

# **M.A.C 2640 CLIRcheck**

## **Portable SO<sub>2</sub>F<sub>2</sub> Monitor**

# **INSTRUCTION MANUAL**



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## **Revision history**

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Release 1.1	August 2014 - modifications due to approval
Release 1.2	October 2015 - calibration timeframe
Release 1.3	June 2016 - minor changes
Release 1.4	June 2017 - modification gas inlet / outlet

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# 1. General Instructions

## 1.1 Indications

This manual contains important information for the operation of **M.A.C 2640 CLIRcheck** SO2F2 monitor.

To assure operator safety and the proper use of the instrument, please read, understand, and follow the contents of this manual.

<p><b>Non-observance of these instructions can result in personal injury or death.</b></p> <p><b>Non-observance of these instructions may also lead to the loss of right to claim for damages or warranty!</b></p>	
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Meaning of signs used in this instruction manual:

*CATCHWORDS* appear in italics on the right hand margin



: Indication of particular importance



: Warnings

Please follow the instructions given. Warnings denote a potential hazard associated with the use of **M.A.C 2640 CLIRcheck** instrument.

Non-observance of warnings can result in personal injury or damages to the instrument.



: Avoid actions marked with this sign

Please follow the instructions given. This symbol denotes potential hazard associated with the use of **M.A.C 2640 CLIRcheck** instrument. Non-observance of the instructions can result in personal injury or death.

## 1.2 Safety Precautions and Important Instructions for Operation of M.A.C 2640 CLIRcheck

The **M.A.C 2640 CLIRcheck** is designed for monitoring concentration levels of SO<sub>2</sub>F<sub>2</sub> gas for determining worker safe entry only.

The **M.A.C 2640 CLIRcheck** instrument is not designed for use in potentially explosive environments. Never place and operate the instrument in areas with a potentially explosive atmosphere!

The instrument should be used only for this field of application and should be operated only by personnel familiar with its operation.

Follow requirements of the fumigant labeling and local and national regulations for worker safety, including PPE required for entry into confined spaces.

After starting measurement by turning on the START-Button, it takes about 30 seconds for the first reliable reading.

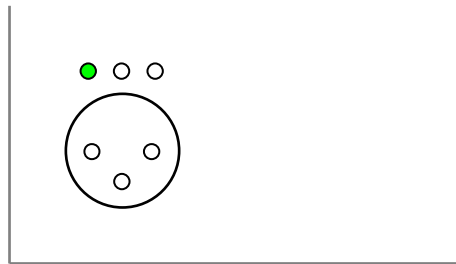
The user could then move slowly through the area without heavy swinging or shaking the instrument.

**An exception would be if the reading exceeds the Permissible Exposure Limit (PEL) and the user is not wearing respiratory protection, such as SCBA. In this situation, the user should immediately leave the affected area.**



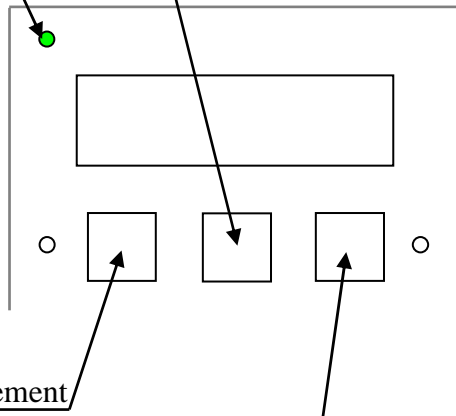
### 1.3 Quick start

- 1) Connect power converter and charge until only green light is on and yellow light is off



- 2) Switch on instrument with 'ON/OFF' button

- 3) Wait until green 'READY' light is on



- 4) Press 'START' to begin measurement

- 5) Suppress audio alarm by button 'AUDIO'

## 2. Description of M.A.C 2640 CLIRcheck

### 2.1 Instrument layout

#### 2.1.1 Top view

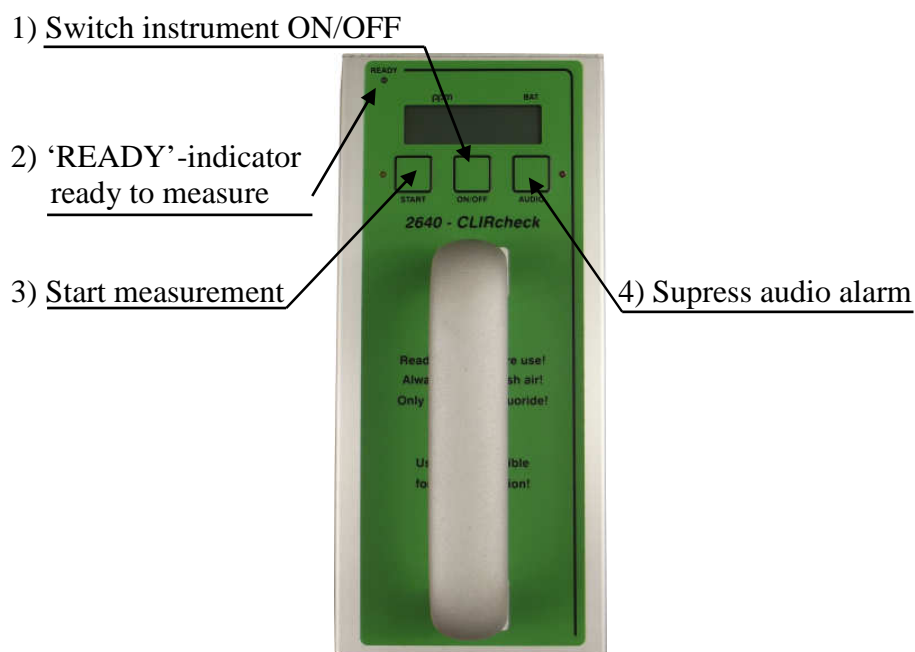


Fig. 1 Top view

#### 2.1.2 Front view

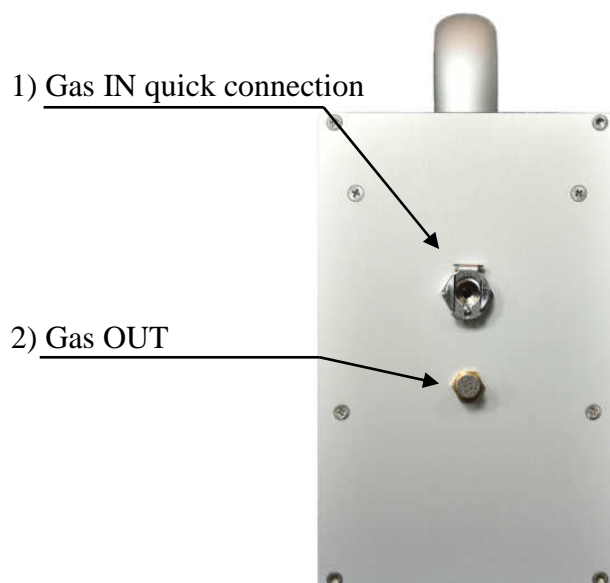
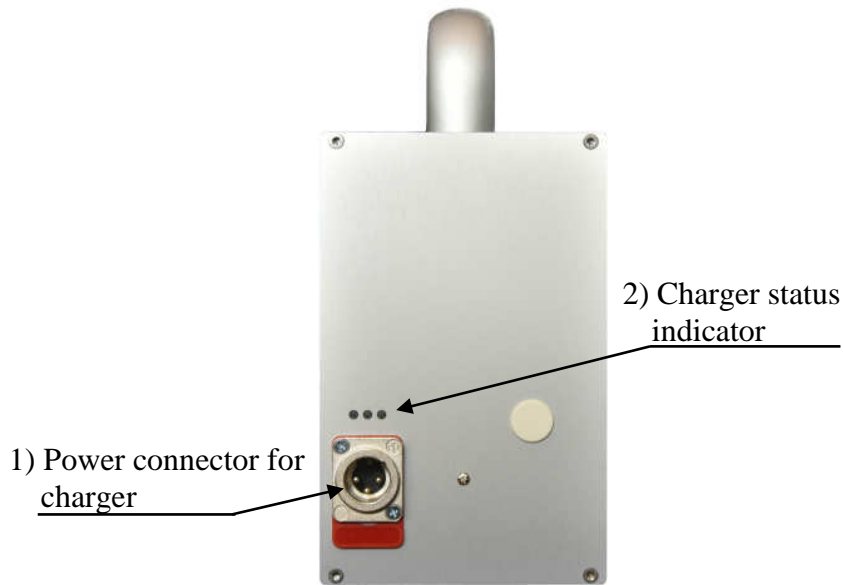


Fig. 2 Front View

- 1) CPC in line fast connector for hoses with 1/8" ID
- 2) Outlet with muffler

### 2.1.3. Rear view



**Fig. 3 Rear view**

- 1) Connector for power supply, XLR type
- 2) Charge status indicator, see chapter 5.7 for details

## 2.2 Description of function

### 2.2.1 Description of basic function

In the **M.A.C 2640 CLIRcheck** a measurement cell is used which operates on the principle of Infrared - Spectroscopy.

#### *PRINCIPLE*

The physical properties of gases to react to electromagnetic waves, such as infrared rays, is utilized for this detection technology. Each type of gas uniquely adsorbs energy to one or more electromagnetic wavelengths.

This effect is converted into electric signals by a measuring transducer. The concentration of the gas component is calculated via calibration functions filed in the instrument configuration library.



### **2.2.2 Description of equipment function**

The **M.A.C 2640 CLIRcheck** is equipped with one gas sampling inlet. Two limiting values (alarm levels) may be set separately in correspondence to existing requirements.

For measurement of the concentration the gas to be analyzed must be drawn into the sensor by the built-in pump (active sample extraction). The measured values are shown on the display and are compared to the limiting values set.

The 1. Alarm level and the 2. Alarm level can be set individually. Overshoot of the first alarm level causes an audible alarm together with a low frequent flashing of display backlight. Exceeding the second alarm level leads to a higher frequency of audible alarm and display flashing. The audible alarm can be suppressed by pushing the 'AUDIO' button. Activated audio suppression will be indicated by the red light beside the button. This suppression will be reset after the alarm state has ended and the audible alarm is armed again for the next occurrence.

## 2.3 Manufacturer-based configuration

For best possible adaptation of instrument to the intended use, the following parameters of the configuration may be determined by the customer or authorities and set at the factory or by authorized service personnel:

- Alarm thresholds 1. and 2. Alarm (in ppm)
- Reference temp. and pressure Standard: 0°C (-32°F) and 1013 mbar
- Time and date Depending on site

## 2.4 Technical data

All dimensions +/- 1,27 mm = 0,05 inch

Dimensions:	Height (incl. handle):	230 mm = 9.0 in
	Width:	105 mm = 4.1 in
	Depth (incl. fittings):	270 mm = 10.6 in
Weight:	approx. 4,3 kg = 9.5 lbs	
Power Supply Unit:	internal, NiMh-Battery-Pack (19.2 V – 72 Ah)	
Power Supply Charger:	100–240 Volt / 47-64 Hertz / max. 110 Watts	
Working time:	with new and fully charged battery: >4 hrs	
Charging time:	approx. 3.5 hrs	
Temperature range:	during storage: between approx.	-10°C to +60°C (+14°F to +140°F)
	during operation: between	+5°C to +40°C (+41°F to +104°F)
Air moisture range:	0 to 95 %, non condensing relative humidity	
Measuring principle:	physical, infrared spectroscopy, optoacoustic sensor	
Compound:	SO <sub>2</sub> F <sub>2</sub> (Vikane <sup>®</sup> , PROfume <sup>®</sup> )	
Display:	1x8 character LC-display, red backlight	
Measuring range:	0.5 ppm to 100 ppm (end level)	
Accuracy:	0 ppm to 10 ppm -> +/- 0.5 ppm 10 ppm to end level -> +/- 0.5% of end level	
Resolution:	0.5 ppm	
Response time:	90% within 20 seconds / 100% within 30 seconds	

### 3. Setup and Installation

#### 3.1 Mechanical setup

GENERAL USE

**The instrument should be used in a clean, dry area that is not subject to temperature or humidity extremes.**



The instrument has been specified for an ambient temperature range from +5°C (+41°F) up to +40°C (+104°F). Condensation of air moisture inside the instrument is to be avoided. An integrated protection mechanism will switch off the measuring operation if the maximum permissible internal temperature exceeds a limit of + 55°C (135°F). In this case the instrument will issue a malfunction message. When possible, avoid exposing the instrument to direct sunlight for an extended time.

For cooling purposes the instrument must be used in such a manner that free circulation of the ambient air is unobstructed. It must also be protected from exposure to extreme dusty environment or to water.

SAMPLE GAS  
CONNECTION


The analyser has one sample gas inlet and one sample gas outlet (refer also to **Chapter 2.1.2**).

If the unit should be used as a stationary device in special situations, the sample gas inlet could be equipped with gas sample tubes of lengths up to 40 metres without adversely affecting instrument operation. On the sample gas outlet, tubes of lengths up to 50 metres (165 feet) could be applied, by exchanging the muffler with a fitting (provided that the tubes have an inner diameter of at least 4 mm [approx. 0.16 inch]).


To avoid clogging of the inlet valves and the measurement chamber, the sample gas tube must be connected to a particle filter which is installed on the intake end of the sample gas inlet.

**Incorrect installation of filter and exceeding recommended maintenance intervals will inevitably lead to malfunction or damage to the instrument!**



<p><b>In order to avoid contamination of the valves and measuring chamber, the instrument may only be operated with filter protecting the gas sampling tube. The filters are to be placed on the intake end of the sample gas inlet.</b></p>	
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Installing the filter protects the instrument against damage from particulate contaminants. Suitable filters must neither adsorb measurable gas components in the filter element nor in the filter housing. As an additional feature the filters must permit the filtration of particles 5 micrometers and larger in size. Proper filters can be ordered from ppm Messtechnik GmbH under the order number G03565.

<p><b>Take utmost care to prevent liquids and moisture condensation from being drawn into the measuring chamber. Equally important is the avoidance of humidity condensation in the measuring cell. Any such event will immediately lead to the destruction of the sensor system!</b></p>	
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## 3.2 Electrical connection

### 3.2.1 Electrical Power Connection (Charger)

The internal battery pack is charged by a highly efficient built-in electronic circuit. The necessary power is supplied by the external converter. The converter has to be connected to the 3 pole XLR-Connector (refer also to **Chapter 2.1.3**).

The charger electronics works with a supply voltage of 33 VDC. The external converter is rated to mains voltage of 100–240 VAC.

**Only connect the specified external converter to the instrument.  
Before connecting instrument or converter to electric power,  
verify if supply voltage meets the requirements. Incorrect voltage  
may cause the fuse of the instrument or converter to blow or  
damage the instrument itself.**



### 3.2.2 Serial UART Interface

The instrument is equipped with a serial UART interface for data transfer. This interface is intended for the use with a data cable in order to perform readjusting the internal settings and calibration of the instrument.

Adjusting and calibration should only be conducted by ppm Messtechnik GmbH or their authorized service providers.

**Never connect an improper data cable to the interface.  
This may lead to serious damage on the instrument.**



## 4. Start of operation

**Before using the unit the first time, connect the external converter to the charger input (see also Chapter 3.2.2) and charge the internal battery until the yellow light on the back turns off. This could take up to 4 hours.**



The instrument is powered up by shortly pressing the ‘ON/OFF’ button. As soon as the instrument is powered up, it will start with normal operation (see chapter 5).

## 5. Operation

After the instrument has been powered up, it will automatically run through the following routines before starting the regular measuring operation:

- **Self-Testing**
- **Warm-up period**
- **Auto-zero adjustment**

This process will take less than 15 minutes for the CLIRcheck instrument.

**The instrument must be in fresh air, free from contaminants (such as the fumigant) during the auto-zero adjustment process!**



During the startup-process, the green ‘READY’ indicator (see **Chapter 3.2.3**) is off.

### 5.1 Self-testing of instrument

Immediately after the instrument is powered up, a self-test is performed.

During the warm-up period and also while in normal operation (except while in Stand-By-Mode) the instrument will carry out periodically automatic self-testing to check important instrument functions. In case of any malfunction, the warm-up period or the actual measurement cycle will be interrupted with the fault message (see **Chapter 6**, malfunctions). In case of an instrument malfunction, a restart of the instrument is necessary.

## 5.2 Warm-up and stabilization period

The warm-up and stabilization is an important point for the accuracy of the sensor. Stabilization-time is set at the factory or by authorized service personnel and can vary between 0.5 minutes up to 2 minutes.

At the end of the stabilization phase the unit starts zero adjustment procedure.

## 5.3 Auto zero adjustment

Zero adjustment at startup will compensate possible changes in the sensor equipment (e.g. aging of infrared source) and this way eliminate zero drift. Zero gas is drawn through the sensor and the response measured is taken as new zero level afterwards.

This can easily be done by providing fresh air during zero adjustment.

**Zero adjustment is only necessary after startup of instrument. The unit will not take further zero measurements during operation.**



### *DURATION OF ZERO ADJUSTMENT*

Duration of zero adjustment is approx. 2 minutes. In the most unfavorable case this operation may take a few minutes more, if e.g. the gas path or the measuring chamber is contaminated. If no correct zero adjustment is being achieved within this time bracket, then a failure indication will be given (see **Chapter 6**).

**A zero measurement in a contaminated atmosphere leads to false measured values!**



After successful zero adjustment the instrument normally switches to "Stand-By-Mode" and the green 'READY' indicator is turned on.

In those cases where **M.A.C 2640 CLIRcheck** is operated with power converter connected over a period of more than 5 days **without interruption**, a manual zero adjustment is recommended. The user may trigger such manual zero adjustment by disconnecting the gas connector, shutting off the instrument for a few seconds. After restart the instrument will zero at fresh air. Reconnect the hoses and continue operation after zeroing.

#### **5.4 Measurement operation**

After successful zero adjustment the instrument switches to "Stand-By" mode.

No measuring is being done.

In "Stand-By" mode **M.A.C 2640 CLIRcheck** is waiting for a measurement request by pressing the "START" button. (for reference see **Chapter 3.2.3**).

#### **5.5 Measurement process**

Each measurement process consists of the following consecutive steps:

1. The measurement cell is being flushed with actual measuring gas.
2. Now the measurement is carried out.
3. The measurement result is being compared with the preset alarm threshold values.

If any of the two alarm thresholds is exceeded, the alarm state is triggered (see Chapter 2.2.2).



## 5.6 End of operation

Before the instrument is switched off, the user should take care to flush the sensor a few minutes with fresh air. This prevents contamination of the internal gas path and possible memory effects.

The 'ON/OFF' button must be pressed for at least 3 seconds to switch off the instrument. Unintended switch-off is thereby prevented.

To protect the battery from deep discharge, the instrument is equipped with a protection electronic. If the instrument is kept switched on even after "LOW BAT" warning, an emergency shut-down is activated.

## 5.7 Charging

The converter for charging can always be connected, even during operation. Only on initial warm-up the charging will be suspended because of the high power consumption.

In general the unit will draw power only from the external converter and charge the battery as long as it is connected. As soon as the converter is disconnected the unit will immediately switch to the internal battery.

**Working time can easily be extended by warming-up and zeroing with connected converter!**



The state of the internal charging electronics can be determined through the light signals on the rear side of the unit (refer **Chapter 2.1.3**).

- Power converter applied, battery full
- Power converter applied, charging in progress
- Power converter applied, battery overtemperature
- Charger or battery fault

Depending on condition of the battery, charging may take up to 4 hours. 90% of full charge is reached after about 2 hours on a completely discharged battery.

**If no light is on, the charger has detected a deep discharge situation. Keep the power converter plugged for at least 4 hours. The charger will try to rescue the battery and switch over to normal charge. If after 4 hours no light is on, please send the instrument for service.**



If the status indicator of the charger shows an overtemperature condition, disconnect the power converter and let the battery cool down about 20 minutes. Afterwards the power converter can be reconnected and the fault indication should not occur again.

If the battery overtemperature fault or the charger/battery fault shows up repeatedly, even after the power converter has been disconnected for a longer time, the instrument should be sent to an authorized service provider or ppm Messtechnik GmbH for maintenance.

## 6. Operational Failures

### 6.1 Description of error codes

Messages about errors are displayed as codes on display. In case of malfunctions of the instrument (e.g. IR-source defect), operation of the instrument cannot be continued right away. For conditions below requiring service, contact ppm Messtechnik GmbH or their authorized service provider.

#### *FAILURES*

#### 6.1.1 Failure messages

are indicating that a direct return to normal operation of the program is not possible. The instrument must be switched off. After successful elimination of cause for failure or breakdown, the instrument may be switched on again for normal start-up procedure.

##### **"Chopper motor" – Code "C"**

Explanation:

Chopper-motor not starting

Probable causes:

- Transportation damage (shutter of chopper bent, motor is jamming)
- Motor defect

Corrective action:

Switch off instrument and restart it after 30 seconds. If failure reoccurs more than twice, exchange of measurement cell will be required (manufacturer).

##### **"IR-Source" – Code "B"**

Explanation:

Evidently no power consumption at infrared source

Probable causes:

- Electronic control defect
- Infrared source defect
- Transportation damage (filament broken)

Corrective action:

- Exchange measuring cell (manufacturer or authorized service provider)

**"Sensor heater" – Code "D"**

Explanation:

Ambient temperatures lower than 5°C (41°F) or ambient temperature higher than 40°C (104°F).

Probable causes:

- Instrument or ambient temperature is outside of the operating parameters.

Corrective action:

- At occurrence of this error message, it should first be checked if external influences such as direct sunlight or extreme heat are causing this critical situation, and if applicable, eliminate those negative influences.
- In case error message was not caused by external influences, defect module(s) should be replaced (manufacturer or authorized service provider).

### **"Zero setting unstable" – Code "E"**

#### **Explanation:**

Sensor unable to conform preset value within determined tolerances during zero setting.

#### **Probable causes:**

- Zero-gas unstable or filter used-up
- Measurement chamber leakage at inlet/outlet gate valve because of insufficient dust filtration or excessive suction (higher than 50 mbar = 0.7 psi)
- Excessive suction may also be caused by tube lengths exceeding permissible length.

#### **Corrective action:**

- Replace zero-gas or filter. If problem re-occurs, exchange of measuring cell is required (manufacturer or authorized service provider).

**Incorrect installation of filter and undue extension of maintenance intervals will cause malfunctions or damages of measuring instrument.**



### **"Cell temperature" – Code "T"**

#### **Explanation:**

Sensor temperature higher than 55°C (131°F).

#### **Probable causes:**

- Instrument is directly exposed to external heat sources (inadequate ventilation, direct sunlight, problematic installation site).
- Electronic control of heater defect.

#### **Corrective action:**

- At occurrence of this error message, operator in charge should at first check if external influences are causing this critical situation, and if applicable, eliminate those negative influences.
- In case error message was not caused by external influences, defect module(s) should be replaced (manufacturer or authorized service provider).

**"RTC" – Code "H"**

Servicing required. Send instrument for repair.

**"EEPROM" – Code "K"**

Servicing required. Send instrument for repair.

**"Error CFG-Data" – Code "L"**

Probable causes:

- Defect in data/program - memory or manipulated data.

Corrective action:

- Servicing required. Send instrument for repair.

## 7. Maintenance

### 7.1 General hints

The instrument has been designed for optimum maintainability. A skilled user may perform all conditioning maintenance work himself if required.

#### CLEANING

The exterior instrument housing may be cleaned with a smooth cloth which has been wetted with water and only a few drops of cleansing agent, e.g. dishwashing detergent or similar.

**Never use organic solvents (e.g. PERC, TRI, Acetone). Organic solvents may be harmful to instrument.**



### 7.2 Exchange of sample gas filters (particle filter)

Appropriate sample gas filters must neither adsorb molecules of the sample gas components in the filter element nor in the filter housing. Furthermore must they permit filtration of 5 micrometer particle size.

**In order to avoid contamination of valves, sample gas tubing and the measuring cell, the instrument should exclusively be operated using genuine particle filters supplied by ppm!  
The filters must be installed right on the intake end of sample inlet.**



When changing sample gas filters, proceed as follows:

- In order to avoid contamination of sample gas tubing during changing of filters, switch off instrument.
- Press the blue ring on the fast connector towards the filter and pull off the filter.
- Plug on new dust filter to the hose.

**Verify the filter is properly installed by slightly pulling on it!**



- Write down actual calendar date on filter label. This allows easy tracking of filter-change schedule. Filter label can be glued on front of instrument.

**We recommend exchanging particle filters every 3 months.**



Refer to **Chapter 7.5** for spare parts.

### 7.3 Battery-Pack maintenance

The instrument is equipped with a NiMH-battery pack in combination with an advanced charging electronics. As for every NiMH-battery we recommend to fully discharge it before recharging. This can easily be done by letting the unit run until low battery shutdown. The internal protection against deep discharge will prevent harm to the battery pack. From this point charge the instrument until the charge light (refer **Chapter 2.1.3**) turns off. This will extend battery lifetime.

**If the battery pack of the instrument is discharged, take care to recharge it within three days.**

**Empty batteries inside the instrument are exposed to the risk of deep discharge. Charge the battery at least after 4 months to prevent self-discharge. Please get in contact with ppm Messtechnik GmbH or our authorized service provider if you want to store the unit for more than 12 months!**



If battery operating time has greatly decreased or increasing battery faults come up during charging, the battery pack should be changed. This could be done by ppm Messtechnik GmbH or our authorized service provider (as part of a complete instrument maintenance).

**To avoid loss of capacity and deep discharge we recommend to keep the instrument connected to the power supply when not used!**





## 7.4 Calibration of Instrument

**The instrument-integrated functions concerning avoidance of zero-drift are described in Chapter 5.3 of this instruction manual.**






For re-calibration of the **M.A.C 2640 CLIRcheck** a special software is necessary. For reference get in contact with our authorized service provider or ppm Messtechnik GmbH.

In case of availability of adequate equipment the calibration may be done by authorized service personnel under adherence to the appropriate safety rules.

Calibration is due within 12 months of the date shown in the display. The initial calibration is a calibration check.

Next calibration is a recalibration and includes servicing. The calibration check and recalibration/ service will be repeated on alternate 12 month intervals. The complete calibration normally is done as part of an instrument maintenance.

## 7.5 Spare parts

Order number	Description
P04008	CPC connector (1/8 hose barb non-valved coupling insert) 
F03840	AC/DC-Converter for charging of instrument 
G03328	In-line particle filter with two fittings (ID 4mm / OD 6mm) 
G03565	Intake filter with quick connector 