is called the end-tidal CO_2 value ($etCO_2$) or also final concentration of carbon dioxide on exhalation. It is displayed as a figure.

3. Hygiene treatment

3.1 Intervals

You must subject MODUL CapnoVol and any accessories used to a hygiene treatment after every use.

After that, always perform a function check (see Section "8. Function check" in the instructions for use).

3.2 MODUL CapnoVol and sensor cable

Warning!
Never immerse MODUL CapnoVol or the sensor cable in disinfectant or other liquids, otherwise damage to the device and thus a hazard to users and patients may result.

MODUL CapnoVol and the sensor cable are kept clean by simply washing or wiping with disinfectant.

We recommend the use of suitable gloves (e.g. household or disposable gloves) for disinfecting.

See the instructions for use for the disinfectant used. For disinfecting by wiping, we recommend TERRALIN.

Parts	**Cleaning**	**Rinse cycle in a washing machine**	**Disinfecting**	**Sterilizing**
Housing for MODUL CapnoVol	Wipe with a damp cloth	Not permitted	Disinfect by wiping	Not permitted
Sensor cable with securing clips	Wipe with a damp cloth	Not permitted	Disinfect by wiping	Not permitted

3.3 Individual parts

Individual parts should be cleaned, disinfected or sterilized as listed in the following table.

We recommend the use of suitable gloves (e.g. household or disposable gloves) for disinfecting.

See the instructions for use for the disinfectant used. We recommend GIGASEPT FF for disinfecting by immersion.

Warning!
The BiCheck flow sensor 13 may not be flushed through with a high-pressure water jet or compressed air, as this may damage the measuring wires.

Parts	**Cleaning**	**Rinse cycle in a washing machine**	**Disinfecting**	**Sterilizing**
BiCheck flow sensor **13** (1)	In hot water with a mild detergent	Wash in a dishwasher at 65 °C. Then dry thoroughly.	Disinfect by immersing (2)	Steam-sterilize (3)
Tube protection sleeve **21**	Wipe with a damp cloth	Rinse cycle 30 °C, no spin	Possible during rinse cycle (4)	Not permitted
CO_2 extraction tube **15**	Not permitted, as disposable			
Water filter **16**				
Luer lock elbow adapter **12**				

(1): You must remove sensor cable **18**, CO_2 extraction tube **15** and the ventilation tube from the BiCheck flow sensor **13**, as these cannot be autoclaved.

(2): Immerse the component in dilute solution so that all surfaces, both internal and external, are wetted without bubbles. Allow full time for product to take effect. Following disinfecting, rinse all parts inside and out thoroughly with distilled water and then leave them to dry.

(3): Hot steam sterilization with devices to EN 285, temperature 134 °C, retention time 5 minutes.

(4): Add a suitable disinfectant additive to the rinse cycle (30 °C in the washing machine, no spin).

4. Test the device

Important!
Perform the following test on the device in accordance with test instruction WM 22401 after every repair and on servicing. The device test can also be used for troubleshooting.

If you find faults or deviations from specified values during testing, you may not use MODUL CapnoVol until the faults have been rectified.

The potential causes of the fault and how to eliminate the malfunction can be found in Section "6. Troubleshooting" on page 20.

We recommend always keeping the following in stock:

- replacement seals for device connections WM 22468, WM 22469
- Ni-Mh battery WM 22458

4.1 Test material required

- Ventilation device, e.g. MEDUMAT with the associated test set, e.g. WM 15382
- KAL Check gas WM 97061 with pressure reducer WM 97062
- PC with installed software WM 22480 from the following set WM 15681
- Set of IR adapter plus software and bracket WM 15681
- Power supply cable, 12 V, WM 22895
- Connecting cable for flow measurement WM 22420
- Measuring and leaktightness adapter WM 22868
- Current measuring adapter MODUL CapnoVol WM 22817
- CO_2 absorber WM 22172
- Set for testing power supply MEDUMAT/MODULES WM 15440
- Set of tools for MEDUMAT Standard WM 15349 or syringe set WM 15359
- Volume flow measuring device (e.g. PF-300), breath volume measurement with O_2 in STP mode
- Digital multimeter
- Patient tube with patient valve
- Pall filter

4.2 Preparation for testing

1. Fit MODUL CapnoVol together with a MEDUMAT ventilation device to a LIFE-BASE carrying system.
2. Connect the external power supply.
3. Connect sensor cable **18**.
4. Connect 12 V power supply cable **22**.

5. Connect the power supply testing set MEDUMAT/MODULES WM 15440.
6. Connect CO_2 extraction tube **15** with water filter.

4.3 Enter device data

Enter the device number and the date of manufacture in the test record.

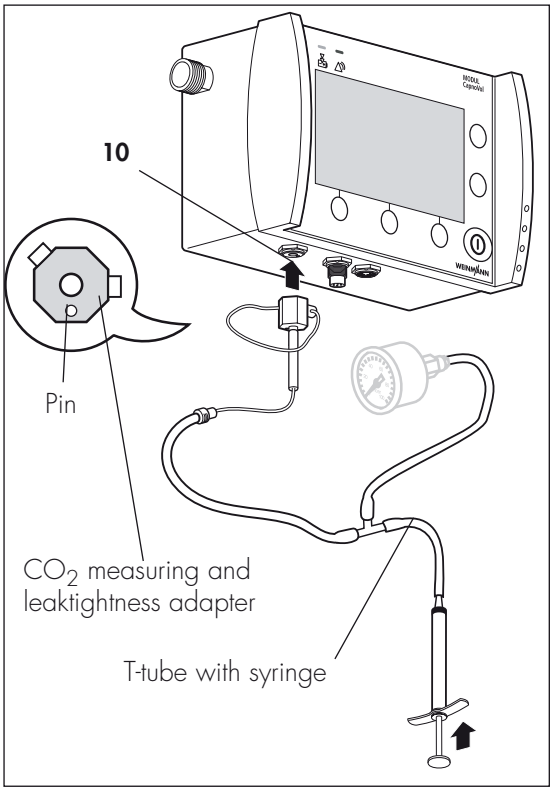
4.4 Test leaktightness

4.4.1 Test oxygen duct

1. Apply a pressure of 6 bar to the inlet side of both devices when they are switched off.
2. Shut off outlet pressure.
   Requirement: the drop in pressure must be ≤ 200 mbar/min.

4.4.2 Test CO_2 measuring section

1. Push the CO_2 measuring and leaktightness adapter onto the intake opening for respiratory gas CO_2 measurement **10**. In the process, ensure that the CO_2 measuring and leaktightness adapter is correctly positioned (the pin must be in the position shown in relation to the device).
2. Put the T-tube with syringe from set WM 15349/WM 15359 onto the CO_2 measuring and leaktightness adapter.
3. Detach the test pressure gage from the T-tube.
4. Connect the volume flow measuring device at the same point.
5. Push the CO_2 measuring and leaktightness adapter against the intake opening for respiratory gas CO_2 measurement **10** of the device to ensure leaktightness.
6. Apply a pressure of 60 mbar to the intake opening for respiratory gas CO_2 measurement **10** with the device switched off.
   Requirement: the drop in pressure must be ≤ 2 mbar/min.



4.5 Test device self-test

1. Ensure that water filter **16** has been correctly fitted before switching on.
2. Switch on MODUL CapnoVol.
   Requirement: after 10 seconds, there should not be any system alarm and the capnometry pump should have audibly started up.

4.6 Test the infrared interface

1. Align the infrared sensor above the infrared interface of MODUL CapnoVol.
2. Start the "CAPNOVOL.EXE" program as described in "Manual CapnoVol Software.pdf" on CD WM 22480.
3. Follow the instructions for reading out measured data from MODUL CapnoVol.
   Requirement: the measured data read out must result in meaningful characters as described in Section 4 "Measured data file" on CD WM 22480.

4.7 Test display elements

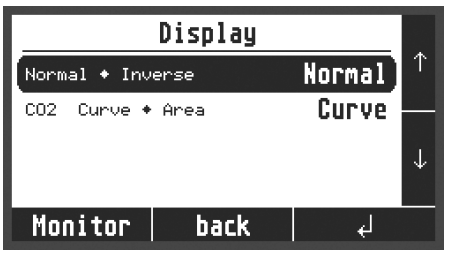
4.7.1 Test power supply LED, alarm LED and alarm transmitter

1. Switch on the device.
2. Switch off the device and then switch back on.
   Requirement: the green and red LEDs must light up one after the other. At the same time, the alarm transmitter must be triggered once.

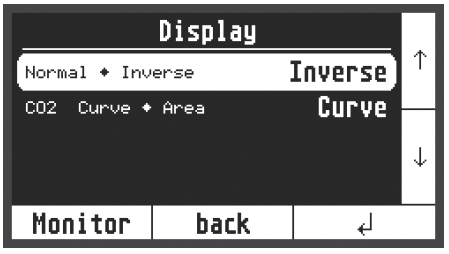
4.7.2 Test display

1. Press the "Menu" key.
2. Use the arrow keys to select the menu item "Default settings". Press the ↵ key.
3. Use the arrow keys to select the menu item "Display". Press the ↵ key.

4. Use the arrow keys to select the menu item "Normal Inverse". Press the ↵ key.



5. You can now use the **+** and **–** keys to switch the display between normal display and inverse display. Confirm your entries in each case by pressing ↵.
Requirement: no image elements may be permanently on or off in either display.

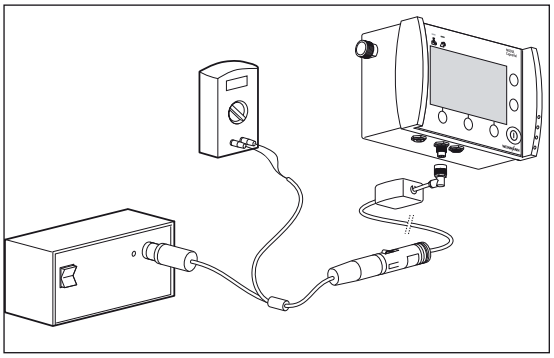


4.8 Test input elements

Press all the operating keys of MODUL CapnoVol within the menu.
Requirement: all keys are detected correctly and initiate the appropriate actions.

4.9 Test battery charging

1. Connect current measuring adapter MODUL CapnoVol WM 22817, 12 V power supply and multimeter to the device.
2. Switch on MODUL CapnoVol.
3. Switch on the power supply and measure current consumption in charging mode.



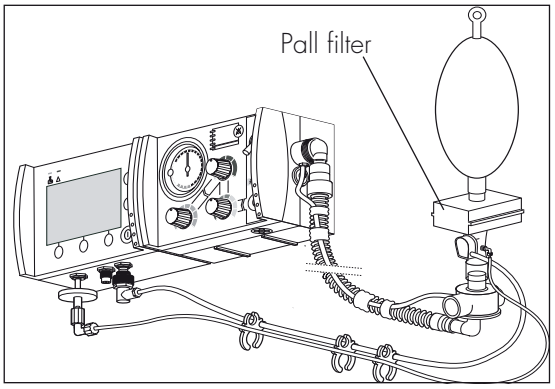
Requirement: charging current at 12 V must be 1.7 A ± 0.2 A.
The power supply of mains charging devices WM 2645 and WM 2610 is higher (13.8 V). If these devices are used, the charging current should be 1.4 A ± 0.2 A.

Note

If the battery is fully charged, the device will not switch to charging mode. In other words, the above-mentioned requirement cannot be met. In this event, leave the device switched on for approx. 10 minutes and then repeat the test.

4.10 Test flow measurement

1. Connect MODUL CapnoVol together with a MEDUMAT ventilation device to BiCheck flow sensor **13**.
2. Set breath volume on the MEDUMAT (f = approx. 20/min, AMV = approx. 9 l/min; pressure limit p = 60 mbar).
3. Switch on the compressed gas supply.
4. Switch on MEDUMAT.
5. Put the Pall filter on the test bag (for filtering flow peaks).
6. Plug BiCheck flow sensor **13** between the patient valve and the test bag with the Pall filter.
7. Start ventilating with the MEDUMAT.
   Requirement: MODUL CapnoVol must display an exhalation volume TVe = 450 ± 70 ml.



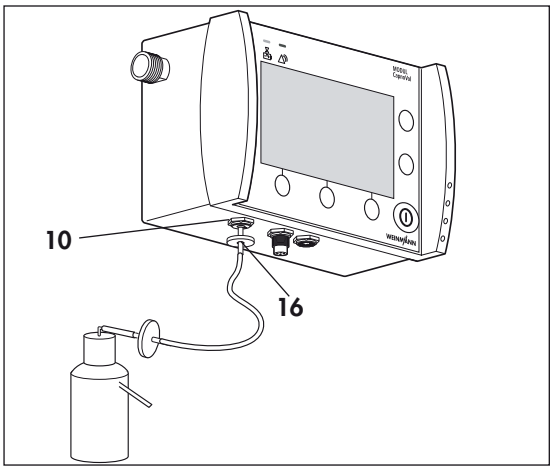
4.11 Test occlusion alarm

1. Take CO_2 extraction tube **15** off MODUL CapnoVol and seal the water filter with a finger.
   Requirement: the device displays an occlusion alarm.
2. Take your finger off the water filter again.
   Requirement: the device no longer displays an occlusion alarm.

4.12 Test CO_2 measurement

4.12.1 Preparation

1. Plug water filter **16** onto the intake opening for respiratory gas CO_2 measurement **10**.
2. Connect CO_2 absorber WM 22172 to water filter **16**.
3. Press the CO_2 absorber at least 20 times to ensure that CO_2-free air is in the system.



4.12.2 Method

Important!

Use only the following components:

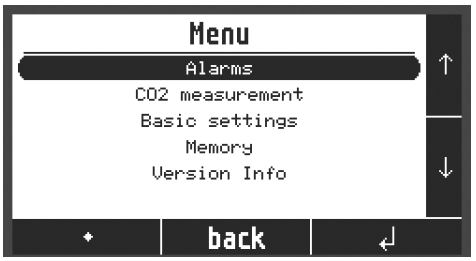
- the KAL Check gas (WM 97061) supplied by WEINMANN
- a suitable pressure reducer (WM 97062)

Observe an ambient temperature of approx. 20 °C to guarantee adequate precision in this test. It is essential to follow the instructions for use and the warning information enclosed with the KAL CHECK gas.

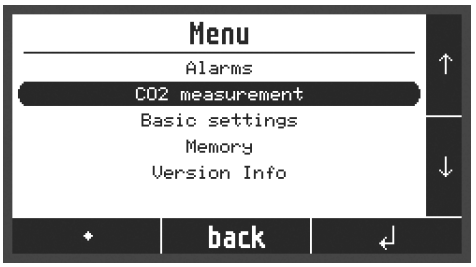
1. Switch on the device.

   Leave MODUL CapnoVol to run for approx. 15 minutes in normal mode.

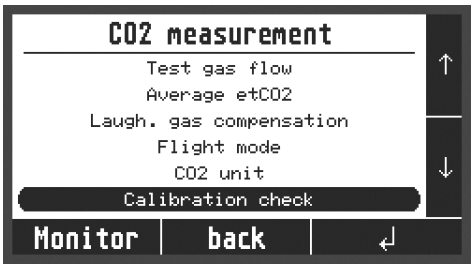
2. Press the "Menu" key. The main menu appears.



3. Use the arrow keys to select the menu item "CO2 measurement".
4. Press the ↵ key to reach the submenu for CO_2 measurement.



5. Use the ↓ key to select the "Calibration check" submenu.
6. Press the ↵ key to reach the submenu.
7. Disconnect CO_2 extraction tube **15** from BiCheck flow sensor **13**.



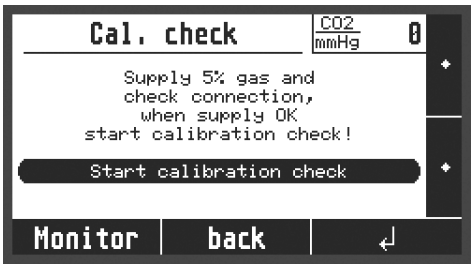
8. Connect CO_2 extraction tube **15** to the Y–piece of the KAL CHECK device.

   Important: the other end of the Y-piece must remain open.

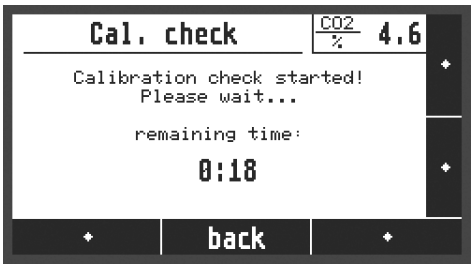
9. Open the valve of the KAL CHECK gas canister far enough for the ball on the flow measuring device to be between the first and second marking ring.

   Important: the gas canister must be upright for this.

10. Press the ↵ key to start the calibration check.



Remaining time is displayed while the calibration check is performed.



When the calibration check has been completed successfully, you will receive the corresponding message.

4.13 Test system clock

1. Check whether the date and time are correct in the display.
2. If necessary, set date and time as described in the instructions for use, Section "5.4 Menu default settings".

4.14 Documentation

1. Record performance of the test on the repair and test record (copy of the form).
2. Following any repairs, send a copy of the record to WEINMANN.

5. Servicing

Note
After servicing and repair, the device must be tested as described in Section "4. Test the device" on page 8.

We recommend having measures such as servicing and repair work carried out by the manufacturer, WEINMANN, or by specialists expressly authorized to do so.

5.1 Intervals and scope

Every 2 years

Servicing

Every two years, MODUL CapnoVol (incl. BiCheck flow sensor, sensor cable and CO_2 extraction tube) must be subjected to servicing by the manufacturer or by specialists expressly authorized to do so by the manufacturer.

Servicing includes:

- hygiene treatment of the devices (see "3. Hygiene treatment" on page 6)
- replacement of wear parts/parts for compulsory replacement (see "8.2 Parts to be changed when servicing" on page 36)
- a check that the equipment is complete
- a visual inspection for:
  - mechanical damage
  - labeling of operating keys
  - all external tubes for damage
- replacement of defective parts
- calibration of the CO_2 sensor
- a complete test of device functions and displays in accordance with Section "4. Test the device"

Safety check

Every two years the MEDUMAT ventilation device (incl. patient valve and tube system) must be subjected to a safety check [Sicherheitstechnische Kontrolle] as per §6 of the Betreiberverordnung [German regulations governing operators] in conjunction with servicing. You can also have the safety check performed by the manufacturer, WEINMANN.

Every 4 years

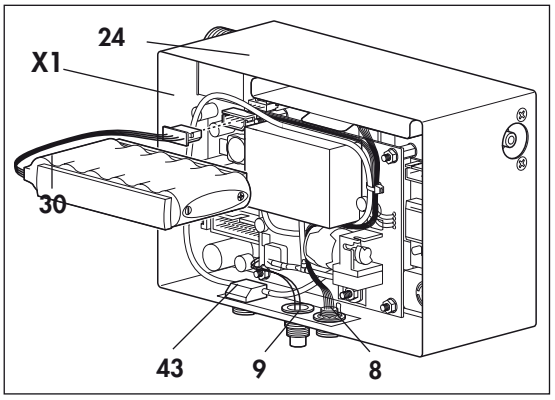
Have oxygen fittings (e.g. pressure reducer, modules) serviced by the manufacturer or by specialist staff authorized by the manufacturer.

Every 10 years

Repeat testing of conventional steel or aluminum oxygen cylinders by TÜV [independent inspection body]. You can read the test date off the shoulder of the cylinder.

5.2 Change battery

1. Open the device as described in "7.2 Open the device" on page 23.
2. Undo cable connection **X1** on the main circuit board.
3. Remove battery **30** from the housing.
4. Insert a new battery.
5. Restore cable connection **X1**.
6. Close the housing as described in "7.3 Close the device" on page 24.



5.3 Change O-rings of plug connection

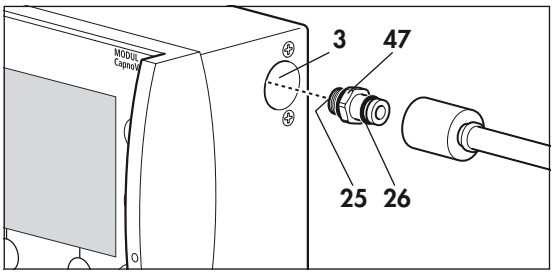
Materials and tools required

- Watchmaker's screwdriver (cleaned with spirit)
- Tubular hexagon box wrench 12 mm

1. Use the 12 mm tubular hexagon box wrench to unscrew plug connection **47** from oxygen duct outlet **3**.
2. Lift O-rings **25** and **26** carefully out of their grooves using the cleaned watchmaker's screwdriver.

Be careful not to damage the grooves.

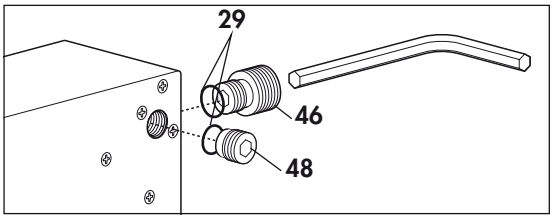
3. Clean the grooves with a dry cloth.
4. Push the new O-rings **25** and **26** carefully into the relevant groove. Do not use a tool for this.
5. Screw the plug connector back into oxygen duct outlet **3**.



5.4 Change O-rings of oxygen duct inlet

Materials and tools required

- Watchmaker's screwdriver (cleaned with spirit)
- Allen key, 5 mm



1. Unscrew threaded connection **46** from oxygen duct inlet **11**.
2. Unscrew sealing screw **48** on the rear of the device using the Allen key.
3. Lift the O-rings **29** carefully out of the two connections using the cleaned watchmaker's screwdriver.

Be careful not to damage the connections.

4. Clean the connections using a dry cloth or a cloth moistened with clean water.
5. Push the new O-rings carefully into the connections in question. Do not use a tool for this.
6. Screw sealing screw **48** back into the connection on the rear of the device.
7. Use the Allen key to screw threaded connection **46** onto oxygen duct inlet **11**.

5.5 Calibrate O_2 sensor

5.5.1 Perform calibration

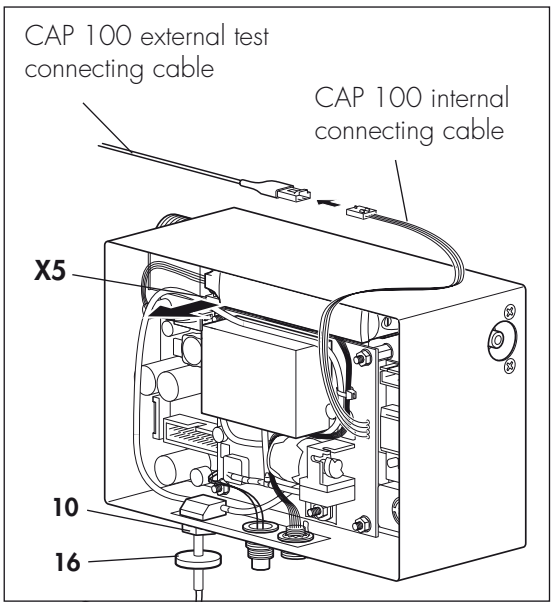
Materials and tools required

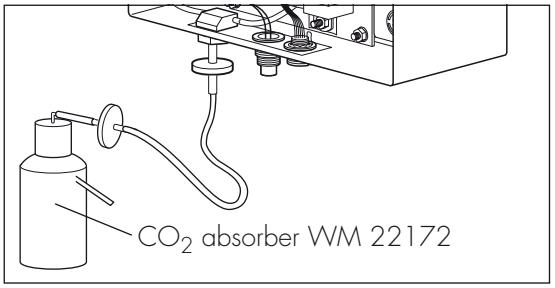
- Service set for MODUL CapnoVol WM 15743 consisting of:
  - level converter WM 22825
  - calibration software WM 22919
  - CAP 100 external test connecting cable WM 22855
  - Plug-in power supply unit WM 22859
- CO_2 absorber WM 22172
- CO_2 gases
  - 2.5 % CO_2 ± 0.2 % in O_2
  - 5 % CO_2 ± 0.2 % in O_2
  - 9.7 % CO_2 ± 0.2 % in O_2

- PC with Windows XP operating system or higher, free serial port and installed calibration software WM 22919.

1. Start calibration software WM 22919.
2. Open the device as described in "7.2 Open the device" on page 23.
3. Push water filter **16** onto the intake opening for respiratory gas CO_2 measurement **10**.
4. Push the latch and take the connector of the CAP 100 internal connecting cable off connection **X5** of the main circuit board.
5. Connect the CAP 100 internal connecting cable to the CAP 100 external test connecting cable.
6. Connect the CAP 100 external test connecting cable to level converter WM 22825
7. Plug power supply WM 22825 into a socket.

   Requirement: the pump must be audibly running.
8. Push CO_2 absorber WM 22172 onto water filter **16** at the intake opening for respiratory gas CO_2 measurement **10**.
9. Follow the instructions in the calibration software (see Help file in calibration software WM 22919).





Note

The flow rate supplied should be at approx. 0.5 l/min.

10. Disconnect the external test connecting cable for the level converter from the CAP 100 internal connecting cable.

5.5.2 After successful calibration

1. Shut off the gas cylinders.
2. Take the CO_2 absorber off MODUL CapnoVol.
3. Close the device as described in Section "7.3 Close the device" on page 24.
4. Test the device (see "4. Test the device" on page 8).

5.6 Storage

If MODUL CapnoVol is not used for a prolonged period, we recommend the following procedure.

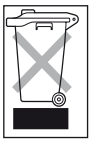
1. Clean and disinfect (see "3. Hygiene treatment" on page 6).
2. Store MODUL CapnoVol dry.

Important!

Even if devices are in storage, servicing intervals must still be maintained, otherwise the device may not be used when it is removed from storage.

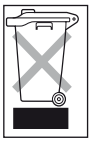
5.7 Disposal

5.7.1 Device



Do not dispose of the device in domestic waste. To dispose of the device properly, contact a licensed, certified electronic scrap disposal merchant. This address is available from your environment officer or from your local authority.

5.7.2 Batteries



Used batteries may not be disposed of with domestic waste. Contact WEINMANN or your local authority waste disposal department.

6. Troubleshooting

Fault	Cause of fault	Remedy
Occlusion alarm	Intake tube kinked or blocked	Remove kink or blockage
Measuring values falsified	Intake tube too long	Use only accessories recommended by WEINMANN
	Intake tube not approved by WEINMANN	
	Filter too large	
	Water filter exhausted	Put in new water filter
	Interference with an electrosurgical unit	Maintain an adequately large distance from potential sources of interference
	X-ray radiation	
	Radiation from an MRT device	
	Radiation from a mobile phone	
	Calibration disrupted by a CO_2 source	Do not position device in the immediate vicinity of the exhalation flow of patients/other people
	Faulty CO_2 calibration	Repeat CO_2 calibration (Section 5.5, Page 17)
Device in charging station but not working.	External power supply or supply cable to power supply defective	Check power supply cable to wall bracket; change fuse of power supply cable if necessary
	Fuse F1 (2.5 A) on main circuit board defective	Replace fuse F1 (2.5 A)
Device in charging station and working, battery not charging	Fuse F2 (2 A) on main circuit board defective	Replace fuse F2 (2A)
Device cannot be switched on or off	External power supply or supply cable to power supply defective	Check power supply cable to wall bracket; change fuse of power supply cable if necessary
	Front film defective	Replace front film (Section 7.12, Page 35)
	Display defective	Replace display circuit board (Section 7.9, Page 32)
	Ribbon cable come loose or defective	Plug in ribbon cable correctly (Section 7.3, Page 24)
		Replace top part of housing (Section 7.11, Page 34)
		Replace main circuit board (Section 7.5, Page 26)
	Battery defective	Replace battery (Section 5.2, Page 16)
Display remains dark, device working	Backlighting defective	Replace display circuit board (Section 7.9, Page 32)

No display during self-test	Electronics fault	Switch off and switch back on
		Replace main circuit board (Section 7.5, Page 26)
Alarm transmitter (beep) does not sound	Alarms are deactivated	Switch on alarms
	Electronics fault	Replace main circuit board (Section 7.5, Page 26)

7. Repair information and repair instructions

7.1 General

Only perform repairs to MODUL CapnoVol at an ESD workstation!

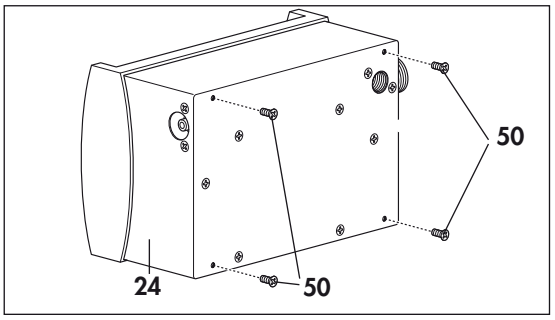
- **Follow the safety instructions in the instructions for use for MODUL CapnoVol.**
- Any handling of this device assumes in-depth knowledge and observance of the instructions for use and of the servicing and repair instructions.
- Only perform repairs described in these servicing and repair instructions. This is the only way to guarantee that MODUL CapnoVol works perfectly.
- Always perform a test after any repair or servicing work (see "4. Test the device" on page 8).
- If you replace components or individual parts, use only genuine WEINMANN replacement parts.
- **Note**
  The item numbers listed in the text which follows are identical to the item numbers in the replacement partslist on Page 35 and in the overview on Page 4.

7.2 Open the device

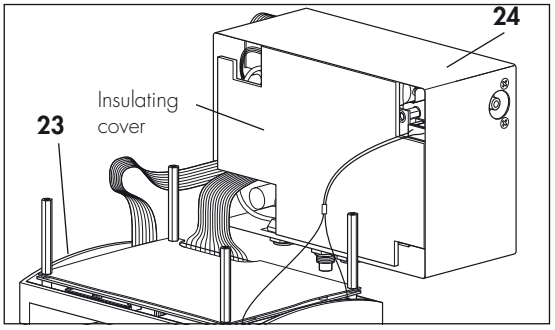
Materials and tools required

- ESD workstation
- Phillips screwdriver, size 2
- Pointed pliers

1. Place the device on a non-slip surface and unscrew the 4 screws **50** from bottom part of the housing **24** .

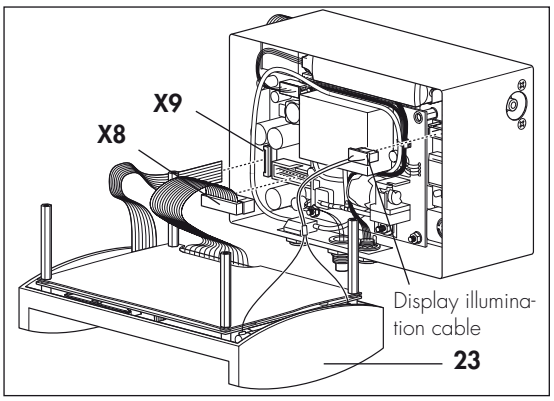


2. Carefully pull off top part of the housing **23** and swing it away.
3. Pull the insulating cover out of the inside of the device.
   Note
   The insulating cover is glued. If the insulating cover (WM 22387) is damaged when pulled out, it must be replaced before the device is closed.



4. Take the display illumination cable connector off the main circuit board.
5. Take connector **X8** off the main circuit board.
6. Undo the ribbon cable from latch **X9**: to do so, pull up the top part of the latch. You can then pull out the cable.

   Warning!
   Ensure that the main circuit board and the cable are not damaged in the process.

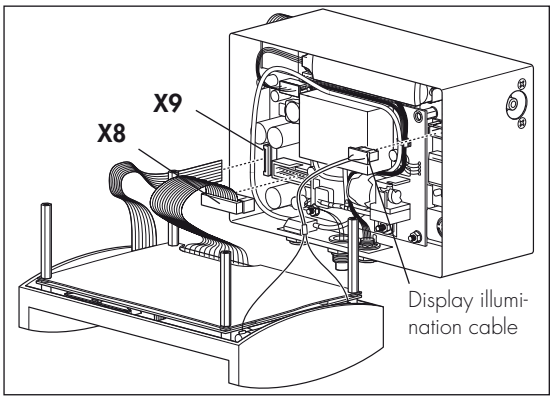


7.3 Close the device

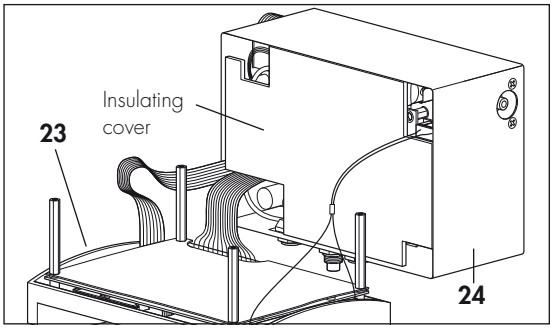
Materials and tools required

- ESD workstation
- Phillips screwdriver, size 2

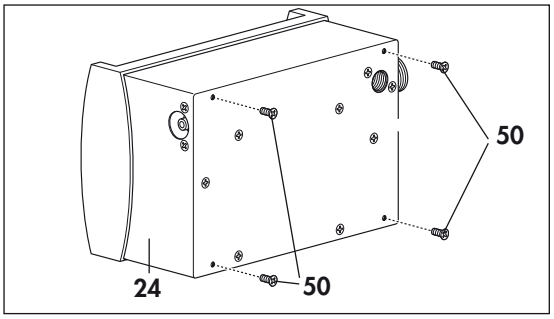
1. Push the ribbon cable into latch **X9** on main circuit board **31** and then push the top part of the latch back in.
2. Push connector **X8** onto the main circuit board **31**.
3. Push the display illumination connector onto main circuit board **31**.



4. Position the insulating cover back inside the device over the main circuit board and CAP 100 circuit board and glue it firmly in place with Loctite WM 14920.
5. Carefully put top part of housing **23** back onto bottom part of housing **24**.



6. Turn the device over and screw the 4 screws **50** into the bottom part of the housing.
7. Test the device (see "4. Test the device" on page 8).

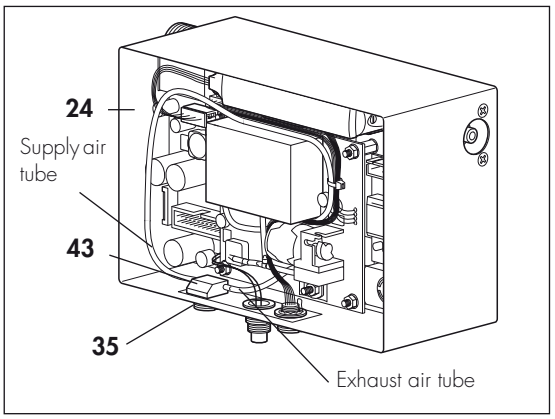


7.4 Replace the Capno connecting adapter

Materials and tools required

- ESD workstation
- Phillips screwdriver, size 2
- Ring spanner WAF 14 mm
- Open-ended spanner WAF 15 mm
- Pointed pliers

1. Open the device (see "7.2 Open the device" on page 22).
2. **Carefully** push supply air and exhaust air tubes off the connectors of the Capno connection adapter **43** using a screwdriver.
3. Fix Capno connection adapter **43** in position using an open-ended spanner.
4. Undo hexagon nut **35** of the Capno connection adapter **43** and push it inside the device.
5. Put a new Capno connection adapter **43** in the bore of bottom part of the housing **24**.
6. Fix Capno connection adapter **43** in position using an open-ended spanner.
7. Screw Capno connection adapter **43** tightly using hexagon nut **35**.
8. Push the supply air and exhaust air tubes back onto the Capno connection adapter **43**.
9. Close the device (see "7.3 Close the device" on page 23).
10. Test the device (see "4. Test the device" on page 8).

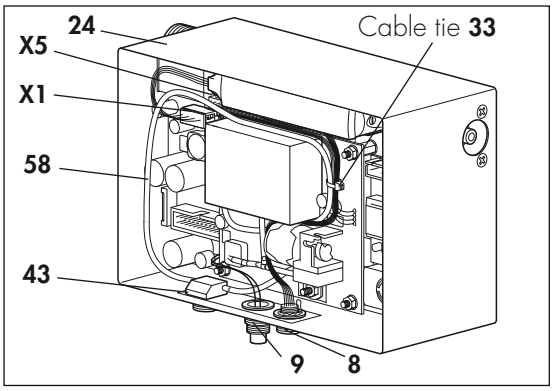


7.5 Replace Nafion tube

Materials and tools required

- Side nippers
- Cable tie

1. Open the device (see "7.2 Open the device" on page 22).
2. Undo the cable tie.
3. **Carefully** release Nafion tube **58** from the white connecting pieces
4. Replace Nafion tube **58.**
5. Secure the cables of the main circuit board and CAP 100 circuit board with a new cable tie **33**.



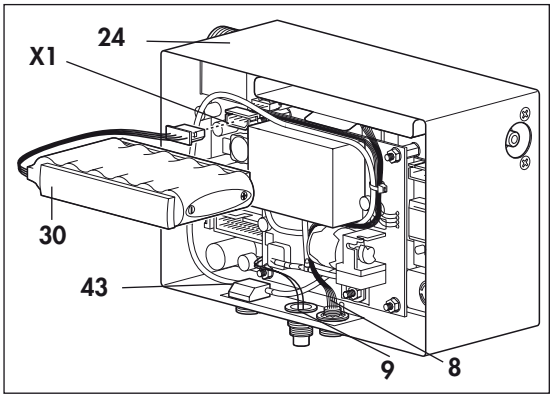
7.6 Replace main circuit board and/or CAP 100 circuit board

Materials and tools required

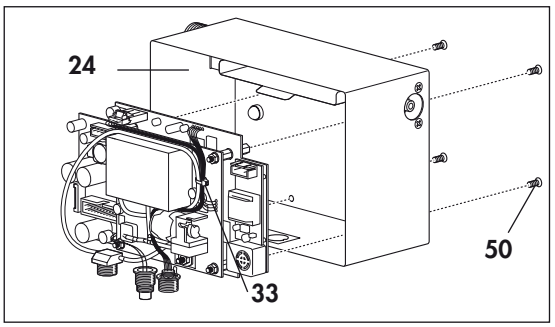
- ESD workstation
- Slot screwdriver, insulated, size 1
- Phillips screwdriver, size 2
- Open-ended spanner WAF 15 mm
- Ring spanner WAF 14 mm
- Tubular hexagon box wrench 5.5 mm
- Side nippers
- Cable tie
- Pointed pliers

7.6.1 Remove components

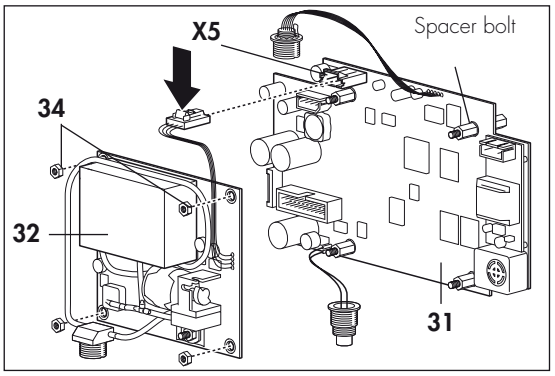
1. Open the device (see "7.2 Open the device" on page 22).
2. Take the connector of battery **30** off terminal **X1** on the main circuit board and take the battery out of the device.
3. Undo the nut of the connection for BiCheck flow sensor **8** and push the connection inside the device.
4. Fix Capno connection adapter **43** in position using an open-ended spanner.



5. Undo the nut of Capno connection adapter **43** and push the adapter inside the device.
6. Undo the nut of power supply connection **9** and push that inside the device.
7. Keep bottom part of the housing **24** with the open side facing downwards. In the process, hold the bottom part and both circuit boards steady in one hand and with the other, undo the four screws **50**.
8. Turn the bottom part of the housing over again and remove both circuit boards.
9. Cut open cable tie **33** using the side nippers.

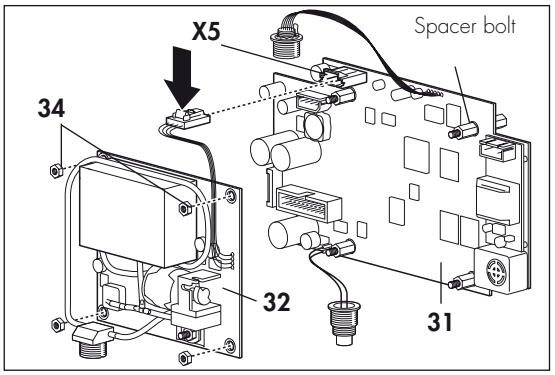


10. Push the latch and pull the connector out of connection **X5**.
11. Undo the four nuts **34**.
12. Take CAP 100 circuit board **32** off main circuit board **31**.
13. Remove the spacer bolts from the main circuit board and keep them safe. The spacer bolts are required for fitting the new circuit boards.



7.6.2 Fit new components

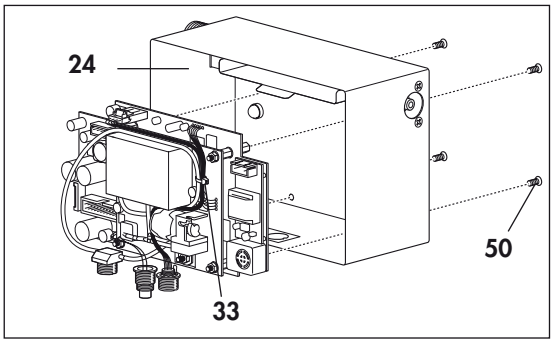
1. Note the serial numbers of the new main circuit board and/or the CAP 100 circuit board in the test record.
2. Wet the first two turns of the threads on the eight spacer bolts with Loctite WM 14920.
3. Screw the spacer bolts onto the new main circuit board.
4. Put CAP 100 circuit board **32** on main circuit board **31** and screw it up using the four nuts **34**.
5. Push the connector of the cable for CAP 100 circuit board **32** onto connection **X5**.
6. Tie the cables of CAP 100 circuit board **32** and of BiCheck flow sensor connection **8** together using a new cable tie **33**.



Caution!

Position cable tie **33** on the plug connection of the Nafion tube to ensure a secure hold.

7. Insert both circuit boards back in bottom part of the housing **24**.

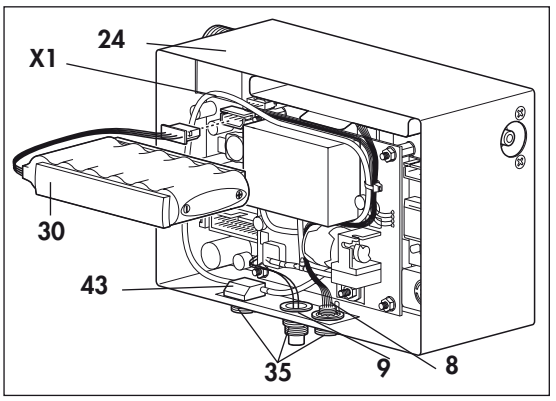


8. Hold bottom part of the housing **24** and the circuit boards in one hand, turn bottom part of the housing **24** over and screw in the four hexagon screws **50**.

Caution!

When fitting the power supply connection, the Capno connection adapter and the connection for the BiCheck flow sensor, ensure that the connections are correctly positioned in the corresponding ducts in the housing (groove and spring), otherwise the connections or the bottom part of the housing may be damaged.

9. Push power supply connection **9** into the corresponding bore of bottom of the housing **24** and screw it up with a hexagon nut **35**.
10. Push Capno connection adapter **43** into the corresponding bore of bottom part of the housing **24** and screw it up with a nut **35** as described in Section "7.4 Replace the Capno connecting adapter" on page 24.
11. Push BiCheck flow sensor connection **8** into the corresponding bore in the bottom of the housing and screw it up with hexagon nut **35**.
12. Put battery **30** in the bracket in the bottom of the housing and connect the connector of battery **30** to connection **X1** on the circuit board.
13. Close the device (see "7.3 Close the device" on page 23).
14. Test the device (see "4. Test the device" on page 8).



Note

Return the faulty circuit boards to WEINMANN.

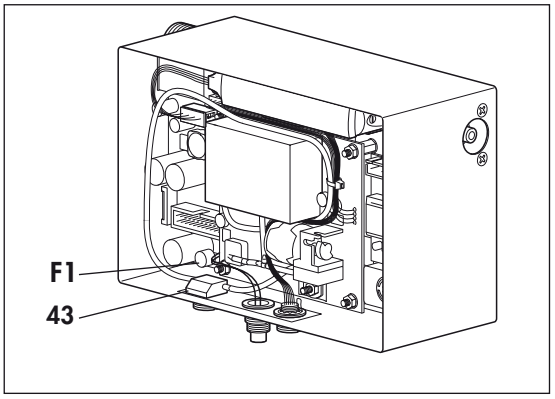
7.7 Replace fuses

Materials and tools required

- ESD workstation
- Phillips screwdriver, size 2
- Ring spanner WAF 14 mm
- Open-ended spanner WAF 15 mm
- Pointed pliers

7.7.1 Replace fuse F1

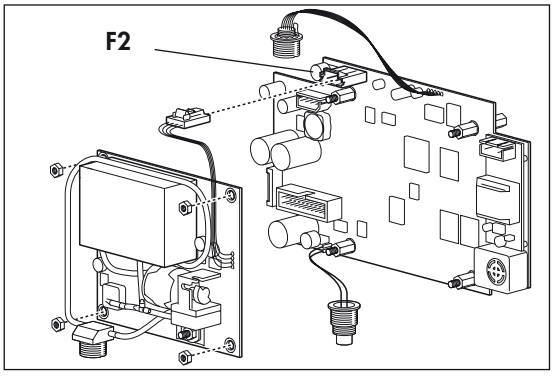
1. Open the device (see "7.2 Open the device" on page 22).
2. Remove Capno connection adapter **43** (see "7.4 Replace the Capno connecting adapter" on page 24).
3. Lay the device on its rear.
4. Take defective fuse **F1** out of the holder using pointed pliers.



5. Insert a new fuse **F1** in the holder using pointed pliers.
6. Refit Capno connection adapter **43**.
7. Close the device (see "7.3 Close the device" on page 23).
8. Test the device (see "4. Test the device" on page 8).

7.7.2 Replace fuse F2

1. Open the device (see "7.2 Open the device" on page 22).
2. Take defective fuse **F2** out of the holder using pointed pliers.



3. Insert a new fuse **F2** in the holder using pointed pliers.
4. Close the device (see "7.3 Close the device" on page 23).
5. Test the device (see "4. Test the device" on page 8).

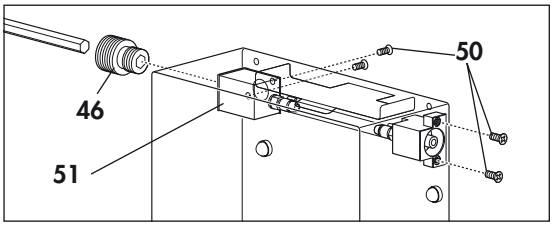
7.8 Replace connecting tube for oxygen duct

Materials and tools required

- ESD workstation
- Slot screwdriver, insulated, size 1
- Phillips screwdriver, size 2
- Ring spanner 14 mm
- Open-ended spanner 15 mm
- Tubular hexagon box wrench 12 mm
- Allen key, size 5
- Side nippers
- Bulldog nippers for single-lug clamp fittings
- Spirit

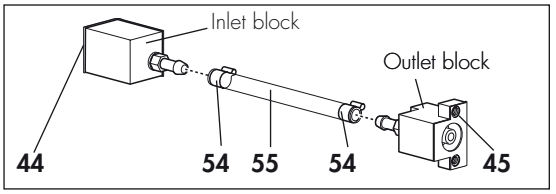
7.8.1 Remove oxygen duct

1. Open the device (see "7.2 Open the device" on page 22).
2. Remove the battery and both circuit boards from the bottom part of the housing (see "7.6 Replace main circuit board and/or CAP 100 circuit board" on page 25).
3. Unscrew threaded connection **46** of oxygen duct inlet **11** from the bottom part of the housing using the Allen key.
4. Unscrew the four screws **50** on the rear of the device.
5. Unscrew the two screws **50** on the right-hand side of the device.
6. Take oxygen duct **51** out of the bottom part of the housing.

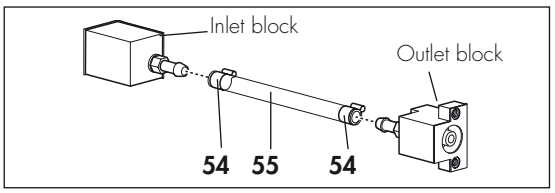


7.8.2 Repair oxygen duct

1. Cut the two single-lug clamp fittings **54** off connecting tube for oxygen duct **55**.
2. Take the connecting tube for oxygen duct **55** off the inlet and outlet blocks.
3. If seal **44** or **45** is damaged, proceed as follows:
   - take off the damaged seal.
   - remove all residues of glue with spirit.
   - allow the spirit to evaporate completely from the block in question.
   - glue on a new seal.
4. Put two new single-lug clamp fittings **54** on a new connecting tube for oxygen duct **55**.

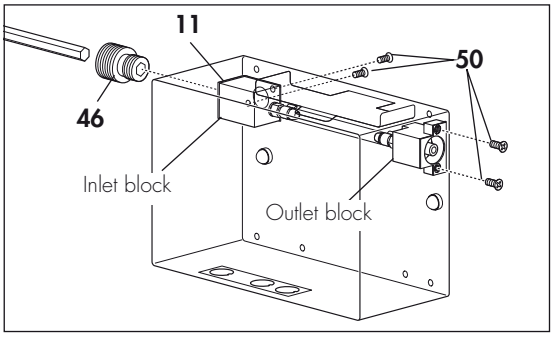


5. Connect the inlet and outlet block to oxygen duct connecting tube **55**.



7.8.3 Fit oxygen duct in bottom part of housing

1. Align the two blocks so that the tube is not twisted in the housing.
2. Push the single-lug clamp fittings **54** onto the ends of the connecting tube for the oxygen duct.
3. Align each of the single-lug clamp fittings downwards and clamp them with the bulldog nippers.
4. Insert the oxygen duct back in the bottom part of the housing.
5. Unscrew the two screws **50** on the right-hand side of the device.
6. Screw the four screws **50** approx. 3 turns into the bottom part of the housing.
7. Do **not yet** fit the top part of the housing. Perform a leaktightness test with the device open.



7.8.4 Perform leaktightness test

1. Push together the bottom part of the housing with the oxygen duct fitted and a MEDUMAT ventilation device.
2. Fit both devices to a LIFE-BASE carrying system.
3. Check the leaktightness of the oxygen duct as described in "4.4 Test leaktightness" on page 9.
4. Remove the devices from the LIFE-BASE carrying system once the test is complete.
5. Separate the bottom part of the housing from the MEDUMAT ventilation device.

7.8.5 Refit device

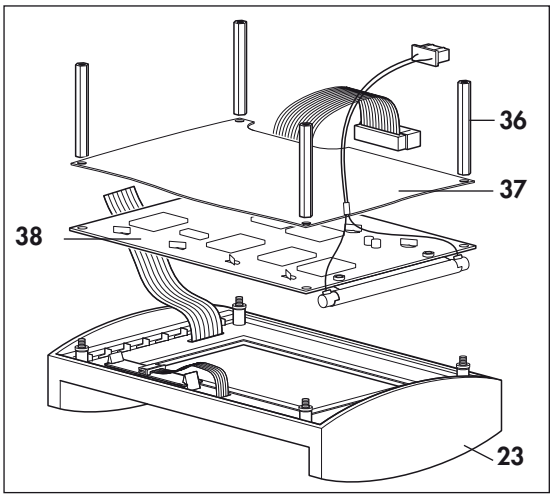
1. Screw threaded connection **46** of the lateral inlet of oxygen duct **11** to the inlet block of the oxygen duct using an Allen key.
2. Tighten the four screws **50**.
3. Refit both circuit boards and the battery (see "7.6 Replace main circuit board and/or CAP 100 circuit board" on page 25).
4. Close the device (see "7.3 Close the device" on page 23).
5. Test the device (see "4. Test the device" on page 8).

7.9 Replace display circuit board

Materials and tools required

- ESD workstation
- Slot screwdriver, insulated, size 1
- Phillips screwdriver, size 2
- Ring spanner 14 mm
- Open-ended spanner 15 mm
- Tubular hexagon box wrench 5.5 mm

1. Open the device (see "7.2 Open the device" on page 22).
2. Unscrew the four spacer bolts **36**.
3. Take the top part of insulating cover **37** off display circuit board **38**.
4. Take display circuit board **38** off top part of housing **23**.
5. Put new display circuit board **38** in top part of housing **23**. When putting it in, ensure that the washers **39** on the screws remain pushed on.
6. Place top part of insulating cover **37** on display circuit board **38**.
7. Wet the first two turns of the threads on the four spacer bolts with Loctite WM 14920.
8. Screw on the four spacer bolts **36**.
9. Close the device (see "7.3 Close the device" on page 23).
10. Test the device (see "4. Test the device" on page 8).

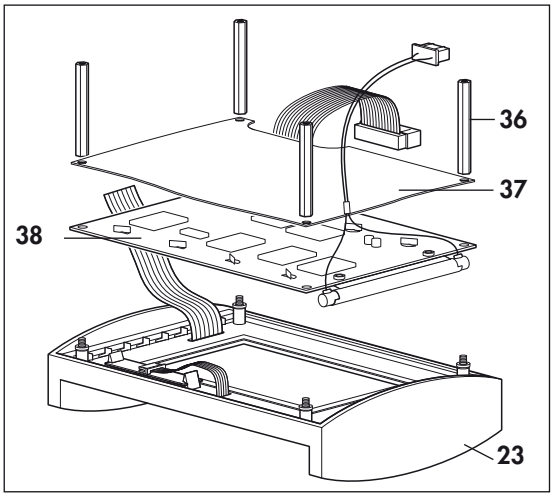


7.10 Replace infrared circuit board

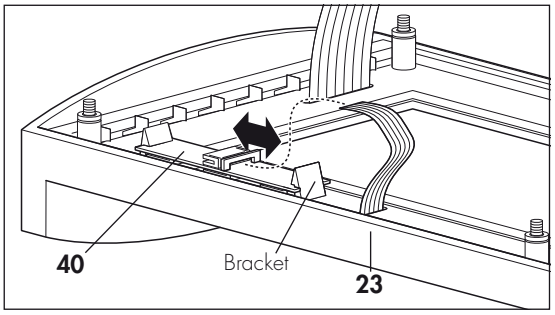
Materials and tools required

- ESD workstation
- Slot screwdriver, insulated, size 1
- Phillips screwdriver, size 2
- Ring spanner 14 mm
- Open-ended spanner 15 mm
- Tubular hexagon box wrench 5.5 mm

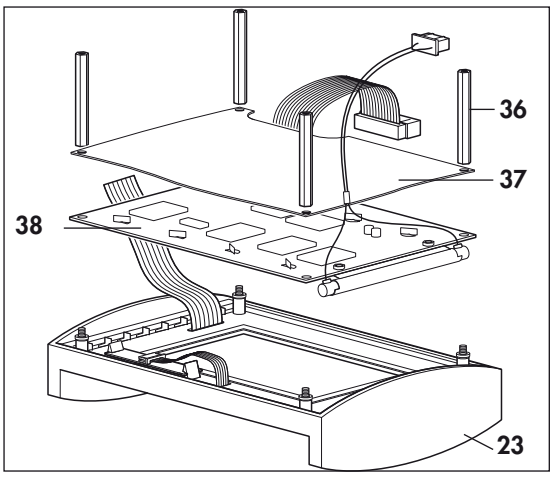
1. Open the device (see "7.2 Open the device" on page 22).
2. Unscrew the four spacer bolts **36**.
3. Take the top part of insulating cover **37** off display circuit board **38**.
4. Take display circuit board **38** off top part of housing **23** and put to one side.



5. Release the ribbon cable from the latch: to do so, pull up the top part of the latch. You can then pull out the cable.
6. Push the bracket for infrared circuit board **40** a little to the side and remove the infrared circuit board.
7. Enter the serial number of the new infrared circuit board in the test record.
8. Push a new infrared circuit board **40** onto the bracket in top part of housing **23** until it engages with a click. The opening of the latch must be pointing towards the ribbon cable.
9. Push the ribbon cable into the latch on infrared circuit board **40** and then push the top part of the latch back in.



10. Put display circuit board **38** in top part of housing **23**. When putting it in, ensure that the washers **39** on the screws remain pushed on.
11. Place top part of insulating cover **37** on display circuit board **38**.
12. Wet the first two turns of the threads on the four spacer bolts with Loctite WM 14920.
13. Screw on the four spacer bolts **36**.
14. Close the device (see "7.3 Close the device" on page 23).
15. Test the device (see "4. Test the device" on page 8).



7.11 Replace top part of housing

Materials and tools required

- ESD workstation
- Slot screwdriver, insulated, size 1
- Phillips screwdriver, size 2
- Ring spanner 14 mm
- Open-ended spanner 15 mm
- Tubular hexagon box wrench 5.5 mm

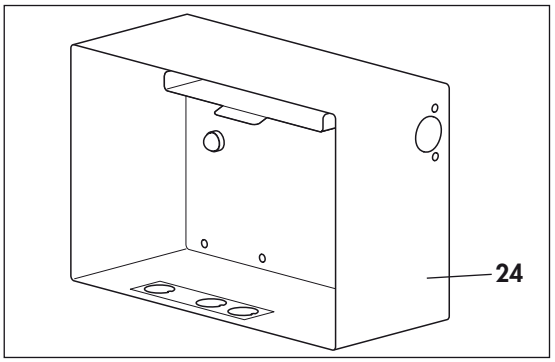
1. Open the device (see "7.2 Open the device" on page 22).
2. Remove the display circuit board and the infrared circuit board (see "7.9 Replace display circuit board" on page 31 and "7.10 Replace infrared circuit board" on page 32).
3. Pick up the new top part of the housing.
4. Fit the display circuit board in the new top part of the housing (see "7.9 Replace display circuit board" on page 31).
5. Fit the infrared circuit board in the new top part of the housing (see "7.10 Replace infrared circuit board" on page 32).
6. Close the device (see "7.3 Close the device" on page 23).
7. Test the device (see "4. Test the device" on page 8).

7.12 Replace bottom part of housing

Materials and tools required

- ESD workstation
- Slot screwdriver, insulated, size 1
- Phillips screwdriver, size 2
- Ring spanner 14 mm
- Open-ended spanner 15 mm
- Tubular hexagon box wrench 5.5 mm

1. Open the device (see "7.2 Open the device" on page 22).
2. Remove the battery and both circuit boards from bottom part of the housing **24** (see "7.6 Replace main circuit board and/or CAP 100 circuit board" on page 25).
3. Remove the O_2 duct from bottom part of the housing **24** (see "7.8 Replace connecting tube for oxygen duct" on page 29).
4. Fit the O_2 duct back in bottom part of the housing **24** (see "7.8 Replace connecting tube for oxygen duct" on page 29).
5. Refit both circuit boards and the battery (see "7.6 Replace main circuit board and/or CAP 100 circuit board" on page 25).
6. Close the device (see "7.3 Close the device" on page 23).
7. Test the device (see "4. Test the device" on page 8).



8. Replacement parts

8.1 Replacement parts list

Note

The item numbers in the following table are identical to the numbers in the text of these servicing and repair instructions and in the instructions for use.

Item no.	Name	Order no.
23	Top part of housing with front film	WM 22402
24	Bottom part of housing* consisting of housing and device ID plate	 WM 22864
25	O-ring 8-1, 5 for plug connection	WM 1145/19
26	O-ring 6-2 for plug connection	WM 1145/68
27	O-ring 50-2	WM 1145/75
28	O-ring 11-1	WM 1145/131
29	O-ring 4.9-1.9 for oxygen inlet	WM 1145/138
30	Ni-Mh battery	WM 22458
31	Main printed circuit board for MODUL CapnoVol Main printed circuit board for MODUL CapnoVol, replacement	WM 22450 WM 22461
32	CAP 100 printed circuit for MODUL CapnoVol CAP 100 printed circuit for MODUL CapnoVol, replacement	WM 22456 WM 22890
33	Cable tie	WM 23258
34	Hexagon nut M3	WM 50911
35	Hexagon nut M12	WM 58403
36	Spacer bolt M3 x 52.5	WM 22486
37	Insulating cover, top part (protective film for display circuit board)	WM 22386
38	Display printed circuit for MODUL CapnoVol (display circuit board)	WM 22408
39	Washer for display circuit board	WM 1145/32
40	RED printed circuit, (infrared circuit board)	WM 22490
41	Spacer bolt M3 x 13.4	WM 22487
42	Spacer bolt M3 x 7	WM 22488
43	Capno connecting adapter, fitted	WM 22431
44	Seal for distributor block (inlet)	WM 22468
45	Seal for plug connector (outlet)	WM 22469
46	Threaded connector G3/8, chrome-plated	WM 22411
47	Plug connector, fitted	WM 22432
48	Sealing screw G1/8 x 5, chrome-plated	WM 22884
49	Sealing screw DIN 908-A4-G1/8 A (stainless steel)	WM 50591
50	Countersunk bolt M3 x 6	WM 51274
51	Oxygen duct, fitted	WM 22485
52	Block for plug connection, anodized (inlet block)	WM 22418
53	Distributor block, anodized (outlet block)	WM 22428

54	Single-lug clamp fitting with insert ring	WM 2077
55	Connecting tube for oxygen duct	WM 22413
56	BiCheck flow sensor (flow duct, complete)	WM 22430
57	Connecting cable for BiCheck flow sensor	WM 22420
58	Nafion tube	WM 22937
59	Sealing plate (nonreturn valve, LIFEBASE II only)	WM 1504
60	Insulating cover, bottom part	WM 22387
61	Fuse F1 2.5 A	WM 22696
62	Fuse F2 2 A	WM 22695

* Please state type, device no. and year of manufacture when ordering

8.2 Parts to be changed when servicing

Item no.	Name	Article no.	Every 2 years	Every 4 years	Every 6 years	Every 12 years
30	Ni-Mh battery	WM 22458	•	•	•	•
55	Connecting tube for oxygen duct	WM 22413			•	•
31	Main printed circuit board for MODUL CapnoVol, replacement	WM 22461				•
32	CAP 100 printed circuit for MODUL CapnoVol, replacement	WM 22890				•
25	O-ring 8-1, 5 for plug connection	WM 1145/19			•	•
26	O-ring 6-2 for plug connection	WM 1145/68			•	•
54	Single-lug clamp fitting with insert ring	WM 2077			•	•
58	Nafion tube	WM 22937		•		•

9. Tools and testing equipment

The following lists all the tools and testing equipment referred to in these servicing and repair instructions. Please see the individual sections to find out which tools and testing equipment you need for particular tasks. Special tools can be ordered from the manufacturer, WEINMANN.

9.1 General tools

- Slot screwdriver, size 0.5 x 3 x 100
- Slot screwdriver, insulated, size 1
- Phillips screwdriver, size 2
- Set of watchmaker's screwdrivers
- Ring spanner 14 mm
- Open-ended spanner WAF 15 mm
- Tubular hexagon box wrench 5.5 mm
- Tubular hexagon box wrench 12 mm
- Allen key, size 5
- Side nippers
- Bulldog nippers for single-lug clamp fittings
- Pointed pliers
- Digital multimeter

9.2 Special tools

The following tools can be obtained from the manufacturer, WEINMANN:

- Set, power supply test for MEDUMAT/MODUL WM 15440
- Test set for ventilation and flow pressure reducer WM 15443
- Set for servicing MODUL CapnoVol WM 15743
- Set, IR adapter with software and bracket WM 15681
- CO_2 absorber WM 22172
- Measuring and leaktightness adapter WM 22868
- Current measuring adapter WM 22817

9.3 Testing equipment

- Ventilation device, e.g. MEDUMAT with the associated test set, e.g. WM 15382
- KAL CHECK gas (5 % CO_2± 0.2 % in O_2) WM 97061 with pressure reducer WM 97062
- CO_2 gases, to be ordered from specialist dealers:
  - 2.5 % CO_2 ± 0.2 % in O_2
  - 5 % CO_2 ± 0.2 % in O_2
  - 9.7 % CO_2 ± 0.2 % in O_2
- PC with installed software WM 22480 from the following set WM 15681
- Set of IR adapter with software and bracket WM 15681
- Power supply cable, 12 V, WM 22895
- Connecting cable for BiCheck flow sensor WM 22420
- BiCheck flow sensor (flow channel, complete) WM 22430
- Measuring and leaktightness adapter WM 22868
- Current measuring adapter for MODUL CapnoVol WM 22817
- CO_2 absorber WM 22172
- Patient tube with patient valve WM 22520
- Test bag 1 l WM 15335
- Loctite WM 14920
- Set for testing power supply MEDUMAT/MODULES WM 15440
- Set of tools for MEDUMAT Standard WM 15349 or syringe set WM 15359
- Volume flow measuring device PF-300, breath volume measurement with O_2 in STP mode

  to order from:
  imtmedical ag
  Gewerbestrasse 8
  CH-9470 Buchs
  Tel.: +41 81 750 66 99
  Fax: +41 81 750 66 95
  Switzerland
  www.imtmedical.com

10. Technical data

		MODUL CapnoVol
Product class to Directive 93/42/EEC		IIa
Dimensions WxHxD in mm		180 x 115 x 90
Weight		approx. 1.1 kg
Temperature range	– operation – storage	+0 °C to +40 °C –20 °C to +70 °C
Air pressure range, operation		600 – 1060 mbar[1]
max. altitude for use in non-compensated aircraft		2,500 m
Electrical rating		12 – 28 V =
Maximum power consumption		20 W
Classification to EN 60601-1	– Type of protection against electric shock – Degree of protection against electric shock – Degree of protection against water	Protection class II Type BF IP X4
Electromagnetic compatibility (EMC) to EN 60601-1-2	– radio interference suppression – radio interference immunity	EN 55011 EN 61000-4 Parts 2 to 6 and Part 11
Permitted humidity in operation and storage		≤ 95 % rh (no condensation)
Standards met		EN 60601-1, EN 864, EN 1789
Device	Warm-up time	approx. 15 s
	Time until specification achieved	approx. 5 min
	Display	LCD with backlighting
	Duration of operation per battery charge	approx. 2 hours (with new battery)
CO_2 measurement	Measuring method	IR photometric method
Frequency of use of BiCheck flow sensor		Cleaned, disinfected or sterilized at least 30 times
Resistance of patient valve (to EN 794-3) in combination with MEDUMAT	Inspiration Exhalation Spontaneous respiration	<6.3 mbar[1] at 60 l/min <6.3 mbar[1] at 60 l/min <2.2 mbar[1] at 30 l/min
Volume measurement	Measuring method	Bi-directional hot-wire anemometry
	Measuring range	MV: 0 – 30 l/min
		TV: 0 – 2,000 ml
	Accuracy	± 15 % from measured value across the full range
Respiratory frequency measurement	Measuring range	2 – 60 bpm (breaths per minute)
	Accuracy	± 1 bpm
$etCO_2$ measurement (at 23 °C)	Measuring range	3 – 75 mmHg/0.4 – 9.9 vol%
	Accuracy at: 0.4 – 5 vol% 3 – 40 mmHg 5.1 – 9.9 vol% 41 – 75 mmHg	 0.2 vol% 2 mmHg 6 % of measured value 6 % of measured value
	Maximum deviation at: 0.4 – 5 vol% 3 – 38 mmHg 5.1 – 9.9 vol% 39–75 mmHg	 ± 0.3 vol% ± 2 mmHg ± 0.5 vol% ± 4 mmHg
	System response time at flow = 150 ml/min flow = 50 ml/min	 1 s 2 s

		MODUL CapnoVol
Connections for		CO_2 extraction tube
		BiCheck flow sensor
		external power supply
		oxygen duct
Mask/endotracheal tube	Connection	Standard connector to ISO 5356-1

(1) 1 mbar ≙ 1 hPa

The right to make design modifications is reserved.

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11. Service record

Device master data	Service and repair work carried out in accordance with service instructions	
Manufacturer: Weinmann GmbH + Co. 22525 Hamburg Device type: **MODUL CapnoVol** ☐ WM 22400 ☐ WM 22440 ☐ WM 22480 Order No.: _____ Date of manufacture: _____ **Functional check:** Before every use _____ After every use _____ Every 6 months _____ After every service _____	**Measures / Comments**	Service performed in accordance with MODUL service instructions Company _____ _____ Date Signature Company _____ _____ Date Signature Company _____ _____ Date Signature Company _____ _____ Date Signature

CapnoVol Test Record

Device: MODUL CapnoVol **WM no.**: ..... **Device no.**: ..... **Date of manufacture**: .....

Component no. for main printed circuit board WM 22450/22461: _____

Component no. for printed circuit IRED WM 22490: _____

Component no. for printed circuit CAP 100 WM 22456/22890: _____

	Value	OK	not OK
1. Testing equipment • as per Servicing and Repair instructions for CapnoVol WM 16796			
2. Preparation for testing • as per Servicing and Repair instructions for CapnoVol WM 16796			
3. Input of device data • as per Servicing and Repair instructions for CapnoVol WM 16796			
4. Test leaktightness • Pressure drop of oxygen duct ≤ 200 mbar/min • Pressure drop of CO_2 measuring section ≤ 2 mbar/min	☐ mbar/min ☐ mbar/min	☐ ☐	☐ ☐
5. Test device self-test • Self-test performed successfully		☐	☐
6. Test infrared interface • Error-free transmission of a dataset		☐	☐
7. Test software versions • Testing only possible on test bench			
8. Test display elements • Function of power supply LED • Function of alarm LED • Function of alarm transmitter • Function of display		☐ ☐ ☐ ☐	☐ ☐ ☐ ☐
9. Test input elements • Function of keys		☐	☐
10.Test battery charging • Permitted charging current is 1.5 to 1.9 A	☐ A	☐	☐
11.Test flow measurement • MODUL CapnoVol displays an exhalation volume TVe = 450 ± 70 ml	☐ ml	☐	☐
12.Test occlusion alarm • Occlusion alarm-test performed successfully		☐	☐
13.Test CO_2 measurement • The value is between 4.7 and 5.3 vol %	☐ vol %	☐	☐
14.Test system clock • Clock test performed successfully		☐	☐

_____ Date _____ Signature

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