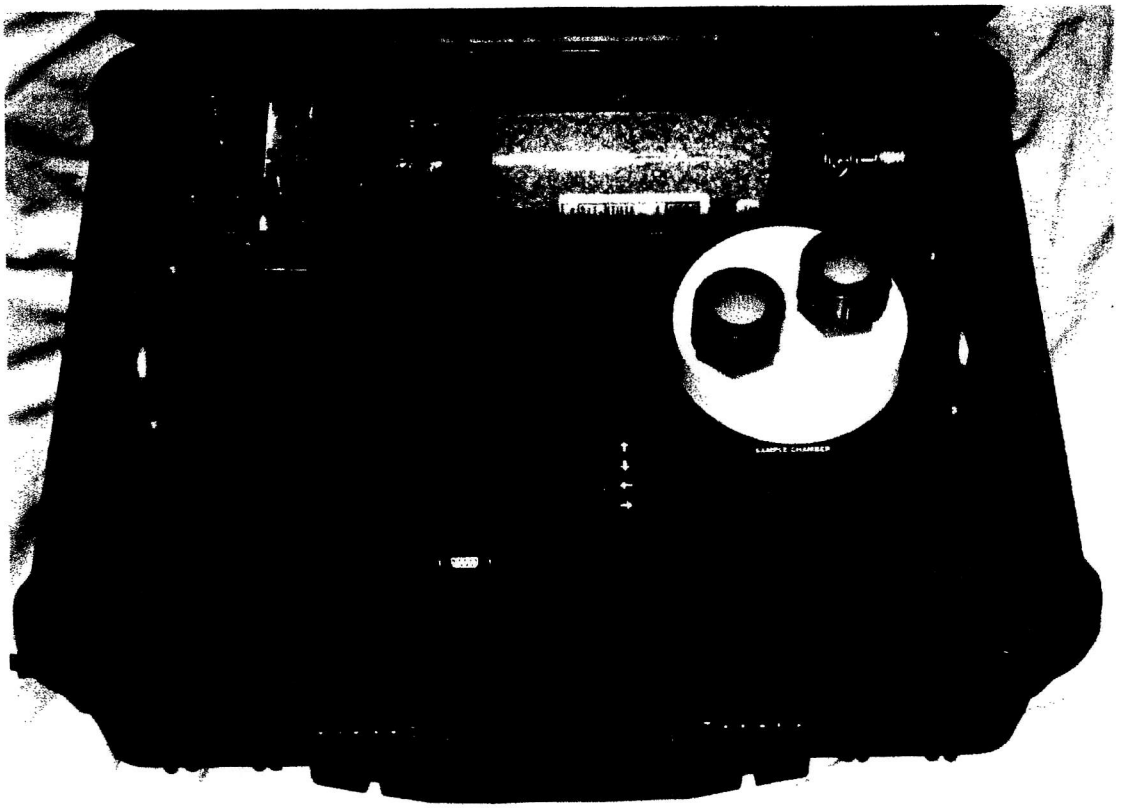
RH CAL

Relative Humidity Calibrator
OPERATORS MANUAL



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From: EdgeTech Customer Service [mhservice@edgetech.com]
Sent: Wednesday, December 09, 2009 7:36 AM
To: Dennis Kuhn
Subject: RE: Adjustment procedure

Dennis, In our instrument the RH is calculated from the temp and chilled mirror dew point. For cal adjustment use the AT ZERO pot, R52 located on the motherboard rather inconveniently partially under the saturator and the DP ZERO pot, R27 located about 3 inches further down to the left. They are labeled accordingly on the silkscreen. Feel free to call me anytime.

Procedure: Step 1 Check the temperature accuracy at at 25C,adjust R52 if needed. Allowed 24.9 to 25.1 for adjustment proposes.

Step 2 Check the %RH @ 20, 50 and 80%, adjust R27 if needed.

Best Regards,

Randy Taylor

Service and Repair Manager

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TABLE OF CONTENTS

RH-CAL
QUICK STARTUP GUIDE – Page 1

STARTUP

1. Connect the RH-CAL to the AC Power Line.
2. Lift Flow Meter to the upright position.
3. Remove Shipping Plug from Water Fill Tube.
4. The correct water level is filled at Edgetech prior to shipping.
5. Set Power Switch to ON position.
6. Wait for equilibration and SERVOLOCK indication on Display.

REPROGRAMMING A SETTING

1. Press ENT on Keypad to enter selection menu.
2. Using ENT key, scroll to the desired location of the parameter to be changed.
3. Press ENT again to begin changing the setting. The selected digit will flash. Use left and right Arrow keys as required to scroll to the change location, and the numerical keypad to input the change.
4. When programming is completed, press ENT to accept the new setting and ESC to exit the menu. The KEEP CHANGES? screen will appear. Press ENT to lock in the change, or ESC to discard the change and return to the previously programmed value.

RH-CAL
QUICK STARTUP GUIDE – Page 2

ROUTINE MAINTENANCE (See Maintenance Section)

WATER FILL

Add distilled water periodically, after 12 to 36 hours of operation, depending on RH settings.

> **Note: If RH readings are constantly lower than the programmed setpoint, water is probably needed.**

AIR DRYER MATERIAL

When the entire Air Dryer tube has turned from blue to pink, the desiccant material inside must be restored. Remove the Air Dryer from the Panel by opening the straps. Disconnect the two clear plastic tubes from the bottom. Open the tube and replace dryer material, or bake the material to remove moisture. Reassemble and reinstall.

MIRROR CLEANING

The Automatic Balance Cycle (ABC) greatly minimizes cleaning requirements of the internal Chilled Mirror Sensor. Contaminants in the air will gradually build up on the mirror, to the point where manual cleaning is eventually required. Periods of 90 days between cleanings are typical, depending on the air source. An indication of CLEAN MIRROR on the Display, after an ABC Cycle, will tell the user when cleaning is needed. The DP Sensor is located in the Test Chamber at the 3 o'clock position, and the opening with the small vertical mirror is located toward the front of the RH-CAL. Use cotton swabs and isopropyl alcohol for mirror cleaning.

AIR FILTER ELEMENT REPLACEMENT

Depending upon the quantity of contaminants in the incoming air, the internal Air Filter element may have to be replaced after a substantial period of operation. Remove the Panel to access the air filter. Unscrew the clear plastic cover, replace the filter with a new one, and reassemble.

2.0 LIST OF ILLUSTRATIONS

3.0 INTRODUCTION

3.1 GENERAL DESCRIPTION

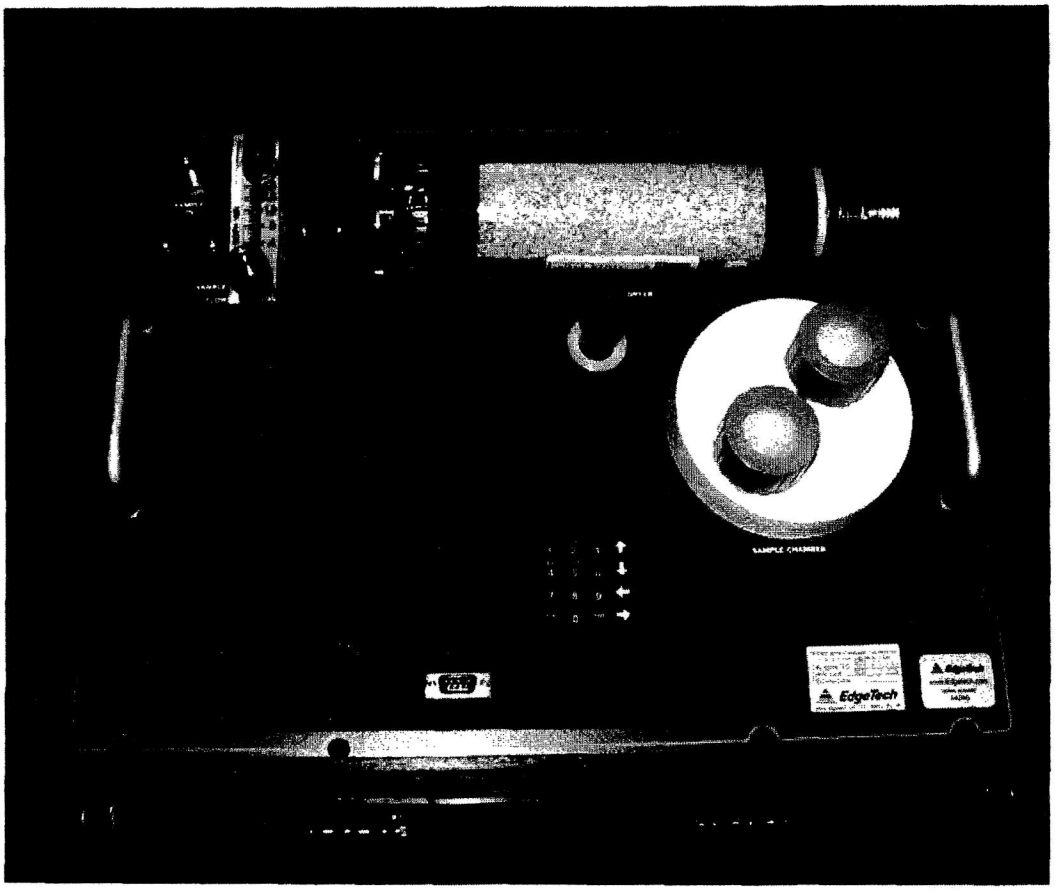
The RH CALIBRATOR is a microprocessor based, programmable humidity control and measurement instrument with many microprocessor controlled features built-in.

Using the NIST Traceable Optical Chilled Mirror primary measurement technique, the RH CALIBRATOR was developed for precise calibration of RH Sensors and Transmitters, as well as laboratory and research applications.

3.2 SYSTEM OVERVIEW

The RH CALIBRATOR has a Test Chamber, a menu driven LCD graphics display, Automatic Balance Cycle (ABC), a selectable analog output, and an RS-232C serial port.

Figure 3-1 RH Calibrator Panel



An Air Temperature Probe and a Type D2 Chilled Mirror Sensor are located in the Test Chamber. The relative humidity and temperature of the chamber are programmable from the Scrolling Menu.

The 40 x 8 character backlit LCD displays Dew Point (C or F), Chamber Temperature (C or F), and Percent Relative Humidity simultaneously.

The Automatic Balance Cycle (ABC) can be set to balance the sensor optics at preset times and intervals or can be initiated manually at any time.

An analog output is available on the Panel as either 0 to 5VDC or 4 to 20 ma, and it can be set to follow any parameter with individually programmable high and low points. The output can be set to *Track* the selected parameter value during the ABC cycle or *Hold* the last value prior to the ABC cycle.

The half duplex configured RS-232C serial port can be used to remotely control the calibrator operation, and to output data to a data recording device.

3.3 OPERATING CONTROLS

The RH CALIBRATOR operates entirely under microprocessor control. State-of-the-art software provides the opportunity to include a flexible, informational, and user friendly interface. The setup and operation of the control unit can be programmed via the front panel keypad or the RS-232 serial port.

LCD Graphics Display: Displays three parameters simultaneously, time, date, operational status, sensor mirror condition, and alerts the user to fault conditions. When activated from the Scrolling Menu, the AT SETPOINT (chamber temperature) and the RH SETPOINT (relative humidity), are displayed. The display of Dew Point may also be selected with the Keyboard.

Keypad: A membrane type keypad allows the user to enter setup and instrument control information. A Scrolling Menu guides the user through the setup procedure. The Setup Parameters include RH SETPOINT, AT SETPOINT, time, date, analog output parameter and scale, ABC start and interval, and serial port settings.

SERVOLOCK ™: The SERVOLOCK feature continuously displays the servo control loop status. This is especially useful when the sample dew point is varying widely or quickly. When SERVOLOCK is displayed, the system is locked on to and tracking the dew point.

ABC Cycle: The Automatic Balance Cycle checks for proper operation of the system and re-balances the sensor to compensate for changes in reflectivity of the mirror due to aging, optics drift, or minor contamination

due to impurities in the sample gas. The on board real time clock permits the user to program the ABC cycle to start at any specified time of day and repeat at regular-programmed intervals. The user can therefore program the ABC cycle to occur at off-hours such as late at night or early morning when the re-balance will cause the least interruption of the sampling process. The cycle can also be initiated manually at any time by a pushbutton on the front panel or via the serial port.

The analog output can be programmed to either TRACK or HOLD the information during an ABC cycle.

Serial Port: The RS-232C serial port can be used to remotely program setup parameters, initiate an ABC cycle, or output data to a local or remote terminal, printer, or computer. The data output function outputs, in ASCII format, the date, time, three parameters, and system status to any RS232C equipped serial device. The data can be sent on command from the external device or automatically at programmed intervals. HELP and STATUS menus can also be displayed to guide the user.

Analog Output: The analog output, either 0-5 VDC or 4-20 ma, is available at the Panel terminal connector. The output can be set to track any parameter, and may be independently scaled via the Scrolling Menu.

Flow meter: A built-in flow meter is provided to adjust the sample flow rate for optimum performance.

4.0 WARRANTY STATEMENT

All equipment manufactured by EdgeTech is warranted against defective components and workmanship for repair at their plant in Massachusetts, free of charge, for a period of twelve months. Malfunction due to improper use is not covered in this warranty and EdgeTech disclaims any liability for consequential damage resulting from defects in the performance of the equipment. No product is warranted as being fit for a particular purpose and there is no warranty of merchantability. This warranty applies only if (i) the items are used solely under the operating conditions and in the manner recommended in the instruction manual, specifications, or other literature; (ii) the items have not been misused or abused in any manner or repairs attempted thereon; (iii) written notice of the failure within the warranty period is forwarded to EdgeTech and the directions received for properly identifying items returned under warranty are followed; and (iv) the return notice authorizes EdgeTech to examine and disassemble returned products to the extent EdgeTech deems necessary to ascertain the cause for failure. The warranties expressed herein are exclusive. There are no other warranties, either expressed or implied, beyond those set forth herein, and EdgeTech does not assume any other obligation or liability in connection with the sale or use of said products.

Equipment not manufactured by EdgeTech is supported only to the extent of the original manufacturer's warranties

5.0 EDGETECH'S COMMITMENT TO QUALITY

Thank you for purchasing one of our products. At EdgeTech, it is our policy to provide cost-effective products and support services that meet or exceed you requirements, to deliver them on time, and to continuously look for ways to improve both. We all take great pride in the products we manufacture.

We want you to be entirely satisfied with your instrument. The information contained in this manual will get you started. It tells you what you need to get your equipment up and running, and introduces its many features.

We always enjoy hearing from the people who use our products. Your experience with our products is an invaluable source of information that we can use to continuously improve what we manufacture. We encourage you to contact or visit us to discuss any issues whatsoever that relate to our products or your application.

The Employees of EdgeTech

6.0 N.I.S.T. TRACEABILITY – WHAT DOES IT MEAN?

The RH-CAL, or Relative Humidity Calibrator, is certified by Edgetech to be traceable to N.I.S.T., the National Institute of Standards and Technology (formerly known as the National Bureau of Standards, or NBS), in Gaithersburg, Maryland, U.S.A. You have received a Certificate of Calibration with this instrument. What does N.I.S.T. Traceability mean in terms of the RH-CAL?

The calibration chamber in the RH-CAL can be set by the user to any desired relative humidity (RH). The instrument measures and controls the chamber RH by measuring both the air temperature (AT) and the dew point temperature (DP) in the chamber. Since there is a mathematical relationship between dew point temperature, air temperature, and relative humidity, a built-in microprocessor can therefore compute the chamber RH.

Dew Point is a fundamental measurement of humidity. It is not affected by temperature. In addition, the chilled mirror dew point sensor in your RH-CAL provides a primary rather then a secondary measurement of dew point temperature.

Both the AT and the DP are measured with Platinum Resistance Thermometers (PRTs). These devices are coils of nearly pure platinum, where the rate of change of resistance with temperature is precisely known. Resistance is accurately measured and is automatically converted to temperature information in the RH-CAL.

TRACEABILITY:

- 1. The precise platinum thermometers are N.I.S.T. traceable by the traceable resistance standards maintained by the PRT manufacturers.

- 2. A multi-point dew point calibration is performed on every RH-CAL chilled mirror dew point sensor, using EdgeTech's traceable secondary dew point standard. This instrument, a precise chilled mirror hygrometer, is periodically sent directly to N.I.S.T. for certification against their dew point transfer standard, a Two-Pressure Generator.

7.0 GLOSSARY

ABC:	Automatic Balance Control – a method of maintaining accuracy in the presence of contamination and minimizing maintenance requirements.
Analog Out	A voltage or current that tracks changes in a parameter.
AT	Air Temperature – the temperature inside the test chamber.
Depression	The magnitude of available mirror cooling in the chilled mirror sensor.
Desiccant	A chemical material which removes moisture from the air sample and thereby produces very dry air.
DP	Dew Point Temperature – the temperature that moisture in the air *just begins* to condense on a cooled surface.
Hold	Analog output which holds the last humidity reading just before the ABC cycle.
Hysteresis	The tendency of a sensor to give one set of readings when going up, and a different set of reading when going down.
Mirror	A small metallic reflective surface within the dew point sensor.
RH	Percent Relative Humidity – the ratio between the *actual* moisture content in the chamber and the *maximum* moisture content if the chamber air was saturated, at a given air temperature.
RS-232	An accepted industry standard for a serial digital interface.
Saturator	A device which brings the air sample to 100% RH.
Serial Port	See RS-232.
Servolock™	A method of indicating that the system is locked on and tracking the dew point.
Slew Rate	The rate of temperature change of the mirror assembly in the chilled mirror dew point sensor.
Track	Analog output which follows (tracks) the mirror temperature during the ABC cycle.

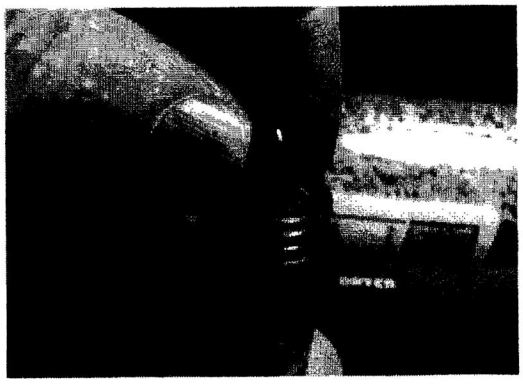
8.0 INSTALLATION

8.1 UNPACKING

Remove the RH CALIBRATOR from its shipping carton and remove any shipping ties, clamps, and packing material. Save the Certificate of Calibration shipped with this manual. Locate and save the Cleaner Kit included in the shipping carton.

IMPORTANT:
1. Locate the RH-CAL on a flat horizontal surface. Leave a minimum of 6 inches (15 cm) on both sides for proper air flow.
2. Before first use, unscrew the Saturator Cap and remove the Shipping Plug (Red Top/Clear Tube) from the small stainless steel Saturator Air Outlet Tube. Put the Shipping Plug away in a safe place – you may need it later.

Figure 8-1. Remove Shipping Plug



NOTE: Whenever the RH CALIBRATOR is moved, the saturator Shipping Plug should be installed to prevent water leakage.

8.2 WIRING CONNECTIONS

Connect the RH CALIBRATOR to a grounded, instrument quality power source of between 100 to 240 VAC, 50-60 Hz. There are no jumper or switch setting modifications over this range; only the fuse must be changed if changing from a nominal 115 VAC to 230 VAC.

Note: The correct fuse is installed at the Factory, depending upon the normally supplied voltage at the shipping location.

Fuse Location: The AC power line fuse is located behind the left side of the carrying handle, on a printed circuit board mounted inside the carrying case.

Fuse Values:
For U.S. use (and others): For power line voltage between 100 to 150 VAC, the fuse type is 3A, 3AG, 250VAC, Slo-Blo. For power line voltage between 150 to 240 VAC, the fuse type is 1.5A, 3AG, 250 VAC, Slo-Blo.
For European use: Use Type T fuses. For nominal 230 VAC, the required fuse value is 1.6A.

8.3 WATER FILL

Figure 8-2. Filling the Saturator

Note: Only distilled or deionized water should be used. The minerals in tap water may gradually contaminate the instrument and cause inaccurate readings.

With power ON, remove the cap from the clear water reservoir. Using the supplied syringe, draw water into the syringe until full. Place the flexible hose at the end of the syringe into the opened Saturator fill tube such that the tip extends below the clear portion of the fill tube, and depress the plunger. Do not fill above the panel surface. In case of overfill, draw the excess water into the syringe and bring the water level below the clear portion of the fill tube. Total capacity of the Saturator is approximately 40 ml (2 – 3 full syringes). Replace the reservoir cap firmly.

8.4 AIR CONNECTION (Optional)

A ¼ inch compression fitting is mounted on the panel. In normal portable operation, it is not necessary to connect anything to this port, since room air is automatically drawn into the calibrator, through the fitting, by the vacuum pump. If you prefer to use your own source of instrument quality dry air, a ¼ inch line may be connected. In this mode, the requirement for periodic maintenance of the desiccant dryer material is eliminated.

Note: Air line pressure must NOT exceed 5 psig.

9.0 BASIC BLOCK DIAGRAM THEORY OF OPERATION

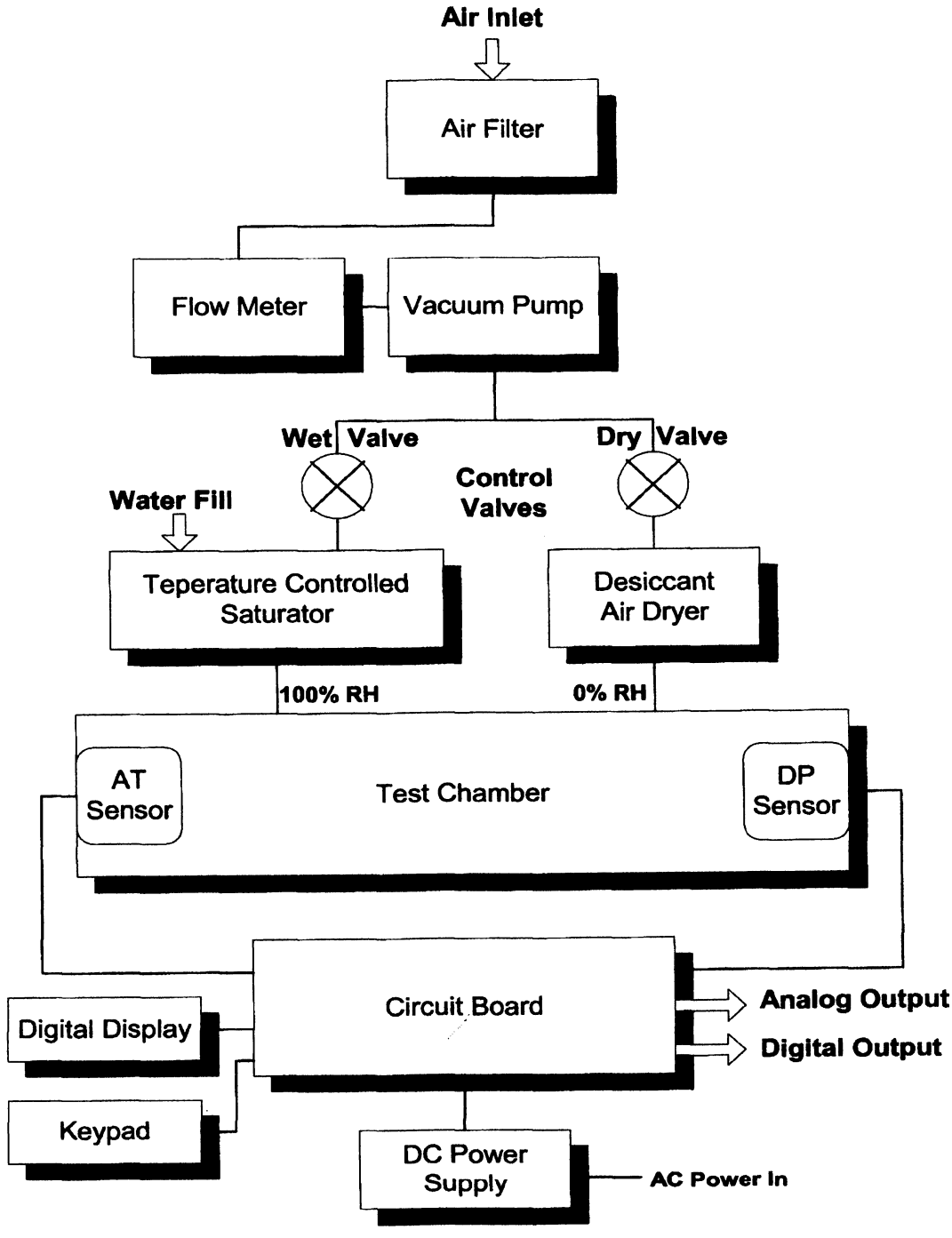


Figure 9-1. Basic Block Diagram

9.1 BASIC BLOCK DIAGRAM DESCRIPTION

See the Basic Block Diagram, Figure 9-1.

Room air enters the instrument, via the fitting on the panel. (Note: See the Installation chapter regarding use of an instrument air line.) Any particulate contaminants in the air are removed from the sample by the **Air Filter**.

A built-in **Vacuum Pump** is used to draw in the air sample, and to provide a positive pressure in the **Test Chamber**.

The user may control the sample air flow rate with the 0 to 2 psi **Flow Meter** mounted on the panel.

The air flow is than divided and sent to a pair of finely matched volumetric **Control Valves**. The RH CAL independently modulates the "Dry" and "Wet" valves from full-open to full-closed, or any points between. The "Wet" valve feeds the heated **Saturator**, which has a water fill mounted on the panel. The "Dry" valve feeds the **Air Dryer**. When a desired **RH** setting is programmed into the instrument by the user, the **Control Valves** automatically control the proper mixing of the wet and dry air in the **Test Chamber**.

A **Dew Point (DP)** sensor is mounted within the **Test Chamber**. Control circuits on the **Circuit Board** control the sensor mirror temperature, which tracks the **Dew Point** up and down as it changes. An **Air Temperature (AT)** sensor is also installed in the **Test Chamber**. Mounted in each of these sensors is a precise platinum thermometer to provide **AT** and **DP** information. When the desired **RH** is selected by the user, a microprocessor on the **Circuit Board** converts this information to **Percent Relative Humidity (RH)**. The proportion of wet and dry air in the chamber is automatically mixed to keep it at the programmed **RH** at all times. In addition, the chamber **Air Temperature(AT)** will also be controlled at any point programmed by the user.

An LCD **Digital Display** is mounted on the panel. It provides all pertinent information to the operator, and allows programming of all parameters, including real time data. The **Keypad** is used to enter desired programming information to the RH CAL.

The **Analog Output** (selectable 0 to 5 Vdc or 4 to 20 mA) is provided at a connector on the panel. The **Digital Output** (RS-232C Serial Port) is also mounted on the panel.

A **Power Supply** module converts the AC power line voltage to DC to power the electronic circuits.

10.0 PANEL DESCRIPTION

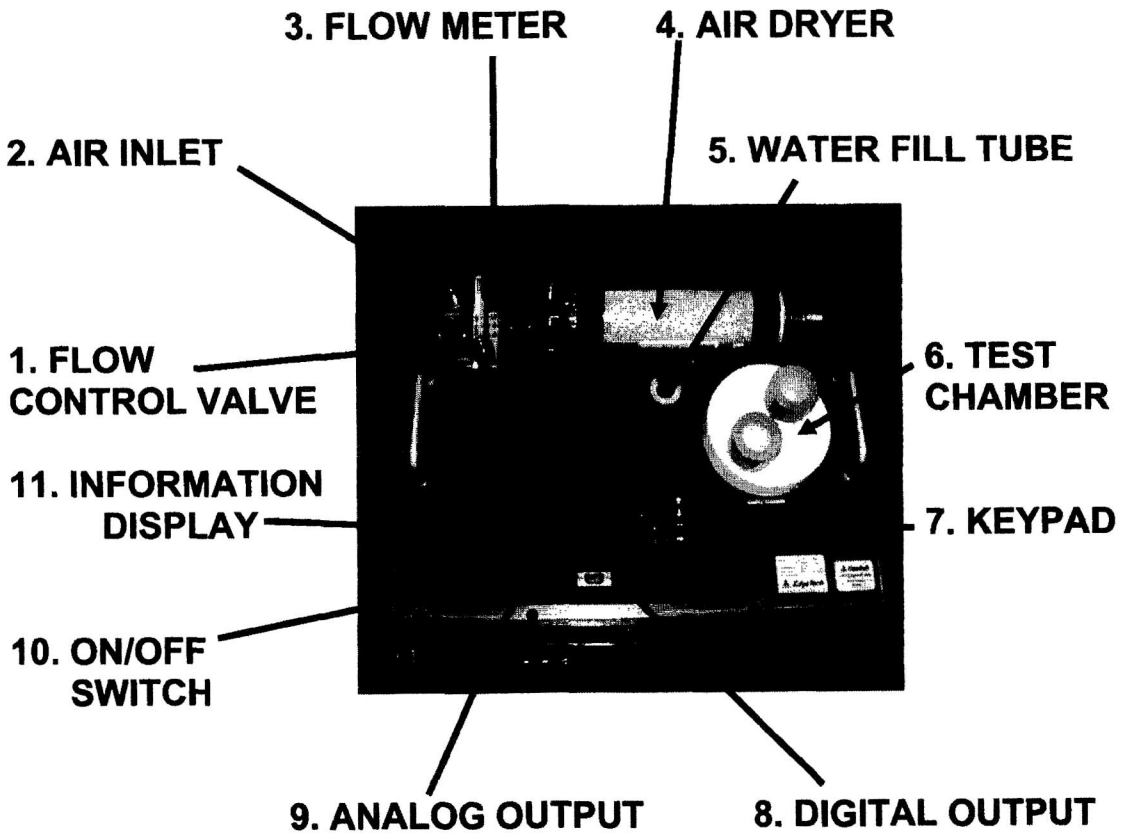


Figure 10-1 RH-CAL Panel Description

1. **Air Flow Control Valve** – Allows the user to control the air flow through the system. 1 liter per minute (2 SCFH) is recommended.

2. **Air Inlet (Sample In)** – Brings in room air for use in the system. An Instrument Air line may also be connected. (1/4 inch compression fitting)

3. **Flow Meter** – Shows system air flow rate.

4. **Air Dryer** – Removes moisture from incoming air.

5. **Water Fill Tube** – Supplies water to the temperature controlled Saturator.

6. **Test Chamber** – Contains controlled RH and Temperature environment for calibrating sensors.

7. **Keypad** – A pressure-sensitive keypad that allows the user to program setpoints and to control functions.

8. **Digital Output** – RS-232C serial port for computer communication.

9. **Analog Output** – Can be programmed to provide information for Dew Point, Air Temperature, or Percent Relative Humidity. User may select either 0 to 5 VDC or 4 to 20 ma.

10. **ON/OFF Switch** – Turns Power ON or OFF.

11. **Information Display** – Reads out all system information, such as Set Points and actual Test Chamber conditions.

ITEMS NOT SHOWN:

- **Air Outlet** – on right rear of carrying case (1/4 inch compression fitting).

- **AC Power Input Socket and Fuse Holder** – on left side of carrying case.

11.0 INFORMATION DISPLAY FUNCTIONS

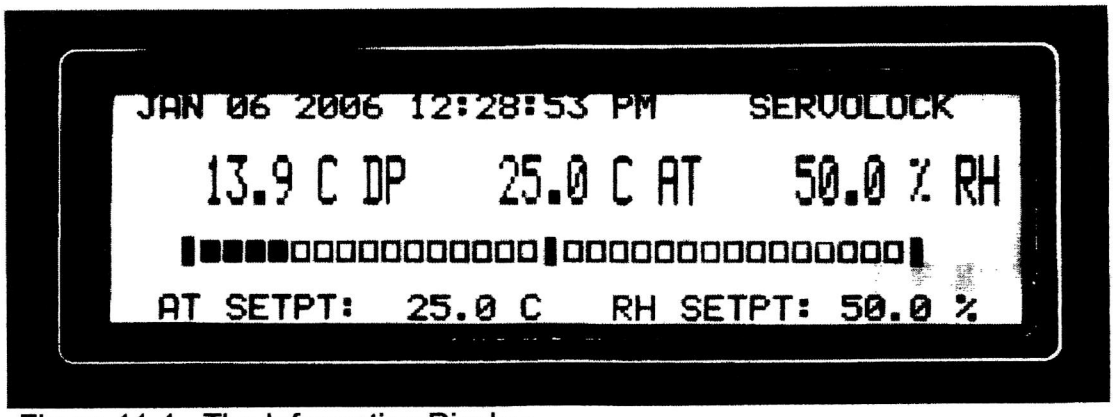


Figure 11-1. The Information Display

11.1 INFORMATION DISPLAYED

The large LCD Display mounted on the Panel provides the user with all the information necessary to properly operate the RH-CAL. It can be used as the primary interface with the instrument, showing status of all parameters, and allowing calibration points to be easily programmed.

NOTES:

1. The RS-232 Serial Port, along with a computer or terminal, may also be remotely used for the same purpose.

2. All programming is in non-volatile memory, so that it is retained when Power is off.

TOP ROW:

DATE	The Current Date
TIME	The Current Time
CONTROL LOOP STATUS	Shows Chilled Mirror Control Loop condition

CENTER ROW (MAIN DISPLAY):

DEW POINT	The actual Chamber Dew Point
AIR TEMPERATURE	The actual Chamber Temp.
RELATIVE HUMIDITY	The actual %RH in the Chamber

Note: The above three parameters may be programmed to be displayed in any desired sequence.

S_HEAT DISPLAY: Cycles on and off to show when power is applied to Saturator heater.

BAR GRAPH DISPLAY: The Bar Graph displays a picture of the dew layer on the chilled mirror surface. The right hand vertical bar indicates the mirror itself, and the white bars show the actual dew layer. The layer can be seen to vary in thickness as the control loop brings the mirror into control, and then maintains a thin layer of dew as the mirror temperature tracks the dew point temperature.

BOTTOM ROW:

AIR TEMP. SETPOINT	The programmable AT setting
RH SETPOINT	The programmable RH setting

12.0 OPERATING THE RH CALIBRATOR

In order to operate this instrument, it is assumed that you have read the INSTALLATION section of this manual, and preliminary tasks have been done.

These include:

1. The Shipping Plug has been removed from the Saturator Fill Tube.
2. The Saturator has been properly filled with water.
3. The instrument has been connected to the AC power source.
4. If desired, the Analog and/or Serial Digital (RS-232) Output has been wired.

If not, the INSTALLATION chapter should be reviewed before proceeding.

1. Turn the Power Switch to the ON position. The small adjacent indicator lamp will light, and the Digital Display will: (1) light up; (2) briefly indicate RH CALIBRATOR by EDGETECH; and (3) go into the normal display mode. A hum will be heard, indicating that the fans and vacuum pump are operating.
2. Lift the Flow Meter from its lowered shipping position to its upright position.
3. Adjust the Flow Control knob on the Flow Meter to 2 SCFH (1 LPM).

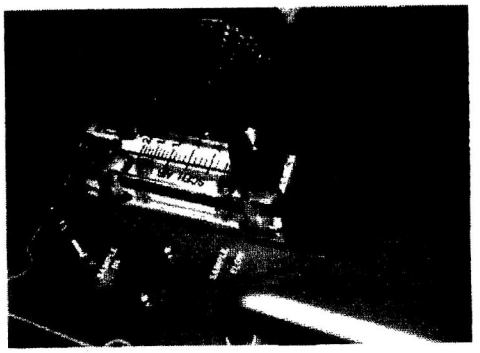


Figure 12-1. Lowered Position

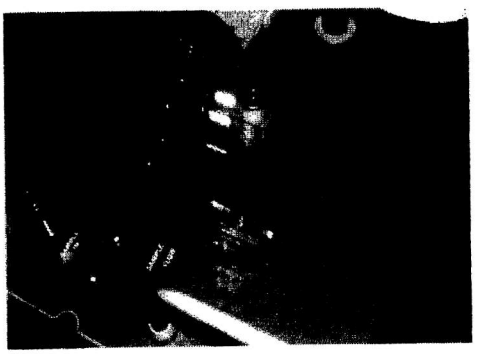


Figure 12-2. Upright Position

12.1 SYSTEM STATUS

The status of the RH-CAL control systems may be seen in the upper right corner of the Display. When first turned on, it will read STARTUP. At other times, it may read MAX HEAT, or ABC: HEAT, or ABC: STABLE, or SEEKING DP. After several minutes, the Display will read SERVOLOCK. This indicates that the system is tracking the Dew Point, and that the RH condition in the chamber is stabilizing.

*The chamber should only be used for calibration when the display reads SERVOLOCK **and** the RH reading has stopped changing and reads the setpoint value +/- the RH-CAL accuracy specification.*

12.2 KEYPAD OPERATION

The RH CALIBRATOR Panel has six keys that support user set up and operation. The label for each key, and its function, is described below.

Key	Function
C/F	Toggles the displayed parameters, internal parameters and RS-232 output between degrees Fahrenheit and Centigrade. Output values are also converted from Fahrenheit to Centigrade when the C/F key is pressed. The analog output level does not change when C/F is toggled, because ranges are converted.
MABC	Starts the Manual ABC cycle. If the RH CALIBRATOR is already in an ABC cycle, this key cancels the ABC cycle.
HEAT	Turns on/off MAN MAX HEAT. Once this key is pressed, the sensor is kept in MAN MAX HEAT until the MAN MAX HEAT key is pressed again. In MAN MAX HEAT, the SERVOLOCK is bypassed and the mirror is heated. The upper right section of the LCD flashes MAN MAX HEAT, and the RS-232 output indicates MAX HEAT. During an ABC cycle, MAX HEAT (MAX COOL) does not function.

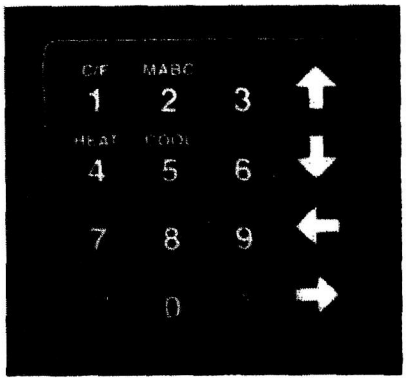


Figure 12-3. Keypad

NOTE: Turning on MAX HEAT turns off MAX COOL and vice versa. Both cannot be activated simultaneously.

COOL Turns on/off MAX COOL. The sensor is kept in MAX COOL until the MAX COOL key is pressed again. The upper right portion of the LCD flashes MAN MAX COOL.

ENT Enter the SCROLLING MENU.
The SCROLLING MENU PROVIDES access to RH SETPOINT, AT SETPOINT, ANALOG OUTPUT, ABC, and SERIAL setup functions. In the SCROLLING MENU use the up, down, left and right arrows to highlight a selection and press ENT to enable changes. The selected function will flash on and off and can now be set to the desired value using the keypad.

ESC Exit from the SCROLLING MENU.

12.3 PROGRAMMING THE RH-CAL

RH SETPOINT: The relative humidity of the sample chamber can be set from 5 to 95% and will operate automatically at the factory default setting unless reprogrammed. The RH SETPOINT will appear in the lower portion of the main display. To change the setting, press ENT to enter the SCROLL MENU, move down to the RH SET box, press ENTER and use the keypad to make the change. Press the ENTER key to accept the new setting and the ESC key to exit the menu.

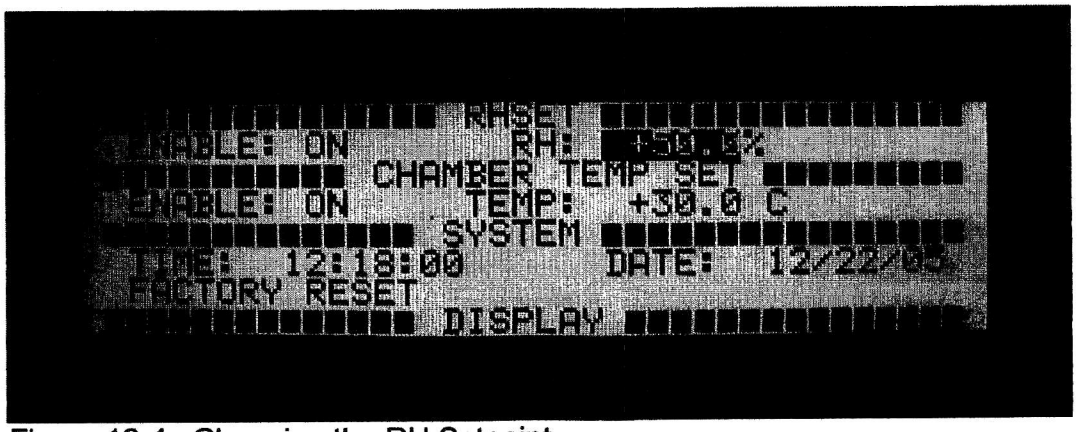


Figure 12-4. Changing the RH Setpoint

RH SETPOINT, AT SETPOINT, OR SERIAL PORT ON/OFF: The RH SETPOINT, AT SETPOINT and, SERIAL PORT all have enable/disable toggle functions located in the SCROLLING MENU. To make a change, go to the appropriate enable box and press the ENTER key. Use the up arrow to toggle on or off and press the ENTER key. If the RH SETPOINT or AT SETPOINT is disabled they will no longer appear on the main display.

AT SETPOINT (CHAMBER TEMPERATURE SETTING): The air temperature in the sample chamber can be set from 10 - 50 Deg. C. (40 -122 Deg. F.) and will operate automatically at the factory default setting unless reprogrammed. If enabled, the AT SETPOINT will appear in the lower right portion of the main display.

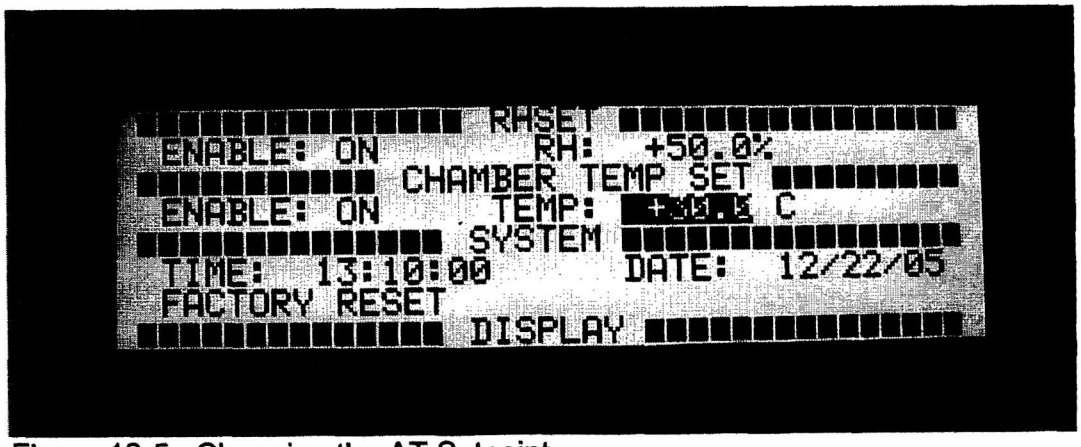


Figure 12-5. Changing the AT Setpoint

SYSTEM: Time and date on the main display can be changed here. Time is programmed in 24 hour time, but displayed in 12 hour time, showing AM or PM.

Note: The Time information does not advance while you are in Programming mode. Therefore, it is recommended that the Time be set last, just before you press ESC to return to normal mode.

DISPLAY: Parameters to be viewed on the main display, left, center or right, can be set in any order. Enter a display box: L, C or R, and use the up or down arrows to choose a parameter (or select NONE). Then press the ENTER key.

ANALOG OUTPUT: The Analog Output is located on the Panel. It can be programmed to track dew point (DP), ambient temperature (AT), or relative humidity (RH).The low and high ends of the range are programmable. The output is factory set at 0-5 VDC. 4-20ma output can be selected from the main circuit board inside the RH-CAL. See the Maintenance section.

ABC CYCLE: The Automatic Balance Cycle (ABC) can be initiated manually at any time or started at any specified time of day (ABC START) and repeat at regular intervals (ABC INTERVAL). The analog output can be programmed to track or HOLD the parameters during an ABC cycle and the alarm is automatically disabled. If ABC HOLD is ON, the analog and serial outputs will be held at the values just prior to initiating the ABC cycle. The display will contain

the message "ABC HOLD". The hold will be released when the ABC cycle is complete and the instrument has stabilized back on the dew point.

SERIAL OUTPUT: To access the serial port it is necessary to have the enable ON and to select the appropriate baud rate.

FACTORY RESET: Selecting and pressing the FACTORY RESET field on the Menu will reset all setup parameters to Factory Default Settings.

Default Factory Settings

Display: DP, AT, and RH are displayed.

Temperature Units: C

RH Setpoint: ON and set to 50 %

AT Setpoint: ON and set to 25 Deg. C **(?)**

ABC Status: ON

ABC Start Time: 00:00 Hrs.

ABC Interval: 06:00 Hrs.

Analog Hold: OFF

Analog Output: RH Parameter, 0 – 100%

Serial Output: OFF

Serial Output Interval: 1 minute

Baud Rate: 9600

LOCKING IN THE PROGRAM CHANGES

Once the modifications to the previously programmed settings have been inserted to your satisfaction, you must lock them in. To do this, press ESC on the Keypad. The KEEP CHANGES? screen will appear.

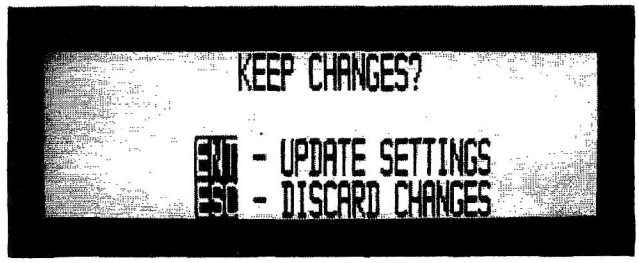


Figure 12-6. Locking In the Changes

If you are not sure, or if you would like to make additional modifications to the

program, press ESC on the Keypad and start over. Only by pressing ENT at this time can you lock in the changes.

12.4 CALIBRATING RH SENSORS WITH THE RH-CAL

It is beyond the scope of this Operator's Manual to discuss the science of calibrating humidity sensors. However, in the interest of successful calibrations, several points should be mentioned.

1. If the Sensors Under Test are small enough to fit entirely inside the chamber, run the sensor cables through the supplied rubber seals. If a longer sensor or an entire RH transmitter is being calibrated, insert the measuring portion of the RH sensor into the chamber. In both cases, try to seal around the cables or sensor barrel as tightly as possible, such that chamber air does not escape and room air does not seep into the chamber. The internal pump creates a small positive pressure inside the chamber to make it more difficult for outside air to enter and contaminate the chamber.

2. If possible, set the chamber air temperature to the same temperature that the sensors will be exposed to in actual operation. This way, you have eliminated the sensor temperature coefficient error.

3. If the Sensor Under Test may exhibit a hysteresis error, run a calibration cycle first upward (from low RH to high RH), then back down (from high RH to low RH). The recorded output curve will show the exact hysteresis error of your sensor.

4. If your sensor will be used to monitor a process (for example) that will always go from low RH to high RH, then calibrate it that way. The hysteresis error will be eliminated.

5. Allow sufficient time for chamber stabilization before calibrating sensors. In addition, allow sufficient time for the Sensor Under Test to completely equilibrate before calibrating each point.

6. If you are calibrating an RH transmitter, it will usually have two calibration adjustments called Offset and Span (or perhaps Zero and Full Scale). It is usually better to start at the low humidity end and adjust the Offset, and then go to the high humidity end and adjust the Span. Since the Offset shifts the entire response curve, it will affect the Span setting and therefore should be set first.

12.5 RS-232 SERIAL PORT SETUP

The RH CALIBRATOR serial port connector located on the Panel can be used to operate the unit, program parameters, or output data to a printer, data terminal, or personal computer. For bi-directional communications (such as with a PC or

Terminal), a communication or terminal emulation software package is needed on the PC. There are many inexpensive communication programs readily available. Two such programs are HyperTerminal in Windows 95 or PROCOMM PLUS by Quarterdeck/Datastorm Corp.

External Device Connection

Connect an RS-232 cable between the Panel 9-pin female D-Type connector and the RS-232 serial port of the external device. A 3-wire XON/XOFF cable is all that is normally required. The serial port is wired as a DTE device (Data Terminal Equipment); i.e., Transmit (TXD) is pin 2 and Receive (RXD) is pin 3. For connection to a DCE device (Data Communications Equipment) such as a PC, a direct pin-to-pin cable can be used. For connection to another DTE device such as a printer, a null modem adaptor is required.

PC or Terminal Setup

Set the RH-CAL to the preferred baud rate via the Scroll Menu. The available baud rates are 19.2K, 9600, 4800, 2400, and 1200. For best performance, the baud rate should be set to the highest rate that the connected device can accommodate reliably. Set up the PC's communication program for a baud rate to match the RH-CAL. The protocol should be 8 data bits, 1 stop bit, and no parity (N81).

RS-232 COMMANDS AND PARAMETER SETTING

General

Several of the setup and operating features of the RH CALIBRATOR are available via the serial port. Commands can be upper or lower case. When any key is pressed, the RH CALIBRATOR will respond with "Input: " and the key that was pressed "key". If the command is a single key command, pressing ENTER will initiate the command. For a two key command, press the second letter and then the ENTER key to initiate the command.

HELP Menu

Once communication has been established, the available commands can be viewed by accessing the HELP menu. Type the letter "H". The display will reply with INPUT: H. Press ENTER and the HELP menu will be displayed on the computer/terminal screen.

Start an ABC Cycle

This command initiates an ABC cycle at any time. The cycle is the same as a programmed ABC cycle. Type the letters "AB" and press the ENTER key.

ABC Enable

Type "AE" and then ENTER to alternately enable or disable the timed ABC function. The start time and interval settings will not be changed.

NOTE: Two digits must be used for each entry field.

ABC Start Time

Type the letters "AS" and press the ENTER key. Enter the time "Hours:Minutes" in 24 hr. format, and press the ENTER key.

Examples: "02:00", is 2:00 AM: "14:30" is 2:30 PM.

ABC Interval

Type the letters "AI" and press the ENTER key. Type the time in "Hours:Minutes" and press the ENTER key.

Example: If the ABC Start Time is 08:00 o'clock in the morning and the ABC Interval is 02:00, the first ABC cycle for the day would occur at 8:00 AM and every two hours thereafter.

ABC Analog Hold

Typing the letters 'AH' will toggle the ABC Hold feature on or off. If ABC Hold is on, the analog and serial outputs will be held at the values just prior to initiating the ABC Cycle. The serial output will contain the message "ABC Hold". The hold will be released when the ABC Cycle is complete and the instrument has stabilized back on the dew point.

Date

Type the letter "D" and then press ENTER.
The DATE format is: MONTH/DAY/YEAR
"01/01/03" = January 1, 2003
"12/31/02" = December 31, 2002

NOTE: Two digits must be used for each entry field and separated by a backslash character.

Output Interval

This is the interval in seconds between automatic data output transmissions of the serial data output. The time range is from 0 to 3600 seconds.

Type the letter "O" and press the ENTER key. Enter the desired interval in seconds and press ENTER.

Poll for Output

This command requests the RH CALIBRATOR to send serial data at any time and is independent of the automatic interval.

Type the letter "P" and press the "ENTER" key.

Manual Heat

This command toggles the Sensor's heater on or off. It can be initiated at any time and can be used to clear excessive moisture from the mirror in flooding situations.

Type the letters "MH" and press the ENTER key. The RH CALIBRATOR will display a flashing MAN MAX HEAT and the temperature will rise. To turn off the MANUAL HEAT mode, enter "MH" again.

Manual Cool

This command toggles the Sensor's cooler on or off. It can be used to test the maximum depression of the Sensor.

Type the letters "MC" and press the ENTER key. The RH CALIBRATOR will display a flashing MAN MAX COOL and the temperature will decrease. To turn off the MANUAL COOL mode, enter "MC" again.

NOTE: After an extended period of time in the cool mode, excess moisture or frost will form on the mirror. It may be necessary to "Manually Heat" the mirror to shorten the drying time.

Time

Type the letter "T" and press ENTER.
The time format is: Hours:Minutes:Seconds. Hours is expressed in 24-hour military time.
Enter the desired time with colon delimiters:
Examples:
"00:00:00" = 12 midnight
"23:59:59" = 11:59:59 pm

Units (F,C)

The RH CALIBRATOR can display temperature in either Degrees C or Degrees F. The display and RS-232 data will reflect the selection.

Type the letter "U" and press ENTER. Type "C" or "F" and press ENTER.

Status Report

This command gives the user a report of all of the current settings. To get a status report, type the letters "ST" and press the ENTER key.

13.0 THE CHILLED MIRROR DEW POINT SENSOR

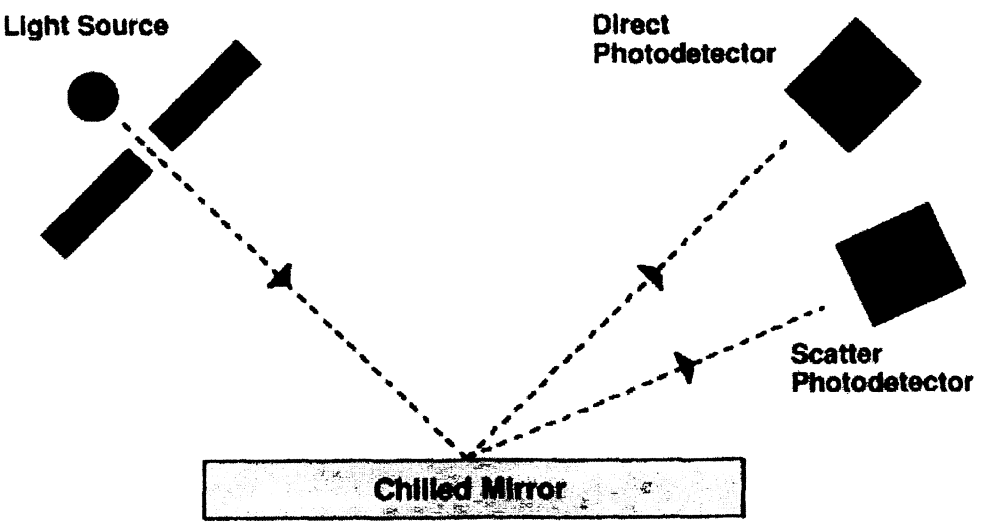


Figure 13-1. Chilled Mirror Block Diagram

13.1 THEORY OF OPERATION

Dew Point is defined as *the temperature that moisture just begins to condense on a surface.* The chilled mirror dew point sensor measures this parameter directly. A highly reflective *rhodium mirror* is mounted to a solid state heat pump, or thermoelectric cooler. A *light source* (LED) is reflected off the *rhodium mirror* onto an opposing *direct photodetector.* The mirror is cooled thermoelectrically to the temperature at which condensation (dew or frost) first begins to form. This condensate causes the *light source* to be refracted, resulting in a reduction of light as seen by the *direct photodetector,* and an increase in light as seen by the *scatter photodetector.* These signals are next sent to a servo amplifier which controls power to the thermoelectric cooler, automatically controlling the mirror at whatever temperature is required to maintain a very thin film of water droplets (or frost) on the surface at all times. This is the dew point (frost point when below 0°C) by definition.

Since the mirror surface is always at the dew point, measuring the mirror temperature provides actual dew point temperature. Temperature data is received from a PRT (platinum resistance thermometer) embedded directly beneath the *chilled mirror* surface. The PRT is very tightly thermally coupled to the mirror surface, in order to minimize measurement error.

The advantages of the chilled mirror are:

- It provides a *primary*, as opposed to a *secondary* measurement of dew point.
- Measurement is continuous, accurate and repeatable.
- Results are traceable to N.I.S.T., supporting ISO 9000 and military test requirements.
- No hysteresis.
- No drift.
- Dew point accuracy of +/- 0.2°C

These advantages make the chilled mirror sensor the technology of choice for the EdgeTech RH Calibrator.

13.2 MIRROR AUTOMATIC BALANCE CYCLE (ABC)

The Automatic Balance Cycle is an important electronic feature of the RH CAL that allows much longer operation of the system without any maintenance. At least 90 days is typical. As contamination from the air sample gradually builds up on the mirror surface, an error in the indicated dew point reading could eventually occur. In order to eliminate this potential source of error, the system periodically reprograms itself by correcting for the loss in reflectivity caused by the contaminants on the surface, allowing the mirror to operate at the actual dew point temperature once again. This is called b*alancing.* The user should always use the ABC feature, because it greatly minimizes mirror cleaning requirements.

The ABC cycle first heats the mirror surface above the dew point, causing the condensate layer to evaporate, leaving only the contamination on the surface. The amount of light received from the dry mirror is then measured, and a correction in the servo loop is made, normalizing the system (balancing) and compensating for the contaminant layer. The balance cycle only takes a few minutes, and at the end of that period the mirror resumes tracking the actual dew point temperature.

TRACK and HOLD: The Analog Output can be programmed with the keypad to provide Relative Humidity, Dew Point, or Temperature information. When Dew Point is selected (or Relative Humidity, which is a function of Dew Point and Temperature), the actual analog value is temporarily incorrect during the ABC Cycle. Since the mirror temperature is constantly measured and defined as the dew point, the heating of the mirror described above is the one time when the mirror temperature is intentionally *not* at the dew point. A keypad programming option allows the user to have the Analog Output remember the last dew point value *just before* the ABC cycle started, and *hold* that value constant for the few minutes that the balance cycle requires. It then continues to track the actual dew point temperature (or RH) as before. This is the HOLD option, which may be the best choice when driving a strip chart recorder or when using a date acquisition

system. If the TRACK option is selected, the resulting positive output pulse on the analog output during the heating portion of the ABC cycle may be recorded and used to tell the operator when the cycle occurred.

13.3 CARE AND MAINTENANCE OF THE CHILLED MIRROR SENSOR

Although the ACB cycle greatly minimizes the requirement for mirror cleaning, eventually the system will have to be shut down and the mirror cleaned. A CLEAN MIRROR indication displayed at the end of the ABC cycle tells the user when cleaning is required. See the Maintenance chapter for detailed instructions in mirror cleaning.

14.0 MAINTENANCE

14.1 ROUTINE MAINTENANCE

To maintain the maximum in accurate and reliable operation of any optical chilled mirror system, a periodic maintenance program should be established.

14.1.1 MIRROR CLEANING SCHEDULE

The buildup of contamination on the mirror surface normally occurs very slowly. Over time, particulates and other matter present in the sample gas that are not captured by filters build up on the mirror. The result of the buildup of contaminants on the mirror surface is reduced dry mirror reflectivity and a change in the optical reference point. The ABC Cycle will automatically readjust the reference point periodically, but eventually the adjustment range will be exceeded and a manual cleaning of the mirror may be necessary. When the contamination becomes too severe to be adjusted automatically, a CLEAN MIRROR warning will be shown on the Display at the end of the periodic ABC Cycle. Normally, intervals of at least 90 days between routine mirror cleanings can be easily achieved. However, if the sample contaminants are particularly high, more frequent mirror cleanings may be required. When cleaning is required, clean the mirror surface and optical parts.

14.1.2 CLEANING THE MIRROR

To clean the mirror surface in the Sensor:

1. Remove the spin-off cover from the Sample Chamber. Notice the oval opening at the bottom of the chamber at the 3 o'clock position. Inside the opening, toward the front of the instrument and oriented vertically, the mirror is the shiny flat metal disk about ¼ inch (0.6 cm) in diameter.

Figure 14-1. Cleaning mirror with swab

2. Press the "HEAT" key on the front panel to heat the mirror and evaporate any condensate.

3. Cotton swabs and an empty cleaner bottle are provided in the Cleaning Kit shipped with the system. Fill the bottle with isopropyl alcohol purchased locally. Moisten a clean cotton swab with isopropyl alcohol. Wipe the mirror surface and the entire vertical mirror cavity area in a circular motion.

After cleaning the mirror surface, wipe the surfaces dry with a clean cotton swab. Do not re-use the swabs. Next, moisten a clean cotton swab with clean, preferably distilled water, and wipe the mirror and surrounding areas again.

4. Dry these areas thoroughly with a clean, dry cotton swab.

5. Replace the sensor cover and the sample chamber cover.

6. Press the "HEAT" key to return to normal operation.

7. Press the "MABC" key to balance the optics and return to normal operation.

A CHECK SENSOR error flag on the Display shows that the dew point sensor control loop is not able to develop a dew layer on the mirror. The only service that can be performed in the field is to lift the Panel and check for a loose connector in the mirror control system, or call the Factory.

14.1.3 DRYER TUBE MAINTENANCE

When the Drier-ite™ pellets in the Dryer Tube have changed color from blue to pink, the drying capability has been exhausted. The dryer cylinder can then be removed by loosening the two Velcro™ straps. Lift the tube out and carefully disconnect the two clear plastic tubes from the fittings at the bottom of the dryer tube.

Figure 14-2a. Open the straps

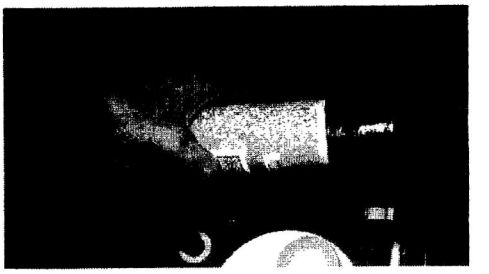


Figure 14-2b. Lift out the Dryer

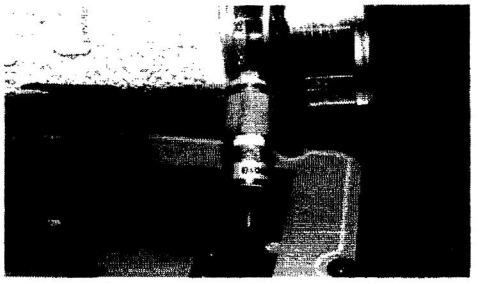


Figure 14-2c. Disconnect clear tubing

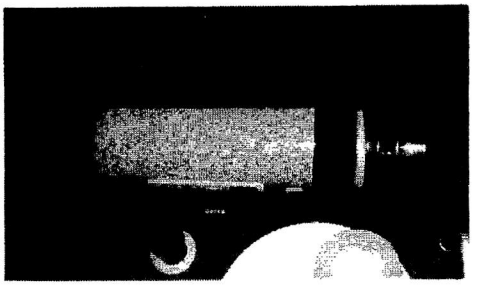


Figure 14-2d. Replace the Dryer

The desiccant pellets may be reclaimed by heating, which will cause the color to return to blue. You may also refill the cylinder with fresh pellets. Reconnect the tubing and reinstall the cylinder.

To reclaim the pellets:

1. Unscrew the end cover, and remove the pellets from the tube. Spread the material in thin layers on a flat oven-proof tray. Do NOT put the clear plastic tube directly in the oven. Do NOT use a microwave oven.

2. Bake the material for 1 to 2 hours, at 200 to 225°C. (390 to 435°F.)

3. Allow to cool and replace in the tube.

Note: Certain countries require the use of cobalt-free dryer material, which is white rather than blue.

14.1.4 FILLING THE SATURATOR

About every 12-36 hours of operation, depending upon relative humidity settings, the saturator should be checked. Using the Keypad, set the RH-CAL for a reading above 50% RH, if operating below this point. Remove the cap to the clear water reservoir. Using the supplied syringe, add clean distilled water up to the level of the panel surface (no higher). If excess water is seen, use the empty syringe to remove the excess. Replace the reservoir cap firmly. If necessary, reprogram the RH setting as desired.

Notes:

1. **The reservoir water level may be too low and it may need refilling if the Sample Chamber RH reading is constantly lower than the programmed value.**

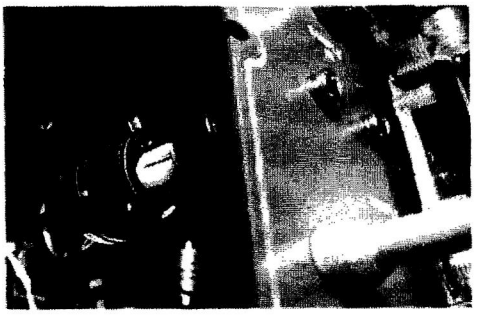
2. **The reservoir water level may be too high and some water may have to be removed if any water drops are seen inside the Sample Chamber. Carefully dry the chamber and remove excess water from the mirror area with a cotton swab.**

14.1.5 REMOVING THE FRONT PANEL

Some periodic maintenance requires access under the Front Panel. To remove the Front Panel:

Remove the 12 screws securing the Front Panel. Remove the spin-off cover from the Sample Chamber. Remove the screw-on water fill cover, the foam cylinder around the tube, and the rubber washer mounted above the panel. Using

the two handles, lift up the Front Panel, then rest the rear portion on the back lip of the case. The front end can now be propped up to allow access inside the case.



14.1.6 AIR FILTER REPLACEMENT

Depending upon the quantity of contaminants in the incoming air, the air filter element may need to be changed periodically. Lift the Panel. The air filter is located behind the Air Inlet port. Remove the plastic cover and twist the element CCW. Insert the new element and reassemble the air filter.

Figure 14-3. Air Filter Location

14.2 REPLACING THE FUSE

The AC power line fuse is located inside the top portion of the AC Power socket on the left side of the carrying case of the RH-CAL. A spare fuse is also supplied in the fuse holder. Insert a small flat screwdriver under the fuse holder, holding it vertically, and press upward and outward to snap it open. To replace the fuse holder, press it inward until it snaps into place.

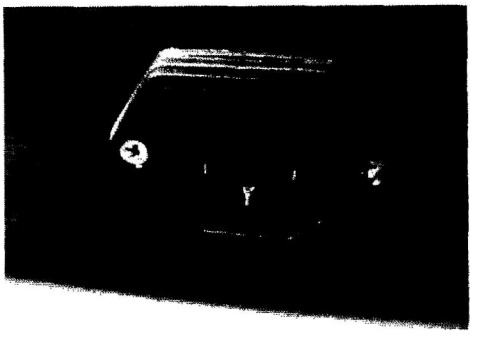


Figure 14-4a. Fuse Holder Location

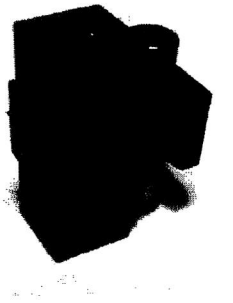


Figure 14-4b. Fuse Holder

Fuse values:

For use in the U.S.A. and in many other countries: For power line voltage between 100 to 150 VAC, the required fuse value is 3A, 3AG, 250VAC, Slo-Blo. For power line voltage between 150 to 240 VAC, the required fuse value is 1.5A, 3AG, 250 VAC, Slo-Blo.

For European use: Use Type T fuses.
For nominal 230 VAC, the required fuse value is 1.6A.

14.3 MODIFYING THE ANALOG OUTPUT

The Analog Output connector is located on the panel. Output scaling is programmed by using the keyboard. The user may select 0 to 5 VDC, 4 to 20 mA, 0 to 20 mA, or 0 to 24 mA for this output. The factory default is 0 to 5 VDC. To change the output, it is necessary to remove the panel and access a 4-pole DIP switch located inside the carrying case. The DIP switch is mounted on a horizontal printed circuit board below the left side of the carrying handle, labeled Analog Output 1.

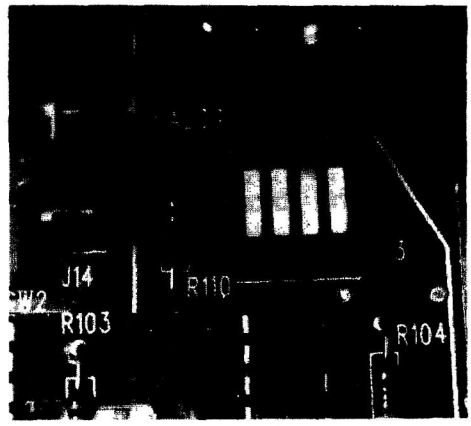


Figure 14-5. Analog Mode Switch

DIP Switch Configuration:

	SWITCH NUMBER			
OUTPUT	**1**	**2**	**3**	**4**
4 - 20 mA	**C**	**O**	**C**	**O**
0 - 20 mA	**O**	**C**	**C**	**O**
0 - 24 mA	**O**	**O**	**C**	**O**
0 – 5 VDC	**C**	**C**	**O**	**C**

Where: **O = Open**
C = Closed

15.0 SPECIFICATIONS

RH and AT Operating Ranges

RH Range: 5 % to 95 % for AT = 15 to 50 C
15 % to 95 % for AT = < 15 C

AT Range: 10 °C to 50 °C

RH Accuracy

Range: 5 % to 50 % +/- 0.5 RH %
51 % to 75 % +/- 1.0 RH %
> 75% +/- 1.5 RH %

Dew/Frost Point and Ambient Temperature Range

–40 to +60°C (–40 to +122°F) D2 Sensor

Dew/Frost Point and Ambient Temperature Accuracy

±0.2°C (±0.36°F) nominal

Dew/Frost Point and Ambient Temperature Sensors

3-wire Platinum Resistance Thermometer (PRT), 100 ohms at 0°C nominal

Precision

0.1 degrees C or F

Chilled Mirror Dew Point Sensor:

Depression

60°C (113°F), nominal, D2 Sensor

Sensor Materials

Chromium, glass, epoxy, anodized aluminum

Slew Rate

1.0°C (1.8°F)/second max., above 0°C

Repeatability

±0.05°C (0.09°F)

Hysteresis

Negligible

Sample Flow Rate

Adjustable. 1 liter/minute (2.0 SCFH) typical

Operating Temperature

Control Unit: 0 to +50°C (+32 to +122°F)

Display

LCD graphics backlit display
0.25-in. high digits

Analog Output

Selectable for Voltage or Current

Voltage

0 to +5 VDC, scaleable from -50 to +100°C (-58 to +212°F)
±0.2 % accuracy.
1 K ohms minimum load resistance.

Current

4 to 20 mA, scaleable from -50 to +100°C (-58 to +212°F).
1000 ohms maximum loop resistance.

Serial Digital Communication

9-pin D sub-miniature connector (female)
RS-232C compatible
Half Duplex
Protocol: N81
Baud Rates: 2400/4800/9600/19200
Functions:
Timed output of date, time, Dew/Frost Point, Ambient Temp., and RH.
Programmable Output interval.
Programming of most keypad functions plus: System Status, Help Menu, Mirror Condition (Contaminated), Alarm Status.

Auto Balance Control

Manually initiate ABC at any time.
Automatic ABC with start time and interval,
programmable from keypad or RS-232 port.
Outputs programmable for Track or Hold during ABC.

Air Filter Replacement

Edgetech Part No. 115169

Weight

15.4 kg (34 pounds)

Mounting Configuration

Carrying Case
Material: Ultra High-impact Structural Copolymer

Dimensions

52.4W x 43.7D x 21.7H cm
20-5/8W x 17-3/16D x 8-9/16H in.

Power Requirements

100 to 240 VAC, 50-60 Hz,
150 Watts maximum

Fuse

For U.S. Operation:
100 - 150 VAC Operation:
3A, 3 AG, 250 VAC, Slo-Blo
150 - 240 VAC Operation:
1.5A, 3 AG, 250 VAC, Slo-Blo

For European Operation:
With nominal 230 VAC – Use Type T fuse, 1.6A.

Notes