

**PRODUCT DATASHEET**

# MODEL 373 Chilled Mirror Analyzers

High Performance Reference  
Chilled Mirror Hygrometer



ISO/IEC 17025  
**ACCREDITED**  
SCS 0125

## Typical applications:

- Calibration transfer standard
- Meteorology reference
- Fundamental research projects
- Trace humidity Measurement
- Critical process monitoring
- Fuel cell research

**High precision**

**Laboratory reference**

**Dual mirror PRT's**

**Wide measuring range**

**Temperature controlled sampling system**

**Fast response**

**Touch screen full color LCD user interface**

## High Precision Chilled Mirror Hygrometry

Chilled mirror hygrometry, a process used to measure the dew or frost point of a gas, works in the following manner. Light shines onto a polished mirror surface, the temperature of which is controlled by a thermoelectric Peltier element. A light-sensitive receiver measures the intensity of the direct reflection. When the mirror is clean and dry, the intensity of the reflected light is at its maximum. Conversely, a cooled mirror with water vapor condensed on its surface scatters the light, resulting in less light directly reflected and in reduced signal intensity. Using this received light signal as feedback in a closed loop control system, the mirror may be cooled to the temperature at which the thickness of the condensed layer,

detected through the intensity of the received light, remains constant. A condensate layer of constant thickness, with no further net increase or decrease in condensation, is in dynamic equilibrium with the gas surrounding the mirror. In this equilibrium condition, the dew or frost point temperature of the gas is determined by measuring the temperature of the mirror. If the condensate is known to be in liquid form, even for temperatures below freezing, then the measured mirror temperature is taken as the dew point. If the condensate is known to be in a solid form as ice or frost, then the measured mirror temperature is taken as the frost point.

### Dew or Frost?

For mirror temperatures above 0°C, water vapor condenses on the mirror as liquid water (dew). A liquid condensation layer is considered a dew point. For mirror temperatures far below 0°C, water vapor condenses on the mirror as solid ice (frost). A solid condensation layer is considered a frost point. However, for mirror temperatures between 0 and approximately -20°C, the state of the condensed layer is indeterminate, and may be either water or ice, or some combination of the two as shown in the picture to the right.

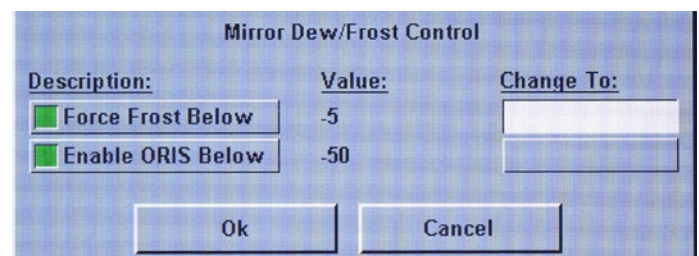


In this temperature range it is difficult to know, without visual observation, whether the system is controlling at the dew point, at the frost point, or somewhere in between. Since these states occur at different mirror temperatures for gas of the same water vapor content, it is important to determine which it is. Errors resulting from this problem can be up to 3°C.

### ForceFrost™ Function

The **Model 373 ForceFrost** function over-cools the mirror to force the condensed layer to the solid phase. This eliminates the uncertainty of whether dew or frost point is measured. Frost is ensured by rapidly cooling the mirror to below -40°C forcing the condensate to solidify, then quickly returning it to the previously predicted frost point temperature. It is then allowed to stabilize while ensuring the mirror temperature remains below 0°C.

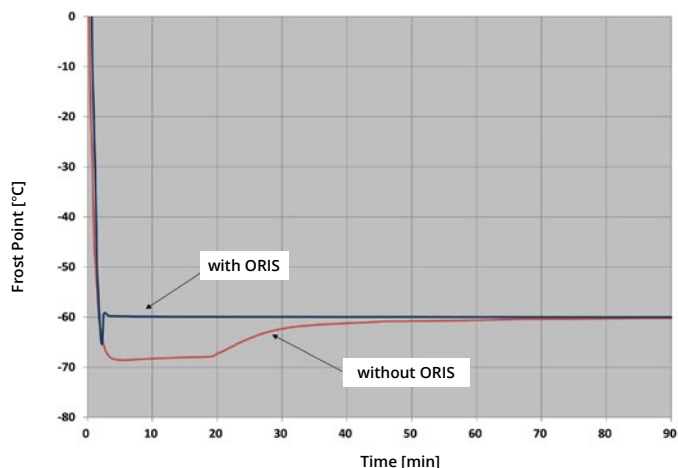
Once forced to freeze in this manner, the condensation will remain in frost for all subsequent mirror temperatures that continue to remain below 0°C.



## Optimum Response Injection System – ORIS

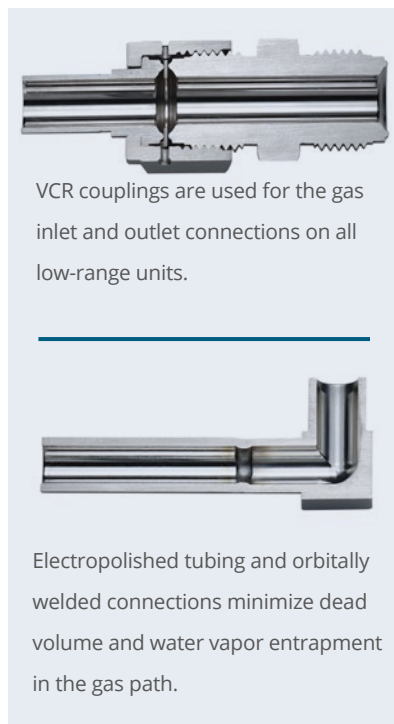
ORIS allows faster measurements at mirror temperatures below  $-60^{\circ}\text{C}$ . At these low frost point conditions, a chilled mirror hygrometer must cool the mirror to a value well below the actual frost point temperature to start the condensation process on the mirror. Due to the low water vapor content of the gas, building even a thin layer of frost on the mirror often requires several hours; the lower the frost point of the gas, the longer it takes. ORIS reduces hours of delay into just minutes. When measuring low frost points, ORIS momentarily injects a small amount of water vapor into the gas stream. This water vapor expedites the initial formation of frost on the mirror, significantly reducing the amount of time required for a stable measurement.

Measurements that once took several hours or more, are now performed in a matter of minutes.



## Low Frost Point Measurement

The **Model 373** is equipped with a dual mode (air-water) heat exchanger for bulk heat removal from the Peltier element. For dew point and frost point temperatures above approximately  $-40^{\circ}\text{C}$ , air-cooling is generally sufficient. For lower values, externally supplied cooling water is often recommended. Cooling water connections are located on the instrument's back panel. The temperature of the mirror, below which water cooling begins, can be selected from the user interface. With the water valve on, the temperature of the recirculating water will control the temperature of the heat exchanger. For measurement of very low frost point temperatures, a Dew Point Mirror 373L(X) must be used. Rather than using an air-water heat exchanger, the 373L(X) is equipped with an integral pre-cooler using a closed-circuit direct refrigerant injection system for bulk heat removal from the Peltier element. The pre-cooler allows the mirror to reach temperatures as low as  $-100^{\circ}\text{C}$  without the need for any auxiliary equipment. The pre-cooler may be operated in either a fixed temperature mode or at some delta above the currently measured frost point temperature. Both the mode and pre-cooler temperature can be selected on the user interface.



VCR couplings are used for the gas inlet and outlet connections on all low-range units.

Electropolished tubing and orbitally welded connections minimize dead volume and water vapor entrapment in the gas path.



## High Dew Point Measurement

In general, making measurements of high dew point temperatures, i.e. those above room temperature, can pose difficulties due to possible condensation within the sampling tubes. Preventing such condensation often requires the use of external heaters and controllers to maintain the temperature of all tubing above the dew point temperature of the gas. The **Model 373** offers a simpler solution. In addition to automatic control of the internal tubing and measurement head temperatures, it controls externally connected heated hose. Simply connect the hose and plug into the electrical connection. The hoses may be controlled at either a fixed temperature, or at some delta above the currently measured dew point temperature. The mode and temperature can be selected through the user interface.

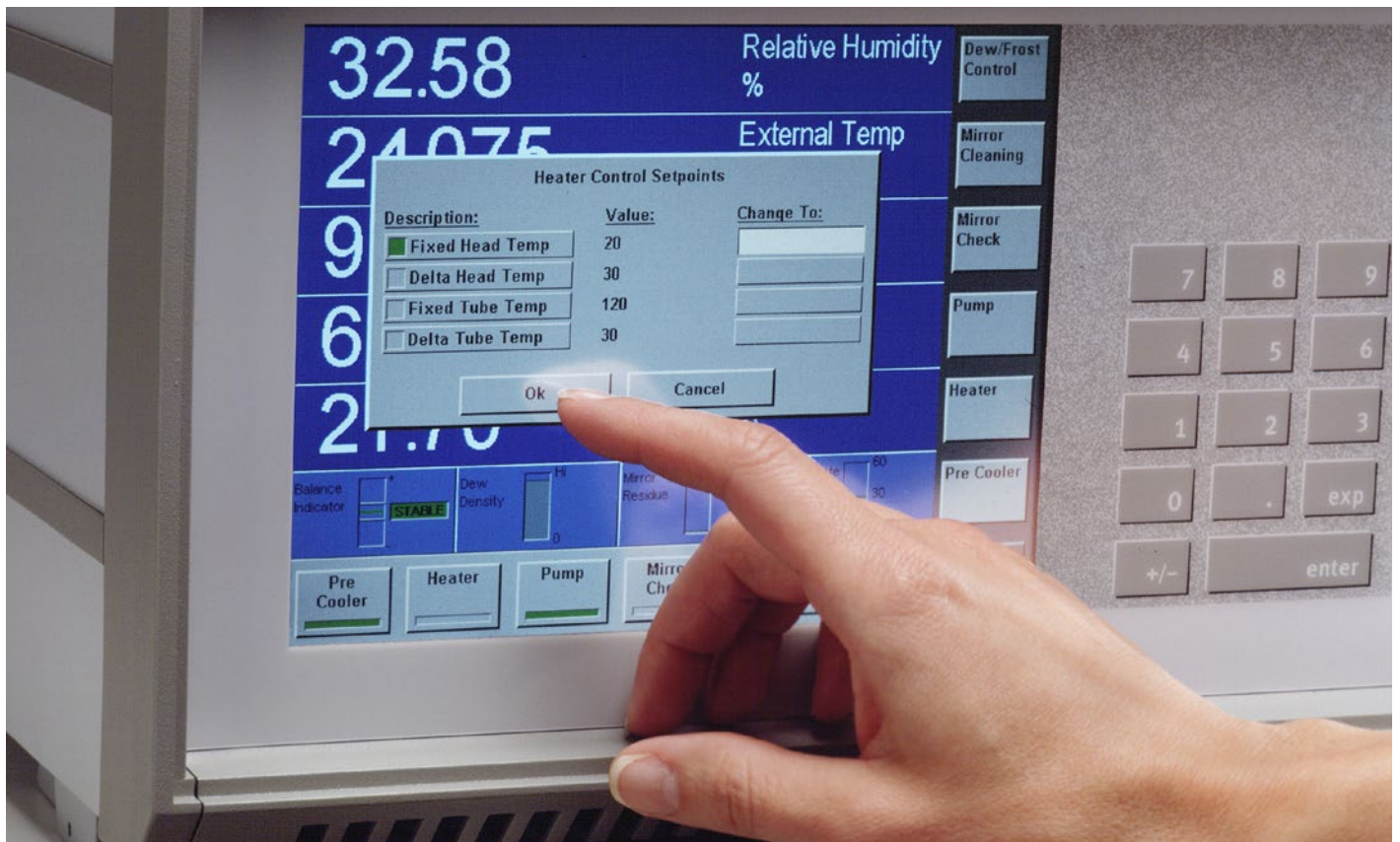
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## Intuitive User Interface

The system uses an 8.4" color touch screen with a high contrast ratio and wide viewing angle for clear and easy readability. Using the on-screen buttons and menus, each line of the instrument display can be configured for a variety of humidity, temperature and pressure parameters that may be viewed in the units of choice. These parameters can be displayed either numerically or graphically with user-configurable axes enabling measurement trends and stability to be confirmed without the need for external data acquisition or display hardware.

## Set It and Forget It

Once the screen is set up the way you like it (parameters, units, numeric, graphic), the system saves this configuration, powering up each time with your customized configuration.



### Convenient Calibration Check

Users can easily check the **Model 373** system's stability at any time using the built-in Ice-Test function. This automated test procedure allows the user to confirm that ice on the mirror melts at 0 °C to verify the accuracy and stability of the mirror temperature measurement system.

### Easy To Use and Minimal Maintenance

The 373 does not require either calibration adjustment or sensor replacement. Maintenance is limited to periodic mirror cleaning. The mirror check feature can be user programmed to regularly check for surface contaminants.

### Easy Mirror Cleaning Access

The mirror is mounted right on the front panel making it easily accessible for cleaning. Simply twist and remove the cover to gain complete access to the removable optical assembly and the flush mounted mirror surface.



# Specifications

Specifications:	373S	373H	373HX	373L	373LX	373LHX	373LHXH
<b>Measuring Ranges</b>							
Frost/Dew Point:							
Working range	-60...20 °C	-60...70 °C	-50...95 °C	-75...20 °C	-95...20 °C	-75...95 °C	-90...95 °C
Calibrated range	-50...20 °C	-40...70 °C	-40...95 °C	-70...20 °C	-90...20 °C	-60...95 °C	-75...90 °C
Temperature	-50...100 °C						
Sample pressure	500...2'000 hPa abs.						
<b>Accuracy</b>							
Frost/Dew point (for calibrated range)	≤ ± 0.1 °C						
Temperature	≤ ± 0.07 °C						
<b>Reproducibility</b>							
Frost/Dew point	≤ ± 0.05 °C						
Temperature	≤ ± 0.04 °C						
<b>Standard Features</b>							
Digital I/O	RS-232						
Display	8.4" LCD with color touch screen						
Mirror cooling	3-stage Peltier thermoelectric						
Mirror temperature sensors	Dual Platinum Resistance Thermometer PRT (Pt-100)						
External temperature probe	Platinum Resistance Thermometer PRT (Pt-100), Ø2 x 100 mm						
Analog outputs	Two analog outputs, user programmable, -10...+10 V and 4...20 mA						
Gas connections	6mm or ¼" Swagelok, VCR Cajon ¼" for L and LX only						
Sample gas flow rate	0...1 l/min (for 373 L and LX: 0...2 l/min)						
Sample gas circuit	Stainless steel, 316 / 316L, electro polished						
Transport case	Robust custom fit, foam lined, hard-shell case						
Power cable	2.5 m						
Operating instructions	English						
Calibration certificate	Factory calibration: humidity (dew and frost point) and temperature						
Cooling	Air/Water	Air/Water	Air/Water	Refrigeration	Refrigeration	Refrigeration	Refrigeration
ORIS	Yes	No	No	Yes	Yes	No	No
Heated sample gas path	No	80 °C	105 °C	No	No	105 °C	105 °C
Internal pump	Yes	Yes	Yes	Optional	Optional	Yes	Yes
<b>Optional</b>							
Pressure upgrades	Pressure upgrades to 1 MPa abs. or 2 MPa abs.						
Calibration upgrade	Upgrade to SCS accredited ISO 17025 calibration available						
Endoscope	Measuring head mount endoscopes						
Vacuum measurement capability	Down to 500 hPa						
<b>Additional Information</b>							
Compliance	CE Compliance						
Operating condition	15...35 °C, 90 %rh non-condensing						
Storage conditions	-10...50 °C, 90 %rh non-condensing						
Power supply	100...120 VAC / 200...240 VAC, 50/60 (auto-switching)				100...120 VAC, 50/60 Hz or 200...240 VAC, 50/60 Hz		
Power consumption	200 W	300 W	300 W	300 W	500 W	500 W	500 W
<b>Weight &amp; Dimensions</b>							
Width	449 mm	449 mm	449 mm	560 mm	560 mm	650 mm	650 mm
Height	236 mm	236 mm	236 mm	260 mm	260 mm	260 mm	260 mm
Depth	461 mm	461 mm	461 mm	520 mm	520 mm	520 mm	520 mm
Weight	20 kg	20 kg	20 kg	41 kg	41 kg	47 kg	47 kg

## Ordering information

Description:		Order code
373S	-50...+20 °C FP/DP	100048
373H	-40...+70 °C FP/DP *	101115
373HX	-40...+95 °C FP/DP *	100050
373L	-70...+20 °C FP/DP	100051
373LX	-90...+20 °C FP/DP	100052
373LHX	-60...+95 °C FP/DP *	100053

Options:	Order code
373-Upgrade to SCS accredited calibration (ISO 17025)	103952
10 bar pressure upgrade 373	103633
100 bar pressure version 373 (L or LX only)	103634
Endoscope 10° (S, H)	103609
Endoscope 30° (HX)	103611
Endoscope 0° (L, LX, LHX)	103610
Twin relay module, two normally open contacts for mirror check status and common fault	103991
Additional 1 year warranty upgrade (maximum 3 years)	103632

For a complete range of options and accessories, please contact us and request our pricelist.

\* Requires a heated hose for measurement of dew points above ambient temperatures.





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For a complete range of products, applications, systems, and service options, please contact us at: [info@process-insights.com](mailto:info@process-insights.com)

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