

SF₆ Multi Analyser (with and without gas return system) Operating Manual (original version)

Type-No.: 3-038R- | 3-038-



DILO. Sustainably tight.



SF₆ Multi Analyser | 3-038(R)-R...

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Please read this operating instruction before putting the device into operation. Thus operating faults can be avoided. In case of no observance of the operating instruction the manufacturer cannot assume any liability or warranty.

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1.1 Safety notes and symbols used

In the following operating manuals specific safety warnings are given in order to draw your attention to residual risks which cannot be avoided during the operation of the device.

These residual risks contain dangers for

- Persons
- Product and machine
- The environment

The symbols used in the operating manuals should draw your attention specially to the safety notes:



This symbol refers to risks for persons (danger to life, danger of injury)



This symbol refers to risks for machines, material and the environment.

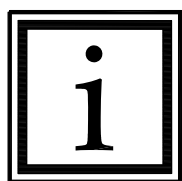


This symbol refers to electric shock

The most important aim of the safety notes is to prevent personal injuries.

- If the warning sign „**Danger**“, appears, danger from machines, materials and the environment are not excluded.
- If the warning sign „**Warning**“, appears, there is no danger for persons.

The corresponding symbol which is used cannot replace the text of the safety note. Therefore the complete text must always be read.



Note

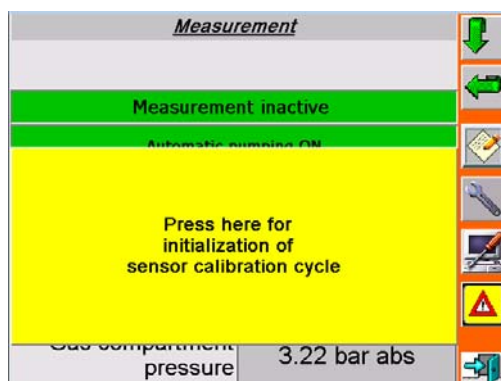
This symbol is not for safety notes, but for information to understand the device better.

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1.2 Initial setting into operation

We recommend that all persons who are involved in the operation and repair of DILo devices are properly and specially trained.

For initial setting into operation of the SF₆ Multi Analyser the following measures are necessary:
When turning on the device with the mains switch the control boots. After the first initialization process the following window appears on the touch panel.



III. 1.2 start screen initial setting into operation

For starting the sensor calibration cycle of 2 years confirm the yellow message on the window by pressing upon it. This must only be carried out in case of initial setting into operation or after having exchanged the sensor.

For measurement follow the instructions in chapter 4.7. "Measurement".

1.3 Correct use of the SF₆ Multi Analyser

The SF₆ Multi Analyser is an important component in the reuse of SF₆-gas to determine the gas quality used in medium and high voltage switchgear. The device can additionally be used for storing and reclaiming of SF₆ measuring gas.

The SF₆ Multi Analyser allows to determine the three most important parameters for reuse of SF₆-gas with only one measurement:

- SF₆ concentration [%]
- Moisture concentration
- SO₂ concentration [ppm_v]
- Option: HF concentration [ppm_v]
- Option: HF, CO and H₂S concentration [in ppm_v each]

Based on the SF₆ concentration, the **percentage of air (optionally the CF₄)** is determined indirectly. By means of determining the SO₂ concentration, it is possible to draw conclusions regarding the total concentration of decomposition products. The SO₂ value is used as indicator for the total concentration and the respective ratio is approx. 1:4 (see Cigré "SF₆-Recyclingguide"), i.e. for example that a SO₂ concentration of 12ppm_v corresponds to a total concentration of 50ppm_v. After measurement the measuring values can be stored in the SF₆ Multi Analyser and transferred to a PC if required.

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Devices with gas return system:

The used measuring gas is stored in an internal vessel. After measurement the stored measuring gas is pumped back into the connected gas compartment by means of the compressor. After deactivation of automatic pumping (see 4.6) the measuring gas can alternatively be pumped in an external vessel.

Devices without gas return system:

are provided for connection to an external gas return system.

For this purpose the device is equipped with an open connection on the outlet which allows to operate the SF₆ Multi Analyser with and without external gas return system. The measuring gas is collected via the connecting hoses by means of the external gas return system.

For the operation without an external gas return system the outlet is open that means the measuring gas can be released easily into the atmosphere.

The device can only be used optionally for different gas mixtures (SF₆-N₂/air and SF₆-CF₄).

1.4 Obligation to exercise due care

The device has been designed and constructed bearing in mind the standards to be observed as well as additional technical specifications.

Safe use of the machine can only be achieved if all the necessary measures are followed.

The operator has to ensure that

- the SF₆ Multi Analyser is only used for the purposes for which it is intended
- the SF₆ Multi Analyser is only operated in accordance with the instructions and in good condition and that the safety devices are regularly checked.
- complete and legible operating manuals are available on site.
- only qualified personnel operates or repairs the device.
- this personnel is regularly instructed in safety procedures and environmental protection and that this personnel is fully aware of the complete operating manuals and particularly in the safety notes.
- the safety and warning notes mounted on the SF₆ Multi Analyser are legible and not removed.



The parts inside the SF₆ Multi Analyser are under dangerous supply voltage in case of connected power connecting cable. Prior to opening the housing switch off and unplug the device.

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1.5. Transport

European Transport Regulations:

SF₆ (Sulphur hexafluoride) service carts are exempt from "Hazardous Goods Transport Regulations" as long as the gas pressure in a tank or vessel at 15 deg C is not more than 2 bar above atmospheric pressure and it remains in a gaseous state during transport. This exemption covers all kinds of vessels and tanks as well as machinery (motors, pumps etc.) (see ADR annex A 1.1.3.2 c – exemptions with regard to the transport of gases).

For carriage of the device by air and sea the integrated pressure vessels must be emptied to atmospheric pressure in accordance with EC directive 859/2008. Contaminated SF₆ must not remain in the pressure vessels.

Otherwise observe the instructions valid in your country.

Installation



Warning

Only operate the device indoors or in dry places outdoors.
Operation in humid places may cause corrosion of couplings and valves.
The ambient temperature during operation of the device should be in the range of -10°C to +50 °C.

Filling for transport

The SF₆ Multi-Analyser as well as the supplied connecting hose have been filled by the factory with SF₆ gas and are immediately ready for use.

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1.6 Procedure and information to be followed when replacing the measuring modules

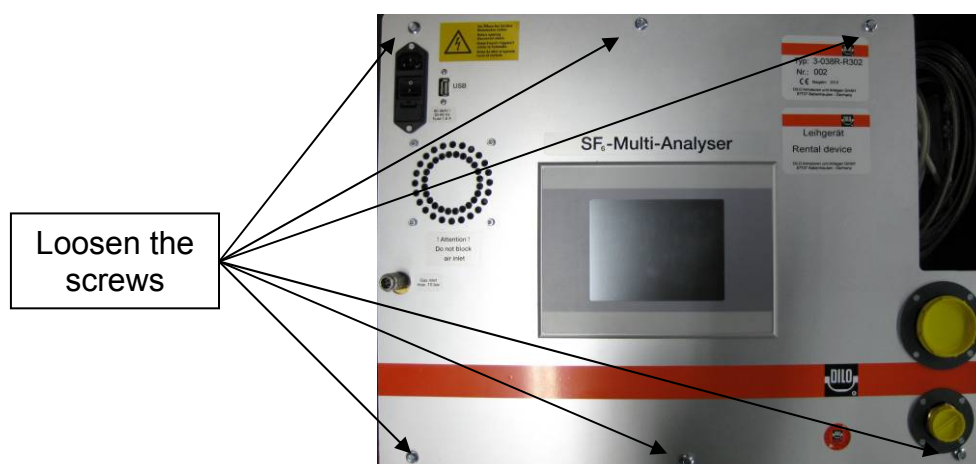
Before the individual measuring modules can be replaced, the device should be opened as follows after it has been switched off via the main switch on the front plate:



The device may only be connected electrically by trained and authorised qualified electricians!

Attention: Before opening the housing, always switch off the device and disconnect the power plug!

- 1) Loosen the six screws on the front plate



- 2) Swing the front plate upwards.

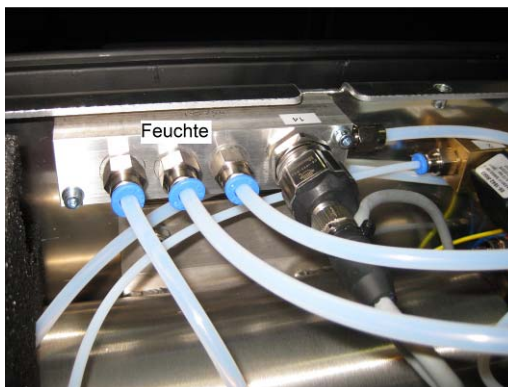


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Afterwards, the individual modules can be replaced as follows:

Moisture module:

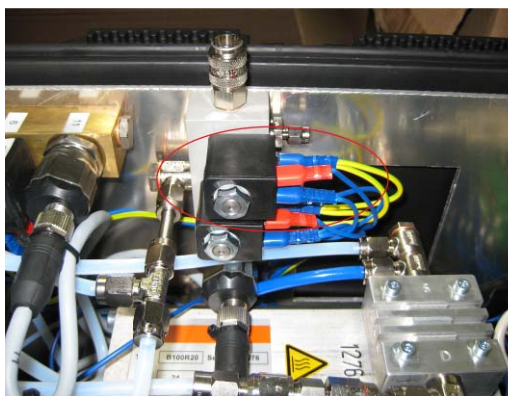
- 1) Loosen the hose connection on the gas outlet by pressing the blue unlocking device using your thumb and index finger backwards and pulling out the hose using your other hand (see figure). The hose remains on the measuring cell.



- 2) Loosen the pipe connection on the gas inlet (see figure; directly on the measuring cell) using a size 12 open-end spanner.

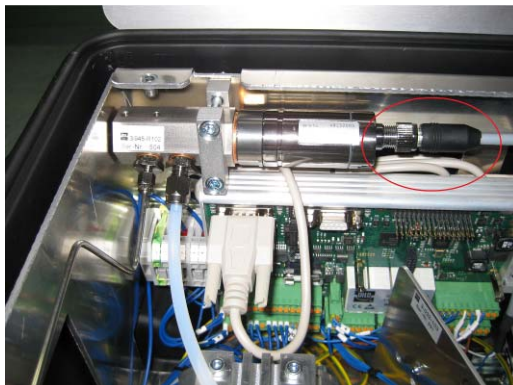


Attention: In order to operate the device without the moisture module, the electrical connection of the solenoid valve 4 must be disconnected.



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- 3) Disconnect the electrical connection on the moisture sensor. For this purpose, the M12 connector is unscrewed (see figure).



- 4) Loosen the two locking screws (see figure) and remove the complete unit (measuring cell + moisture sensor).



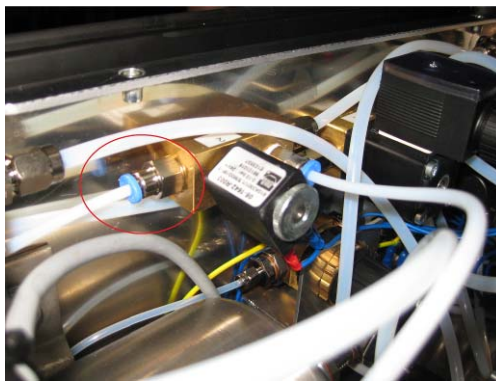
- 5) Insert the recalibrated moisture unit and fasten using the two screws. (See figure item 4)
- 6) Establish the electrical connection. For this purpose, the M12 connector is screwed on (see figure item 3) and the electrical connection of the solenoid valve 4 is reconnected (see figure 2 item 2).
- 7) Fasten the pipe connection on the gas inlet (directly on the measuring cell) using a size 12 fork wrench. (See figure 1 item 2)
- 8) Fasten the hose connection of the gas outlet by inserting the hose into the plug-in connector. When recoupling, make sure that the hose has been inserted completely into the plug-in coupling. (See figure item 1)
- 9) Place the front plate on the housing frame and fasten it using the six (6) screws.
- 10) Switch the main switch on again. After the initialisation has been completed, the SF₆ Multi-Analyser is again ready for use.

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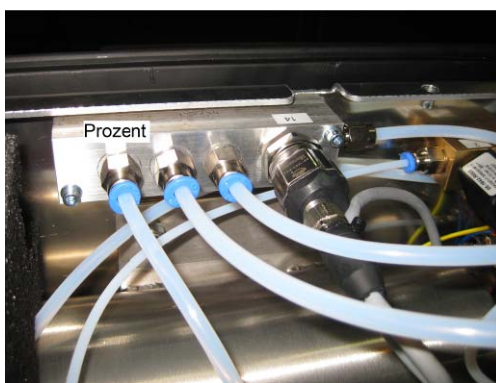
Percentage module:

- 1) Loosen the hose connection on the gas inlet and gas outlet pressing the blue unlocking device using your thumb and index finger backwards and pulling out the hose using your other hand (see figures). The hoses remain on the measuring cell.

Gas inlet of the percentage module:

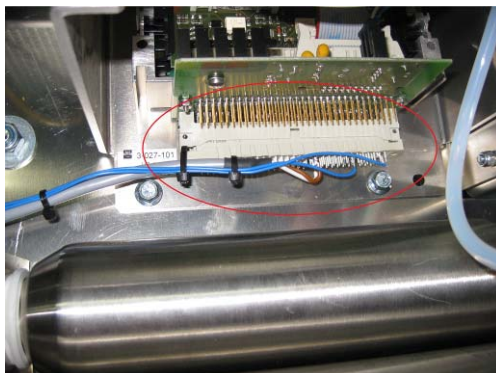


Gas outlet of the percentage module:



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- 2) Disconnect the electrical connection of the percentage module. For this purpose, the 96-pin connector strip is removed on the front side of the module. (See figure)



- 3) Loosen the three (3) locking screws on the bottom plate and the side panel of the device (see figure) and remove the module.



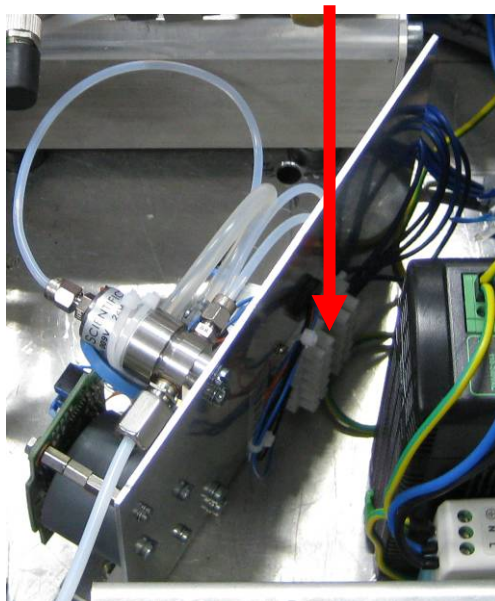
- 4) Insert the recalibrated percentage module and fasten the module to the bottom plate and side panel of the device using the three (3) screws. (See figure item 3)
- 5) Establish the electrical connection of the percentage module. For this purpose, the 96-pin connector strip is inserted on the front side of the module. (See figure item 2)

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- 6) Fasten the hose connections by inserting the hoses into the plug-in connectors. The connecting hoses cannot be confused with each other because of different hose diameters on the inlet (4mm) and on the outlet (6mm). When recoupling, make sure that the hoses have been inserted completely into the plug-in couplings. (See figure item 1)
- 7) Place the front plate on the housing frame and fasten it using the six (6) screws.
- 8) Switch the main switch on again. After the initialisation has been completed, the SF₆ Multi-Analyser is ready for use once again.

SO₂ module:

- 1) Switch on the main switch and wait until the device is ready for use.
- 2) Disconnect the electrical connection of the SO₂ module. For this purpose, the 6-pin terminal is removed on the rear side of the module. Then wait for at least **15s**.

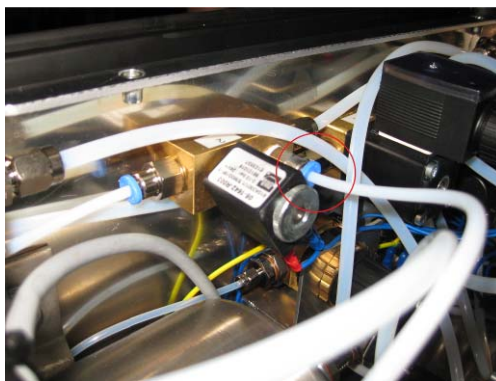


- 3) Switch off the main switch.

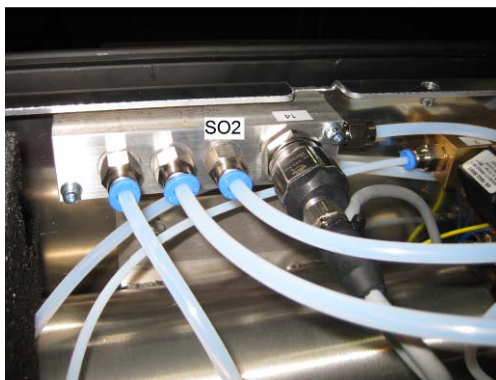
SF₆ Multi Analyser | 3-038(R)-R...

- 4) Loosen the hose connections on the gas inlet and gas outlet pressing the blue unlocking devices using your thumb and index finger backwards and pulling out the hoses using your other hand (see figures). The hoses remain on the measuring cell.

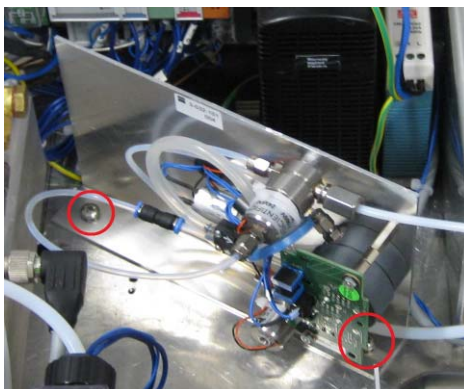
Gas inlet of the SO₂ module:



Gas outlet SO₂ module:



- 5) Loosen the locking screws on the bottom plate of the device (see figure) and remove the module.



- 6) Insert the recalibrated SO₂ module and fasten the module to the bottom plate of the device using the two screws. (See figure item 5)
- 7) Fasten the hose connections by inserting the hoses into the plug-in connectors. The connecting hoses cannot be confused with each other because of the different hose diameters on the inlet (4mm) and on the outlet (6mm). When recoupling, make sure that the hoses have been inserted completely into the plug-in couplings. (See figure item 4)
- 8) Establish the electrical connection. For this purpose, the 6-pin terminal is reinserted on the rear side of the module. (See figure item 2)
- 9) Place the front plate on the housing frame and fasten it using the six (6) screws.
- 10) Switch on the main switch again and wait until the device is ready for use. Acknowledging the displayed "Initialisation" message window (see chapter 1.2), the lifetime of the SO₂ sensor is started.
- 11) The SF₆ Multi-Analyser is again ready for use.

In case the SF₆-Multi-Analyser is equipped with more than one electrochemical sensor it can be exchanged in the same way as the SO₂ sensor.

Since the complete module is to be exchanged and all electrochemical sensors have a lifetime of two years the exchange at devices with SO₂/HF and SO₂/HF/CO/H₂S sensor is identical to devices with SO₂ sensor. (picture below: module with SO₂/HF/CO/H₂S sensors – electrochemical)



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2. Overview of SF₆ Multi Analyser

The SF₆ Multi Analyser allows the measurement of the following values:

- SF₆ volume percentage
- Moisture concentration
- SO₂ decomposition products
- Option: HF decomposition products
- OPTION: HF / CO / H₂S decomposition products

After each measurement the measuring values can be stored, indicating a name.

The following main components of the SF₆ Multi Analysers are installed dependant on the version: one measuring module with a SF₆ volume percentage sensor, a moisture sensor as well as a module with SO₂ sensor. Furthermore power supply units, a central unit with touch panel, pressure sensors and tubing with solenoid and control valves. All components of the SF₆ Multi Analyser are installed in a compact modular housing.

All values measured are indicated digitally.

The standard version of the SF₆ volume percentage sensor is calibrated to a SF₆/N₂ or SF₆ air mixture and measures the SF₆ content in volume percent in such gas mixture. The SF₆ volume percentage sensor works independently of air pressure and installation position.

The moisture sensor measures the dew point temperature of the SF₆ gas in °C dew point at inlet pressure. The measuring value of the dew point in °C can automatically be indicated or converted into all established indicating units in case of modified setting. Measuring the dew point at inlet pressure, a higher accuracy of the measurement is achieved with a reduced measuring time. The dew point at ambient pressure is calculated based on this value.

Furthermore, the SF₆ Multi Analyser can also include a SO₂ sensor (as option) which measures the decomposition products of SF₆ gas.

The modular construction of the SF₆ Multi Analyser enables to send each single measuring gas module for verification, calibration or exchange to the manufacturer. In principle, it is also possible to measure with only one measuring module.

The SF₆ Multi Analyser is very easy to operate on the front side.

Devices with gas return system are equipped with:

- a "Gas inlet" coupling
- power socket with "ON/OFF" switch
- 5.7" coloured touch panel
- USB connection
- two fixing facilities for couplings for hose connections DN8/DN20

Devices without gas return system additionally include:

- a "Gas outlet" coupling

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2.1 Technical data



III. 2.1. SF₆ Multi Analyser with standard accessories

Dimensions of the device **with** gas return system (transport case included)

Length (L):	500 mm
Width (B):	625 mm
Height (H):	297 mm

Weight:	33 kg
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Dimensions of the device **without** gas return system (transport case included)

Length (L):	500 mm
Width (B):	625 mm
Height (H):	218 mm

Weight:	20 kg
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General data:

Input pressure:	p _e 0.3 – 9 bar
Operating temperature:	-10° - +50 °C
Air humidity:	up to 90 % non condensing
Operating voltage:	100 – 240V /50 – 60Hz (L, N, PE)
Interface:	USB
Mains fuse:	2 x 3.15 A/T (time delay)
Measuring time (individual measurement):	< 15 min. (automatically calculated)
Limit value vol.-%:	0.0 to 100.0 vol.-%
Limit value dew point:	-60 °C to +20 °C
Limit value SO ₂ :	0.0 to 500.0 ppm _v
Flow rate (all sensors):	18.3 – 20.5 l _N SF ₆ /h = 111 – 125 g SF ₆ /h
Number of measured values to be stored:	100
Recommended calibration interval of the sensors:	2 years

SF₆ volume percentage sensor:

Measuring media:	SF ₆ /N ₂ or SF ₆ /air gas mixtures and SF ₆ /CF ₄ gas mixtures (option)
Measuring range:	0.0 to 100.0 vol.-% SF ₆
Measuring accuracy:	± 0,5 vol.-% for gas mixtures SF ₆ /N ₂ or SF ₆ /air ± 2 vol.-% for gas mixtures SF ₆ /CF ₄
Measuring condition:	measurement is carried out at atmospheric pressure
Flow rate:	0.3 – 0.5 l _N SF ₆ /h = 1.8 – 3.1 g SF ₆ /h
Operating temperature:	-10 °C – +50 °C

Moisture sensor:

Measuring range:	-60 °C – +20 °C dew point temperature
Measuring accuracy:	± 2°C at > -40°C dew point temperature ± 3°C at < -40°C dew point temperature
Measuring condition:	measurement is carried out at input pressure, atmospheric dew points and ppm _v values are converted by the device
Flow rate:	18 – 20 l _N SF ₆ /h = 109 – 122 g SF ₆ /h
Operating temperature:	0 °C – +60 °C

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SO₂-Sensor:

Measuring range:	0 – 20ppm _V 0 – 100ppm _V 0 – 500 ppm _V
Measuring accuracy:	< ± 2% of measuring range
Measuring condition:	measurement is carried out under atmospheric pressure
Flow rate:	1 – 3 l _N SF ₆ /h = 6,2 – 18,6 g SF ₆ /h
Operating temperature:	-20 °C – +50 °C

Option:

HF sensor (only in combination with SO₂ or with SO₂, CO and H₂S):

Measuring range:	0 – 10 ppm _V
Measuring accuracy:	< ± 10% of measuring range
Measuring condition:	measurement is carried out under atmospheric pressure
Flow rate:	1 – 3 l _N SF ₆ /h = 6,2 – 18,6 g SF ₆ /h
Operating temperature:	-20 °C – +50 °C

CO sensor (only in combination with SO₂, HF and H₂S):

Measuring range:	0 – 500 ppm _V
Measuring accuracy:	< ± 2% of measuring range
Measuring condition:	measurement is carried out under atmospheric pressure
Flow rate:	1 – 3 l _N SF ₆ /h = 6,2 – 18,6 g SF ₆ /h
Operating temperature:	-20 °C – +50 °C

H₂S sensor (only in combination with SO₂, HF and CO):

Measuring range:	0 – 100 ppm _V
Measuring accuracy:	< ± 2% of measuring range
Measuring condition:	measurement is carried out under atmospheric pressure
Flow rate:	1 – 3 l _N SF ₆ /h = 6,2 – 18,6 g SF ₆ /h
Operating temperature:	-20 °C – +50 °C



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Order numbers for measuring cells:

SF₆ volume percentage module

Moisture sensor

SO₂-Sensor 20 ppmv:

100 ppmv:

500 ppmv:

Spare:

3-027-201

3-945-201

3-032-201

3-032-202

3-032-203

Exchange:

3-027-201-61

3-945-201-61

3-032-201-61

3-032-202-61

3-032-203-61

SO₂ (0-20 ppm_V) / HF unit (0-10 ppm_V)

3-032-211

3-032-211-61

SO₂ (0-100 ppm_V) / HF unit (0-10 ppm_V)

3-032-212

3-032-212-61

SO₂ (0-500 ppm_V) / HF unit (0-10 ppm_V)

3-032-213

3-032-213-61

SO₂ (0-100 ppm_V) / HF unit (0-10 ppm_V) /

H₂S (0-100 ppm_V) / CO unit (0-500 ppm_V)

3-032-232

3-032-232-61

2.2 Standard accessories

- 1 6 m long PTFE connecting hose with metal braiding and self-closing stainless steel couplings on both ends
- 1 DILO connecting coupling DN 20
- 1 DILO connecting coupling DN 8
- 1 2 m long power cable
- 1 USB stick with data file for evaluation
- 1 CD-ROM with data file for evaluation and reading out of measured data

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3. Functional description

3.1 Function of the SF₆ volume percentage sensor

The measuring principle is based on the evaluation of the different velocities of sound of gases. The velocity of sound in air is normally about 330 m/s, while in pure SF₆-gas it is only about 130 m/s. The velocity of sound measured in the measuring cell is temperature compensated and converted into SF₆ volume percent by means of a microprocessor.

The measuring results are transmitted to the host computer.

3.2 Function of the moisture sensor

The moisture sensor is based on the absorption of water molecules in a special ceramic substrate acting as dielectric in a capacitor. This changes the capacitance of the capacitor which is recorded by the electronic evaluation system and converted into a standard signal. This signal is forwarded to the main computer.

3.3 Function of the SO₂ sensor and HF sensor

These sensors are based on the electrochemical measuring principle and consist of three gold-plated electrodes and a water-based acidic electrolyte. The structure of the sensors is the same for both SO₂ and HF, but different electrolytes are used and the reactions to determine the concentrations vary:

Electrochemical sensors:

The change in current generated by the lost electrons is recorded by the electronic evaluation system including temperature compensation and calibration in that area and converted into a standard signal. This signal is forwarded to the main computer and converted into ppm_v value. The sensors have a lifetime of two (2) years.



The CO and H₂S sensors are identical to the SO₂ and HF sensors with the difference that other electrolytes are used for CO and H₂S sensors which are adjusted to the substance to be measured.

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SO₂-Sensor:

The SF₆ filled in diffuses into the SO₂ sensor and reacts on the measuring electrode in an oxidative process according to the equation below:

Equation 1: **measuring process**

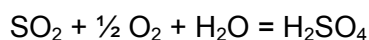
Sulphur dioxide (SO₂): $\text{SO}_2 + 2\text{H}_2\text{O} = \text{H}_2\text{SO}_4 + 2\text{H}^+ + 2\text{e}^-$

The counter electrode tries to keep the occurring reaction at equilibrium by means of an oxygen reduction producing water.

Equation 2: **counter reaction:**

Oxygen reduction: $\frac{1}{2} \text{O}_2 + 2\text{H}^+ + 2\text{e}^- = \text{H}_2\text{O}$

Overall reaction in the measuring cell:



If the SF₆ gas to be examined contains SO₂, electrons are lost according to equation 1 by shifting the electrochemical equilibrium.

HF sensor:

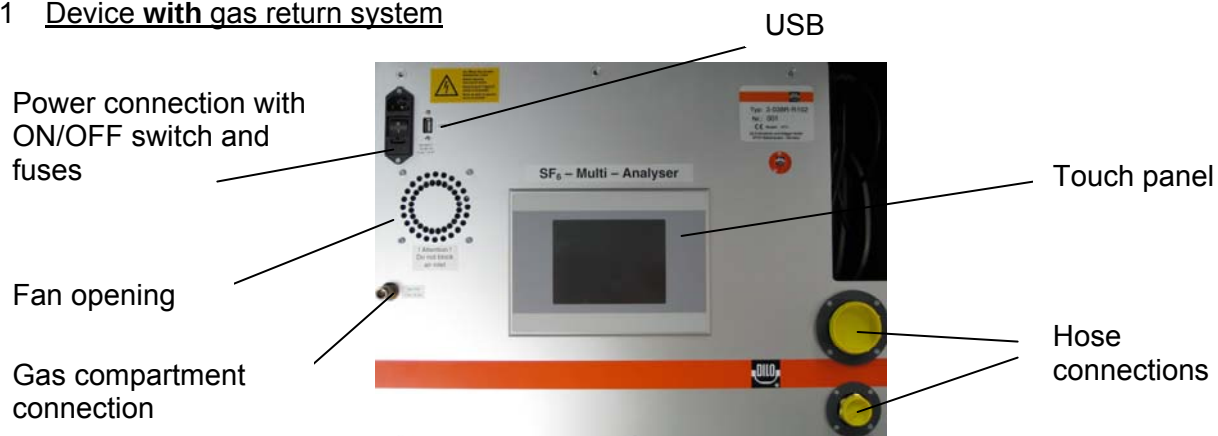
The SF₆ filled in diffuses into the HF sensor and in case that HF is contained, a PH reduction takes place in an electro-catalytic reduction. By means of the following CL₂ reaction and subsequent redox reaction, electrons are lost.

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4. Description of the device and measuring process

4.1 Components of the device

4.1.1 Device **with** gas return system



III. 4.1.1 top view of the 3-038R

4.1.2 Device **without** gas return system



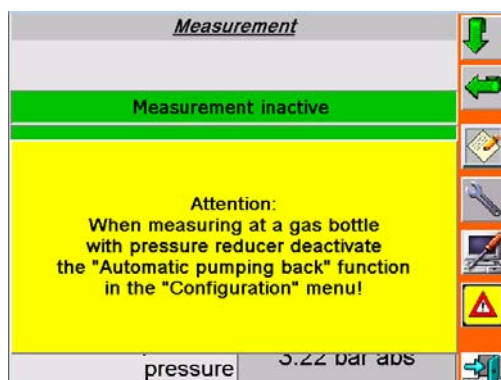
III. 4.1.2 top view of the-038

The SF₆ Multi Analyser is switched on and off with the I / 0 rocker switch on the front side.

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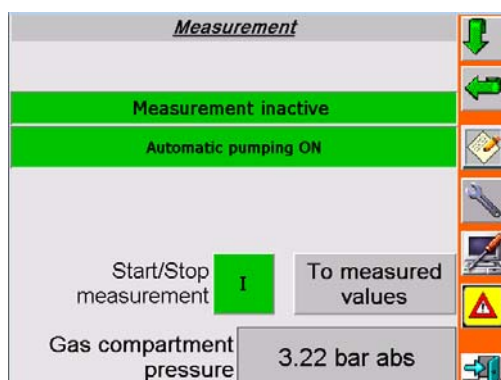
4.2 Setting into operation

Turning on the power switch the control is booting. After the initialization process the following window appears on the touch panel (only at devices with gas return system)



III. 4.2.1 information window

The information window can be confirmed by pressing upon the yellow field. Then the following start screen appears (only at devices with gas return system immediately after the initialization process)



III. 4.2.2 start screen

The SF₆ Multi Analyser is ready for operation now.

The rinsing time of the measuring hose (at the beginning of the measurement) is calculated automatically by using the input pressure and the internal storage pressure.

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4.3 Basic functions

After switching on the device the start screen appears (ill. 4.2).

All functions of the SF₆ Multi Analyser can be selected here . There is a status bar on the upper side of the screen to indicate which window has been selected.

It is possible to select between different windows on the right side of the screen via keys.



III 4.3 selection of windows

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4.4 Setting possibilities

After pressing the



key the following window appears:



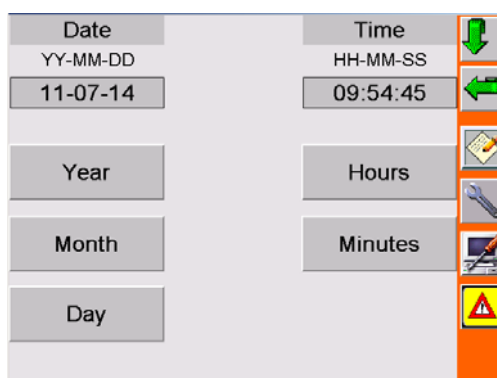
III. 4.4.1 settings

1. Language selection
2. Selection of the pressure unit [bar abs., bar rel., psi, kPa, MPa]
3. Selection of the carrying gas [%-N₂, %-CF₄] (Option: activated by DILo)
4. Selection of the moisture unit [°C abs., °C (p), °F abs., °F (p), ppm_v, ppm_w]
5. Setting of date / time

The units of the measuring values are indicated behind the measuring values.

When selecting the carrying gas the volume percentage is distinguished referred to the carrying gas N₂ or the carrying gas CF₄ (as option).

After pressing the "Set" key the date can be set in the YY-MM-DD format and the time in the HH:MM:SS format.



III. 4.4.2 date / time

SF₆ Multi Analyser | 3-038(R)-R...

4.5 Service

After pressing the



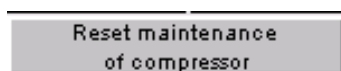
key the following window appears:

Service				
Compressor	Operating hours	Operating hours last maintenance	Maintenance interval [h]	
	0.00 h	0.00 h	500 h	
(Double-click to reset)		Reset maintenance of compressor		
No maintenance required				
Configuration				
Status				
Pressures:	Input	Measuring cells	Compressor input	Internal storage
	4.0 bar abs	1.0 bar abs	0.9 bar abs	1.2 bar abs
Valves:				

III. 4.5 service

1. Setting of operating hours and maintenance (only for devices with return system)
2. Possibility to switch over to the "Configuration" window.
3. Status indications (operating pressures and valves)

With the

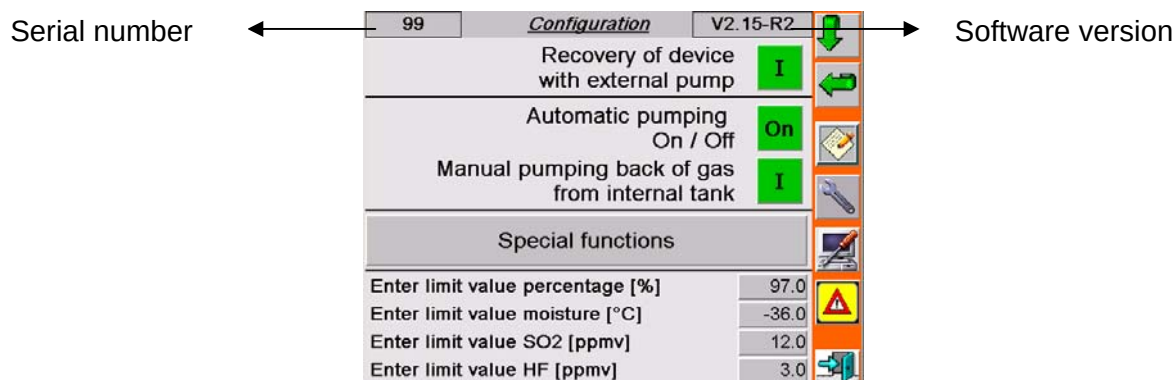


key the maintenance counter must be reset after having carried out the maintenance works on the compressor.

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4.6 Configuration

After pressing the **Configuration** key the following window appears:



III. 4.6 configuration

1. Recover the device with an external pump (only for devices with gas return system)
2. Automatic pumping On /Off (only at devices with gas return system)
The actual status of the function is indicated on the start screen.
3. Manual pumping back the gas from the internal tank (only at devices with gas return system)
4. Special functions
5. Input limit value (percentage): 0.0 to 100.0 Vol.-%
6. Input limit value (moisture): -60.0 to +20.0 °C dew point
7. Input limit value SO₂: 0.0 to 500.0 ppm_v
8. Input limit value HF: 0.0 to 10.0 ppm_v



In case of negative limit values the numerical values must first be input. Then press the „ - “ key.

If the input limit values are exceeded or if they fall below the input value the “Limit value fallen below” or “Limit value exceeded” message appears (see chapter 4.7).



The “Manual pumping back of gas from internal tank” function can only be started if the automatic pumping back function has been switched off by pressing the “Automatic pumping ON / OFF” key (OFF indication).

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4.7 Measurement



Carry out gas measurements directly at the gas compartment.

For devices with integrated gas return system:

For measurements on “Downpiping systems” it is absolutely necessary to switch off the “Automatic pumping back” function.

Devices with integrated gas return system:

Connect the measuring gas hose to the coupling (DN 8 or DN 20) by means of the self-closing miniature coupling and couple to the “Gas inlet”. Connect the coupling (DN 8 or DN 20) to the gas compartment

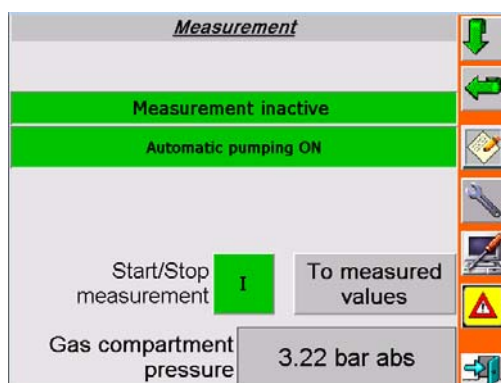
Device without gas return system:

Connect the measuring gas hose to the coupling (DN 8 or DN 20) by means of the self-closing miniature coupling and couple to the “Gas compartment” connection of the external gas return system. Connect the coupling (DN 8 or DN 20) to the gas compartment.

The connection between the measuring device and external gas return system is established via two hoses which are included in the scope of supply of the gas return system.

In case moisture is visible on the couplings it must be wiped with a dry and lint-free cloth beforehand. Then dry the couplings with a commercial hairdryer for several minutes, however the temperature of the couplings must not exceed 70°C. If moisture penetrated in the measuring gas hose disconnect it from the device and rinse it with dry gas for about 5 minutes (e. g. nitrogen). The connecting coupling on the compartment to be tested must also be dry and clean.

After having carried out all necessary settings start the measurement on the start screen with the “Measurement Start / Stop” key.



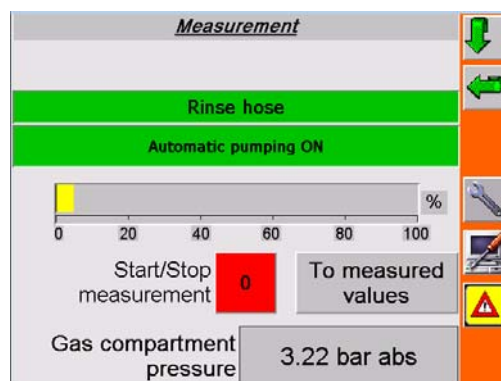
III 4.7.1 start screen

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The current function is indicated on the green bar. The current measuring status is shown on the bar diagram in yellow colour.

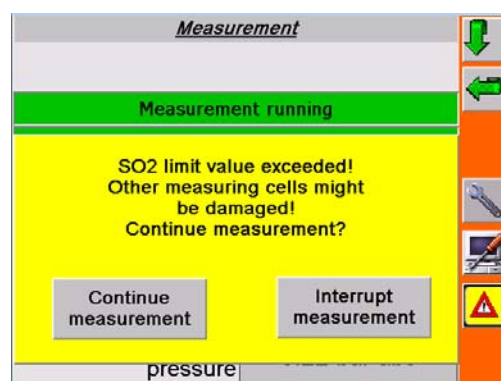
The following functions are running one after another:

1. Rinsing the hose



III. 4.7.2 measurement

2. SO₂-measurement in operation (in case SO₂ sensor is available). In this case the SO₂ content in the gas to be measured is determined beforehand. If the value is higher than the set limit value on the "Configuration" window the following message appears:



III. 4.7.3 SO₂ measurement

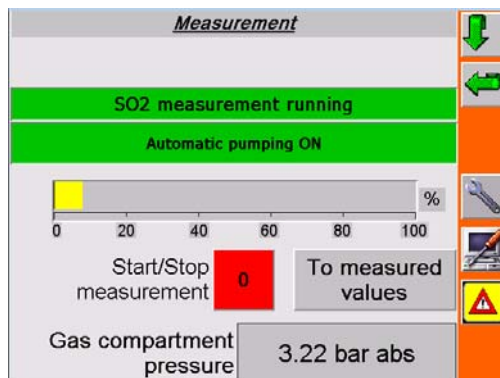
The operator can select between:

- Continue measurement: measurement until the measuring result appears
- Interrupt measurement: measurement is interrupted and the start screen appears again.

In case the value is lower than the set limit value on the "Configuration" window the measurement is continued under item 3 without interruption.

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3. Measurement running

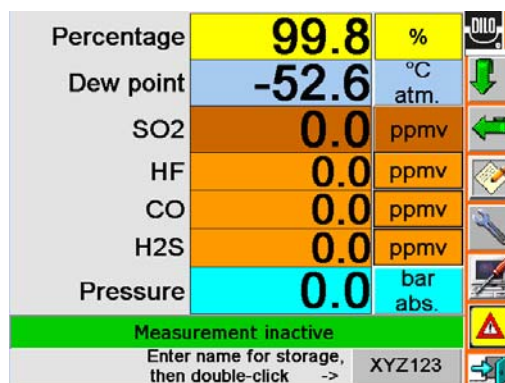
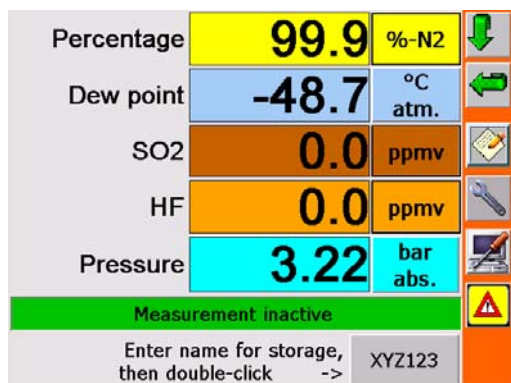


III. 4.7.4 measurement running

- Measurement completed.
- Pumping back measuring gas (only at devices with gas return system)
- Rinsing the SO₂ sensor (if SO₂ sensor is available and the value is higher than 2ppm_v)

The **To measured values** key enables to switch over to the current measuring values during measurement.

After the end of the measuring time it is automatically switched over to the "Measuring results" window.



III. 4.7.5 measuring result with SO₂ and HF (left) and with SO₂, HF, CO and H₂S (right)

SF₆ Multi Analyser | 3-038(R)-R...



Note

In case the values fall below or exceed the limit values entered on the “Configuration” window a “Limit value fallen below ” or “Limit value exceeded message appears on the “current measuring value” window”.

Limit value fallen below	30.9	%-N ₂	↓
Limit value exceeded	-9.6	°C atm.	←
SO ₂	0.0	ppmv	📄
HF	0.0	ppmv	🔧
Pressure	3.22	bar abs.	📊
Measurement inactive			⚠️
Enter name for storage, then double-click ->		XYZ123	

III. 4.7.6 limit values



Warning

Oil or condensated moisture must not penetrate the SF₆ Multi Analyser.

Make sure that the pressure in the gas compartment to be measured does not exceed p_e 9 bar prior to connect the SF₆ Multi Analyser.



Note

The solenoid valves in the SF₆ Multi Analyser open automatically during the measurement. If there is back pressure e. g. because the “Gas outlet” is closed on the outlet or the SF₆-gas cannot be transported the input solenoid valve is closed and the measurement is interrupted by a message. The back pressure cannot continue to increase.

SF₆ Multi Analyser | 3-038(R)-R...

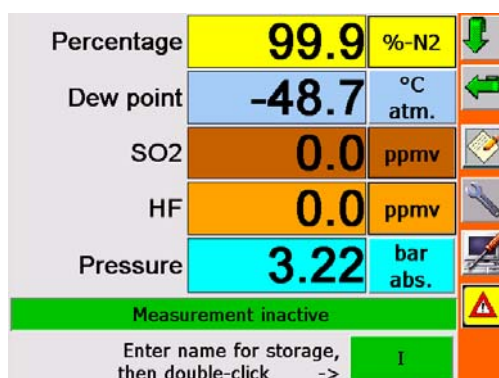
4.8 Storage of measurements

After the automatic measuring process the measured values can be stored in the device. For this purpose press the “XYZ123” key on the “Measuring results” key. The following prompt appears:



III. 4.8.1 enter name of measuring value

Enter the desired name and confirm with the “RET” key.



III. 4.8.2 storage of measuring value

Confirm the inputs by double clicking the green “I” key.
The current measuring value is stored in the device now.

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The stored measuring value can be indicated by pressing the  key. The current memory capacity with a total of 100 is indicated on the top right. The arrow keys enable to browse up and down in single increment or increments of 10.

Stored measured values		No.
Name	1	1
Date	2011-07-14	
Time	10:37:40	
Percentage	99.9 %-N2	
Dew point	-48.7 °C atm.	
SO2 value	0.0 ppmv	
HF-value	0.0 ppmv	
Pressure	3.22 bar abs	
Data storage (double-click):		all
Delete data (double click):	current	all

III. 4.8.3 measuring result

In the “Delete data (double click)” line either the value indicated currently or all measuring values can be deleted.

In the “Data storage (double click)” line the values can be transmitted to an USB stick (see chapter 5.1)

SF₆ Multi Analyser | 3-038(R)-R...

5. Transmission of the measuring data on PC

The stored measuring data of the SF₆ Multi Analyser can be transmitted to an USB stick for filing. For this purpose press the “All” key in the “Data storage (double click)” line.



III. 5.1, data transmission

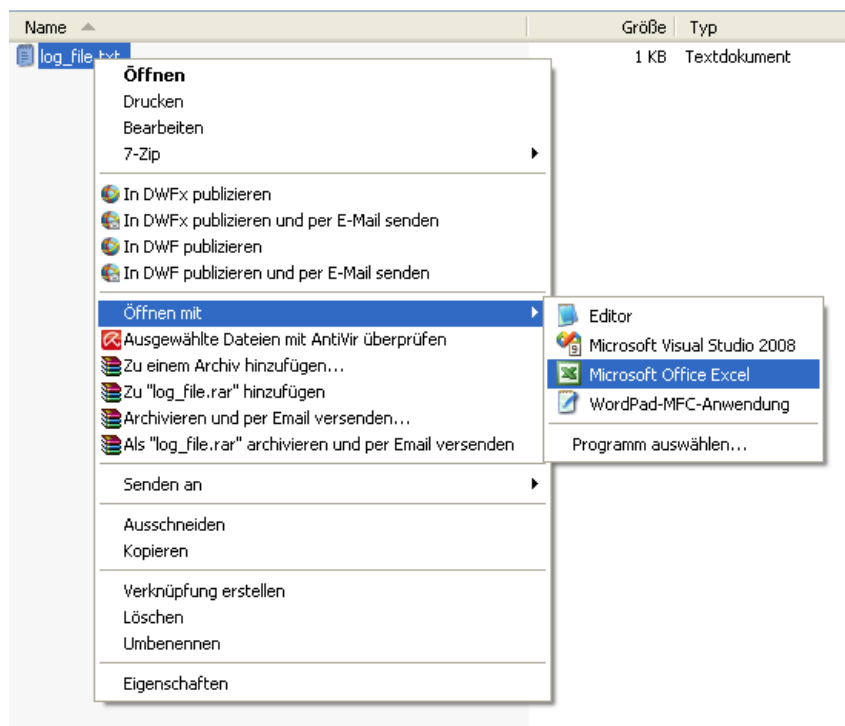
After having completed the data transmission a message appears after about 2 seconds.



5.1 Storing the data on USB stick

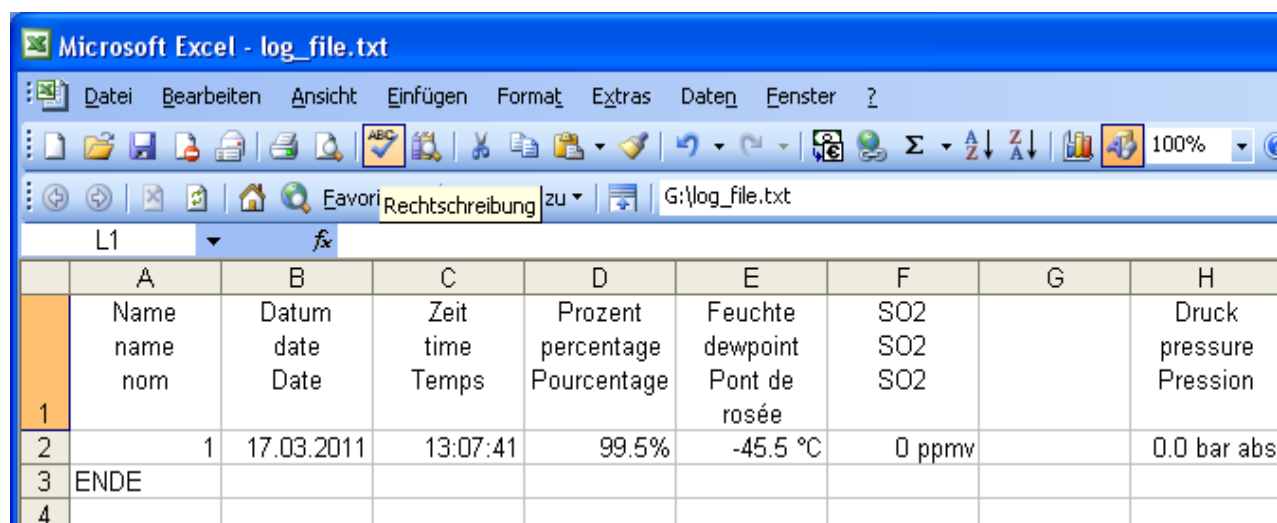
Procedure:

- Plug in the USB stick on the front side of the SF₆ Multi Analyser.
- Storage is carried out by double clicking on the “all” key.
The “Data transmission successful” message appears.
- Open the “log_file.txt” file of the USB stick on the personal computer as follows:
 - right mouse button on the file
 - selection “open with (öffnen mit)”
 - select “Microsoft Office Excel”



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d) The measuring values are indicated in an Excel file.



The screenshot shows a Microsoft Excel window titled "Microsoft Excel - log_file.txt". The menu bar includes Datei, Bearbeiten, Ansicht, Einfügen, Format, Extras, Daten, and Fenster. The toolbar contains various icons for file operations and editing. The address bar shows the file path "G:\log_file.txt". The worksheet has columns labeled A through H and rows numbered 1 through 4. The data is as follows:

	A	B	C	D	E	F	G	H
	Name name nom	Datum date Date	Zeit time Temps	Prozent percentage Pourcentage	Feuchte dewpoint Pont de rosée	SO ₂ SO ₂ SO ₂		Druck pressure Pression
1								
2	1	17.03.2011	13:07:41	99.5%	-45.5 °C	0 ppmv		0.0 bar abs
3	ENDE							
4								

The data can only be processed by means of the known Excel functions and stored in all current file formats.

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6. Fault correction

It is not recommended to carry out repair works of the SF₆ Multi Analyser by yourself (except for disassembling the single modules, see chapter 1.6).

But do not carry out any works on the measuring cells. In case of malfunction return them to the manufacturer of the device.

If there is no indication after switching on the device check whether correct power supply is connected and the mains plug is fixed tightly.

If this is correct check both mains fuses which are in the fuse carrier on the main s plug and can be opened by pressing both interlocks. In case an indication does not yet appear the SF₆ Multi Analyser must be sent to DILLO.



Danger

Prior to the removal of the mains fuse unplug the power plug.
If the mains fuse is replaced only use the same type (see technical data 2.1.)

In case the device cannot be started or if there are malfunctions during operation qualified personnel is to be consulted for repair and maintenance.

To avoid danger to life by electrical shock:

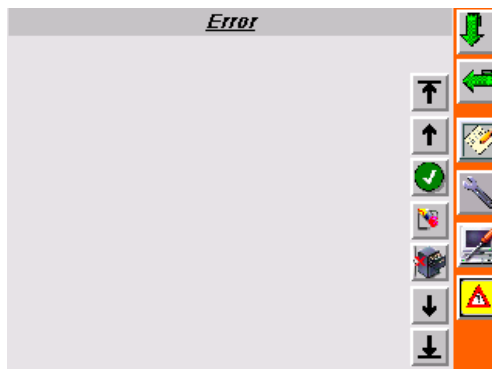


Danger

- Only properly trained electricians should carry out maintenance and repair works on electrical equipment.
- The operator should only eliminate faults, which result from operating or maintenance errors.

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Breakdown and warning messages are released on the error window of the touch panel.



III. 6.1 error message

It is possible to browse up and down with the  and  keys in single increments.

It is possible to browse up and down with the  and  keys in increments of ten.

A message can be confirmed with the  key.

The error history can be deleted with the  key.

The error history can be switched on or off with the  key.

The following error messages are indicated on the panel:

- 00: Pressure sensor defective storage vessel
- 01: Pressure sensor defective compressor
- 02: Pressure sensor defective input
- 03: Pressure sensor defective measuring cells

The following warning messages are indicated on the panel:

- 00: Storage pressure too high
- 01: Suction pressure too high
- 02: Input pressure too high
- 03: Output pressure too high
- 04: Input pressure too low
- 05: Lifetime of measuring cells expired
- 06: Start "Stop -> manual pumping back"
- 07: Error commutation CF₄ (only for devices with selection of N₂/CF₄ carrying gas)

SF₆ Multi Analyser | 3-038(R)-R...

List of failure on the touch panel:

Error message	Possible cause of error	Correction
Defective pressure sensor	Defective pressure sensor	Check pressure sensor
	Cable not connected	Check sensor connection
Storage pressure too high	Pressure in the internal storage vessel too high	Reduce pressure by "Manual pumping" (see chapter 4.6)
Suction pressure too high	Check the compressor The solenoid valves downstream from the compressor do not open	Carry out pressure test (see chapter 8.1) Check the solenoid valves
Input pressure too high	The pressure of the connected gas compartment is $> p_e = 9$ bar	Reduce the input pressure
Output pressure too high	The pressure downstream from the measuring cells is too high	Check the valves between measuring cells or compressor start "Emptying buffer tank" special function (see Ill. 8.1)
Input pressure too low	The pressure of the connected gas compartment is $< p_e = 0.3$ bar	Increase the input pressure
Lifetime of measuring cells expired	The lifetime of two years will expire in three months	Purchase an exchange sensor or send the device to DILo for verification
Start "Stop-> manual pumping back"	The storage pressure for the current measurement is too high	Reduce the pressure by "Manual pumping" (see chapter 4.6)
Error commutation CF ₄	The percentage module does not commute	Check whether - output .2 on SPS storage module K04 lights up (3-038R) - output .3 on SPS storage module K03 lights up (3-038)
"-----" indication on the result page	Measuring cell does not provide any measuring value	Check the electric connection of the measuring cell

List of other breakdowns:

Error message	Possible cause of error	Correction
The compressor does not reach any high output pressure	The incorrect solenoid valves are opened Defective piston rings, defective valve seats	Check the position of the solenoid valves Check the compressor in accordance with the operating manuals of the compressor

SF₆ Multi Analyser | 3-038(R)-R...

7. Gas return system

Legal directives becoming more and more strict and the voluntary self-commitment of the SF₆-users also require the collection of used gas even of smallest amounts of SF₆, as being discharged during measurements. For this purpose, the gas return system has been developed.

Devices with integrated gas return system:

At these devices the collected measuring gas is pumped back automatically in the connected gas compartment. (This function is preset in our works).

However this function can be deactivated in the configuration menu (see chapter 4.6). Then the measuring gas can be pumped in other vessels manually (max. pressure $p_e = 9\text{bar}$).

Devices without integrated gas return system:

These devices are provided for connection to an external gas return system.

The measuring gas inlet and outlet are connected to the external gas return system.

The gas compartment is directly connected to the external gas return system.

If the internal intake capacity of the external gas return system is reached the input valve of the external gas return system closes and the measuring device does no longer receive measuring gas on the inlet. The measurement is stopped and the measuring gas is automatically pumped back in the connected gas compartment. (This function is preset in our works).

However this function can be deactivated in the configuration menu of the external gas return system. Then the measuring gas can be pumped manually in other vessels (max. pressure $p_e = 9\text{bar}$).

External gas return system

This single device is available for devices without gas return system.

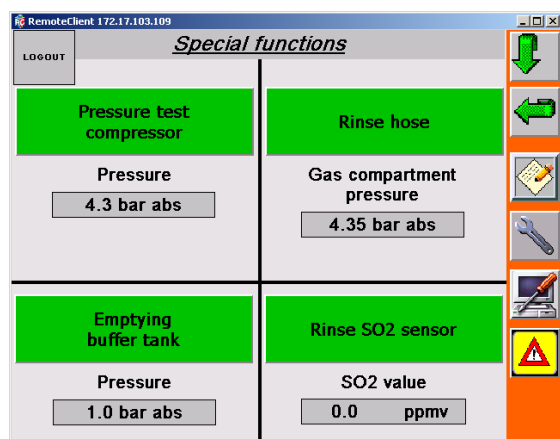
SF₆ Multi Analyser | 3-038(R)-R...

8. Special functions

After pressing the

Special functions

key in the configuration menu the “Special



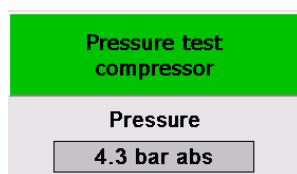
1. LOGOUT
2. compressor pressure test
3. rinse hose
4. emptying buffer tank
5. rinse SO₂ sensor

III. 8, special functions

8.1 Function at devices with gas return system

8.1.1 Pressure test of compressor

We recommend checking the compressor for faults once a year or not later than the maintenance interval indicated.



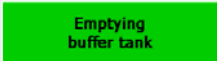
III. 8.1.1 compressor pressure test

1. Do not connect any gas compartment that means remove the hose from the input coupling.
2. The function can be started by the “Pressure test compressor Start / Stop” key.
3. Indication of the current pressure on the pressure side of the compressor.
4. After the test time a window with the following message appears:
 - A) “Pressure test successful” if a final pressure of $p_e = 8$ bar has been reached or
 - B) “Pressure test not successful” if a final pressure of $p_e = 8$ bar is not reached.
5. In case the function is stopped prior to expiry of the test time the “Pressure test not successful” appears.
6. The function is completed by pressing the red “Pressure test compressor Start/Stop” key.

In case of successful pressure test it can be continued to operate without hesitation.
If the pressure test is not successful the device should be sent to DILo for verification.

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8.1.2 Emptying the buffer tank

It is possible to reduce a too high measuring cell pressure manually (see “output pressure too high” error message in chapter 6) by pressing the  key.

The measuring cell pressure is illustrated below the function key.

The function can only be started if the pressure in the measuring cell becomes higher than 1.1 bar abs.

8.2 Common functions

8.2.1 Rinse hose

Only start the function if the pressure in the hose (corresponds to the gas compartment pressure at coupled hose) is higher than the pressure in the internal tank.

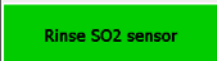
The hose connected to the measuring gas input can be rinsed by pressing the  key. The gas compartment pressure is shown below the function key.

The function is stopped by pressing the key once again or stops automatically when there is an increase in pressure of 0.5 bar in the internal tank.

ATTENTION:

For using devices without gas return system an external gas return system is to be connected to the measuring gas output, otherwise the measuring gas could flow into the atmosphere via the open output.

8.2.2 Rinsing the SO₂ sensor

The SO₂ sensor can be rinsed with ambient air manually by pressing the  key. The SO₂ value is illustrated below the functional key.

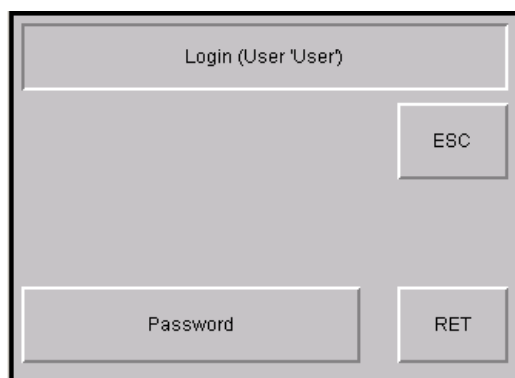
The function can be stopped by pressing the key again or stops automatically at a SO₂ value lower than 1 ppm_v, but after 15 minutes at the latest.

SF₆ Multi Analyser | 3-038(R)-R...

8.2.3 LOGOUT

It is possible to change to the WINDOWS-CE operating system level by the LOGOUT function. This function is password protected and is only required for necessary Updates.

After pressing the  key in the upper left corner the following window appears:



Login (User 'User')

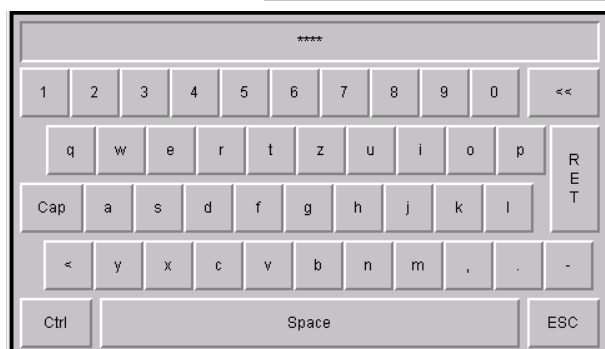
ESC

Password

RET

ESC = back to user interface
Password = enter password
RET = confirmation of entering password

After pressing the  key you are requested to enter the password.



1 2 3 4 5 6 7 8 9 0 <<

q w e r t z u i o p RET

Cap a s d f g h j k l

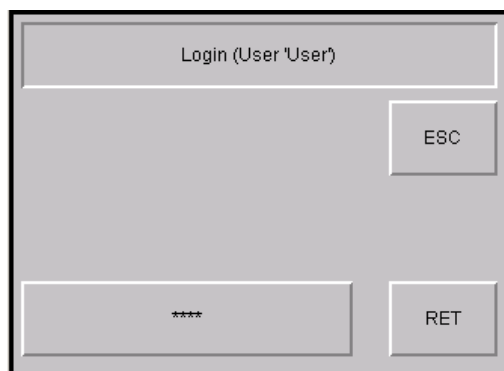
< y x c v b n m , . -

Ctrl Space ESC

The pass word is:

87727

After pressing the  key the Login window with encrypted password appears.



Login (User 'User')

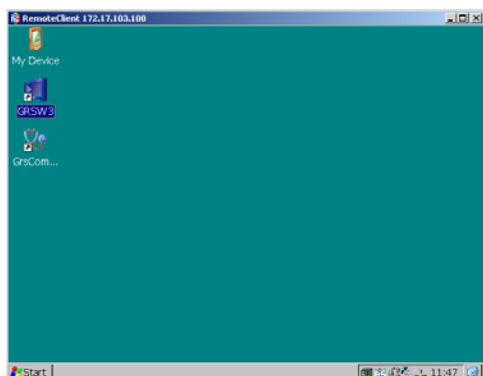
ESC

RET

The  symbol appears down right by pressing again the  key.

SF₆ Multi Analyser | 3-038(R)-R...

After having pressed this symbol the WINDOWS-CE operating system is reached.



The operating interface of the panel is started by double-clicking the  symbol

After a short booting process the start screen appears (see chapter 4.2) and the measuring device is ready for operation.

SF₆ Multi Analyser | 3-038(R)-R...

9. Maintenance



Only authorized personnel should carry out purification and maintenance works in accordance with maintenance instructions and regulations for the prevention of accidents. In case of non compliance this could result in injury or death and also considerable damage to the equipment.

Carry out maintenance works only if the device is switched off!

- Touch hot components (compressor) only after they have cooled down!
- Exchange filters which contain or are saturated with decomposition products!

Maintenance

Preventive measures

Object	Maintenance works	Recommended control interval
Compressor B100R20	Valve seat, piston ring, O-rings	Check every 500 hours and exchange if necessary (exchange by DILO GmbH)
Particle filter SK-552	Purify or exchange	During each compressor revision (exchange by DILO GmbH)

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10. Appendix

Moisture Content Conversion Chart for SF₆ at atmospheric pressure

°F	°C	PPM _m	PPM _v
30	-1	780	6326
28	-2	700	5677
27	-3	625	5069
25	-4	575	4663
23	-5	500	4055
21	-6	450	3650
19	-7	410	3325
18	-8	390	3163
16	-9	350	2839
14	-10	320	2595
12	-11	290	2352
10	-12	260	2109
9	-13	240	1946
7	-14	220	1784
5	-15	200	1622
3	-16	185	1500
1	-17	175	1419
0	-18	150	1217
-2	-19	145	1176
-4	-20	135	1095
-6	-21	120	973
-8	-22	110	892
-9	-23	100	811
-11	-24	90	730
-13	-25	80	649
-15	-26	70	568
-17	-27	64	519
-18	-28	57	462
-20	-29	50	406
-22	-30	44	357
-24	-31	40	324
-26	-32	36	292
-27	-33	32	260
-29	-34	29	235

°F	°C	PPM _m	PPM _v
-31	-35	27	219
-33	-36	24	195
-35	-37	22	178
-36	-38	19	154
-38	-39	17	138
-40	-40	15	122
-42	-41	13	105
-44	-42	12	97
-45	-43	11	89
-47	-44	9	73
-49	-45	8.5	69
-51	-46	7.5	61
-53	-47	6.8	55
-54	-48	6	49
-56	-49	5.5	45
-58	-50	5	41
-60	-51	4.2	34
-62	-52	4	32
-63	-53	3.5	28
-65	-54	3	24
-67	-55	2.5	20
-69	-56	2.3	19
-71	-57	2	16
-72	-58	1.7	14
-74	-59	1.5	12
-76	-60	1.3	11

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Best Practice – Correct Dew Point Measurement

Dew point measurement is quite complex. In order to get correct or stable dew point values during measurement the following basic rules need to be adhered to:

Measurement carried out on SF₆ bottle:

1. The SF₆ bottle filled with liquid gas must always be placed horizontally prior to measurement, thus causing gas mixture inside the bottle.
2. The pressure reducer must be made of stainless steel (see Z340R10 adapter kit for measuring devices) => **NO rubber diaphragm!!!**
3. No rubber hoses may be used between bottle / gas compartment and measuring device!
4. If possible, only the 6m long measuring gas hose (included in the scope of supply) should be used. Using longer hoses may cause longer measuring time and dew point falsification.

Conditions having negative effects on dew point values:

1. Use of rubber hoses in measuring line
2. Extreme differences in ambient temperature
3. Alternating measurements with humid and dry gas on the same gas compartment
4. Multiple measurements with automatic pumping back on the same gas compartment
5. Measurements on gas compartments with down piping
6. Rinsing time too short when starting measurements with unknown gas inside hose

Remedial action when dew point values differ:

1. Check the above-mentioned points
2. Set hose length to 12m (=> longer rinsing time)
3. Manual rinsing when gas quality is unknown
4. First measurement without automatic pumping back. Second measurement with automatic pumping back results in correct dew point.

In general, the operating temperature of measuring device needs to be observed:

3-031:	+ 5°C to 35°C
3-037:	0°C to +50°C
3-038 Multimeter:	0°C to +40°C
3-038 Multi Analyser:	-10°C to +50°C