

## 973-SF<sub>6</sub> Analyzer

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**Operation Manual**  
**Version 973-SF<sub>6</sub>**  
**V4.0**



# Warranty

MBW Calibration Ltd. (MBW) guarantees that its products are manufactured to the highest quality of material and workmanship specifications. MBW guarantees the reliability of its products for a period of 24 months from the date of initial shipment when operated in normal use and within the specified design limitations. Under this Warranty, MBW will, at its discretion, repair or replace any component that upon examination by MBW or its duly authorized representatives proves to be defective during the warranty period provided the system is returned to the factory for inspection and repair shipping prepaid. Improper or unauthorized maintenance, storage, repair, or alteration of any kind by personnel other than MBW or its duly authorized representatives may void all warranties. Warranty may also be voided for misuse, neglect, accident, corrosion, and improper installation. This Warranty is exclusive and in lieu of any and all other warranties of merchantability, fitness for a particular purpose, or any other warranty, expressed or implied, and all other liabilities and obligations on the part of MBW. MBW will not be liable for any other claims or damages, either direct, indirect, or consequential arising out of the use of its products.

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# 1. General

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This manual explains the function of the 973-SF<sub>6</sub> Analyzer with and without the SO<sub>2</sub> option. Throughout this manual the instrument will be called 973.



Should the 973 be used in any other way than that described in this user's manual, or outside the limits described, the built-in safety protection of the instrument may be compromised.

**Vol SF6 %**

All descriptions in ***bold italic*** are related to the text on the front panel, the display and the back panel of the 973.

If you wish to use the instrument as quickly as possible, we recommend reading the chapters **Initial Setup** (page 11) and **Measurement** (page 19). Standard use of the instrument is explained in these two chapters.



# 2. Short Description

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## Reliable Measurements in SF<sub>6</sub>

The 973 was specifically designed for measurement of humidity, SF<sub>6</sub> purity and SO<sub>2</sub> concentration in gas insulated switchgear systems. Humidity measurement data is displayed in ppm<sub>v</sub>, ppm<sub>w</sub> and Frost/Dew Point at either gas compartment pressure or standard pressure. SF<sub>6</sub> purity measurement is displayed directly in % Volume SF<sub>6</sub>. Both the humidity and purity measurements utilize accurate and reliable condensation techniques. SO<sub>2</sub> concentration is measured with an electrochemical cell with results displayed in ppm<sub>v</sub>.

## Gas Recovery and Pressure Measurement

The 973 is equipped with a gas recovery system that stores the sampled gas during the measurement process in its internal storage cylinder. After completion of the measurement, the stored gas is pumped back into the original compartment or into another vessel. The compartment pressure is also measured.

## Easy, Automated Measurement

The 973 is equipped with a user configurable full color active matrix LCD with integrated touch screen. The 973 may be configured for measurement of Humidity and % Volume SF<sub>6</sub> with either automatic or manually initiated Pump Back. Using the bi-directional RS-232 communications port, all measurement data may be easily transferred to a computer.

## Calibration

Users can easily check the 973 calibration at any time using the built-in Ice Test function, providing instant verification of system accuracy and integrity.

## LCD Display with Touch Panel

The 973 utilizes a full color active matrix liquid crystal display with an integral touch panel. It has a high contrast ratio and a wide viewing angle for easy readability. Data is displayed in large, easy to read fonts. Using the on-screen function and menu keys, you can easily configure each line of the display and navigate the menus.

Versions equipped with the SO<sub>2</sub> option will have alternative display and data line formats. Please refer to page 21 for further information on the measurement of SO<sub>2</sub> concentration.

## Connect and Go

The system is supplied ready for immediate use.

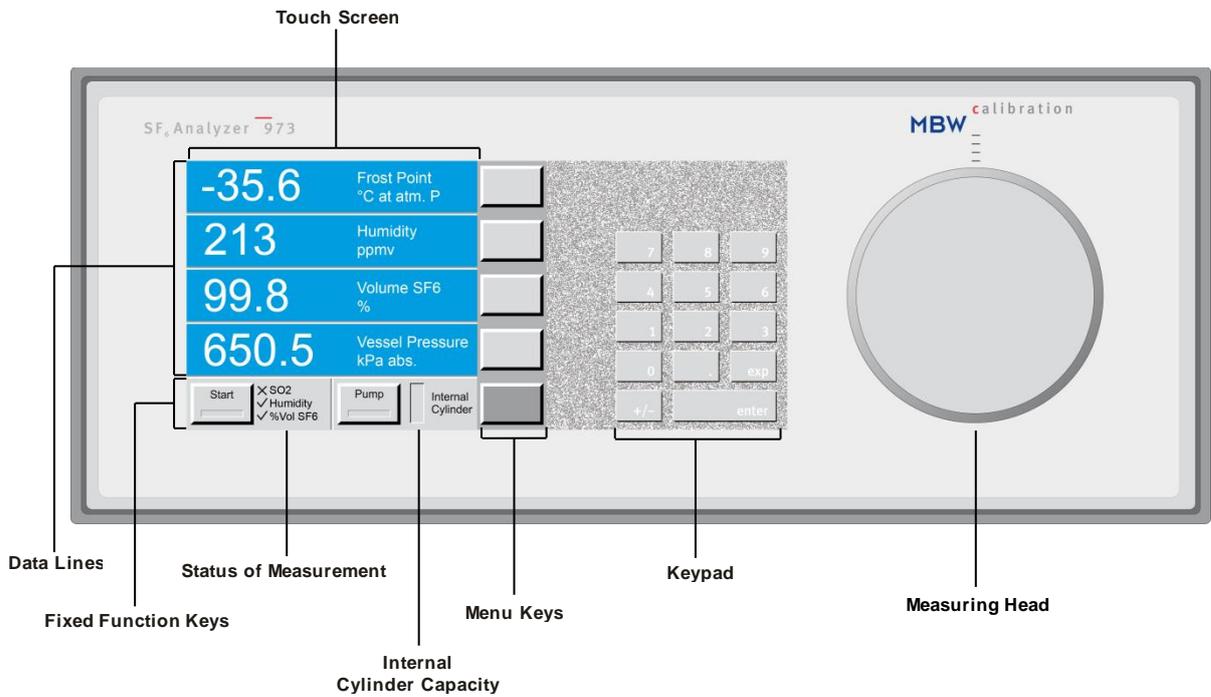
## 973-SF<sub>6</sub> with Standard Accessories

The 973-SF<sub>6</sub> Analyzer will be delivered with the following standard accessories:

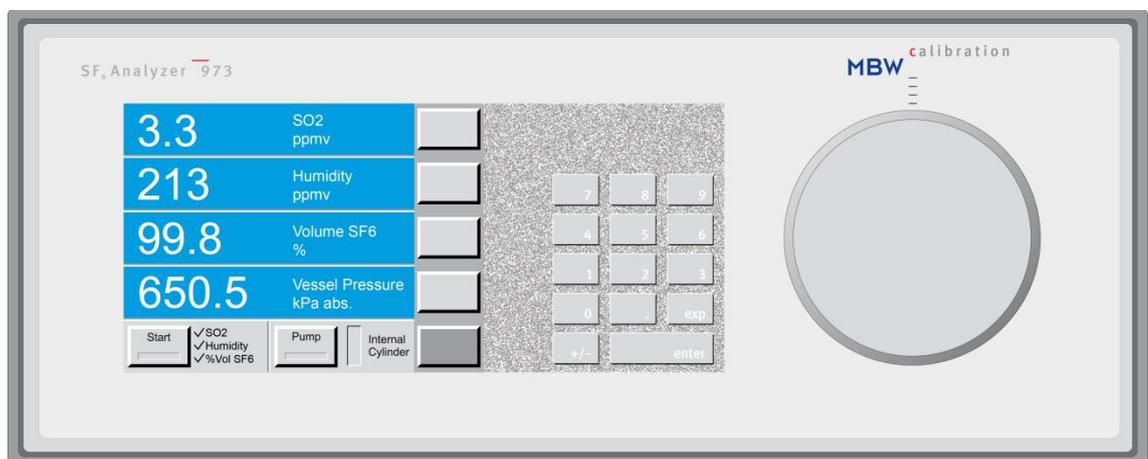
- Transport Peli-Case 1620 Order code: 141343
- 6 m Stainless Steel armored PTFE tubing Order code: 102764
- SF<sub>6</sub> coupling DN8 with quick coupling (Rectus) Order code: 102983
- SF<sub>6</sub> coupling DN20 with quick coupling (Rectus) Order code: 102984
- 90° Angle for Rectus-Coupling Order code: 103410
- Serial cable DB9 3m 1:1 male/female Order code: 101258
- RS-232 / USB Adapter Order code: 140446
- USB stick with 973-SF<sub>6</sub> Software and operation manuals Order code: 141673
- Power cable (country specific) Order code: 105006
- Hex key for SO<sub>2</sub> module Order code: 103947
- SO<sub>2</sub> Dummy sensor Order code: 103972
- Cotton swabs, sterile (10 pieces) Order code: 101429
- Operation Manual (2 pieces) Order code: 105007
- Calibration Certificate Order code: 105008

# 3. Operation

## Front Panel without SO<sub>2</sub> Option

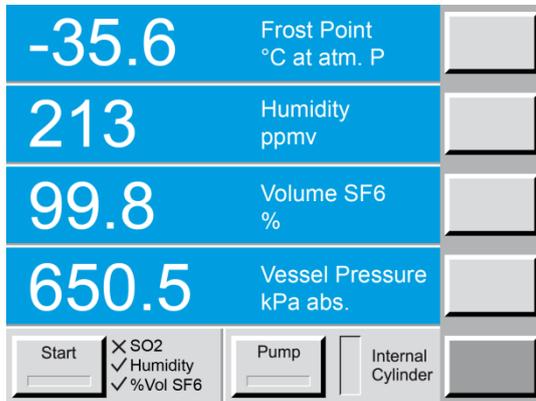


## Front Panel with SO<sub>2</sub> Option



## Data Lines

The first four lines of the display are for numeric representation of the measured data. We refer to those first four lines as Data Lines. Numeric data lines contain the value to the left, with the parameter description and units to the right. The displayed parameters and units can be changed, but after a restart of the instrument, the values will be reset to the stored standard configuration.



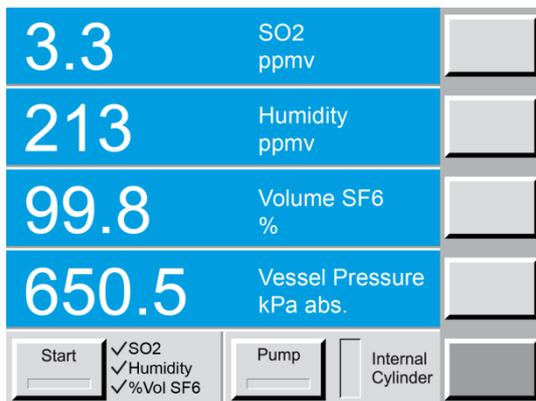
### Data Line 1

This line displays the measured Dew/Frost Point. The unit is °C at atmospheric pressure.

In the standard configuration, instruments equipped with the SO<sub>2</sub> option show the SO<sub>2</sub> concentration expressed in ppm<sub>v</sub>. The standard SO<sub>2</sub> configuration is shown on the second display.

### Data Line 2

This line displays the humidity content in either ppm<sub>v</sub> (parts per million by volume) or ppm<sub>w</sub> (parts per million by weight). Both units are pressure independent.



### Data Line 3

This line displays the purity in % Volume SF<sub>6</sub>.

### Data Line 4

This line indicates the current pressure of the gas compartment. The unit is kilo Pascal absolute pressure.



The data lines indicating the measured humidity and SO<sub>2</sub> concentrations as well as the % Volume SF<sub>6</sub> will only be displayed after completion of the measurement. During the measurement only the current gas pressure of the measured compartment is indicated.

## Fixed Function Keys and Status Line

### Without SO<sub>2</sub> Option

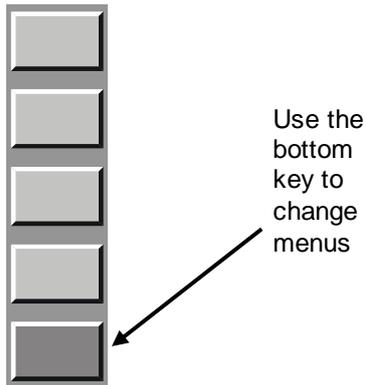


### With SO<sub>2</sub> Option



The bottom line of the display contains two fixed function keys. The measurement process is started by pressing the **Start** button. With the **Pump** button, pump back of stored gas in the internal cylinder can be activated manually. These function keys are not changeable and are always available. Additionally, this line contains the status indication, which indicates the current operation mode. The level indicator of the internal cylinder indicates the current storage capacity. A 973 without the SO<sub>2</sub> option will display an **X** next to **SO<sub>2</sub>** to indicate that the measurement of SO<sub>2</sub> concentration is not available.

## Menu Keys



To the right side of the display is a column of menu keys. Each of these keys changes function as needed.

Note that the bottom key in this column is different from the rest. The bottom key is used to cycle the upper keys through the various menu options. The text on the bottom key changes to indicate the currently selected menu option. The text of the upper keys change based on the functions available in the menu.

## Keypad



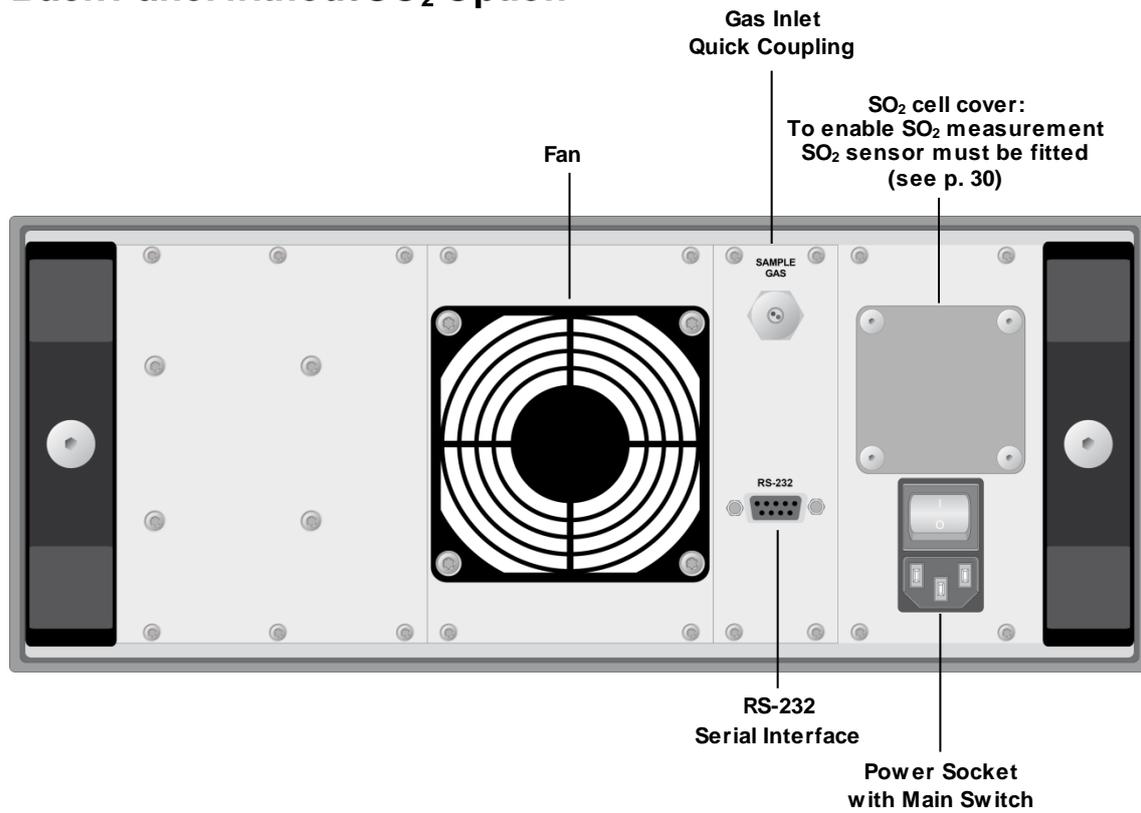
The keypad is used for entering data into the 973. For normal operation it is rarely used.

## Carrying Handle

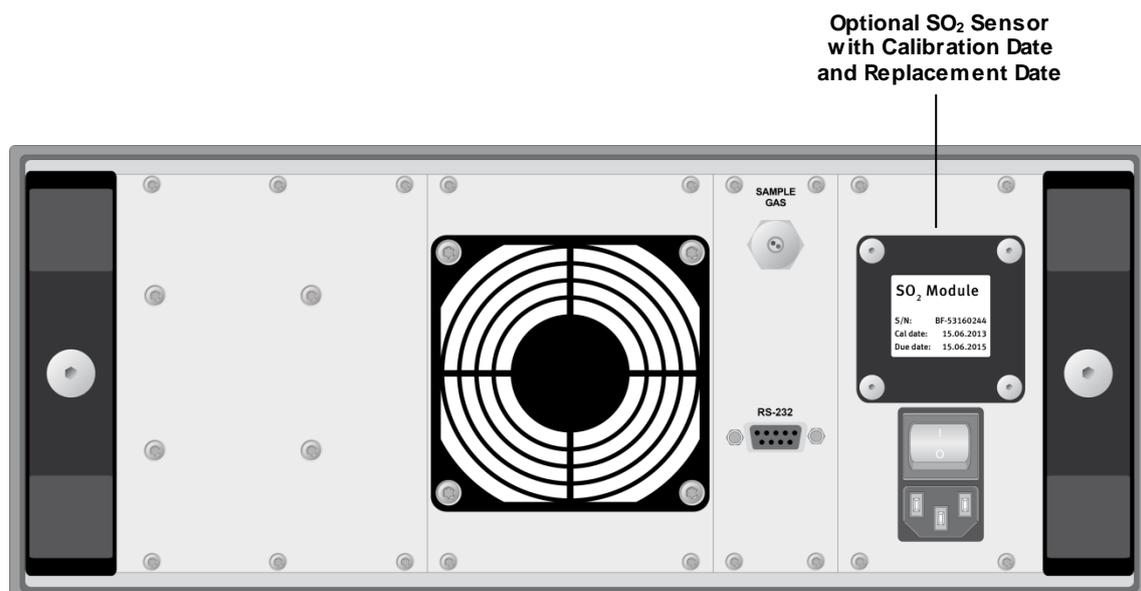


To adjust the position of the carrying handle, press the buttons on both sides to unlock it before rotating. Release the buttons when the desired position is found.

## Back Panel without SO<sub>2</sub> Option



## Back Panel with SO<sub>2</sub> Option



## **Power Connection**

The AC power cord is connected to the power socket on the instrument back panel. The power socket also includes the power switch. The power supply voltage is 100-120 VAC / 200-240 VAC at 50 to 60Hz. The power supply is internally fused and will automatically switch off in case of an overload. To restart the power supply, the instrument main switch must be switched to *0* and *I* again.

## **SO<sub>2</sub> Module**

When fitted, the SO<sub>2</sub> module is mounted to the back panel of the 973 which allows the SO<sub>2</sub> sensor to be easily replaced by the user. The sensor has to be replaced every two years. The calibration and replacement dates are indicated on the SO<sub>2</sub> module.

## **Gas Inlet Quick Coupling**

The sampling line is connected to the sample gas inlet. If the instrument is not in use the inlet should be protected with the blue cover.

## **RS-232 Serial Interface Connector**

The RS-232 connector is used when connecting the 973 to a computer. Use the supplied 9 pin 1:1 cable to connect the 973 to a desktop or laptop computer. This cable has a male connector on one end and a female connector on the other end. It is most often referred to as a serial extension cable.

## **Fan**

When the 973 is switched on, the cooling fan always runs independent of the ambient and instrument temperatures.



# 4. Initial Setup

---

## Preparation

The 973 needs a source of normal AC power. The label on the back panel indicates the acceptable input voltage range. The instrument has been designed to work with a power range between 100-120 VAC / 200-240 VAC at 50 or 60 Hz. This normally covers all usual AC line voltages.

## Electrical Connection



The power socket and the main power switch are on the back panel of the instrument. Use the provided power cable to connect the instrument to the AC power.

Start the instrument by turning on the power switch. The display of the 973 comes up immediately following the processor's boot phase. The boot phase may take several seconds to complete.

## Connection of the Serial Interface



If you intend to transfer the measured data to a computer, connect the serial cable between the instrument and the computer.

If your computer is equipped with a USB interface, you can use the provided RS-232/USB converter. The installation and data collection will be explained in the chapter '**Data Collection**' on page 25.

## SF<sub>6</sub> Gas Connection



The quick coupling on the instrument side of the sampling tube must be connected to the **SAMPLE GAS** inlet.

**Note:**

To prevent contamination, the blue cover caps of the instrument and sampling tube should always be installed when the instrument is not in use.



The standard accessories of the 973 include a DN8 and a DN20 SF<sub>6</sub> coupling.

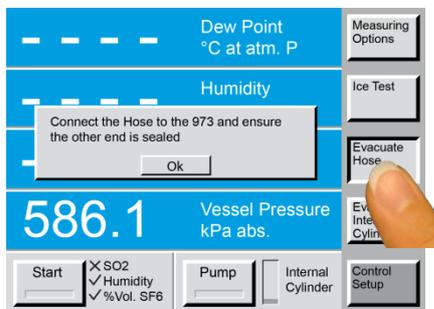
## Evacuate the Sampling Tube

The sampling tube must be evacuated before the first initial measurement is started. Once initially evacuated, there is no need to re-evacuate the hose, even when moving the connection to the next compartment.



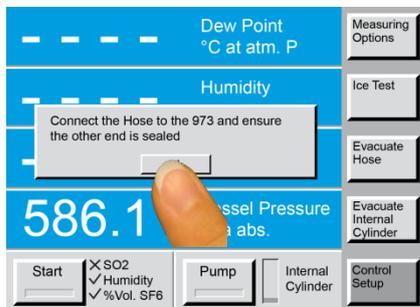
Make sure that a SF<sub>6</sub> coupling DN8 or DN20 is properly installed on the sampling tube, but do not connect the SF<sub>6</sub> coupling to anything else at this time. Since the SF<sub>6</sub> couplings are self-sealing, the sampling tube is sealed.

Ensure that the other end of the sampling tube is properly connected to the 973.

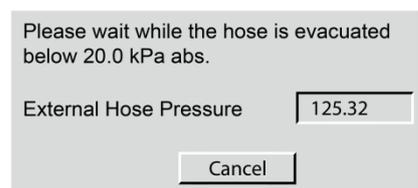


Press the lower right key in order to select the **Control Setup** menu. **Control Setup** appears on the key, while on the upper keys the available menu options are indicated.

Press the **Evacuate Hose** key.



With the sampling tube correctly connected, press the **Ok** key in order to start the evacuation process.



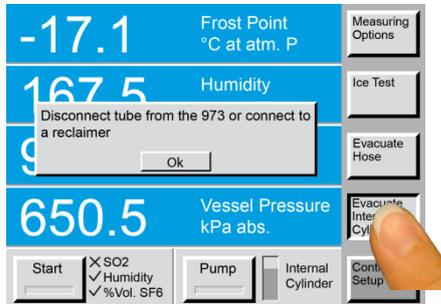
After the evacuation has started, the next window indicates the decreasing pressure of the sampling gas tube while evacuating.

After reaching the set residual pressure of 20 kPa, the evacuation process is stopped automatically and the window closes. The instrument and the sampling tube are now ready for measurement.

By pressing the **Cancel** key during evacuation, the process can be manually stopped.

## Evacuate the Internal Cylinder

If the content of the internal cylinder is unknown, or contaminated SF<sub>6</sub> gas is stored inside it, the internal storage cylinder can be evacuated.

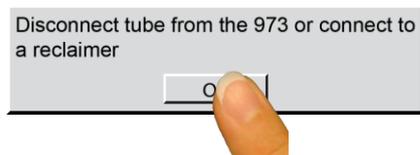


Press the **Evacuate Internal Cylinder** key in the **Control Setup** menu.

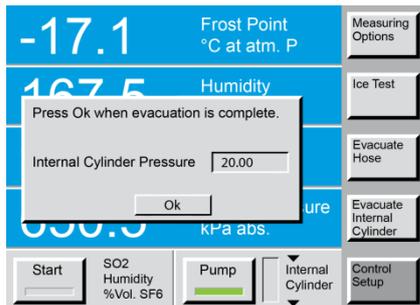
The dialogue box requests you to remove the sampling gas tube or connect an SF<sub>6</sub> reclaimer to the 973.



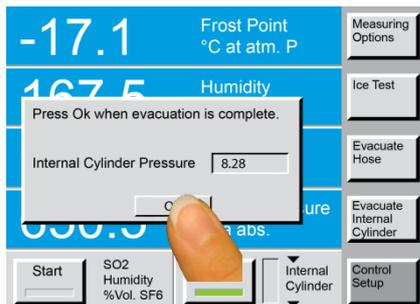
Disconnect the quick coupling from the **SAMPLE GAS** inlet or connect the instrument to an SF<sub>6</sub> reclaimer.



Press the **Ok** button to start the internal cylinder evacuation.



The dialogue box indicates the current internal cylinder pressure during evacuation. After evacuating below 20 kPa residual pressure, the internal pump automatically stops. The evacuation process can be stopped by pressing the **Ok** button.



If the 973 is connected to an external reclaimer, evacuation can be continued with the reclaimer until the desired residual pressure is reached. By pressing the **Ok** button, the evacuation process can be stopped.

## SF<sub>6</sub> Gas Connection to the Compartment



If the sampling tube was properly evacuated before the first measurement, it is now ready to connect to the gas compartment. When moving the connection from compartment to compartment, there is no need to re-evacuate.

Remove the dust caps from fittings, check both threads are clean, carefully screw on the fitting and ensure a good seal is made.



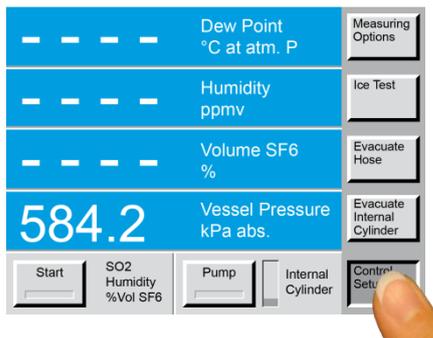
# 5. Measurement Options

## Navigating the Menus

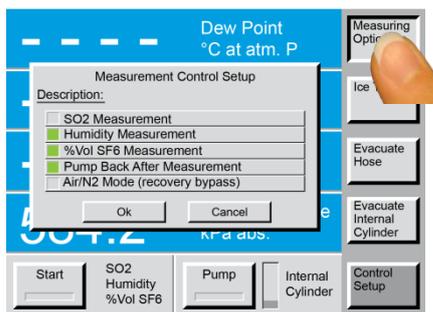
The various menus of the right column of keys are navigated by using the key in the lower right corner of the touch screen. Each time you press the lower right key, a new menu appears on the keys directly above it. The menu is circular, meaning that once you go past the last menu, the first one appears again and the process starts over. You can use the  $\pm$  key on the keypad to move backward through the menus. Use the **Enter** key to clear the menu.

## Selecting the Measurement Options

With the measuring options you can select either the humidity measurement, % volume SF<sub>6</sub> measurement, or both. In addition, you can select automatic pump back of the stored gas after the termination of the measurement. If the instrument has an SO<sub>2</sub> module installed, then the user can also choose to activate or deactivate the SO<sub>2</sub> measurement. With the standard 973-SF<sub>6</sub> configuration, humidity measurement, % volume SF<sub>6</sub> measurement and automatic pump back are selected. This configuration can be changed. However, after restarting the instrument, it will be set back to the standard configuration.

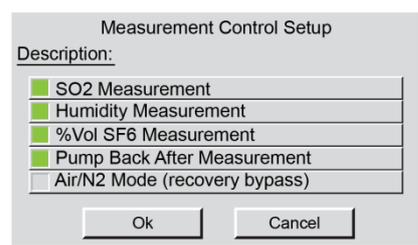


Press the lower right menu key once to select the **Control Setup** menu. **Control Setup** appears on the key while the keys above change to available menu options. Note that the top key indicates **Measuring Options**.



Press the **Measuring Options** menu key at the top right corner of the screen. The **Measurement Control Setup** window appears.

This standard 973 configuration without the SO<sub>2</sub> module is **Humidity Measurement**, **% Vol SF<sub>6</sub> Measurement**, and **Pump Back After Measurement**.



For the 973 equipped with the SO<sub>2</sub> option, the standard configuration is **SO<sub>2</sub> Measurement**, **Humidity Measurement**, **% Vol SF<sub>6</sub> Measurement**, and **Pump Back After Measurement**.

## Measuring Mode Examples

The examples shown include the measuring options for the 973 when equipped with the SO<sub>2</sub> option. When the SO<sub>2</sub> measurement option is not activated, the **SO<sub>2</sub> Measurement** button is disabled and cannot be selected.

Measurement Control Setup  
Description:

<input type="checkbox"/>	SO <sub>2</sub> Measurement
<input checked="" type="checkbox"/>	Humidity Measurement
<input type="checkbox"/>	%Vol SF <sub>6</sub> Measurement
<input type="checkbox"/>	Pump Back After Measurement
<input type="checkbox"/>	Air/N <sub>2</sub> Mode (recovery bypass)

Ok Cancel

For the purpose of this example, select only **Humidity Measurement**, and disable **SO<sub>2</sub> Measurement**, **% Vol SF<sub>6</sub> Measurement** and **Pump Back After Measurement**.

Now press the **Ok** button.

With this configuration, only humidity measurement is performed. The sample gas is collected and held in the internal cylinder and not automatically pumped back.

Measurement Control Setup  
Description:

<input type="checkbox"/>	SO <sub>2</sub> Measurement
<input type="checkbox"/>	Humidity Measurement
<input checked="" type="checkbox"/>	%Vol SF <sub>6</sub> Measurement
<input type="checkbox"/>	Pump Back After Measurement
<input type="checkbox"/>	Air/N <sub>2</sub> Mode (recovery bypass)

Ok Cancel

For the purpose of this example, select only **% Vol SF<sub>6</sub> Measurement**, and disable **SO<sub>2</sub> Measurement**, **Humidity Measurement** and **Pump Back After Measurement**.

Now press the **Ok** button.

With this configuration, only the SF<sub>6</sub> purity measurement is performed. The sample gas is collected and held in the internal cylinder and not automatically pumped back.

Measurement Control Setup  
Description:

<input checked="" type="checkbox"/>	SO <sub>2</sub> Measurement
<input type="checkbox"/>	Humidity Measurement
<input checked="" type="checkbox"/>	%Vol SF <sub>6</sub> Measurement
<input type="checkbox"/>	Pump Back After Measurement
<input type="checkbox"/>	Air/N <sub>2</sub> Mode (recovery bypass)

Ok Cancel

For the purpose of this example, select only **SO<sub>2</sub> Measurement** and **% Vol SF<sub>6</sub> Measurement**, and disable **Humidity Measurement** and **Pump Back After Measurement**.

Now press the **Ok** button.

With this configuration, SO<sub>2</sub> measurement and % volume SF<sub>6</sub> measurement will be performed without humidity measurement and automatic pump back.

Measurement Control Setup  
Description:

<input type="checkbox"/>	SO <sub>2</sub> Measurement
<input checked="" type="checkbox"/>	Humidity Measurement
<input checked="" type="checkbox"/>	%Vol SF <sub>6</sub> Measurement
<input checked="" type="checkbox"/>	Pump Back After Measurement
<input type="checkbox"/>	Air/N <sub>2</sub> Mode (recovery bypass)

Ok Cancel

For the purpose of this example, select **Humidity Measurement**, **% Vol SF<sub>6</sub> Measurement** and **Pump Back After Measurement**.

Now press the **Ok** button.

With this configuration, humidity and SF<sub>6</sub> purity measurements will be performed, followed by automatic pump back of the sample gas. This is the standard 973 configuration.

Measurement Control Setup  
Description:

<input type="checkbox"/>	SO <sub>2</sub> Measurement
<input checked="" type="checkbox"/>	Humidity Measurement
<input type="checkbox"/>	%Vol SF <sub>6</sub> Measurement
<input type="checkbox"/>	Pump Back After Measurement
<input checked="" type="checkbox"/>	Air/N <sub>2</sub> Mode (recovery bypass)

Ok Cancel

In this example, select the **Humidity Measurement** and **Air/N<sub>2</sub> Mode**.

Now press the **Ok** button.

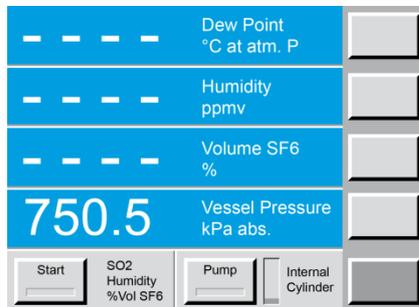
With this configuration, only the humidity measurement is performed. The measured gas will be pumped to atmosphere rather than being stored in the internal storage cylinder. This mode is only used for the measurement of air or nitrogen (N<sub>2</sub>) and should never be used for measurement of SF<sub>6</sub> gas.

# 6. Measurement

## Measurement without SO<sub>2</sub> Option

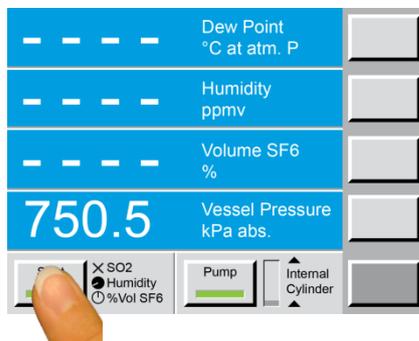
This section describes the measurement sequence for the 973 without the SO<sub>2</sub> option. Please refer to page 21 for the equivalent procedure for instruments equipped with the SO<sub>2</sub> option.

If you intend to collect the measurement data automatically, please install the Excel Protocol sheet, as described on page 25, before the start of the measurement.

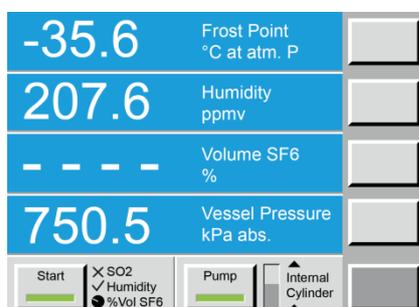


As soon as the 973 is connected to the gas compartment, the current vessel pressure is indicated. The standard configuration for the pressure unit is kPa absolute. The input pressure range is 120...1'000 kPa abs.

When the instrument is switched on, the standard measuring mode with **Humidity Measurement**, **% Volume SF6 Measurement** and **Pump Back After Measurement** is activated.



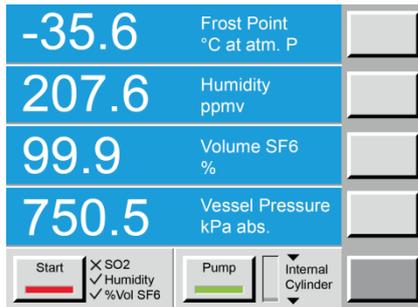
Press the **Start** button. The **Start** button and the **Pump** button turn green. Because the SO<sub>2</sub> measurement is disabled, an **X** appears next to **SO2**. The pump starts and the humidity clock, located next to the **Start** button, begins to spin. During the measurement, SF<sub>6</sub> gas flows from the gas compartment, through the hose, through the measuring head, and into the internal storage cylinder. The internal cylinder trend arrows and level indicator show the rising pressure in the internal storage cylinder.



After completion of the humidity measurement, the spinning clock stops. Both the measured Frost/Dew Point and the humidity content in ppm<sub>v</sub> are displayed.

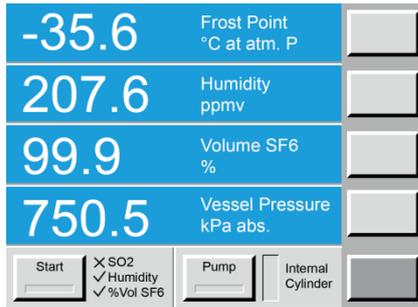
Then the % Volume SF<sub>6</sub> measurement starts and the corresponding clock begins to spin.

The internal cylinder trend arrows and level indicator show the rising pressure in the internal storage cylinder.



The pump back already starts during the % volume SF<sub>6</sub> measurement. The trend arrows and level indicator show the decreasing pressure of the internal storage cylinder.

After completion of the % volume SF<sub>6</sub> measurement, the spinning clock stops and the measured % volume SF<sub>6</sub> is displayed. The mirror heats up, as indicated by the red **Start** key. During the heating phase the **Start** key is locked.



At the completion of pump back, the measuring head pressure is reduced to 100 kPa abs. (approximately atmospheric pressure). After stabilization of the displayed gas compartment pressure (approx. 5 seconds), the measurement results are now available on the data lines as well as on the serial interface for data transfer to the excel protocol (see page 25).

The measurement data for humidity and % volume SF<sub>6</sub> remain stored and displayed until the next measurement is started by pressing the **Start** button. The vessel pressure measurement always indicates the current pressure at the 973 sample gas input. After completion of the measurement, the gas compartment pressure remains properly indicated as long as the sampling tube is connected to the gas compartment.

After connection of the sampling tube to the next gas compartment, the next measurement can be started by pressing the **Start** button.

## Termination of Measurement

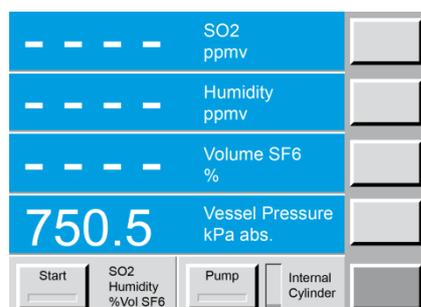
After completion of the measurements, disconnect the SF<sub>6</sub> coupling from the gas compartment and close it with the yellow screw cover. Then disconnect the quick coupling from the 973 and cover the gas inlet as well as the coupling of the tube with the blue caps. The last measured SF<sub>6</sub> remains in the sampling tube. A correctly closed sampling tube is protected from dust and ambient air.

If the measurement was stopped with a normal pump back sequence, 100 kPa abs. pressure (~0 kPa gauge) will remain in the internal storage cylinder. The instrument can now be correctly transported.

## Measurement with SO<sub>2</sub> Option

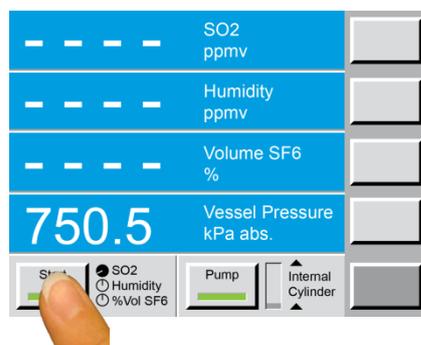
The section describes the measurement procedure for the 973 equipped with the SO<sub>2</sub> option. Refer to page 19 for equivalent procedures for instruments without the SO<sub>2</sub> option.

If you intend to collect the measurement data automatically, please install the Excel Protocol sheet, as described on page 25, before the start of the measurement.

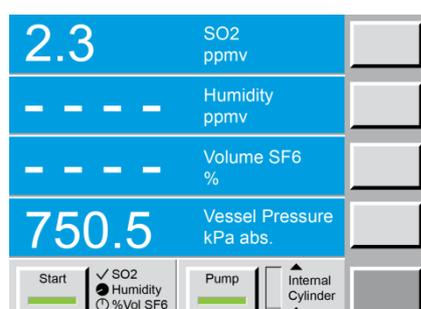


As soon as the 973 is connected to the gas compartment, the current vessel pressure is indicated. The standard configuration for the pressure unit is kPa absolute. The input pressure range is 120...1'000 kPa abs.

When the instrument is switched on, the standard measuring mode with **SO<sub>2</sub> Measurement**, **Humidity Measurement**, **% Volume SF<sub>6</sub> Measurement** and **Pump Back After Measurement** is activated.

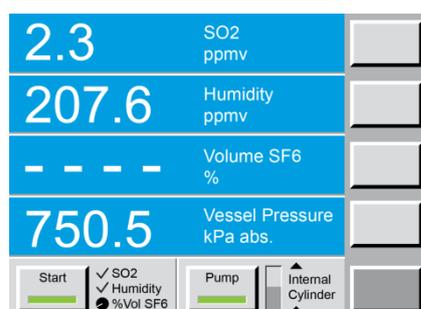


Press the **Start** button. The **Start** button and the **Pump** button turn green. The pump starts and the **SO<sub>2</sub>** clock, located next to the **Start** button, begins to spin. During the measurement, SF<sub>6</sub> gas flows from the gas compartment, through the hose, through the SO<sub>2</sub> module, and into the internal storage cylinder.



Once the SO<sub>2</sub> measurement is complete, the spinning clock stops and the measured SO<sub>2</sub> concentration is displayed.

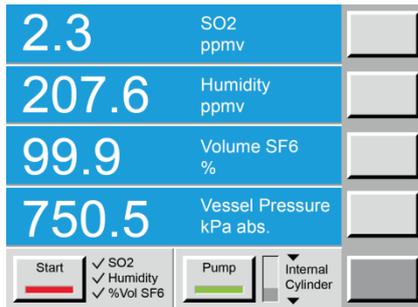
The 973 then automatically initiates humidity measurement. The spinning clock indicates that measurement is in progress. During humidity measurement, SF<sub>6</sub> gas flows from the gas compartment through the measurement head, and into the internal cylinder.



After completion of the humidity measurement, the spinning clock stops and the humidity content in ppm<sub>v</sub> is displayed.

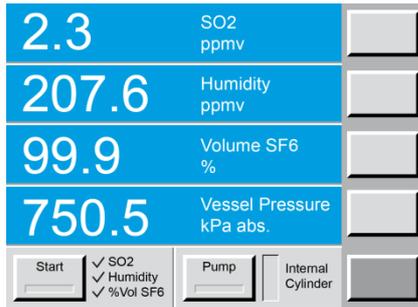
Then the % volume SF<sub>6</sub> measurement starts and the corresponding clock begins to spin.

The internal cylinder trend arrows and level indicator show the rising pressure in the internal storage cylinder.



The pump back already starts during the % volume SF<sub>6</sub> measurement. The trend arrows and level indicator show the decreasing pressure of the internal storage cylinder.

After completion of the % volume SF<sub>6</sub> measurement, the spinning clock stops and the measured % volume SF<sub>6</sub> is displayed. The mirror heats up, as indicated by the red **Start** key. During the heating phase the **Start** key is locked



At the completion of pump back, the measuring head pressure is reduced to 100 kPa abs (approximately atmospheric pressure). After stabilization of the displayed gas compartment pressure (approx. 5 seconds), the measurement results are now available on the data lines as well as on the serial interface for data transfer to the excel protocol (see page 25).

The measurement data for SO<sub>2</sub>, humidity and % volume SF<sub>6</sub> remain stored and displayed until the next measurement is started by pressing the **Start** button. The vessel pressure measurement always indicates the current pressure at the 973 sample gas input. After completion of the measurement, the gas compartment pressure remains properly indicated as long as the sampling tube is connected to the gas compartment.

After connection of the sampling tube to the next gas compartment, the next measurement can be started by pressing the **Start** button.

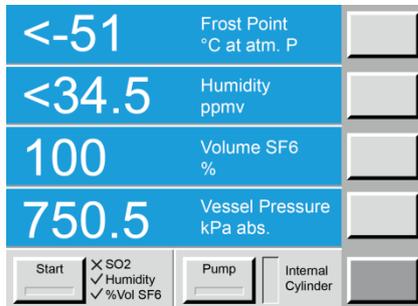
## Termination of Measurement

After completion of the measurements, disconnect the SF<sub>6</sub> coupling from the gas compartment and close it with the yellow screw cover. Then disconnect the quick coupling from the 973 and cover the gas inlet as well as the coupling of the tube with the blue caps. The last measured SF<sub>6</sub> remains in the sampling tube. A correctly closed sampling tube is protected from dust and ambient air.

If the measurement was stopped with a normal pump back sequence, 100 kPa abs. pressure (~0 kPa gauge) will remain in the internal storage cylinder. The instrument can now be correctly transported.

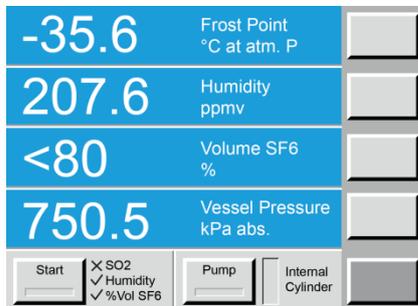
## Measuring Range Limitations

The lower measuring limits of the 973 are approximately 40 ppm<sub>v</sub> (depending on pressure) for humidity and 80% for volume SF<sub>6</sub>. If the measured value for humidity or % volume SF<sub>6</sub> is below this measuring limit, the instrument indicates these conditions as follows:



If the measured value of humidity is below the measuring limit of the 973, the display shows the symbol < (“smaller than”) followed by the lower limit humidity value indicated in °C frost point and ppm<sub>v</sub>.

This indicates that the actual measured humidity value is below the displayed value, and below the measuring limit of the instrument.

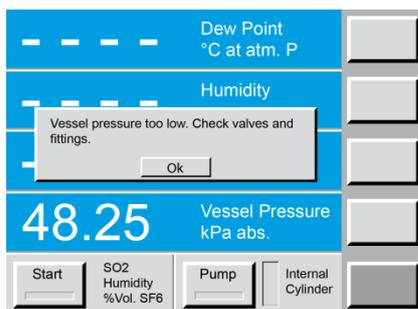


If the measured value of % volume SF<sub>6</sub> is below the measuring limit of the 973, the display shows **<80**.

This indicates that the actual % volume SF<sub>6</sub> value is below the measuring limit of the instrument.

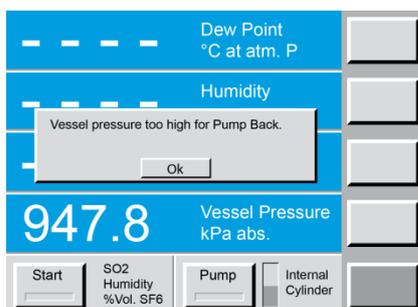
If the instrument indicates a reading of **>100** for % Volume SF<sub>6</sub>, service or calibration may be needed. Please contact the manufacturer or your local supplier for further information.

## Alarm Messages



If the gas compartment pressure is too low, or if the SF<sub>6</sub> coupling is not correctly connected to the gas compartment an underpressure occurs in the sampling tube and the measurement stops automatically. The 973 displays that the pressure is too low.

Make sure the sampling tube is correctly connected on both sides and the minimal gas pressure of at least 120 kPa absolute is available.



If the gas compartment pressure is too high to allow the pump back, the 973 turns the pump off automatically and indicates that the compartment pressure is too high. The maximum pump back pressure is 900 kPa abs.

Connect the 973 to a gas compartment or an SF<sub>6</sub> reclaiming with a lower pressure to pump back the stored SF<sub>6</sub>.

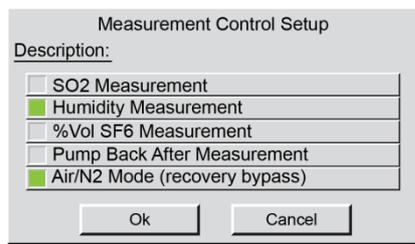
## Measurement Aborted

If the measurement is aborted due to low or high pressure conditions, the 973 will heat up the mirror, restore the measuring head pressure to 100 kPa abs (approximately atmospheric pressure), and stop. Pump back of the stored gas in the internal cylinder can be started by pressing the **Pump** key.

The measurement can also be aborted manually by pressing the **Start** key again. Also, the Pump back can be stopped manually by pressing the **Pump** button.

## Measurement of Air or Nitrogen (N<sub>2</sub>)

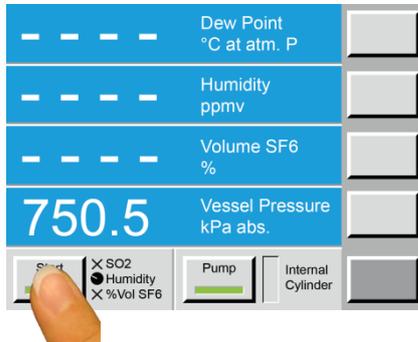
The 973 is equipped with a measuring mode for air or nitrogen. The measured air/nitrogen is not stored in the internal cylinder and will be pumped to atmosphere through a small vent point internal to the 973.



Activate the Air/N<sub>2</sub> measurement mode by selecting **Humidity Measurement** and **Air/N<sub>2</sub> Mode** in the **Measuring Options** Menu.

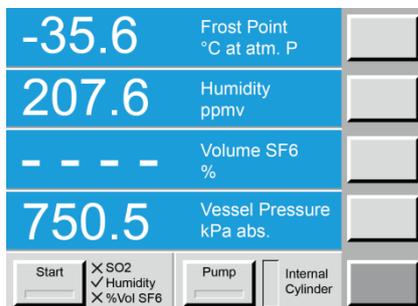
Press the **Ok** key.

In this measuring mode, only the humidity measurement is performed, without storing the gas in the internal cylinder.



Press **Start**.

During measurement, the 973 will pump gas through the gas connection port, over the measuring head and through a vent to atmosphere.



Once the humidity value is stable, the instrument beeps and holds the measured value on the display.

# 7. Data Collection

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## RS-232 to USB Adapter Installation



The ES-U-1001-R10 RS-232 / USB adapter is a standard accessory that is supplied with the 973-SF<sub>6</sub> Analyzer.

This product is supported on multiple Operating Systems; Windows, MAC-OS, Linux, Android and WinCE 4.2 onwards.

In Windows 7, 8 and 10 this adapter works without any driver installation (Plug and Play).

In other cases you will find the drivers here:  
<http://www.ftdichip.com/Drivers/VCP.htm>

Installation instructions may be downloaded from:  
<http://www.ftdichip.com/US232R>

# Data Collection over RS-232 with the Excel Protocol

When the 973 is connected to a computer via the RS-232 connection, the measuring results may be transferred directly into the Excel Protocol.



973-SF6 Protocol VXX

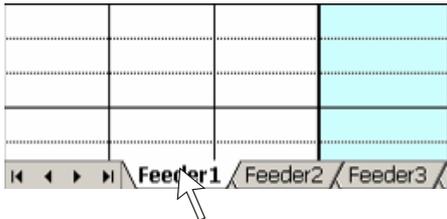
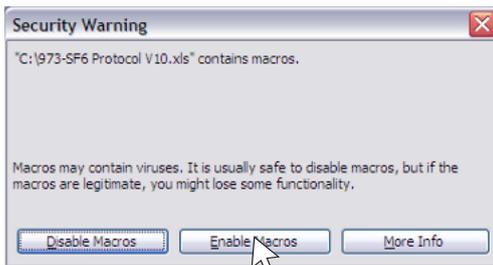
On the provided USB flash drive you will find the 973-SF<sub>6</sub> protocol.

Double click on:

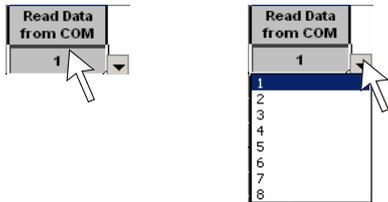
### 973-SF6 Protocol VXX

(XX = equals Version No. supplied on CD)

After opening the 973-SF<sub>6</sub> protocol the safety warning may appear. Please select **Enable Macros**.



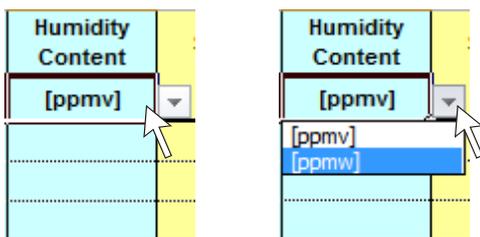
The protocol initially has only one worksheet named 'Feeder 1'. You may add additional sheets as required using the New Worksheet functions of Excel. Additional worksheets will be added with names such as 'Feeder 2', 'Feeder 3', and so on.



Click on the cell below the field **Read Data from COM**. An arrow appears on the right side. By clicking on the arrow the window for the input selections of the COM Port Number opens.



After input of the COM Port Number the window Parameter Selection opens, with which you can confirm whether your selection should apply to only this worksheet, or all worksheets (Feeder 1...n) in the file. Although not required, it is generally preferable to copy the parameter changes to all sheets.



In order to change the different units, click on the respective unit field. On the right side an arrow appears. By clicking on this arrow a selection window with the possible units opens. The selection of units of the Excel Protocol is independent of the display of the 973.

Feeder Bay	Gas Comp.	Phase
1	B0	R
1	B0	S
1	B0	T

Enter the gas compartment identification in the appropriate fields (the three leftmost columns).

Use the **Start** button to initiate a measurement with the 973. After completion of a measurement, the measuring results for humidity and % SF<sub>6</sub> (and SO<sub>2</sub> if your instrument is equipped with the SO<sub>2</sub> option) are available on the display and on the serial port.

The pressure value on the display indicates the current gas compartment pressure as long as the sampling tube is connected to the corresponding gas compartment. Data is now ready for transfer.

The measurement is finished if all selected modes are confirmed with a check mark and the red light of the start button expires after the end of the mirror heating phase.

If your instrument is not equipped with an SO<sub>2</sub> module then an **X** will remain next to **SO2** indicating that no SO<sub>2</sub> measurement took place. However, if your instrument is equipped with the SO<sub>2</sub> option, and that measurement mode was selected, a check mark will appear in front of **SO2**.

D	E	F	G	H	I	J
SO2 [ppmv]	Dew/Frost Point [°C at atm P]	Humidity Content [ppmv]	SF6 Vol [%]	Pressure [kPa abs]	Date [dd/mm/yy]	Read Data from COM8
---	-23.6	720.3	99.8	214.956	20.07.11	Read
						Read
						Read

By clicking the **Read** button the measured values for **Dew/Frost Point**, **Humidity Content**, **SF6 Vol** and **Pressure** are transferred into the corresponding cells. If your instrument is not equipped with an SO<sub>2</sub> module, the **SO2** line will simply remain empty. If you have the SO<sub>2</sub> option, then the SO<sub>2</sub> reading will also appear in its column.

D	E	F	G	H	I	J
SO2 [ppmv]	Dew/Frost Point [°C at atm P]	Humidity Content [ppmv]	SF6 Vol [%]	Pressure [kPa abs]	Date [dd/mm/yy]	Read Data from COM8
0.14	-23.6	720.3	99.8	214.956	20.07.11	Read
						Read
						Read

Additionally the **Date** is recorded. The value for the pressure measurement corresponds with the measured value at the moment when the **Read** button is pressed. The stored data for **Dew/Frost Point**, **Humidity Content** and **SF6 Vol** remain stored in the 973 until the next measurement is started.

Instrument ID: 973-SF6 Instrument S/N: 05-0714

The instrument type and serial number are automatically stored in the last line at the bottom of the page

Note that data communication can be accomplished after completion of the measuring cycle. If the **Read** button is pressed during the measurement, a message appears which requests you to wait for completion of the measurement. If you see this message, just click **Ok** and wait for the measurement to complete, then press the corresponding **Read** button again.



# 8. SO<sub>2</sub> Module

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The 973 internal SO<sub>2</sub> module provides the user with the capability to measure SO<sub>2</sub> concentration in SF<sub>6</sub> gas compartments. The module is conveniently mounted on the back panel of the instrument with the sample gas connections internally connected.

The module uses an electrochemical cell specifically for SO<sub>2</sub>. The measurement cell is designed to provide accurate and stable results for two years in normal operation. Calibration checks can be performed using gas standards with certified SO<sub>2</sub> concentration. Please contact the manufacturer or your local supplier for further information.

## Replacement of SO<sub>2</sub> Measurement Cell

Back panel mounting means that the user can easily replace the measurement cell assembly. Replacement cell assemblies are readily available and are supplied pre-adjusted for direct installation into the 973. To replace the SO<sub>2</sub> cell, follow the procedure:



Contact the manufacturer or your local supplier to obtain a replacement cell assembly.

Disconnect the 973 from gas or electrical connections and remove the four module screws.



Pull straight back to remove the existing SO<sub>2</sub> measurement cell assembly.



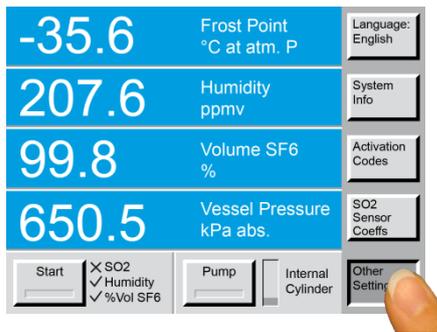
Install the replacement assembly making sure the sealing O-ring remains correctly located and the pins line up.

Replace the cover and screws.

Reconnect power and sample gas lines to continue measurement.

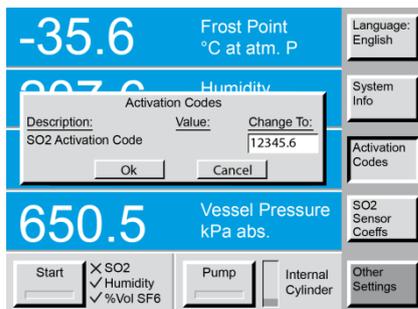
## Activation of SO<sub>2</sub> Measurement

If you have an instrument without SO<sub>2</sub> measurement, but with the serial number 12-0000 or higher, then your instrument is “SO<sub>2</sub> ready”. This means that, to enable the SO<sub>2</sub> measurement you only need to replace the installed measurement cell cover with an SO<sub>2</sub> sensor. Please follow the instructions in chapter ‘**Replacement of SO<sub>2</sub> Measurement Cell**’ on page 29 to install the SO<sub>2</sub> sensor. In addition to installing the SO<sub>2</sub> sensor, you will need to activate the SO<sub>2</sub> measurement as follows:



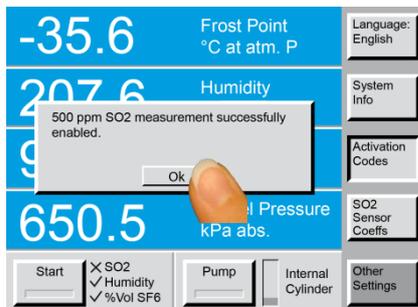
Press the bottom right corner menu key until the **Other Settings** menu is displayed.

Then press the **Activation Codes** key.



A window will appear where you can enter the activation code provided by the manufacturer or your local supplier.

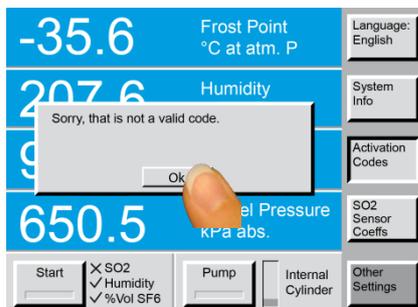
Press **Ok** after entering the code.



If the correct code was entered, a window appears confirming the activation of the SO<sub>2</sub> measurement.

The instrument recognizes the type of the sensor fitted and displays its ppm range.

Press **Ok** and the window will disappear. The instrument is now ready to perform SO<sub>2</sub> measurements.

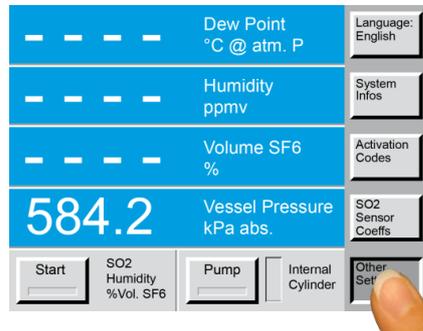


If a wrong code was entered, a window appears indicating that the code is not valid. Press **Ok** and try again.

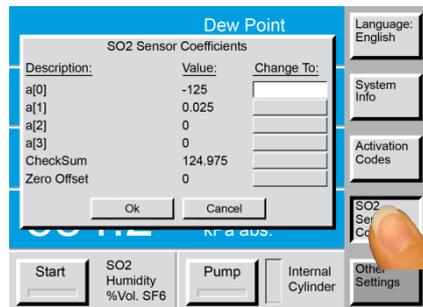
In the event that the code is not accepted, please contact the manufacturer or your local supplier.

## Set Coefficients for new SO<sub>2</sub> Measurement Cell

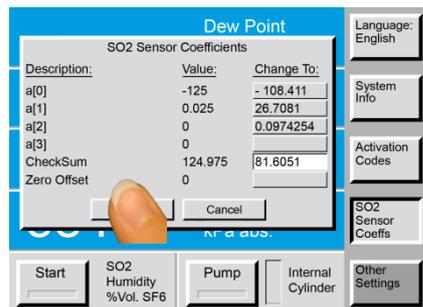
After installation of the new SO<sub>2</sub> Measurement Cell, the coefficients must be adjusted on the 973.



Press the bottom right corner menu key until the **Other Settings** menu is displayed.



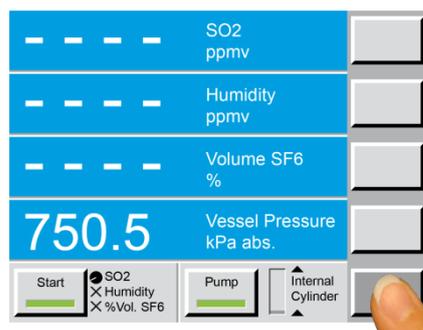
Press the **SO2 Sensor Coeffs** key to open the pop-up window.



Enter the sensor coefficients, which can be found on the datasheet of the sensor (including the CheckSum). Press **Ok** to confirm, the sensor is now ready for operation.

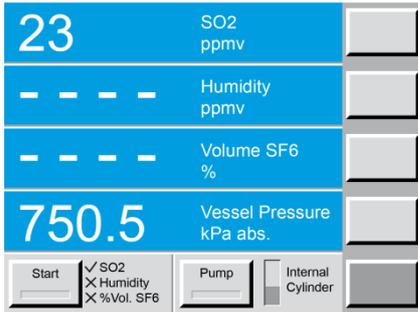
## SO<sub>2</sub> Zero Function

Changes in the SO<sub>2</sub> sensor zero response are due to inherent drift of the electrochemical sensor used to measure SO<sub>2</sub> concentration. The SO<sub>2</sub> zero function enables the application of a zero offset (from software version 170704a). This offset can be used when the 973 indicates an incorrect SO<sub>2</sub> value [ppm<sub>v</sub>]. Please follow these instructions:

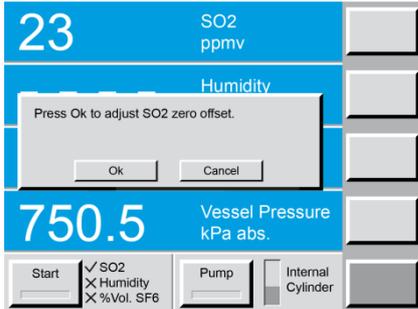


Perform an SO<sub>2</sub> measurement (according to chapter 6) with **100 %Vol SF<sub>6</sub> gas**. Use a certified pure SF<sub>6</sub> gas cylinder for this purpose.

**WARNING:** Incorrect reference gas would corrupt the correction. Electrochemical sensor response is carrier gas dependent, so only use SF<sub>6</sub>, not Nitrogen or other gases for the zero correction of the SO<sub>2</sub> sensor.

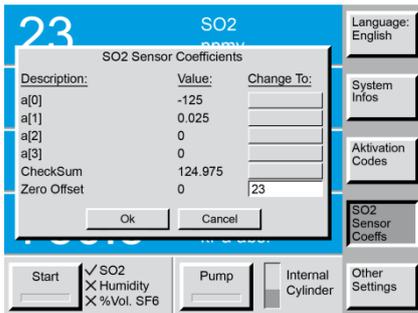


After the measurement has been completed, the measured value is displayed, and this is subsequently used by the 973 as an offset to correct the SO<sub>2</sub> measurement.

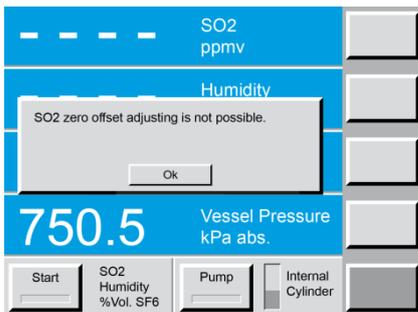


To perform a zero offset correction, press and hold the number **2** on the numeric keypad for approximately 3 seconds.

A dialog window opens and asks to press **OK** to adjust the SO<sub>2</sub> zero offset. Confirm with **OK** or **Cancel** if required.



The result can be viewed in the **SO<sub>2</sub> Sensor Coefficients** Menu under **Zero Offset** and, if necessary, edited manually. The zero offset has no effect on the linearity of the SO<sub>2</sub> measurement response.

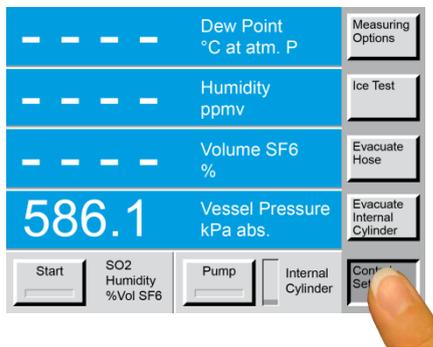


If the message **SO<sub>2</sub> zero offset adjusting is not possible**, either no SO<sub>2</sub> sensor is installed or no SO<sub>2</sub> measurement was performed, which is necessary to calculate the offset.

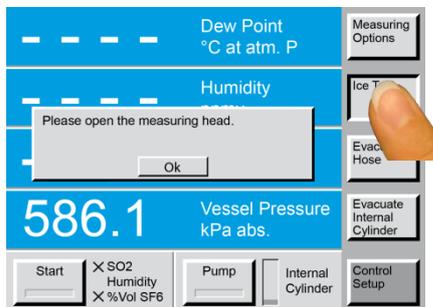
# 9. Test Functions

## Ice Test

Measurement accuracy can be checked with a simple, built-in test. The test may be performed at any time, and is recommended if the results of your normal measurements do not correspond to expectations or the instrument is assumed to be in error.



Press the lower right menu key once to select the **Control Setup** menu. **Control Setup** appears on the key while the keys above change to the available menu options. Note that the second key from the top indicates **Ice Test**.



Press the **Ice Test** menu key. A window requests you open the measuring head.

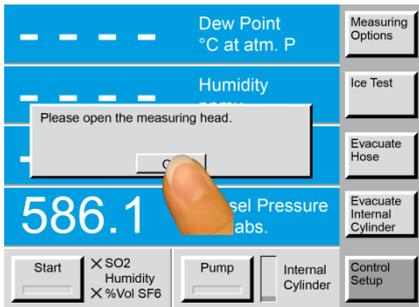


The measuring head of the 973 is located on the right side of the front panel. In order to get to the mirror the measuring head must be opened. Twist the screw cover counter-clockwise. After about 3 full turns you will be able to remove the lid.

More detailed information on the removal/installation of the measuring head is available beginning on page 44.



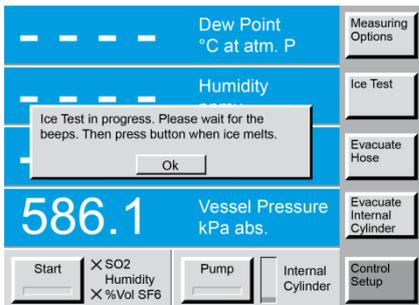
Once the screw cover has been removed, the black optical module can be removed by pulling it straight toward you. The mirror is now visible and you are ready to perform the Ice Test.



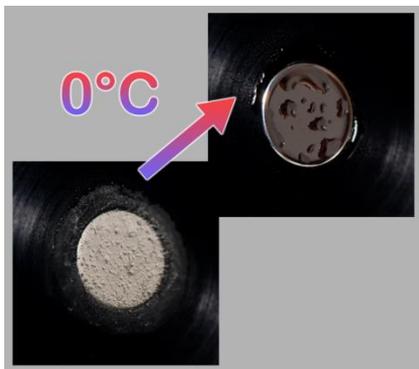
Confirm that you opened the measuring head and are ready for the Ice Test by pressing the **Ok** button.

**Note:**

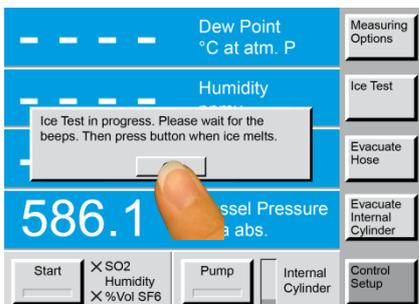
The test starts immediately after pressing the **Ok** button.



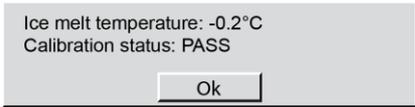
During the Ice Test, the mirror rapidly cools to approximately -30 °C. Because the measuring head is open, humidity from the ambient air starts to condense on the mirror. This forms a frost layer on the mirror which can be strengthened if necessary by blowing on it. After reaching the low temperature and forming ice on its surface, the mirror begins heating. As the temperature approaches 0 °C, the instrument begins to beep, with those beeps becoming faster as the mirror gets closer to ice-melting temperature.



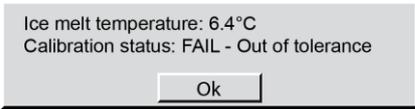
Visually observe the mirror. As soon as the mirror temperature crosses 0 °C, the ice will melt into liquid water drops (phase transition).



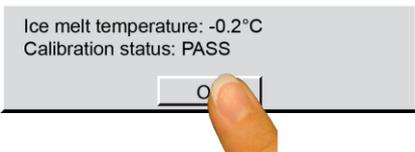
When you observe the phase transition on the mirror, press the **Ok** button. The mirror temperature is measured at that moment and a dialog box appears with the test results.



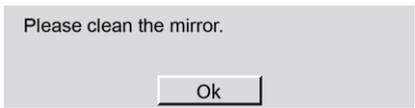
If the measured ice-melt temperature was in the range of  $\pm 0.2$  °C, the check is successful and will be indicated with the calibration status **PASS**.



If the measured ice-melt temperature was outside the range of  $\pm 0.2$  °C, the check was not successful and will be indicated with the calibration status **FAIL**. In this case the ice test should be repeated. If it continues to fail, the instrument should be sent to the manufacturer or an authorized agent for evaluation and/or repair.



Press the **Ok** button on the **PASS/FAIL** status window.



The next window requests you to clean the mirror.



Clean the mirror with a clean cotton bud or lint free tissue. More detailed mirror cleaning information is available on page 44.



Refit the optical module while observing the guide pin and up arrow. Close the measuring head with the screw cover.

## SF<sub>6</sub> Condensation Test

The 973-SF<sub>6</sub> measures the condensation temperature of SF<sub>6</sub> to determine SF<sub>6</sub> purity. By measuring SF<sub>6</sub> gas with at least 99.9% purity, the user can evaluate the performance of the instrument and whether recalibration is necessary.

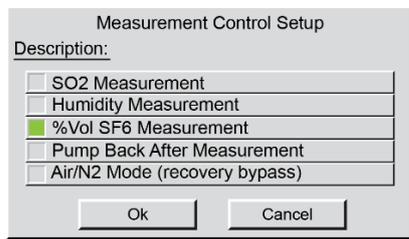


Connect the sample hose to the 973 and run the **Evacuate Hose** procedure, as described on page 13.



Connect the sample tube to a certified pure SF<sub>6</sub> cylinder with the regulator set to a value lower than 10bar (1000kPa)

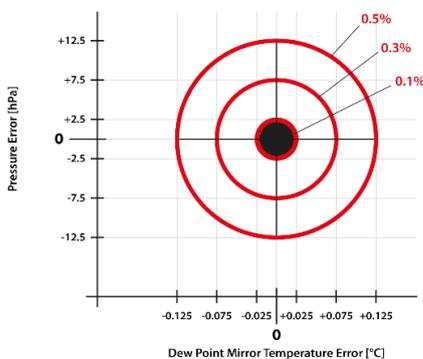
SF<sub>6</sub> quality of 3.0 (>99.9%) is sufficient. The condensation temperature of pure SF<sub>6</sub> is -47.75 °C at 250kPa (2.5bar)



For this test, you only need to activate the **%Vol SF<sub>6</sub> Measurement** in the **Measurement Control Setup**.

Make sure that **Pump Back After Measurement** is deactivated; pump back through a cylinder regulator is not possible. See chapter 'Measurement Options' on page 17 for more details.

The result of the SF<sub>6</sub> Condensation test must be within  $\pm 0.5\%$  for the instrument to be in specification. If the result is outside of this range after 3 tests, contact MBW or your local supplier for service support.



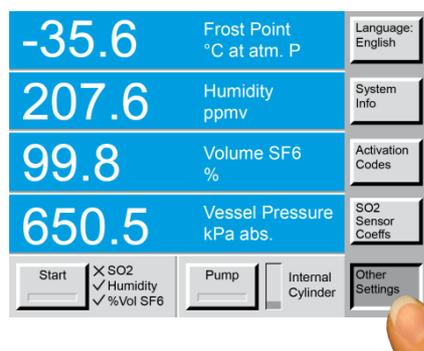
By completing the **Ice Test** and **SF<sub>6</sub> Condensation Test** you have evaluated the Dew Point Mirror temperature measurement at 0 °C and -47.75 °C. Having two calibration points allows you to assume a linear Dew Point Mirror temperature error between those two points.

These On-Site Calibration Checks only work with Chilled Mirror Instruments using the condensation technique for the SF<sub>6</sub> purity measurement.

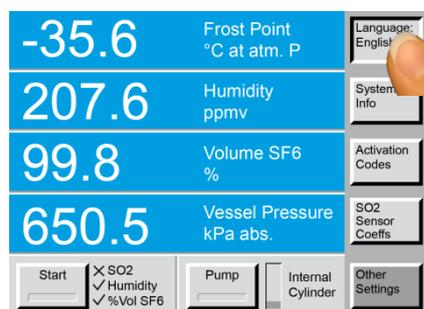
# 10. Additional Settings

## Selection of Languages

The menus of the 973 can be displayed in different languages. In order to set the system to your preferred language, proceed as follows:



Press the lower right menu key repeatedly to select the **Other Settings** menu.



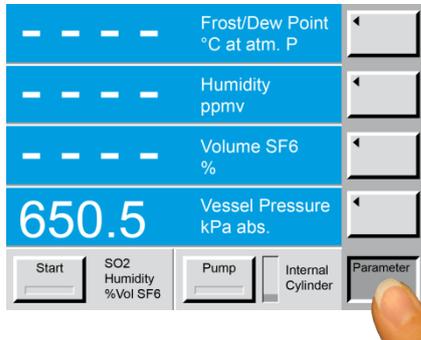
Then press the **Language** key until your preferred language is displayed.

Typical languages available are:  
English, German, French, Italian and Spanish

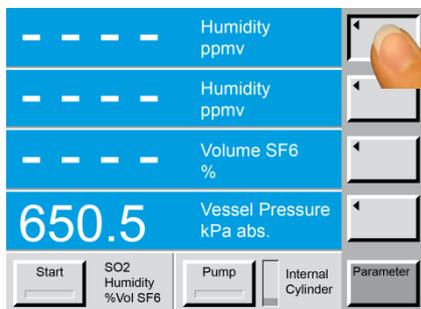
The selected language remains displayed as long as the 973 is in operation. After restart of the 973 the display language is set back to the standard configuration. If you wish to save your chosen language in the power-up default of the instrument then please follow the instructions in chapter '**Saving the Default Configuration**' on page 41.

## Selection of Parameters

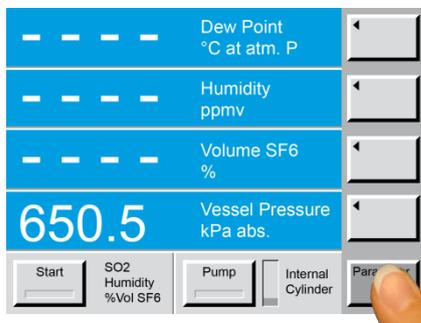
Selecting which parameter to display on the four data lines is easy. It is done with the **Parameter** menu.



Press the lower right menu key a couple of times to select the **Parameter** menu. Note that each of the upper keys correspond to the data lines they point toward.



Press the arrow key corresponding to the data line you wish to change. Note that each time you press the arrow key, the parameter of the data line changes. The parameter selection is circular, meaning that once you reach beyond the last available parameter, the first one is again displayed and the cycle starts over. Change the parameters on any of the other three data lines with the same method.

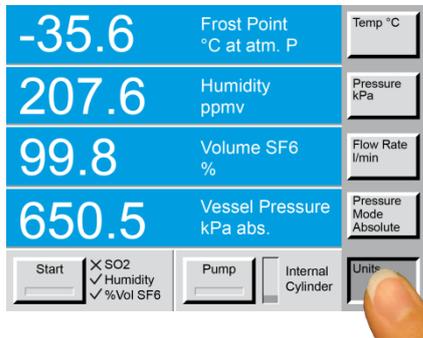


If you like, you may clear the menu keys when finished by cycling through all the menus using the lower right key on the touch screen, or more easily by pressing the **Enter** key once. Note that this is not required and nothing is wrong with leaving the **Parameter** menu (or any other menu) on the screen.

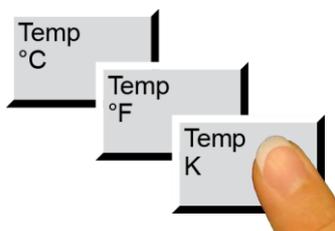
The changed selection of the **Parameter** menu remains displayed as long as the 973 is in operation. After restart of the 973, the display is set back to the standard configuration. Both the parameters of the instrument and those of the Excel Protocol are independent of each other and must separately be selected.

## Selection of Units

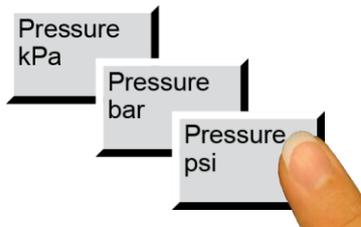
The data may be viewed in any of the many available units.



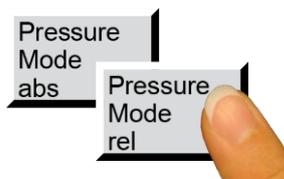
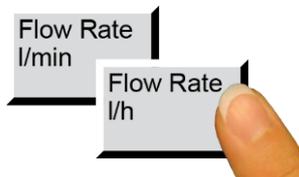
Use the lower right menu key to select the **Units** menu. **Units** appears on the key and the keys above show the various units. Note that each of the keys shows different types of units. Unlike the **Parameter** menu, the keys do not correspond to the data lines, but rather to different unit types.



To change temperature units, press the key labeled **Temp**. Note that the corresponding unit changes each time the key is pressed. Also note that any data line that is currently indicating temperature data also changes to the new unit.

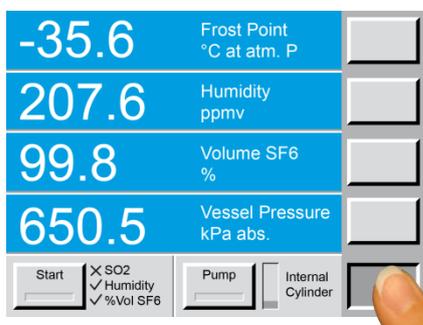


Change other units such as **Pressure**, **Flow Rate**, etc. with the same method.



In addition to setting the **Pressure** units, the mode may be set to either absolute or relative mode.

Note: Relative mode is often referred to as 'gauge mode' or 'over-pressure'.



If you like, you may clear the menu keys when finished by cycling through all the menus using the lower right key on the touch screen, or by pressing the **Enter** key once. Note that this is not required and nothing is wrong with leaving the **Units** menu (or any other menu) on the screen.

**Note:**

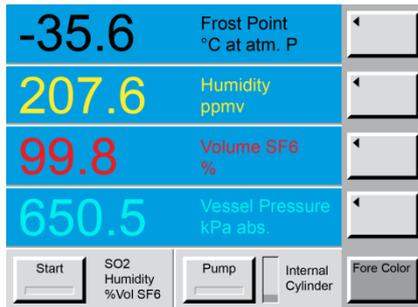
The changed units remain displayed as long as the instrument is in operation. After restart of the instrument, the display is set back to the standard configuration. Both the units of the instrument and those of the Excel Protocol are independent of each other and must separately be selected.

## Changing Color

You are free to change the foreground and/or background color of any data line with the **Fore Color** and **Back Color** menus. Access the **Fore Color** and **Back Color** menus with the menu selection key. To revert to the standard system default color scheme, press and hold the 9 key for a few seconds (see page 42).

### Fore Color

Fore color affects the color of the numbers and letters. To change a data line's fore color:



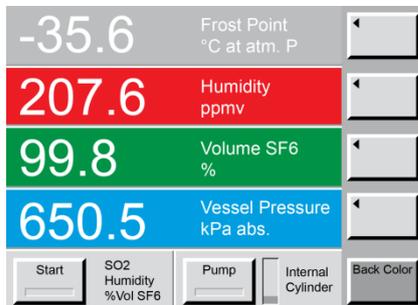
Access the **Fore Color** menu. **Fore Color** appears on the key, and the keys above contain left pointing arrows. Note that each of the upper keys correspond to the data lines they point toward.

Press the arrow key corresponding to the data line you wish to change. Note that the fore color of the data line changes with each press of the key.

Change the fore color on any of the other data lines with the same method.

### Back Color

Back color affects the background color of the data lines. To change a data line's back color:



Access the **Back Color** menu. **Back Color** appears on the key, and the keys above contain left pointing arrows. Note that each of the upper keys correspond to the data lines they point toward.

Press the arrow key corresponding to the data line you wish to change. Note that the back color of the data line changes with each press of the key.

Change the back color on any of the other data lines with the same method.

The changed selections of the **Fore Color** and **Back Color** menus remain displayed as long as the 973 is in operation. After restart of the 973 the display is set back to the standard configuration.

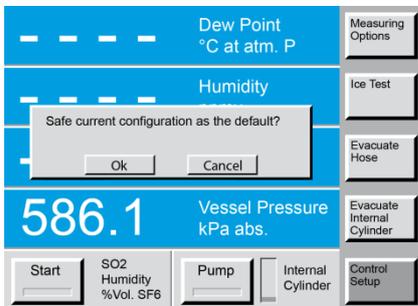
## Saving the Default Configuration

The 973 is delivered with a standard configuration. Options you change during normal use are not saved and the instrument reverts to its default settings after cycling the power. You may however store your preferred configuration settings as the power-up default for this instrument. Save your preferred configuration as the default with the following procedure:



Press and hold the number **1** on the keypad for about 5 seconds.

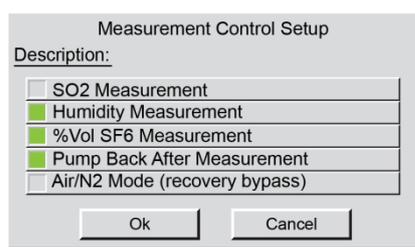
You hear a beep and a window appears asking for confirmation to store the current configuration as the new default.



By pressing the **Ok** button, the current instrument settings will be stored as the new default configuration.

By pressing the **Cancel** button the default settings remain unaltered. The system will revert to its stored default settings at the next power-up cycle.

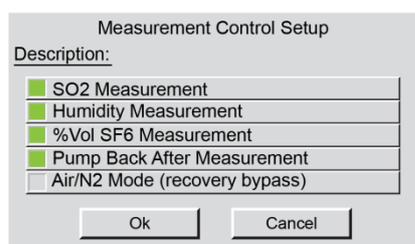
## The Default Configuration includes the following Settings:

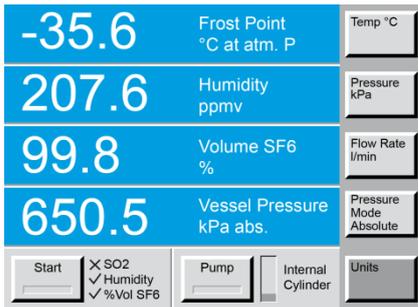


### Measurement Options

The standard configuration includes the chosen measuring options.

The first illustration displays the standard configuration for a 973 without an SO<sub>2</sub> module. The second is for a 973 equipped with an SO<sub>2</sub> module.

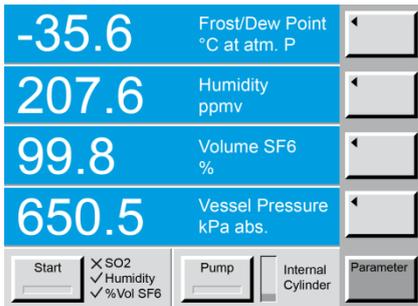




### Units

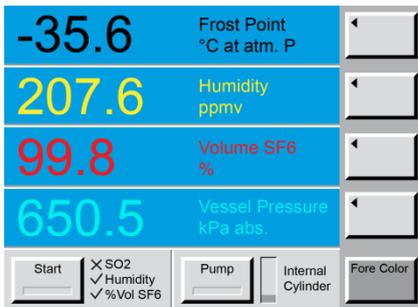
#### Absolute or Relative Pressure Mode

The default configuration includes the units for all parameters as well as the absolute or relative pressure mode.



### Parameters

The default configuration includes the parameter selection of the data lines.



### Colors

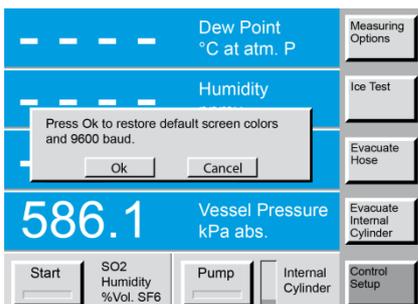
The default configuration includes the front and background colors selection.

## Restore Color Settings and Baud Rate



Press and hold the number **9** on the keypad for about 5 seconds.

You hear a beep and a window opens.



By pressing the **Ok** button, the standard display color configuration and the standard baud rate 9600 are restored.

By pressing the **Cancel**, button the window closes without restoring the standard colors or baud rate.

# 11. Maintenance

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## Touch Screen Calibration

The 973 utilizes a touch screen for user interaction. To activate a menu option or toggle a function on or off, simply touch the screen directly over the key or object desired.

Before using the instrument for the first time, or when the instrument is used by different operators, you may need to calibrate the touch screen to your finger positioning preference. Left and right handed people, for example, may have different points of pressure when using the touch screen. To calibrate the touch screen, follow the instructions:



Press and hold the **Enter** key on the numeric keypad for 3 to 4 seconds. If you have done it correctly, you will hear two short beeps and a key in the upper right corner will turn yellow. If not, release the **Enter** key and try again.



With the tip of your finger, press the center of the yellow key in the upper right corner of the touch screen. It is labeled **Touch This Key**. Once you touch it, the yellow color goes away and another key turns yellow.



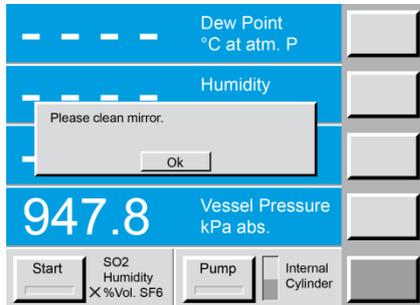
Now, touch the yellow key that is in the lower left corner of the touch screen. Once you touch it, the yellow color goes away and you have successfully calibrated the touch screen.

Test your new touch screen calibration by pressing the bottom right menu selection key several times. If it seems not to work well, just repeat the calibration steps again from the beginning.

You may recalibrate the touch screen as often as needed, however it is rarely required. If the touch screen does not seem to be working, please attempt to recalibrate it.

## Mirror Cleaning

The heart of the 973 is the measuring head assembly. It is designed to be highly sensitive and accurate, yet rugged and easily accessible for periodic mirror cleaning. To ensure best performance, the mirror should be cleaned before starting a series of measurements.



### Request for Mirror Cleaning

If the 973 detects that a mirror cleaning is necessary after completion of a measurement, you will hear a beep and a window will open with a request to clean the mirror.



### Removing the Measuring Head Cover

The measuring head is located on the right side of the 973 front panel. To gain access to the mirror and opto-electronic components, you must first remove the screw cover.

The cover looks like a large tan colored knurled knob. To remove it, simply twist it counterclockwise. It requires approximately three full turns to completely unscrew, allowing you to remove it.



### Removing the Optical Module

Once the screw cover has been removed, the black optical module is now removed by pulling it straight toward you.



### Inspecting / Cleaning the Mirror

Clean the mirror with a clean cotton swab or lint free tissue.

**Note:**

- Never attempt to polish the mirror.
- If needed, the mirror may also be cleaned with alcohol such as IPA or Ethanol. Always follow the use of these cleaning chemicals with distilled water to ensure they are completely rinsed from the mirror surface.



**Reassemble the Mirror Components**

Reassemble the mirror components in the reverse order of disassembly.

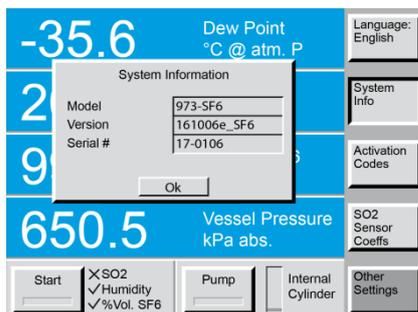
1. Install the optical module, taking note of the guide pin. Ensure that the arrow is pointing upward toward the top of the unit.
2. Replace the screw cover. Hand tighten until snug. Do not over tighten.

## Exterior Cleaning

### Front Panel

The 973 front panel is completely sealed and easily cleaned with glass cleaner or other mild cleaning chemical moistened on to a cloth. Clean the front panel periodically as needed.

## System information



In the menu **Other Settings** press the button **System Info** to get detailed information regarding model, software version and serial number of the instrument.

## Instrument Calibration

One of the most important attributes of the 973-SF<sub>6</sub> is its precision and long-term stability thanks to the fundamental chilled mirror technology used in the measurement of dew/frost point and SF<sub>6</sub> purity.

Calibration checks can be performed by the user (see section 9), but when measurement errors are identified, or to meet the requirements of Quality Systems, re-calibration can be performed by MBW or an approved service centre (see [www.mbw.ch](http://www.mbw.ch)).

Calibration frequency is the responsibility of the user to define based on usage, user calibration check results or the user's quality procedures. MBW recommends a calibration frequency of 3 years.

### Recalibration of the 973-SF<sub>6</sub> Analyzers

MBW offers the following calibration options:

- Complete Standard Calibration 973-SF<sub>6</sub> Analyzer Order code: 103722  
Includes:
  - Software update
  - Evacuation of the instrument and check of the tubings
  - Calibration:
    - Pressure sensors P1, P2, P3
    - Dew points +1 & -40 °C
    - SF<sub>6</sub> purity in %
  
- Complete Standard Calibration 973-SF<sub>6</sub> Analyzer incl. SO<sub>2</sub> Order code: 141062  
Includes:
  - Software update
  - Evacuation of the instrument and check of the tubings
  - Calibration:
    - Pressure sensors P1, P2, P3
    - SO<sub>2</sub> module
    - Dew points +1 & -40 °C
    - SF<sub>6</sub> purity in %

### Calibration of optional SO<sub>2</sub> Measurement Cell

Electrochemical SO<sub>2</sub> measurement cells have a life of 2 years, after which they must be replaced with a new calibrated sensor module. SO<sub>2</sub> calibration can also be performed during factory or service centre calibration. The SO<sub>2</sub> sensor can be supplied with a calibration certificate if required.

SO<sub>2</sub> sensor module as spare part:

- 100 ppm<sub>v</sub> / 500 ppm<sub>v</sub> incl. coefficients Order code: 103915 / 103916
- 100 ppm<sub>v</sub> / 500 ppm<sub>v</sub> incl. coefficients, exchange\* Order code: 103917 / 103918
- Calibration certificate for SO<sub>2</sub> sensor module Order code: 141217

\* Old SO<sub>2</sub> sensor module must be returned to MBW.

Information regarding replacement of the SO<sub>2</sub> sensor module can be found in the SO<sub>2</sub> Module section on page 29.

