S8000 RS
Chilled Mirror Hygrometer
User’s Manual

97315 Issue 9.1
January 2020

Please fill out the form(s) below for each instrument that has been purchased.

Use this information when contacting Michell Instruments for service purposes.

Analyzer	
Code	
Serial Number	
Invoice Date	
Location of Instrument	
Tag No	

Analyzer	
Code	
Serial Number	
Invoice Date	
Location of Instrument	
Tag No	

Analyzer	
Code	
Serial Number	
Invoice Date	
Location of Instrument	
Tag No	

S8000 RS

For Michell Instruments' contact information please go to
www.michell.com

Contents

Tables

Figures

Appendices

Safety

The manufacturer has designed this equipment to be safe when operated using the procedures detailed in this manual. The user must not use this equipment for any other purpose than that stated. Do not apply values greater than the maximum value stated.

This manual contains operating and safety instructions, which must be followed to ensure the safe operation and to maintain the equipment in a safe condition. The safety instructions are either warnings or cautions issued to protect the user and the equipment from injury or damage. Use qualified personnel and good engineering practice for all procedures in this manual.

Electrical Safety

The instrument is designed to be completely safe when used with options and accessories supplied by the manufacturer for use with the instrument. The input power supply voltage limits are 85 to 264 V AC, 47/63 Hz. Refer to Appendix A - Technical Specifications.

Pressure Safety

Before pressurizing, the user must ensure through appropriate protective measures that the system or the device will not be over-pressurized. When working with the instrument and pressurized gases safety glasses should be worn.

DO NOT permit pressures greater than the safe working pressure to be applied to the instrument. The specified safe working pressure is 10 barg (145 psig). Refer to Appendix A - Technical Specifications.

Application of gas pressures higher than the specified maximum will result in potential damage and may render the instrument unsafe and in a condition of incorrect functionality. Only personnel trained in the safe handling of high pressure gases should be allowed to operate this instrument.

Toxic Materials

The use of hazardous materials in the construction of this instrument has been minimized. During normal operation it is not possible for the user to come into contact with any hazardous substance which might be employed in the construction of the instrument. Care should, however, be exercised during maintenance and the disposal of certain parts.

Repair and Maintenance

The instrument must be maintained either by the manufacturer or an accredited service agent. Refer to www.michell.com for details of Michell Instruments' worldwide offices contact information.

Calibration

The recommended calibration interval for the S8000 RS is one year, unless otherwise specified by Michell Instruments Ltd. The instrument should be returned to the manufacturer, Michell Instruments, or one of their accredited service agents for re-calibration (go to www.michell.com for contact information).

Safety Conformity

This product meets the essential protection requirements of the relevant EU directives. Further details of applied standards may be found in the product specification.

Abbreviations

The following abbreviations are used in this manual:

DCC	Dynamic Contamination Correction
FAST	Frost Assurance System Technology
MAXCOOL	Maximum Sensor Cooling
AC	alternating current
atm	pressure unit (atmosphere)
bar	pressure unit (=100 kP or 0.987 atm)
°C	degrees Celsius
°F	degrees Fahrenheit
COM	common
dp	dew point
EU	European Union
g/kg	grams per kilogram
g/m^3	grams per cubic meter
HMI	Human Machine Interface
Hz	Hertz
IEC	International Electrotechnical Commission
Nl/min	normal liters per minute
lb	pound
mA	milliampere
max	maximum
min	minute(s)
mV	millivolt(s)
N/C	normally closed
N/O	normally open
No	number
ppm_V	parts per million (by volume)
ppm_W	parts per million (by weight)
PRT	Platinum resistance thermometer (typically type Pt100)
psig	pound(s) per square inch (gauge)
rh	relative humidity
RTU	Remote Terminal Unit
scfh	standard cubic feet per hour
SD	storage device card (memory card for storing datalog files)
sec	second(s)
temp	temperature
USB	Universal Serial Bus
V	Volts

Warnings

The following general warnings listed below are applicable to this instrument. They are repeated in the text in the appropriate locations.

Where this hazard warning symbol appears in the following sections, it is used to indicate areas where potentially hazardous operations need to be carried out.

Where this symbol appears in the following sections it is used to indicate areas of potential risk of electric shock.

1 INTRODUCTION

The S8000 RS is a high precision instrument used for the measurement of moisture content in air and other gases. Relative humidity and other calculated parameters based on dew point, pressure and temperature of the sample gas can also be displayed. Gases can be sampled at a maximum pressure of 10 barg (145 psig).

The S8000 RS is capable of measuring dew points as low as -80°C or -90°C (-112°F or -130°F) (depending on the model - RS80 or RS90); it can measure dew points up to (but not including) the point of condensation.

1.1 Operating Principle

The system operates on the chilled mirror principle, whereby a gas sample is passed into the sensor housing and flows over the surface of the chilled mirror contained within. At a temperature dependent upon the moisture content in the gas, and the operating pressure, the moisture in the gas condenses out on the surface of the mirror.

An optical system is used to detect the point at which this occurs, and this information is used to control the mirror temperature and maintain a constant thickness of the condensation layer on the mirror surface.

A light emitting diode (1) provides a light beam of constant intensity which is focused by a lens system (2) to become the incident beam on the mirror surface (3), flooding it with a pool of light.

Before the light beam reaches the mirror (3), a beam splitter (4) directs part of the beam via a lens system (5) onto a sensor (6) which monitors the intensity of the LED light and provides a feedback loop to keep this at a constant level.

Two sensors (7 and 8) monitor the light level reflected by the mirror. One of these sensors (7) measures the light level due to the reflected incident beam and the other (8) measures the degree of light scatter due to the formation of water/ice on the mirror surface. Each sensor has its own optical lens system (9) and (10) to concentrate the reflected light onto the sensor.

The output from each of these sensors is compared and then used to control the drive to a Peltier heat pump (11). Dependant on the result of this comparison, the control system will cause the heat pump (11) to either heat or cool the mirror (3) in order to maintain the desired condensation film thickness on the mirror surface.

At an equilibrium point, where the evaporation rate and condensation rate on the surface of the mirror are equal, the mirror temperature, read by a Pt100 platinum resistance thermometer (12) embedded in the mirror, represents the dew point.

The 'hot' side of the Peltier is coupled to an auxiliary cooling system through a thermal mass (13) – which smooths its response. The cooling system removes heat from the hot side of the Peltier, by cooling it to an appropriate temperature. This supplements the depression capabilities of the heat pump, and enables measurement of very low dew points.

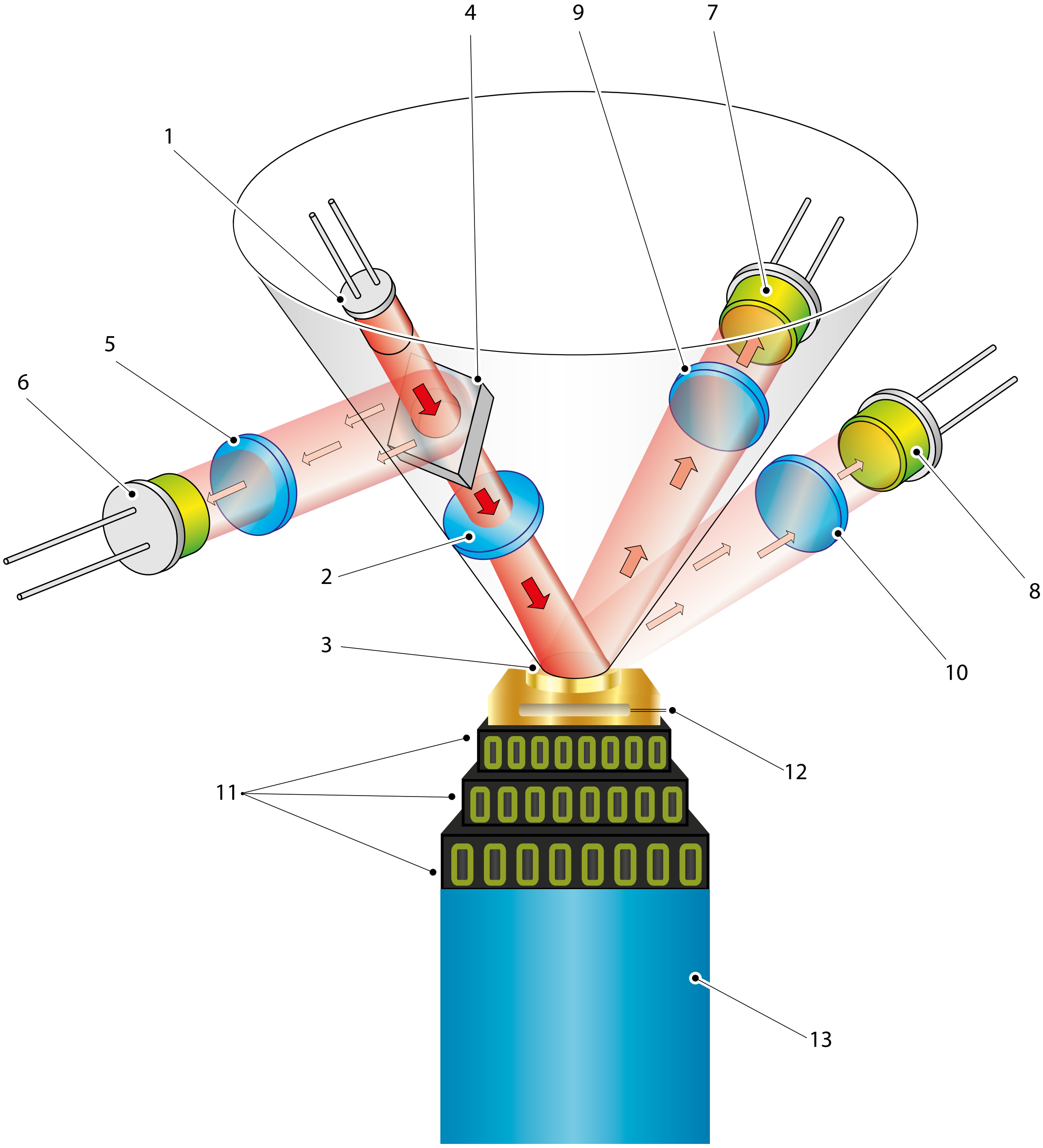


Figure 1 *Operating Principle*

2 INSTALLATION

2.1 Safety

It is essential that the installation of the electrical and gas supplies to this instrument be undertaken by competent personnel.

2.2 Unpacking the Instrument

The S8000RS is a heavy instrument and should be unpacked by two people. Carefully open the crate and check for any signs of transit damage before touching the instrument. Remove the accessories before touching the instrument.
Carefully lift the unit out holding the case and not the foam as these may become loose and allow the instrument to fall.
Ensure one person has a good grip of the unit whilst the other removes the foam protectors:

Save all the packing materials for the purpose of returning the instrument for re-calibration or any warranty claims.

Failure to return the instrument in the original packing, or failure to return the instrument with the transit clamp fitted may result in warranty claims being denied.

The accessories crate should contain the following items:

- Traceable calibration certificate
- SD memory storage card
- USB or Ethernet communications cable
- IEC power cable
- Microscope
- Remote Pt100 temperature probe (optional)
- Optics cleaning kit (optional)
- 19" Rack mount kit (optional)
- Transport case (optional)

If there are any shortages please notify the supplier immediately.

2.3 Transportation Clamp Removal

Prior to powering the instrument on, the transportation clamps must be removed. There are two separate clamps:

1. Rear clamp

Carefully place the instrument on its side, with the sensor head side down.

As per Figure 3, there are two slots machined into the outer case. A bolt will be visible through each.

Figure 2 *Rear clamp*

Use a 5mm Allen key to loosen each bolt (do not try to remove them) and slide them into the forward position in the slots. Re-tighten the bolts in this position so they cannot move around.

Carefully place the instrument back onto its base.

2. Front clamp

As per Figure 4, use a 3mm Allen key to remove the 2 bolts on either side of the front clamp. Keep these bolts safe for future use.

Figure 3 *Front clamp*

Remove the microscope cover. The front clamp should now slide away from the instrument.

2.4 Operating Requirements

2.4.1 Environmental Requirements

It is important to operate the S8000 RS within the following environmental conditions:

Minimum Operating Temperature	5°C
Maximum Operating Temperature	30°C
Maximum Relative Humidity	80%

2.4.2 Electrical Requirements

The S8000 RS requires the following electrical supply:

- 85 to 264 V AC, 47/63 Hz, 250 VA max
- Alarm outputs comprise two sets of changeover relay contacts, one set for a **PROCESS** alarm and one set for an **INSTRUMENT FAULT**. Both sets of contacts are rated at 24 V, 1A. **NOTE: THIS RATING MUST NOT BE EXCEEDED.**

2.5 Exterior Layout

The controls, indicators and connectors associated with the S8000 RS are located on the front and rear panels of the instrument.

The controls and indicators relating to the operator interface are located on the front panel. The gas outlet, gas inlet, external PRT connection, mains power IEC socket, analog output connector, remote temperature probe connector, alarm relay connector, and the USB/RJ45 Ethernet socket are located on the rear panel.

Front Panel

Figure 4 *Front Panel*

No	Name	Description
1	SD Card Slot	Takes an SD card used to store logged data See Section 3.3.8 for more details on how to use the logging features
2	Touch Screen Display	Displays measured values and enables the user to control the operation of the instrument See Section 3.3 for information about the touch screen and menu system
3	Sensor Housing	Exterior housing of the sensor See Section 5.2 for instructions on how to remove the housing and clean the mirror

Table 1 *Front Panel Controls*

Rear Panel

Figure 5 *Rear Panel*

No.	Name	Description
1	¼" Swagelok Gas Outlet	Connection for venting sample gas to atmosphere or vent line once it has passed through the instrument
2	¼" VCR Gas Inlet	Connection for supplying the instrument with sample gas, usually at a pressure slightly higher than atmospheric to maintain flow through the instrument
3	External PRT Connection	Banana sockets for external 4-wire measurement of the internal PRT See Section 3.3.11 for more info
4	Mains power IEC Socket	Universal power input 85 to 264 V AC, 47/63 Hz Fuse - 3.15 A, Anti-Surge, Glass, 20mm x 5mm Features integrated power **ON/OFF** switch
5	6-Way Analog Output Connector	Three configurable 2-wire channels providing 0-20 mA, 4-20 mA or 0 - 1 V output. The 0/4-20mA outputs are active (sourcing) and must be connected to a passive (sinking) input on the receiving equipment. See Section 3.3.9 for instructions on how to configure the analog outputs See Section 2.6.2 for general information
6	Remote Temperature Probe Connector	6-Pin Lemo socket for connection of remote Pt100 temperature probe
7	6-Way Alarm Relay Connector	Process and Fault alarm outputs See Section 2.6.3 for general information on the alarm relays See Section 3.3.10 for instructions on how to configure the process alarm
8	RJ45 Ethernet Socket (Optional)	Used for communication with the instrument over a network connection See Section 3.3.13 for details on how to configure the network settings See Section 4.1 for information on using and installing the application software
9	USB Type B	Used for communication with the instrument via the application software See Section 4.1 for information on using and installing the application software

Table 2 *Rear Panel Connections*

2.6 Rear Panel Connections

These tasks should be undertaken only by competent personnel.

DANGER
Electric
Shock Risk

All the connections to the rear panel are electrical connections.
Exercise due caution, particularly when connecting to external alarm circuits which could be at high potential.

Connections to the rear panel of the instrument are explained in the following sections.

2.6.1 Power Supply Input

The AC power supply is a push fit into the power input socket as shown in *Figure 7.* The method of connection is as follows:

1. Ensure that both ends of the power cable are potential free, i.e. not connected to an AC power supply.
2. Check that the **ON/OFF** switch (1) is switched to **OFF**.
3. Push the IEC connector (3) firmly into the power input socket (2).
4. Connect the free end of the power cable to a suitable AC power supply source (voltage range 85 to 264 V AC, 47/63 Hz) and switch on the AC supply. Switch on the instrument, as required, using the power **ON** switch.

Figure 6 *Power Supply Input*

2.6.2 Analog Output Connections

The three analog outputs can be configured to represent any of the directly measured or calculated output parameters. They are provided as 2-wire signals from a 6-way connector located on the rear panel of the instrument.

Each of these outputs can be set up as either a current loop signal (4-20 mA or 0-20 mA) or alternatively, as a 0-1 V voltage signal. The 0/4-20mA outputs are active (sourcing) and must be connected to a passive (sinking) input on the receiving equipment. The configuration of these outputs, i.e. parameter represented, output type (current loop or voltage) and upper/lower span levels are set up via the Setup Menu Screen (refer to Section 3.3.5).

These signals may be used to control external systems. During a **DCC** cycle, and for the hold period following a **DCC** cycle, they are held at the level that they were at immediately prior to the start of the cycle. When the dew-point measurement is stable, or if the maximum hold period has expired, they are released and will track the selected parameter throughout the measurement cycle.

The default settings of these analog outputs are:

Channel 1: Dew point, -80 to +20ºC
Channel 2: ppm_V, 0 to 3000
Channel 3: Flow, 0 to 1000ml/min

NOTE: The analog outputs are only active during the MEASURE phase. They will, therefore, be off after switch-on and remain off until the system enters the MEASURE phase.

The three analog output ports connections are made via a single, 6-way, push fit connector block as shown in *Figure 8*. All outputs are 2-wire, positive-going signals referenced to a common 0 V line. To differentiate between the outputs it is recommended that a black lead be used for each of the COM (common) lines and a separate color for each of the positive lines.

For each output:

1. Remove the terminal block fitted into the analog output socket.
2. Strip back the wire for the common (black) connection to the **CH1** output, exposing approximately 6mm (0.25"). Insert the wire into the **COM1** terminal way and screw into the block. **Do not overtighten the screw.**
3. Strip back the wire for the signal (e.g. red) connection to the **OP1** output, exposing approximately 6mm (0.25"). Insert the wire into the **OP1** terminal way and screw into the block. **Do not overtighten the screw.**
4. Repeat operations 1 and 2 for the other analog outputs, selecting a different color wire for the **OP2** and **OP3** outputs.
5. Locate the terminal block over the connector labelled **ANALOG OUTPUTS** and push the terminal block firmly into the connector.

Figure 7 *Alarm and Analog Output Connection*

2.6.3 Alarm Output Connections

Two alarm outputs are provided from a terminal block, located on the rear panel of the instrument, as two pairs of potential free, change-over relay contacts. These are designated as a **PROCESS** alarm and a **FAULT** alarm.

Under the Setup Menu Screen, (refer to Section 3.3.5), the **PROCESS** alarm can be configured to represent any one of the measured or calculated parameters and set up to operate when a pre-set parameter threshold level is exceeded. By default, the **PROCESS** alarm is set to monitor the dew-point parameter.

The **FAULT** alarm is a non-configurable alarm which continuously monitors the degree of contamination of the chilled mirror. During normal operational conditions, this alarm will be off. If the optics or the mirror contamination exceeds 100% of the film thickness, or if a fault exists on the Pt100, the alarm is triggered and the relay contacts will change state.

This fault is also reported to the status area of the Main Screen.

The two alarm output ports are connected to the instrument via a single 6-way, push-fit connector block as shown in *Figure 8*. Each output comprises a 3-wire set of potential free, change-over relay contacts.

Each contact set is labelled **COM** (common 0 V), **N/O** (normally open with respect to **COM**) and **N/C** (normally closed with respect to **COM**).

To differentiate between the alarm output channels, it is recommended that a black lead is used for each of the **COM** (common) lines and a separate color for each of the **N/O** and **N/C** lines.

WARNING: Alarm leads MUST be potential free when wiring to the connector block. Both sets of contacts are rated at 24 V, 1A. THIS RATING MUST NOT BE EXCEEDED.

For each output:

1. Strip back the wire for the common (black) connection to the **COM** connector way for the **FAULT** alarm contact set, exposing approximately 6mm (0.25") wire. Clamp into the screw block **COM** terminal way. **Do not overtighten the screw.**

2. Strip back the wire for the **N/O** (e.g. green) connection to the **N/O** connector way for the **FAULT** alarm contact set, exposing approximately 6mm (0.25") wire. Clamp into the screw block **N/O** terminal way. **Do not overtighten the screw.**

3. Strip back the wire for the **N/C** (e.g. blue) connection to the **N/C** connector way for the **FAULT** alarm contact set, exposing approximately 6mm (0.25") wire. Clamp into the screw block **N/C** terminal way. **Do not overtighten the screw.**

4. Repeat operations 1 to 3 for the **PROCESS** alarm contact set, using appropriately colored wires.

5. Locate the terminal block over the connector labelled **ALARMS** and push the terminal block firmly into the connector.

2.6.4 Remote PRT Probe

1. Rotate the body of the PRT probe connector until it locates in the socket labeled **REMOTE TEMPERATURE** (see *Figure 9).*

2. Push the connector into the socket until it locks. **NOTE: Do not attempt to force it into the socket. If it does not fit in, rotate it until the key locks and it pushes in easily.**

3. To remove the connector, slide the connector's body collar (1) back along its axis, away from the instrument, to release the lock. Gently pull the connector body out of the socket. **NOTE: Do not attempt to pull the connector out with the cable - make sure that the collar is first released.**

Figure 8 *Remote PRT Connection*

2.6.5 USB/Ethernet Communications Port Connector

The instrument features a USB port and an optional Ethernet port for communication with the application software. The appropriate cable will be supplied with the instrument.

1. Check the orientation of the connector and gently push it into the communications socket (see *Figures 9 and 10)*.

2. To remove the connector, pull it out of the socket by holding the connector body. If using an Ethernet cable there will be a small locking tab that needs to be depressed in order to release the connector. **Do not attempt to remove the connector from the socket by pulling on the cable.**

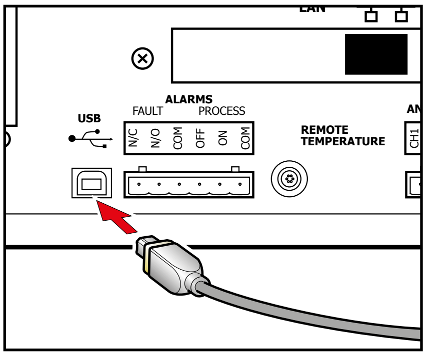


Figure 9 *USB Port Connection*

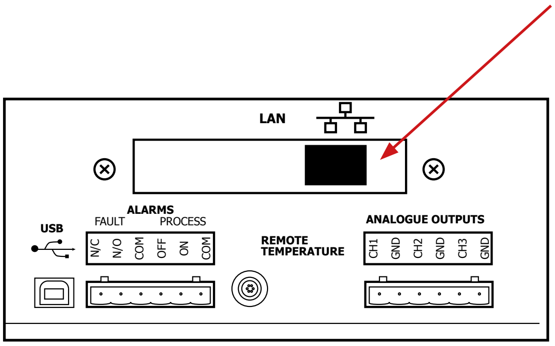


Figure 10 *Ethernet Port*

USB Connection

The application software includes a virtual serial port driver allowing the customers own software to be used with the device. The communications protocol used is Modbus RTU. Refer to Appendix C for the Modbus register map.

Ethernet Connection

The communication protocol used with the Ethernet port is Modbus TCP. Refer to Appendix C for the Modbus register map.

2.6.6 RS232/485 Port (optional)

The instrument features an optional RS232/485 port for communication with the application software. This is designed to be used with a standard 9-pin D-sub connector. The communications protocol used is Modbus RTU. Refer to Appendix C for the Modbus register map.

1. Check the orientation of the connector and gently push it into the socket labelled **RS232** or **RS485**, and tighten the retaining screws.

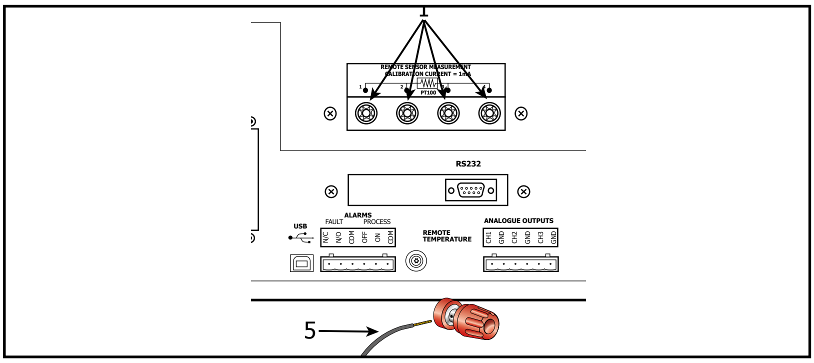


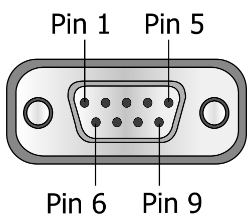
Figure 11 *RS232/485 Port (optional)*

2. Loosen the retaining screws, and pull the connector out of the socket by holding the connector body.

RS232

Pin 2	TXD
Pin 3	RXD
Pin 5	GND

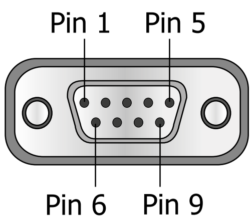
RS232 Pinout (9-pin female)



RS485

Pin 3	A
Pin 5	GND
Pin 8	B

RS485 Pinout (9-pin female)



2.7 Conversion of S8000 RS to Rack Mount

To convert an S8000 RS to a rack mounted version, a rack mounting kit (Part No. S8K401-PKI) is required. This conversion pack comprises two steel wings and four rack mounting screws and washers. Each wing bolts to the side of the instrument with four screws (already in the instrument) as shown in *Figure 12.*

Figure 12 *Conversion to Rack Mount*

1. Turn the unit on its left hand end and remove the four screws and washers from the side panel.
2. Line up the fixing holes on the right hand side of the instrument with the corresponding holes in the right hand wing (flange facing outwards).
3. Insert the four screws and washers through the wing and tighten finger tight.
4. Ensure that the front flange is square to the front of the instrument and tighten the screws.
5. Turn the unit on its right hand end and repeat operations 1 to 4.

To remove the rack support wings remove the unit from the rack (if necessary) and follow the directions above, in reverse.

NOTE: The rack mounting wings are designed to hold the unit into the rack, not to support its full weight. The instrument should be placed onto a shelf or rails

2.7.1 Fitting Rack Mounted Version into Rack

1. Remove the connector blocks from the alarm and analog output sockets.
2. If necessary, remove any covers from the rack cabinet to gain access to the rear and side.
3. Connect up the analog and alarm output connector blocks to the internal rack wiring (refer to Section 2.6.2 & Section 2.6.3), ensuring that there is sufficient free cable to permit withdrawal of the instrument from the rack.
4. Slide the instrument into the rack and onto the correctly positioned shelf or rails. Insert the four rack mounting screws and washers.
5. Ensure that the front panel of the instrument is flush and square with the front of the rack and tighten the fixing screws.
6. Connect the sample pipework to the gas inlet, and the vent line to the gas outlet, as required.
7. Insert the analog and alarm connectors into their respective sockets on the rear of the instrument (refer to *Figure 7)* and connect the external PRT probe and USB communications cable and connector as appropriate (refer to *Figure 8* and *Figure 9*).
8. Connect the power supply cable and switch the **ON/OFF** switch to **ON**.
9. Refit any covers to the rack as necessary.

To remove from the rack follow the directions above, in reverse.

3 OPERATION

As supplied, the S8000 RS is ready for operation and a set of default parameters has been installed. This section describes both the general operation of the instrument and the method of setting it up and changing the default parameters (see Section 3.3.5) should this become necessary.

3.1 General Operational Information

While the instrument can physically operate in a flowing gas stream of between 500 and 1000 ml/min (1 and 2.1 scfh), Michell Instruments recommends operating at 750 ml/min (1.6 scfh), which is the flow-rate used during calibration. Operating at an alternative rate could impact the instrument’s response time.

The sample inside the sensor is passed over a Peltier chilled, gold-plated mirror. The instrument controls the mirror temperature to a point where a level of condensate is maintained on the mirror surface. The temperature of the mirror is then measured as the dew point.

The S8000 RS is suitable for the measurement of moisture content in a wide variety of clean, non-corrosive gases. It will not contaminate high purity gases and is safe for use in critical semi-conductor and fiber optic manufacturing applications.

3.1.1 Sample Flow Adjustment

- The sample flow is measured by the internal flow meter installed into the sample line - preferably after the dew-point sensor.
- The recommended flow setting is 750 ml/min (1.6 scfh).
- The sample flow can be adjusted by the installation of a needle valve in the sample line. If a pressurized sample is to be measured at atmospheric pressure, the needle valve needs to be installed and adjusted upstream of the sensor. For measurements at sample pressure, the flow adjustment should be made downstream of the sensor.

3.2 Start-up procedure when measuring in flammable gases

The S8000RS has a migration path to prevent condensation occurring in the area immediately surrounding the thermo-electric cooler. In order to prevent a potentially explosive mixture forming in this area as the flammable sample gas combines with the residual air, the instrument should be purged prior to operation.

This can be achieved in one of two ways:

1. With inert gas for a minimum of 8 hours at the normal sample flow rate of 750ml/min. The instrument does not need to be powered on while this purge is in progress.
2. With the flammable sample gas for a minimum of 8 hours at the normal sample flow rate of 750ml/min. **The instrument MUST BE POWERED OFF while this purge is in progress.**

3.3 Instrument Display

The S8000 RS features a 5.7" color touch screen display.

When the instrument is switched on an **Initialising** overlay will be shown while the menu system loads.

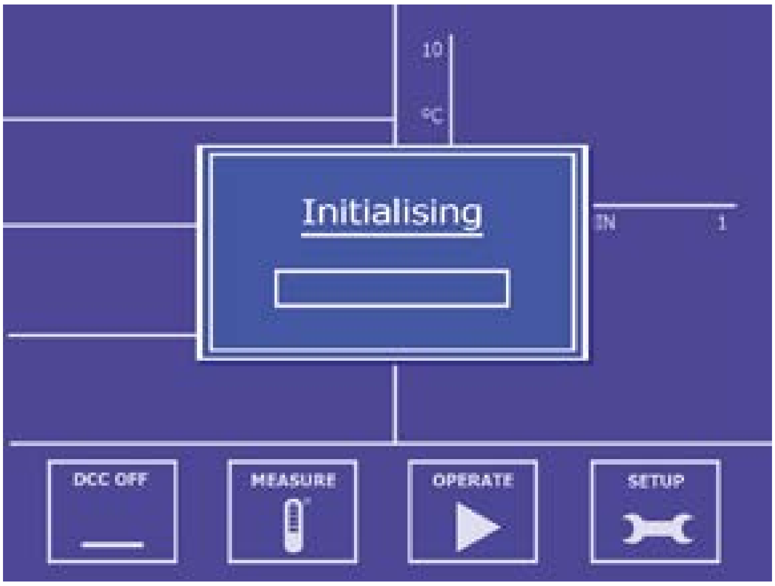


Figure 13 *Initialising Overlay Screen*

After the menu system has loaded, the Main Screen will show.

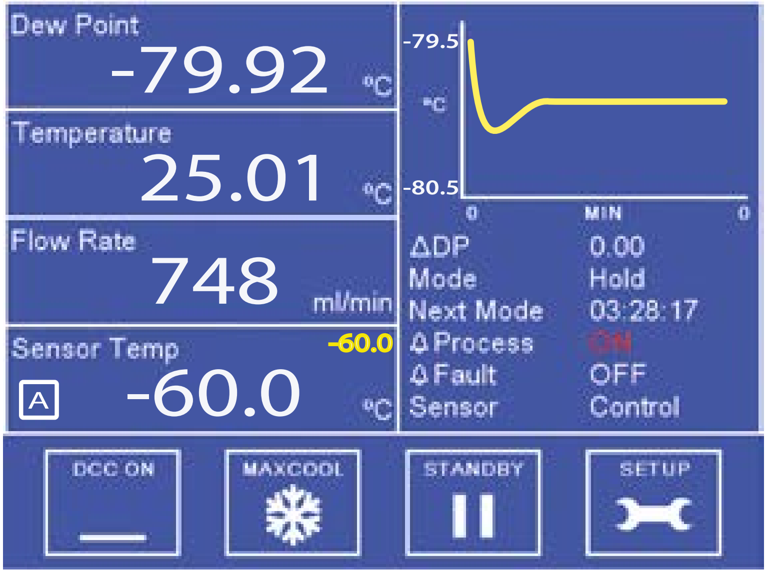


Figure 14 *Main Screen*

3.3.1 Main Screen

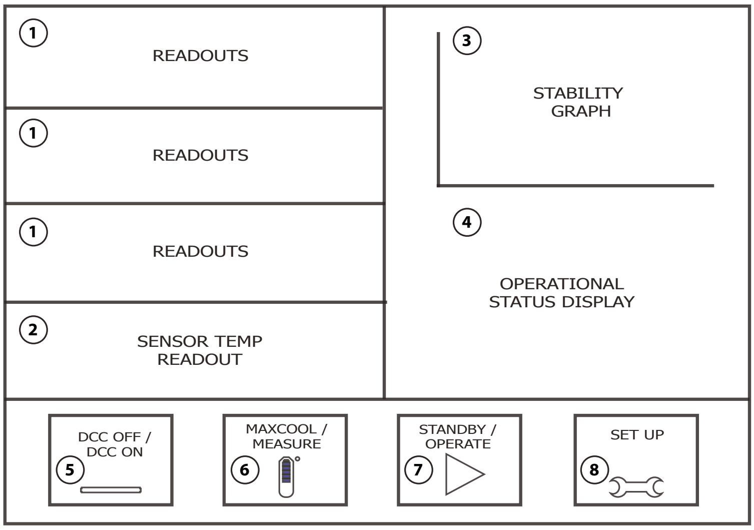


Figure 15 *Main Screen Layout*

No	Name	Description
1	Readouts (Customizable)	These readouts display measured instrument parameters See Section 3.3.2 for additional information
2	Sensor Temperature Readout	This readout primarily shows the measured sensor body temperature The sensor body temperature set-point is displayed in yellow in the top right of the readout The cooler mode of operation - automatic or manual - is indicated by a small A or M See Section 3.3.4 for cooler setup parameters Touch the readout once to display the cooler setup menu The instrument will indicate when flood recovery is active by means of a yellow **FR** (Flood recovery) warning icon displayed in the sensor temperature window. The **sensor status** indicator will also show **FR** in red text. See section 3.5.1.3 for further information.
3	Stability Graph	Displays a plot of the dew point over time Touch the readout once to enter full screen mode
4	Operational Status Display	A detailed description of each item displayed in this area is in Section 3.3.3
5	DCC Button	Initiate a DCC cycle. See Section 3.4 for a detailed explanation of the DCC function See Section 3.3.7 for DCC setup parameters
6	MAXCOOL Button	Toggle MAXCOOL mode. See Section 3.6.3 for a detailed explanation of the MAXCOOL function
7	STANDBY Button	Switch between Measure and Standby mode When switching to Measure mode a DCC cycle will be initiated See Section 3.6.7 for a detailed explanation of standby mode
8	SETUP Button	Access to the Setup Menu See Section 3.3.5 for more information about the setup menu system

Table 3 *Main Screen Description*

3.3.2 Customizable Readouts

The three readouts on the Main Screen can be configured by the user to show any of the following parameters:

- Dew point
- Temperature
- Temperature – Dew point
- Relative Humidity, %RH
- Water Content (ppm_V; ppm_W; g/kg; g/m^3)
- Pressure *
- Flow

* Pressure is only available as an option if a pressure transducer is installed in the instrument

The parameters displayed by default are Dew point, Water Content (ppm_V) and Flow.

Follow these instructions to change the parameter:

1. Touch the readout once to enable parameter selection
2. Touch the left or right arrows to select the parameter to be displayed
3. Touch the center of the readout to confirm selection

Full Screen Mode

Any of the readouts can be shown in full screen mode by touching and holding the readout.

3.3.3 Operational Status Display

The Operational Status display includes the following:

	Indicates data logging is enabled. Refer to Sections 3.3.8 and 3.6.5
ΔDP	Represents the change in dew point over the stability time of the graph
Mode	Reports current operational mode This will either be **Measure, Standby, DCC, Hold** or **Maxcool**
Next Mode	Shows the time (in Hours: Minutes: Seconds) remaining until the transition to the next mode of operation
Process	This two-state, **ON/OFF** notification indicates whether a parameter process alarm is either **ON** or **OFF** The process alarm can be set on any parameter (refer to Section 3.3.10)
Fault	Used to monitor the optical system and the degree of mirror contamination During normal operation, with no fault conditions, this will read **OFF**. It will be set to **ON** if there is either a fault with the optics or dp temperature measurement or if the mirror contamination exceeds 100% of the film thickness
Sensor	Indicates the operational mode of the sensor This can be either **CONTROL**, **HEATING** or **COOLING**

Table 4 *Operational Status Display*

3.3.4 Cooler Set up

The Cooler Setup screen is accessed by touching **Sensor Temp readout** on the Main Screen. Refer to Section 3.6 for detailed information on the operation of the sensor cooling system.

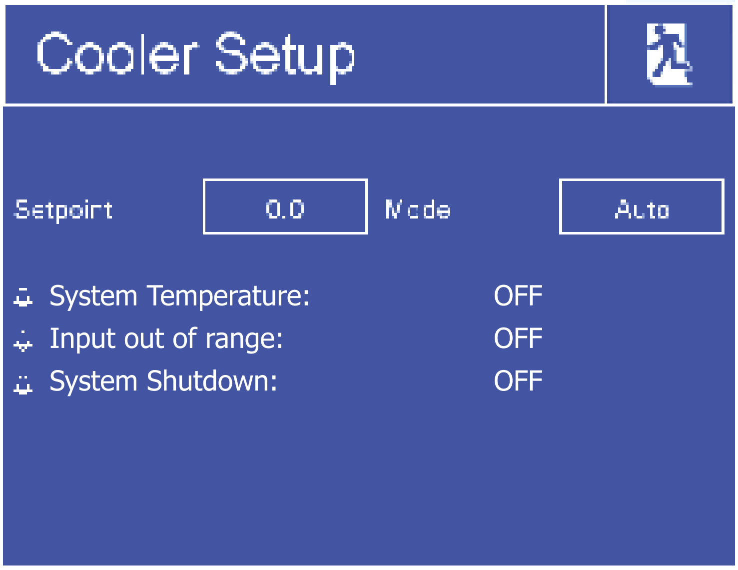


Figure 16 *Cooler Setup Screen*

Parameter	Description
Set-point	Controls the sensor temperature
Mode	Changes between Automatic and Manual cooler control

Table 5 *Cooler Setup Parameters*

In manual mode the cooler set-point must be maintained higher than the dew-point of the applied gas. A margin of at least 10°C is recommended.

Cooler Alarm Warnings	Description
System Temperature	Cooler heat-sink close to maximum safe temperature The environmental temperature may be too hot, or the fan may have stopped operating Continuing to operate the S8000 RS without addressing this problem may cause the cooler to overheat
Input out of range	Hardware fault Contact Michell Instruments' service department
System Shutdown	Cooler has been automatically disabled to prevent damage May be caused by overheating, power supply problem or other safety issue

Table 6 *Cooler Alarm Warnings*

3.3.5 Setup Menu Screen

The Setup Menu is used to adjust the operational parameters of the instrument, change the display setup and start or stop the data logging feature.

Initially, when the Setup Menu Screen is opened, a set of labelled icons is displayed. Touching one of these icons will take you to the appropriate submenu.

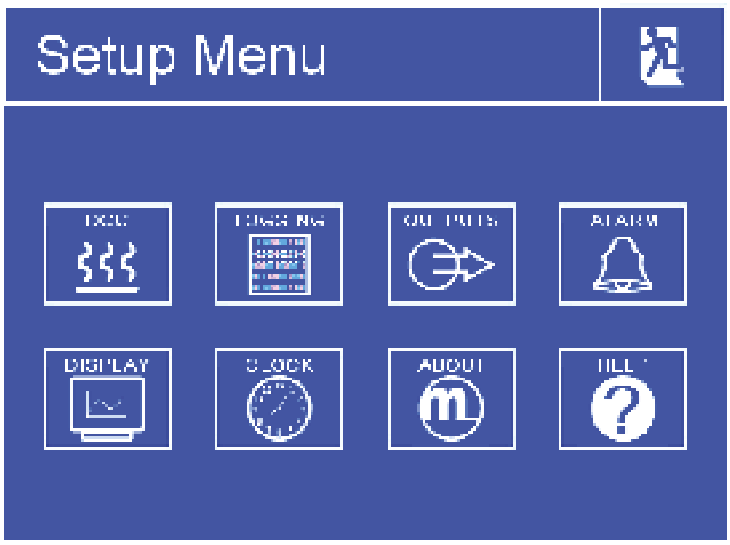


Figure 17 *Setup Menu Screen*

Once a submenu has been entered, parameters can be changed by touching the outlined values. There are three types of input for editable values:

- Toggle Button – Touching the outlined value will switch between predefined states, i.e. On/Off or Auto/manual
- List Selection – A list of options will be displayed for the user to select
- Numeric Input – Touching the outlined value will bring up the numeric keypad (see following page)

Numeric Input

When entering a numeric value a virtual keypad will be displayed.

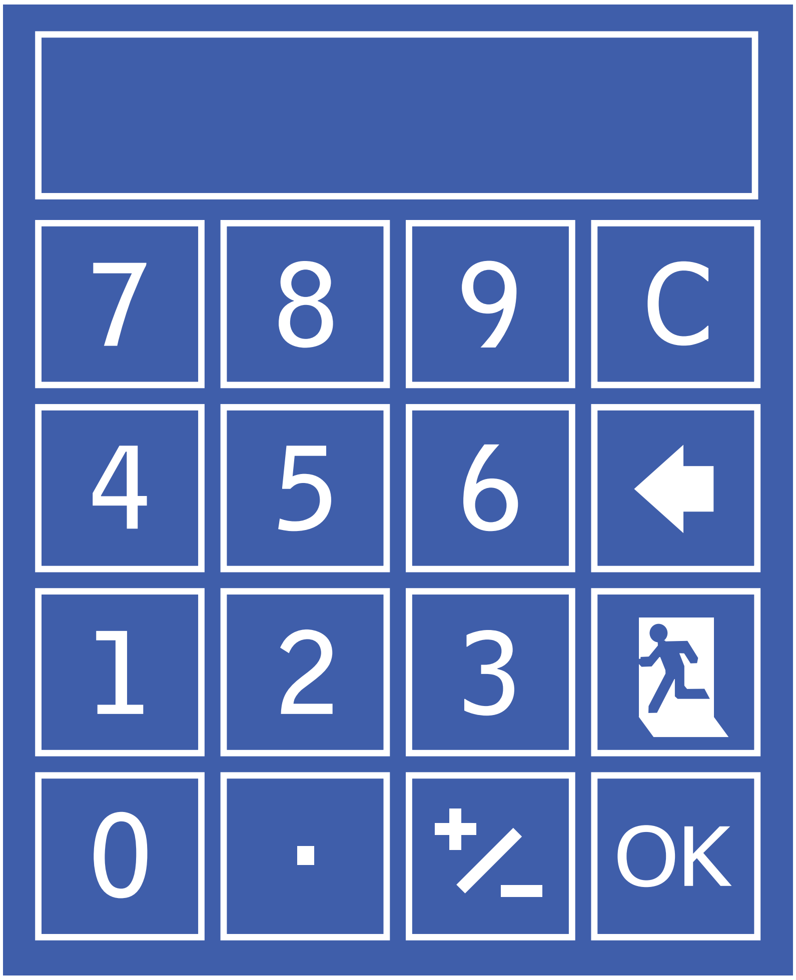


Figure 18 *Virtual Keyboard*

The allowable range will initially be shown at the top of the keypad, e.g. 0 → 50

Some parameters can be disabled by entering a value of 0, this will be indicated by 0[off] → 50

- C Clear Input
- Backspace
- Cancel input
- OK Save input

Leaving Menus

To return from a menu or to cancel a numeric input, touch the exit icon.

3.3.6 Menu Structure

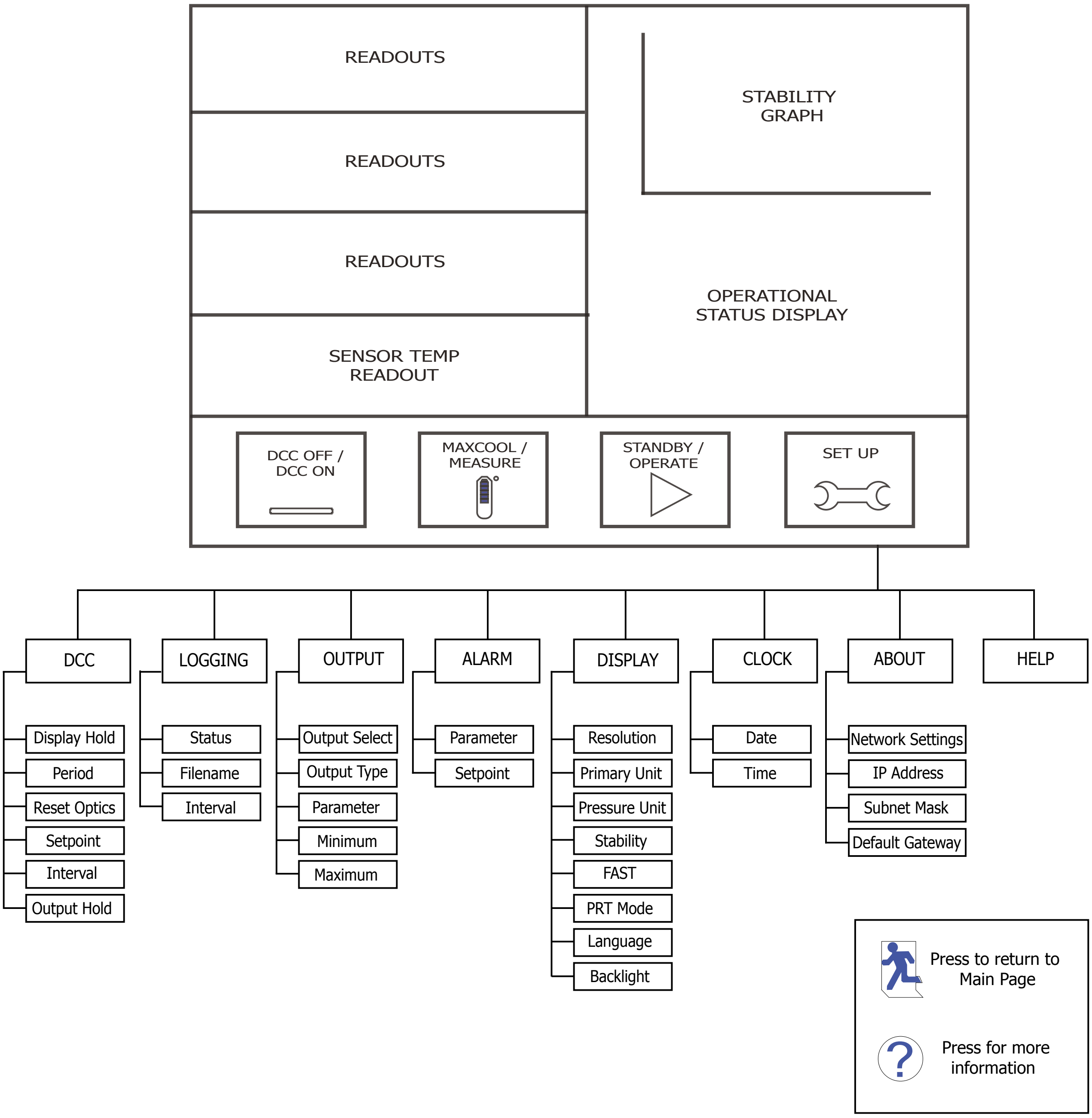


Figure 19 *Menu Structure*

3.3.7 DCC

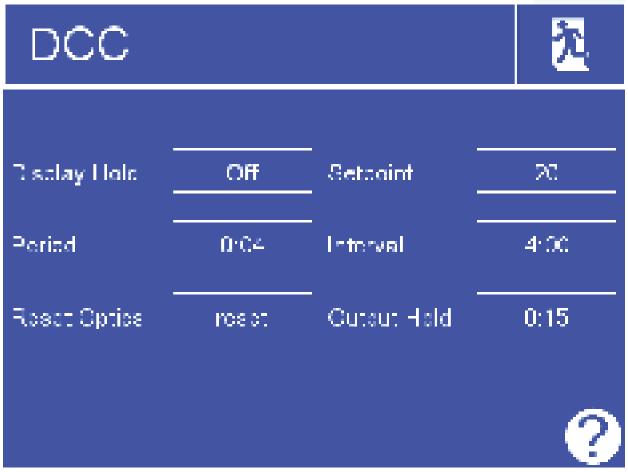


Figure 20 *DCC Screen*

Parameter	**Description**
Display Hold	Holds the values on the display while the instrument is in HOLD mode **Available Input:** On/Off
Period	Duration of the DCC cycle **Available Input:** 1 to 59 minutes
Reset Optics	Triggers a reset of the optical signal level on the next DCC cycle
Setpoint	Mirror heating temperature above measured dew point during DCC cycle **Available Input:** 10 to 40°C (50 to 104°F)
Interval	Time between automatic DCC cycles **Available Input:** 1-99 hours. Set to 0 to disable automatic DCCs
Output Hold	Time to hold the output at the last measured value after finishing a DCC cycle **Available Input:** 1 to 59 minutes

Table 7 *DCC Parameters*

3.3.8 LOGGING

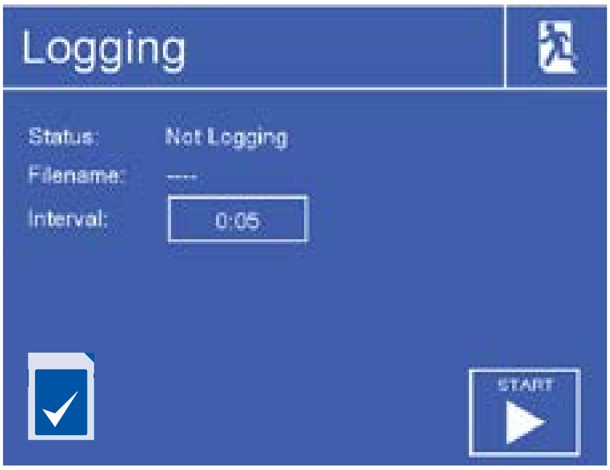


Figure 21 *Logging Screen*

Parameter	Description
Status	Displays the status of the current logging operation
Filename	Displays the filename of the current log file
Interval	Time in seconds between recording readings in the log file **Available Input:** 5 to 600 seconds
SD Card Icon	Shows the SD card status - refer to Table 9
START/STOP Button	Automatically generates a new file name based on current time and date - Starts logging at specified interval

Table 8 *Logging Parameters*

The table below explains the status of the SD card. The icon is shown in the bottom left hand corner of the Logging screen.

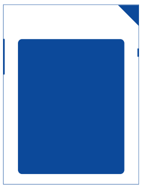
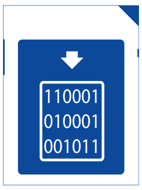
Icon	Description
	SD Card not fitted Insert SD Card
	Initializing SD Card Wait before attempting to start logging
	SD Card ready to start logging
	SD Card locked/write protected Remove the SD Card and set the write-protect switch on the top left side of the card to the **UP** position
	Information being transferred to the SD Card Do not remove the SD Card or power off the instrument
	Logging in progress Do not remove the SD Card or power off the instrument
	SD Card error Check the card is formatted correctly (FAT-32)
	Hardware error Contact Michell Instruments' service department

Table 9 *SD Card Status Indicators*

3.3.9 OUTPUTS

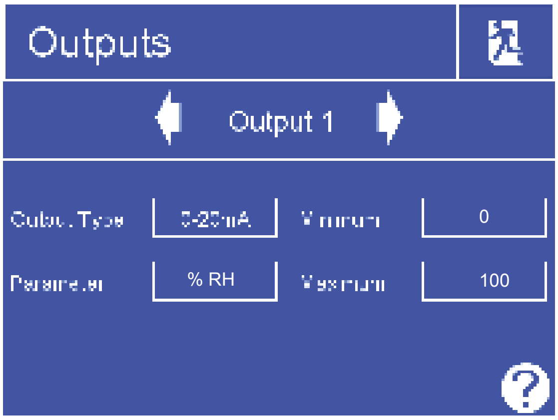


Figure 22 *Outputs Screen*

Parameter	Description
Output Select	Selects the output to be adjusted **Available Input:** Output 1, 2 or 3
Output Type	Selects the type of analog output signal to use **Available Input:** 4-20 mA/0-20 mA/0-1 V
Parameter	The parameter used to control the selected output **Available Input:** g/m^3, g/kg, T-DP, DP, %RH, ppm$_V$, ppm$_W$, T, psig, barg, kPa, MPa, ml/min
Minimum	The minimum output range for the selected parameter **Available Input:** Dependent on parameter
Maximum	The maximum output range for the selected parameter **Available Input:** Dependent on parameter

Table 10 *Outputs Parameters*

3.3.10 ALARM

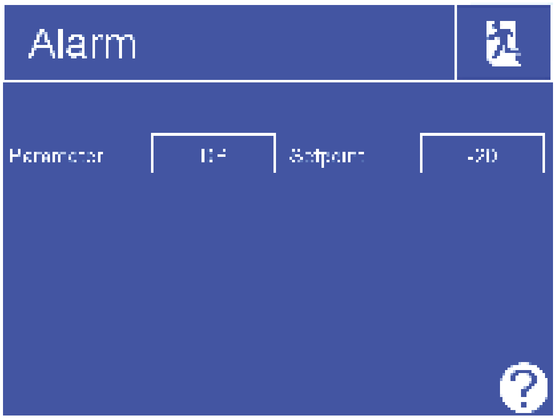


Figure 23 *Alarm Screen*

Parameter	Description
Parameter	The parameter used to control the alarm **Available Input:** g/m^3, g/kg, T-DP, DP, %RH, ppm$_V$, ppm$_W$, T, psig, barg, kPa, MPa, ml/min
Setpoint	Set point that triggers the alarm relay to activate. The alarm is a HIGH alarm that triggers when the selected parameter exceeds the setpoint. **Available Input:** Dependent on parameter

Table 11 *Alarm Parameters*

3.3.11 DISPLAY

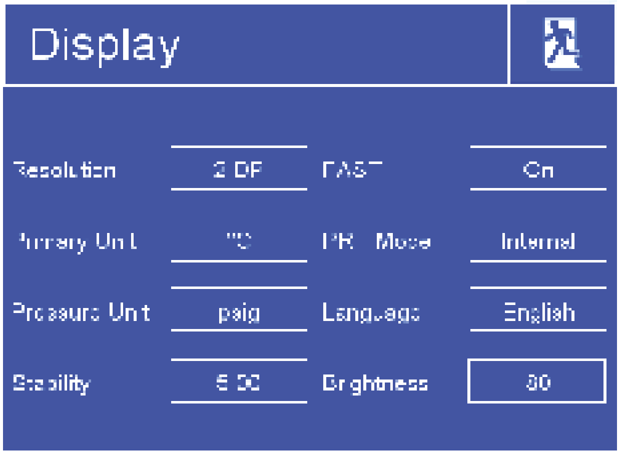


Figure 24 *Display Screen*

Parameter	Description
Resolution	Number of decimal places used when displaying parameters on the Main Screen **Available Input:** 1, 2, 3
Primary Unit	Temperature unit to be used on the display and menus **Available Input:** ºC / ºF
Pressure Unit	Pressure unit to be used on the display and menus **Available Input:** psig, barg, kPa, MPa
Stability	Time scale in minutes for the Stability Graph on the Main Screen **Available Input:** 1 to 600 minutes
FAST	Enables or disables the Frost Assurance System Technology. See Section 3.6.6 **Available Input:** OFF / ON
PRT Mode	If required for the calibration process or for external monitoring, the internal PRT can be made available for external connection via the 4 banana sockets on the back of the instrument Please note that this will disable the internal PRT measurement circuit of the instrument **Available Input:** INTERNAL / EXTERNAL
Language	Selects the language used for the menu screens **Available Input:** English / Deutsch / Español / Francais / Italiano / Português / USA / Russian / Chinese
Backlight	The brightness of the backlight **Available Input:** 5 to 100%

Table 12 *Display Parameters*

3.3.12 CLOCK

Figure 25 *Clock Screen*

Parameter	Description
Date	Current date
Time	Current time

Table 13 *Clock Parameters*

3.3.13 ABOUT (Network Settings)

When using an S8000 RS that is fitted with an Ethernet module this page is accessible via the About Screen.

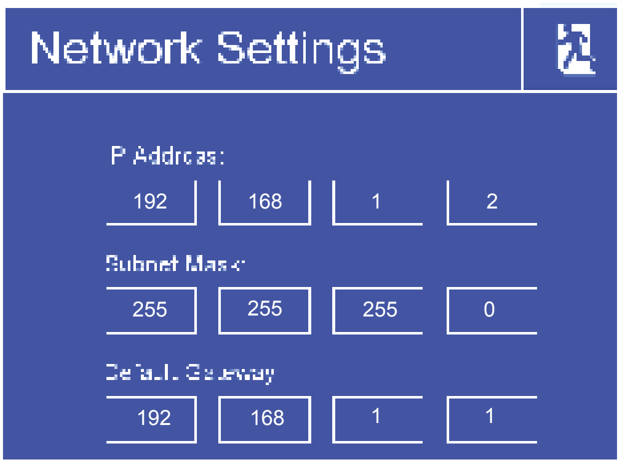


Figure 26 *Network Settings Screen*

Parameter	Description
IP Address	The IP address of the instrument
Subnet Mask	The subnet mask that determines what subnet the IP address is on
Default Gateway	The default gateway for network communication

Table 14 *Network Parameters*

3.4 Operational Functions

3.4.1 Operating Cycle

The default parameters set up for the instrument define an operating cycle, see *Figure 27.*

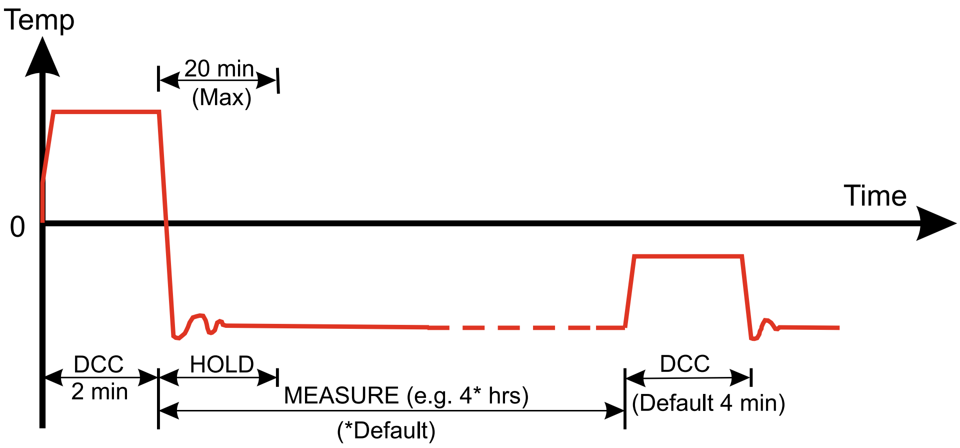


Figure 27 *Typical Operating Cycle*

At initial switch-on, the instrument enters a DCC cycle for 2 minutes. This heats the mirror 20°C (36°F) above the previously measured value - at the time of switch on this will be ambient temperature. This ensures that all moisture is driven off the surface of the mirror.

The mirror is maintained at this temperature for the DCC duration (default 4 minutes) or 2 minutes on switch-on. During the DCC process, Data Hold fixes the analog outputs at the value(s) read before DCC commenced. Data Hold typically lasts 4 minutes from the end of a DCC cycle, or until the instrument has reached the dew point. This procedure is in place to prevent any system which is connected to the outputs from receiving a 'false' reading.

After the DCC period has finished, the measurement (**MEASURE**) period commences, during which the control system decreases the mirror temperature until it reaches the dew point. The sensor will take a short amount of time to settle on the dew point. The length of this stabilization time depends upon the temperature of the dew point. When the measurement is stable the Sensor area of the display will indicate **CONTROL.**

The end of a DCC cycle re-sets the interval counter, meaning that another DCC will start (by default) in 4 hours time. Once the measurement is stable, **HOLD** will release, and the analog outputs will resume their normal operation. At this point, the **STATUS** area of the display will change to **MEASURE.**

3.5 Operating Guide

3.5.1 Automatic Mode

3.5.1.1 Description

When the instrument is switched on the cooler set-point will initially be +20°C (+68°F). The instrument will initialize by running a DCC cycle. After the DCC cycle is complete, the system will cool the mirror. As soon as moisture is detected on the mirror, the instrument will calculate the required sensor temperature set-point, which will be displayed in yellow in the top right of the sensor temperature readout on the Main Screen.

If the dew point is -40°C (-40°F) or higher, the sensor temperature set-point will be set to +20°C (+68°F), otherwise the sensor temperature set-point will be set to at least 30°C (54°F) above the dew point. For example, if the dew point is between -60 and -69°C (-76 and -92°F), the sensor temperature will be set to -30°C (-22°F).

If the system does not detect moisture on the mirror on the first attempt, it will change the sensor temperature to -50°C (-58°F), run another DCC cycle and repeat the process of cooling the mirror, until condensation is detected.

The instrument will monitor the dew point and sensor temperature values and, if the dew point rises to within 10°C (18°F) of the sensor temperature, the sensor temperature set point will be increased by 10°C (18°F). However, if the dew point decreases to 30°C (54°F) below the sensor temperature, then the sensor temperature set-point will decrease by 10°C (18°F). This means that the instrument will track the dew point and increase, or decrease, the sensor temperature accordingly in order to maintain this differential.

If there is a sudden large increase in dew point and the dew point rises rapidly by more than 20°C (36°F), the instrument will wait for the dew point reading to stabilize before changing the sensor temperature. This will ensure that short dew-point disturbances do not cause the sensor temperature to change unnecessarily.

Sensor temperature will only change during measurement mode, never during DCC.

3.5.1.2 Operating Practice

Avoid situations in your operating cycle where a dew point is introduced to the instrument which is greater than the current sensor temperature. Precautions should be taken to either gradually increase the sample humidity, or manually change the cooler temperature in advance. If precautions are not taken, condensation may form in the inlet tubing – see Section 3.5.1.3, Flood Recovery, for more detail.

During transitions from a wet to a dry dew point, condensate formed during the wet measurement may not always clear from the mirror before it cools to the new dew point. Poor frost formation will result, leading to a interruption of the measurement. To prevent this; when the sensor temperature target changes to at least 30°C (54°F) below its present value, a DCC will be triggered automatically to clear any remaining condensate from the mirror.

3.5.1.3 Flood Recovery

If the sensor has detected that a flooding event has occurred, the following steps will be taken to recover the measurement:

1. The sensor cooler will be switched off, and the sensor temperature will rise to +20°C (+68°F).
2. The mirror temperature will be increased.
3. Once the sensor temperature has reached +20°C (+68°F), a DCC will be initiated.
4. Once a DCC cycle has been completed, normal measurement will resume.

The instrument will indicate when flood recovery is active by means of a yellow **FR** (Flood recovery) warning icon displayed in the sensor temperature window. The **sensor status** indicator will also show **FR** in red text.

3.6 Manual Mode

3.6.1 Description

When the instrument is switched on, the cooler set-point will initially be +20°C (+68°F). The user is responsible for selecting the appropriate sensor temperature set-point via the Cooler Setup Page.

3.6.1.1 Operating Practice

The S8000 RS will only be capable of measuring dew points down to -50°C (-58°F) with the cooler temperature set to +20°C (+68°F). When measuring dew points below -50°C (-58°F), it is necessary to set the sensor temperature to approximately 30°C (54°F) above the dew point to be measured in order to maintain a fast speed of response.

If the dew point is not known, then it is advisable to operate in automatic mode to allow the instrument to find the correct temperature autonomously. If manual cooler operation is essential, then following steps should be taken to determine the dew point, before setting the cooler temperature:

1. Ensure that the mirror is clean, and the sample flow rate is correctly set to 750ml/min (1.6 scfh).
2. Switch the instrument on.
3. Ensure the sensor temperature is set to +20°C (+68°F).
4. After the DCC is complete, the S8000 RS will cool the mirror down:
    a. If the dew point is wetter than -55°C (-67°F):
        i. The instrument will cool the mirror below -55°C (-67°F). Frost will then begin to form on the mirror, after which the mirror temperature will start to increase, and settle on that of the dew point.
        ii. The S8000 RS will only measure this dew point for approximately 40 minutes with the cooler temperature set to +20°C (+68°F). Once the dew point has been found, set the cooler temperature to approximately 30°C (54°F) above the dew point.

b. If the dew point is dryer than -55°C (-67°F):

i. The instrument will cool the mirror down to approximately -55 to -65°C (-67 to -85°F) (depending on the actual sensor temperature). When the mirror has been cooled to the minimum temperature possible, it will remain at that value. However, due to heat generated by the Thermo-electric cooler cooling at the limit of its capacity, the mirror temperature will gradually increase.

ii. Observing the mirror through the microscope will confirm that there is no frost on the mirror, and therefore the dew point is lower than the displayed mirror temperature.

iii. Switch the instrument to **Standby**.

iv. Set the sensor temperature to -50°C (-58°F), and wait for it to stabilize.

v. Switch the instrument to **Operate.**

vi. The instrument will cool the mirror below the dew point. Frost will then begin to form on the mirror, after which the mirror temperature will increase to that of the dew point.

3.6.2 DCC - Dynamic Contamination Control

Dynamic Contamination Control (**DCC**) is a system designed to compensate for the loss of measurement accuracy which results from mirror surface contamination.

During the **DCC** process the mirror is heated to a default temperature of 20°C above the dew point to remove the contamination that has formed during measurement. The surface finish of this mirror, with the contamination which remains, is used by the optics as a reference point for further measurements. This removes the effect of contamination on accuracy.

After switch-on, the mirror is assumed to be clean, therefore the instrument will only run a **DCC** for 2 minutes to quickly establish a clean mirror reference point. By default, every subsequent **DCC** is 4 minutes in duration and will automatically occur every 4 hours.

At certain times, it may be desirable to disable the **DCC** function in order to prevent it from interrupting a measurement cycle, e.g. during a calibration run.

A manual **DCC** can be initiated or cancelled by touching the **DCC** button on the Main Screen. The DCC button is context sensitive, i.e. if **DCC** is on, the Main Screen shows **DCC OFF** as being selectable. Similarly if **DCC** is off, **DCC ON** is shown.

It is possible to change the parameters relating to the **DCC** cycle on the **DCC** Setup Screen, refer to Section 3.3.7.

3.6.3 MAXCOOL Function

The **MAXCOOL** function over-rides the dew-point control loop and applies maximum cooling drive to the Peltier heat pump. It can be used:

- to determine what temperature the mirror can be driven down to with reference to the sensor body. This temperature is indicated on the display.
- to determine whether or not the instrument is controlling at the dew point and whether it is able to reach it. This situation could, for instance, arise when attempting to measure very low dew points where, possibly due to a high ambient temperature, the Peltier heat pump is unable to depress the temperature far enough to reach the dew point.
- to determine whether the instrument is controlling by switching **MAXCOOL** on for a short period and then switching back to **MEASURE**. This will depress the mirror temperature briefly and when it is switched back to **MEASURE** the control loop should be able to stabilize the mirror temperature at the dew point again.

The **MAXCOOL** function can be turned on by touching the **MAXCOOL** button on the Main Screen.

3.6.4 Pressure Input

As an option, the S8000 instrument can be fitted with an internal pressure sensor that measures the sample gas pressure. The pressure measured by this sensor is then used internally as the basis for calculation of all of the pressure related parameters, ppm_V, ppm_W, g/m^3 and g/kg. If a pressure transducer is not fitted 101.3 kPa is used as the basis of all these calculations. The internal pressure transducer is ranged 0 to 16 bara (0 to 232 psia).

3.6.5 Data Logging

The data logging function allows all of the measured parameters to be logged at a user specified interval on the supplied SD card via the SD card slot on the front of the instrument. The filename for each log file is generated automatically from the instrument date and time.

Log files are saved in CSV (comma separated value) format. This allows them to be imported easily into Excel or other programs for charting and trend analysis. To set-up data logging refer to Section 3.3.8.

3.6.6 Frost Assurance System Technology (FAST)

Theoretically, it is possible for water to exist as a super-cooled liquid at temperatures down to -40°C (-40°F).

A gas in equilibrium with ice is capable of supporting a greater quantity of water vapor at a given temperature than a gas in equilibrium with liquid water. This means that a measurement below 0°C taken over water will read approximately 10% lower than the same measurement taken over ice.

When turned on and **FAST** is enabled, the S8000 RS makes an initial dew point measurement. If the initial measurement is between 0°C and -40°C then the mirror is driven down to below -40°C to ensure the formation of ice on the mirror surface. The instrument then continues operation as normal – once ice has formed it will remain as ice until the temperature is raised above 0°C (+32°F).

If required, the instrument's **FAST** function can be switched on and off. To enable or disable the **FAST** function, refer to Section 3.3.11.

3.6.7 STANDBY Mode

This function is used for applications where the dew point of the sample gas changes very quickly from dry to wet, creating conditions which may cause the sensor to saturate. Alternatively, it may be used in applications requiring infrequent manual measurements to be taken, where it is preferable to have the sensor disabled between measurements.

In **STANDBY** mode, drive to the Peltier heat pump is removed. While **STANDBY** mode is enabled the sensor temperature will remain constant.

The main use for this feature is during set up (when measurements are not required), i.e. when flow rates are being adjusted and the analog outputs are being configured.

4 APPLICATION SOFTWARE

The S8000 RS features either USB or Ethernet communications depending on the model.

The application software is also available from the support section of the Michell Instruments' website at: http://www.michell.com/uk/support/sware-downloads.htm

4.1 Installation

1. Extract the contents of the supplied zip file to a suitable location.
2. Close all currently running Windows programs.
3. Launch the installer and follow the on-screen instructions.
4. The installer will ask for an authorization code, enter 7316-MIL1-8000.
5. Restart the PC to complete the installation.

4.2 Establishing Communications

When launching the application software, the Communications Setup screen will be displayed. The following sections explain how to establish communication with the S8000 RS, depending on whether it is fitted with a USB or Ethernet module.

Figure 28 *Communications Setup Screen*

4.2.1 USB Communication

1. Connect the S8000 RS to the PC using the supplied USB cable.
2. Windows will recognize the instrument and automatically install the relevant drivers. If the driver installation has been successful, then the Windows Device Manager will list the following driver (see *Figure 29)*:

   Michell Instruments USB to UART Bridge Controller

3. Launch the application software and choose one of the following types of connection:

   Auto Detect – The application software will attempt to find the correct COM port automatically.

   Manual – Choose the appropriate COM port from the drop down list, as shown in the Windows Device Manager (see *Figure 29).*

4. Click the **OK** button to proceed to the next screen.

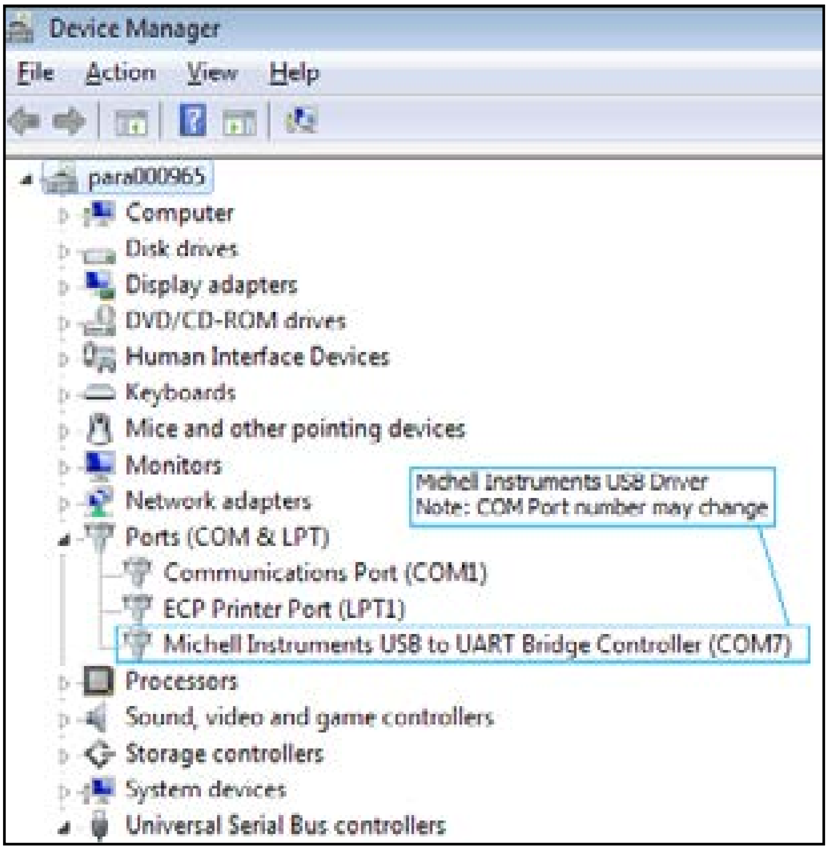


Figure 29 *Windows Device Manager Screen*

4.2.2 Ethernet Communication

1. Configure the network settings of the instrument. Refer to Section 3.3.13.
2. Connect the S8000 RS to the network using the supplied Ethernet cable.
3. Launch the application software and choose the Network Connection option.
4. Click the TCP Settings button to enter the IP address of the instrument.
5. Click the Test button. If communication with the instrument is successful then proceed to the next screen by clicking the **OK** button, otherwise check network settings and try again.

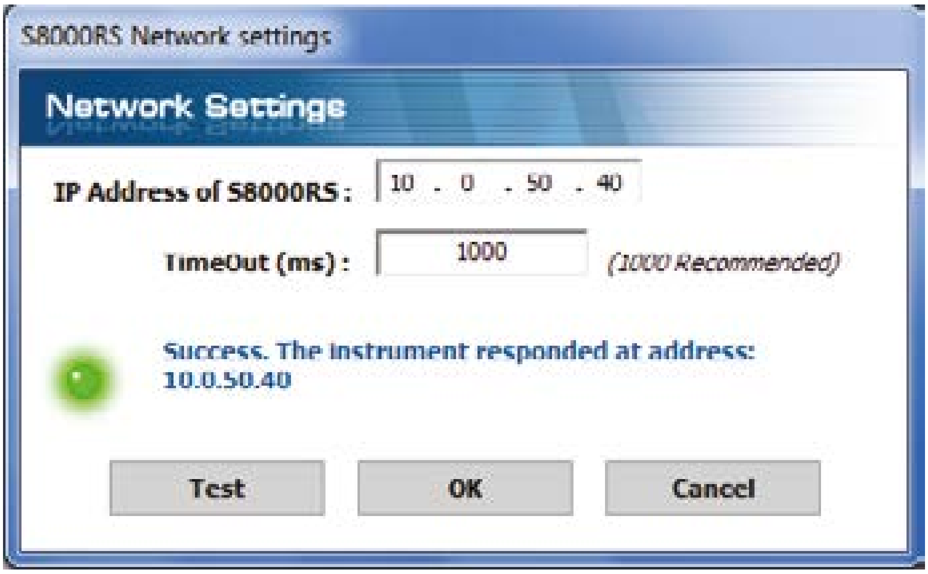


Figure 30 *Network Settings Screen*

4.3 Data Acquisition or Edit Variables Mode

Once communication has been established, the Options Screen is displayed.

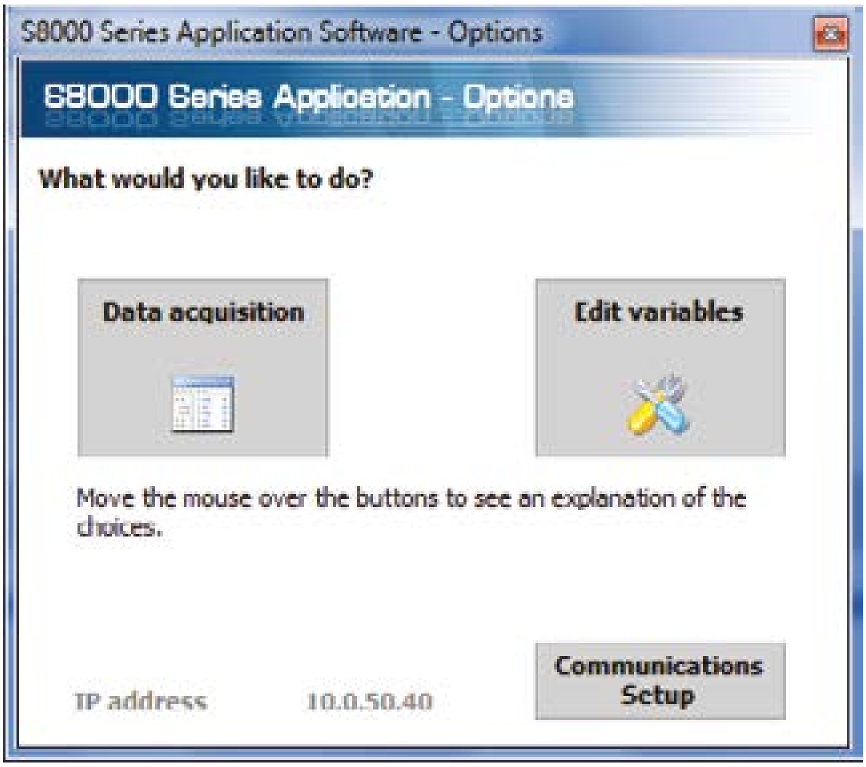


Figure 31 *Options Screen*

4.3.1 Data Acquisition

This mode of operation allows all measured instrument parameters to be graphed and logged in real time.

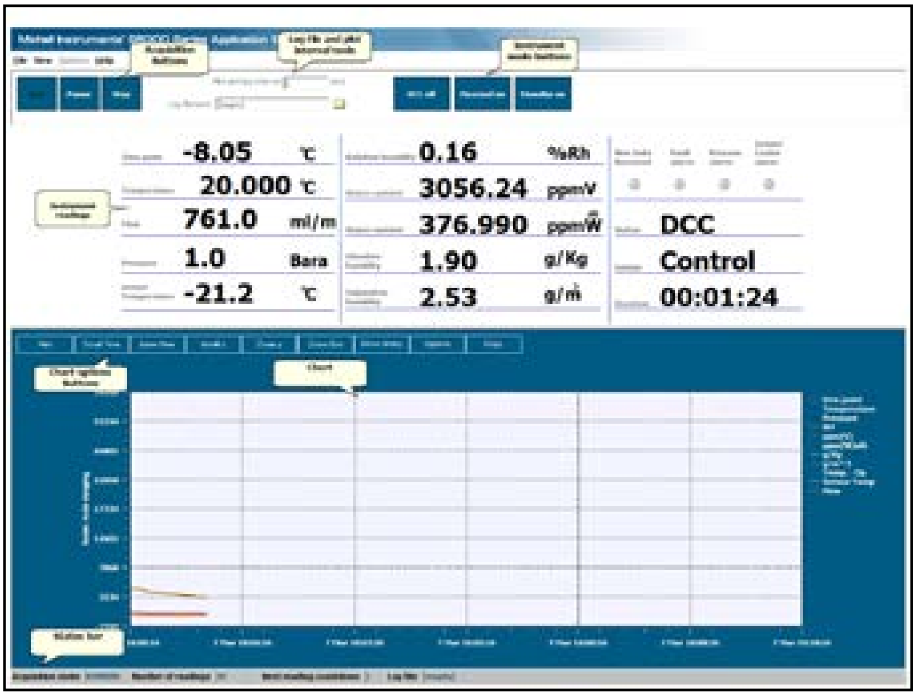


Figure 32 *Data Acquisition Screen*

Data Acquisition Control Toolbar

Name	Description
Run	Begin data acquisition and logging A filename must be first be selected to enable data logging
Pause	Pause data acquisition
Stop	Stop data acquisition
Plot and log interval	Time in seconds between graph and log file updates
Log filename	Path and filename of the log file Click the small folder icon next to this text box to create a new log file
DCC	Initiate a DCC cycle Refer to Section 3.6.2 for detailed information on the DCC function
Maxcool	Toggle between Maxcool and Measure mode Refer to Section 3.6.3 for detailed information on the Maxcool function
Standby	Toggles between Standby and Measure mode Refer to Section 3.6.7 for detailed information on the Standby function

Table 15 *Data Acquisition Control Description*

Instrument readings and status

This area displays all measured instrument parameters and shows the status of the Fault, Process and Sensor Cooler Alarm.

Graph Controls

Name	Description
Plot	Automatically advances the graph as new data is acquired
Scroll Time	Dragging the mouse on the graph scrolls along the time axis Drag to the left to scroll forwards Drag to the right to scroll backwards
Zoom Time	Dragging the mouse on the graph changes the scale of the time axis Drag to the left to increase the scale size Drag to the right to decrease the scale size
Scroll Y	Dragging the mouse on the graph scrolls along the Y axis Drag down to scroll up Drag up to scroll down
Zoom Y	Dragging the mouse on the graph changes the scale of the Y axis Drag up to increase the scale size Drag down to decrease the scale size
Zoom Box	Zooms in on both axes in the user selected area
Show time/Y	Select a parameter from the legend on the right hand side of the graph Dragging the mouse along the graph will move the vertical cursor along the time axis The Y value for the selected parameter at the position of the cursor will be displayed above the graph
Options	Displays the chart options window
Copy	Copies the chart to the clipboard as a bitmap file

Table 16 *Graph Control Description*

Graph

Plots the parameters selected by the user in the chart options window.

Status Bar

Name	Description
Acquisition state	Indicates whether data acquisition is running, paused or stopped, with the messages RUNNING, PAUSED or IDLE
Number of readings	Number of readings taken since starting the current acquisition session
Next reading countdown	Countdown timer (in seconds), which indicates when the next reading will be taken
Log file	Full path of the log file (if specified)

Table 17 *Status Bar Description*

4.3.2 Variable Edit

The variable edit mode allows the instrument configuration to be changed through the application software. On launch, it will automatically read and display the current values of each of the instrument variables.

Note: The variables are not periodically updated on-screen. To obtain up-to-date values, click the Read button.

Editing variables

To edit a variable, first click on it to highlight it.

If the variable has a fixed list of options, a drop-down arrow will appear in the right-hand column. Choose a new value from the drop-down list provided.

If the variable does not have a fixed list of options, type the new value into the right-hand column text input area.

NOTE: The variable background colour will turn pink to indicate it has been changed on-screen and is pending upload to the instrument.

Click the Write button to upload changed values to the instrument.

NOTE: Variable values and formatting are checked by the application software before they are uploaded to the instrument.

A message box will report any errors found.

Once a modified value has been written to the instrument, the background colour will return to white.

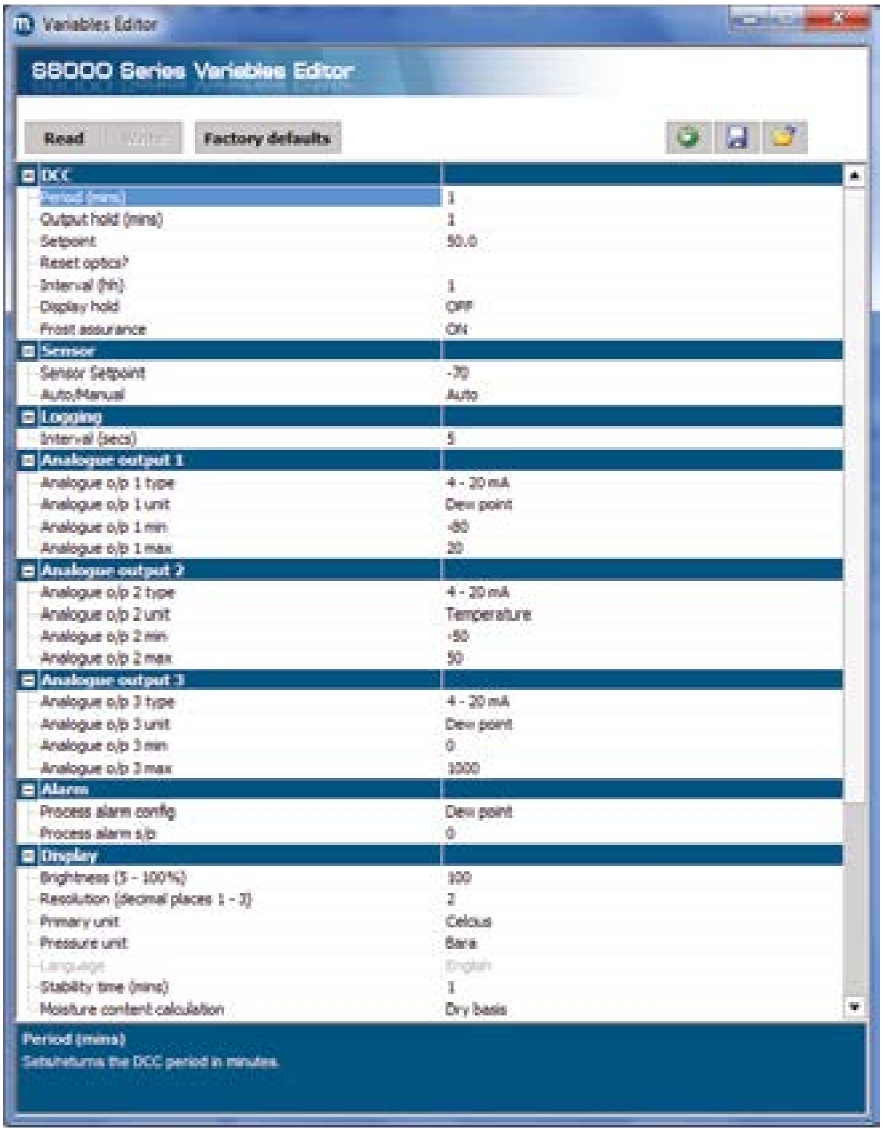


Figure 33 *Variables Editor Screen*

5 MAINTENANCE

There are few user-serviceable parts on the S8000 RS. These include removal and replacement of the AC power supply fuse and cleaning the sensor mirror.

Safety

This equipment operates from power supply voltages that can be lethal and at pressures (depending upon application) that could cause injury.

Ensure that any test installation meets the standards described in Section 2.4 of this manual.

Under NO circumstances should the instrument case be removed or the air vents covered or in any way restricted.

Maintenance and repair, other than that described in this section, must only be carried out by trained personnel and the instrument should be returned to the manufacturer for this purpose.

5.1 Fuse Replacement

If the instrument fails to operate after it has been connected to an AC power supply (85 to 264 V AC, 47/63 Hz) and switched on, proceed as follows:

1. If the power supply cable is fitted with a fused plug, switch off the power supply and remove the plug. Check and, if necessary, replace the fuse. If, after fitting a new fuse and switching the power supply on, the instrument still fails to operate, proceed as follows.

Figure 34 *Fuse Replacement*

2. Switch the instrument's ON/OFF switch to OFF, isolate the external power supply and remove the IEC power connector from the instrument's power socket.
3. Locate the fuse carrier and pull it out of the connector housing. A small screwdriver inserted under the lip may be useful in order to lever it out.

4. Replace the fuse cartridge. NOTE: It is essential that a fuse of the correct type and rating is fitted to the instrument (fuse - 3.15A, Anti-Surge, Glass, 20mm x 5mm).

5. Fit a new fuse cartridge into the fuse carrier and push the fuse carrier back into the power connector housing.

6. Replace the IEC power connector into the power socket, switch on the external power supply and switch on the instrument. Check that the instrument is now operational. If the fuse blows immediately on switch-on either contact the manufacturer or their service agent. **DO NOT ATTEMPT ANY FURTHER SERVICING PROCEDURES**

5.2 Sensor Mirror Cleaning

Warning
Before disassembling the sensor it is important to de-pressurize the sensor head.
Failure to follow this warning may result in operator injury or damage to the instrument.

Throughout the life of the instrument, periodic cleaning of the mirror surface and optics window may be required. The frequency of this depends upon operating conditions and the potential in the application for contaminants to be deposited on the mirror. Sensor cleaning is mandatory if the instrument indicates an optics fault. The cleaning procedure is as follows:

Figure 35 *Sensor Mirror Cleaning*

1. Switch off the instrument and unscrew the large stainless steel sensor cover (1) on the front of the instrument.
2. Carefully pull the optics block (2) out to reveal the mirror (3). Clean the mirror surface and optics window with a cotton bud/QTip soaked in distilled water. If the sensor has been exposed to oil based contamination then use one of the following solvents: methanol, ethanol, or isopropyl alcohol. To avoid damage to the mirror surface, do not press too firmly on the cotton bud/Q-Tip when cleaning. Allow the cleaning solvent to fully evaporate.
3. If alcohol has been used to clean the mirror then always follow by cleaning with distilled water.
4. Replace the optics block, taking care to align the gold contacts on the block with the gold contacts on the instrument.
5. Replace the large stainless steel cover, screwing it in firmly but taking care not to overtighten it.

6 GOOD MEASUREMENT PRACTICE

6.1 Sampling Hints

Ensuring reliable and accurate moisture measurements requires the correct sampling techniques, and a basic understanding of how water vapour behaves. This section aims to explain the common mistakes and how to avoid them.

Sampling Materials – Permeation and Diffusion

All materials are permeable to water vapour since water molecules are extremely small compared to the structure of solids, even including the crystalline structure of metals. The graph below demonstrates this effect by showing the increase in dew point temperature seen when passing very dry gas through tubing of different materials, where the exterior of the tubing is in the ambient environment.

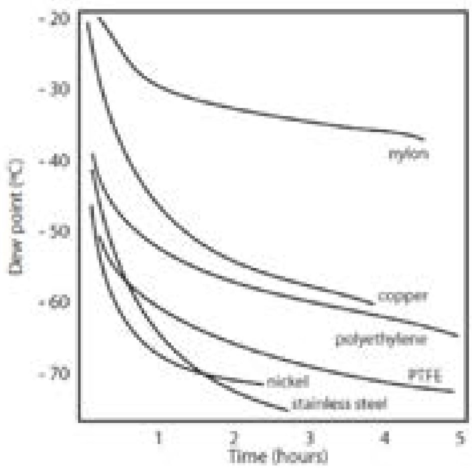


Figure 36 *Material permeability comparison*

What this demonstrates is the dramatic effect that different tubing materials have on the humidity levels of a gas passed through them. Many materials contain moisture as part of their structure and when these are used as tubing for a dry gas the gas will absorb some of the moisture. Always avoid using organic materials (e.g. rubber), materials containing salts and anything which has small pores which can easily trap moisture (e.g. nylon).

As well as trapping moisture, porous sampling materials will also allow moisture vapour to ingress into the sample line from outside. This effect is called diffusion and occurs when the partial water vapour pressure exerted on the outside of a sample tube is higher than on the inside. Remember that water molecules are very small so in this case the term 'porous' applies to materials that would be considered impermeable in an everyday sense – such as polyethylene or PTFE. Stainless steel and other metals can be considered as practically impermeable and it is surface finish of pipework that becomes the dominant factor. Electropolished stainless steel gives the best results over the shortest time period.

Take into consideration the gas you are measuring, and then choose materials appropriate to the results you need. The effects of diffusion or moisture trapped in materials are more significant when measuring very dry gases than when measuring a sample with a high level of humidity.

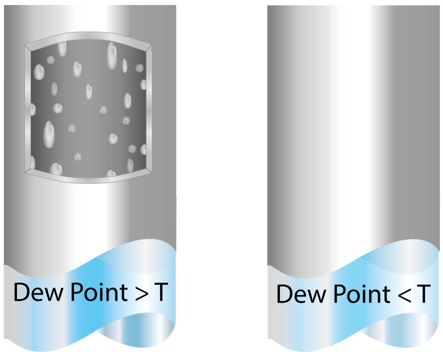
Temperature and Pressure effects

As the temperature or pressure of the environment fluctuates, water molecules are adsorbed and desorbed from the internal surfaces of the sample tubing, causing small fluctuations in the measured dew point.

Adsorption is the adhesion of atoms, ions, or molecules from a gas, liquid, or dissolved solid to the surface of a material, creating a film. The rate of adsorption is increased at higher pressures and lower temperatures.

Desorption is the release of a substance from or through the surface of a material. In constant environmental conditions, an adsorbed substance will remain on a surface almost indefinitely. However, as the temperature rises, so does the likelihood of desorption occurring.

Ensuring the temperature of the sampling components is kept at consistent levels is important to prevent temperature fluctuation (i.e. through diurnal changes) continually varying the rates of adsorption and desorption. This effect will manifest through a measured value which increases during the day (as desorption peaks), then decreasing at night as more moisture is adsorbed into the sampling equipment.



If temperatures drop below the sample dew point, water may condense in sample tubing and affect the accuracy of measurements.

Maintaining the temperature of the sample system tubing above the dew point of the sample is vital to prevent condensation. Any condensation invalidates the sampling process as it reduces the water vapour content of the gas being measured. Condensed liquid can also alter the humidity elsewhere by dripping or running to other locations where it may re-evaporate.

Although ambient pressure does not change drastically in a single location, the gas sample pressure does need to be kept constant to avoid inconsistencies introduced by adsorption or desorption. The integrity of all connections is also an important consideration, especially when sampling low dew points at an elevated pressure. If a small leak occurs in a high-pressure line, gas will leak out, however, vortices at the leak point and a negative vapour pressure differential will also allow water vapour to contaminate the flow.

Theoretically flow rate has no direct effect on the measured moisture content, but in practice it can have unanticipated effects on response speed and accuracy. An inadequate flow rate may:

- Accentuate adsorption and desorption effects on the gas passing through the sampling system.
- Allow pockets of wet gas to remain undisturbed in a complex sampling system, which will then gradually be released into the sample flow.
- Increase the chance of contamination from back diffusion. Ambient air that is wetter than the sample can flow from the exhaust back into the system. A longer exhaust tube can help alleviate this problem.
- Slow the response of the sensor to changes in moisture content.

An excessively high flow rate can:

- Introduce back pressure, causing slower response times and unpredictable changes in dew point
- Result in a reduction in depression capabilities in chilled mirror instruments by having a cooling effect on the mirror. This is most apparent with gases that have a high thermal conductivity such as hydrogen and helium.

System design for fastest response times

The more complicated the sample system, the more areas there are for trapped moisture to hide. The key pitfalls to look out for here are the length of the sample tubing and dead volumes.

The sample point should always be as close as possible to the critical measurement point to obtain a truly representative measurement. The length of the sample line to the sensor or instrument should be as short as possible. Interconnection points and valves trap moisture, so using the simplest sampling arrangement possible will reduce the time it takes for the sample system to dry out when purged with dry gas.

Over a long tubing run, water will inevitably migrate into any line, and the effects of adsorption and desorption will become more apparent.

Dead volumes (areas which are not in a direct flow path) in sample lines, hold onto water molecules which are slowly released into the passing gas. This results in increased purge and response times, and wetter than expected readings. Hygroscopic materials in filters, valves (e.g. rubber from pressure regulators) or any other parts of the system can also trap moisture. Plan your sampling system to ensure that the sample tap point and the measurement point are as close as possible to avoid long runs of tubing and dead volumes.

Filtration

All trace moisture measurement instruments and sensors are by their nature sensitive devices. Many processes contain dust, dirt or liquid droplets. Particulate filters are used for removing dirt, rust, scale and any other solids that may be in a sample stream. For protection against liquids, a coalescing or membrane filter should be used. The membrane provides protection from liquid droplets and can even stop flow to the analyser completely when a large slug of liquid is encountered, saving the sensor from potentially irreparable damage.

7 CALIBRATION

7.1 Traceability

The calibration of this instrument is traceable to national standards. For this reason the instrument can only be calibrated in an accredited e.g. NIST or UKAS accredited, standards laboratory.

If these facilities do not exist, the instrument must be returned to the manufacturer, Michell Instruments, or one of their approved agents (see www.michell.com for contact details).

The **DCC** function can be disabled for calibration purposes (refer to Section 3.6.2).

A calibration certificate bearing a four point calibration is issued with each instrument. If required, an option is available to add further specific calibration points. Contact Michell Instruments for further information (www.michell.com).

MICHELL Instruments

CERTIFICATE OF CALIBRATION

The under-mentioned item has been calibrated at the following points in the Michell Instruments' Humidity Calibration Laboratory against Test Equipment traceable to the NATIONAL PHYSICAL LABORATORY, Middlesex, United Kingdom and to the NATIONAL INSTITUTE OF STANDARDS & TECHNOLOGY, Gaithersburg, Maryland, USA.

Certificate Number	54321	*Ack Number*	A12345
Test Date	12 Mar 2012	*Test Equipment*	Q0332/Q0238/Q0354/Q0383
Instrument Serial Number	123456	*Product Type*	S8000 RS

Generated Dewpoint °C	*Instrument Display °C*
-80.10	-80.06
-60.09	-60.15
-30.11	-30.07
9.98	10.03

Remote PRT 123457 read 18.21°C at a temperature of 18.30°C

Comments:
Calibration PASS. No adjustments required. The results are within specification at the measured points.

NOTE Traceability to National Physical Laboratory is over the range -90°C to +90°C.
Traceability to National Institute of Standards and Technology is over the range -75°C to +20°C
Uncertainty of measurement:
+/- 0.20 @ +20°C DP increasing linearly to +/- 0.40 @ -60°C DP then rising linearly to +/- 0.63 @ -75°C DP
+/- 0.31 between +20°C DP and +82°C DP
The uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a level of confidence of approximately 95 %

Approved Signatory *12 Mar 2012*

Michell Instruments Ltd.
www.michell.com

Figure 37 *Typical Calibration Certificate*

Appendix A

Technical Specifications

Appendix A Technical Specifications

Dew-Point Sensor Performance	
Measurement Technology	Chilled Mirror
Measurement Range	RS80: -80 to +20°Cdp (-112 to +68°Fdp) RS90: -90 to +20°Cdp (-130 to +68°Fdp)
Measurement Accuracy*	±0.1°C (±0.18°F)
Reproducibility	±0.05°C (±0.09°F)
Mirror	Gold plated copper
Temperature Measurement	4 wire Pt100, 1/10 DIN class B
Sample Flow Rate	500 to 1000 ml/min (1 to 2.1 scfh)
Sample Gas Pressure	1 MPa (10 barg / 145 psig) max
Remote PRT	
Temperature Measurement	4 wire Pt100, 1/10 DIN class B
Measurement Accuracy	±0.1°C (±0.18°F)
Cable Length	2m (6.6ft) (250m (820ft) max)
Flow Sensor	
Measurement Range	0 to 1000 ml/min (0 to 2.1 scfh)
Optional Integrated Pressure Sensor	
Measurement Range	0 to 1.6 MPa (0 to 16 bara / 0 to 232 psia)
Measurement Accuracy	0.25% Full Scale
Measurement Units	barg, psig, kPa, MPa
Monitor	
Resolution	User selectable to 0.001, depending on parameter
Measurement Units	**Moisture**: °Cdp or °Fdp, % RH, g/m^3, g/kg, ppm$_V$, ppm$_W$ (SF_6) **Temperature**: °C or °F **Pressure**: barg, psig, kPa, MPa
Outputs	**Analog**: Three channels, user selectable 4-20 mA, 0-20 mA or 0-1 V **Digital**: USB and Modbus TCP (over Ethernet) **Alarm**: Two volt free changeover contacts, one process alarm, one fault alarm; 1 A @ 30 V DC
HMI	5.7" LCD with touchscreen, white on blue graphics
Data Logging	SD Card (512 Mb supplied) and USB interface. Supports SD Card (FAT-32) - 32 Gb max. that allows 24 million logs or 560 days, logging at 2 second intervals
Environmental Conditions	+5 to +30°C (+41 to +86°F) max 80% RH
Power Supply	85 to 264 V AC, 47/63 Hz
Power Consumption	250 VA
Mechanical Specification	
Dimensions	188.9 x 440 x 479.3mm (7.358 x 17.323 x 18.870") (h x w x d)
Weight	22.4kg (49.38lbs)
Sample Gas Circuit	316 Stainless steel
Sample Gas Connections	**Inlet:** 1/4" VCR (MALE) **Outlet:** 1/4" Swagelok (MALE)
Optional Integrated Sample Pump	Flow rate: 1.4l/min maximum Sample gas connections: 1/4" Swagelok (MALE) with bypass loop
General	
Calibration	5-point in-house calibration, national standards traceable as standard UKAS accredited calibrations optional – please consult factory

* Measurement accuracy means maximum deviation between instrument under test and corrected reference. To this must be added the uncertainties associated with the calibration system and the environmental conditions during testing or subsequent use.

Figure 38 *Operational Range*

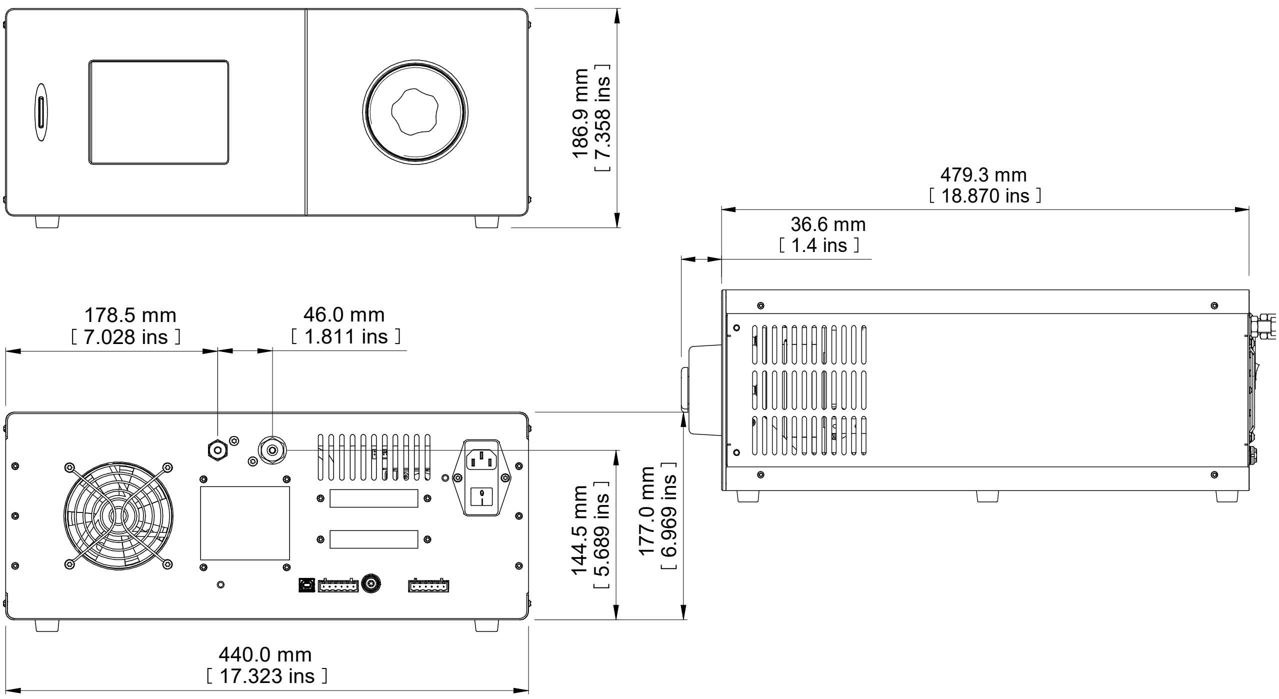


Figure 39 *S8000 RS Dimensions*

Appendix B

Default Set-Up Parameters

Appendix B Default Set-Up Parameters

Sub Menu	Parameter	Value	Unit
MAIN SCREEN	Top Readout Parameter Mid Readout Parameter Bottom Readout Parameter	Dewpoint ppm_V Flow	
DCC	Display Hold Period/Duration Setpoint Interval/Measurement Time Output Hold/Hold Duration	0 (Off) 4 20 4 20	minutes minutes ºC hours minutes
LOGGING	Interval	5	seconds
DISPLAY	Resolution Primary Unit/Temperature Unit Pressure Unit Stability Time FAST PRT Mode Language Brightness/Display Contrast	3 ºC bara 1 On Internal English 100	decimal places minute %
OUTPUTS	Output 1 Parameter Output 2 Parameter Output 3 Parameter Output 1 Type Output 2 Type Output 3 Type Output 1 Min Output 1 Max Output 2 Min Output 2 Max Output 3 Min Output 3 Max	Dewpoint ppm_V Flow 4-20 mA 4-20 mA 4-20 mA -80 20 0 3000 0 1000	 ºC ºC ppm_V ppm_V ml/min ml/min
ALARM	Parameter Setpoint	Dewpoint 0	 ºC
COOLER	Mode Setpoint	Automatic N/A	

Table 18 *Default Set-Up Parameters*

Appendix C

Modbus Holding Register Map

Appendix C Modbus Holding Register Map

All the data values relating to the S8000 RS are stored in holding registers. Each of these registers is two bytes (16-bits wide). Some of these registers contain instrument specific values e.g. its own unique system address, IP address values, etc. Others registers hold specific real time data e.g. measured dew-point and temperature.

Each Modbus message has a two part address code, one for the low byte (bits 0 through 7) and one for the high byte (bits 8 through 15). The facility exists for multiple registers, specified by a high and low byte contained in the query message, to be addressed and read by the same message.

The table below describes the instruments' registers with their respective address locations, together with their relevant register configurations and register map definitions. **Note: Hexadecimal (Hex) addresses marked with an asterisk denote instrument specific parameters stored in the instrument's flash memory.**

The register maps below the table define the data allocated to each bit/byte for each register type.

Address Dec	Address Hex	Function	Read/ Write	Default Value	Register Confi-guration	Register Map Definition
0	0000*	Instrument Address	R/W	0001H	H	INSTID
1	0001	Dew point Value – Hi Word	R		N	HUMIDITY_HI
2	0002	Dew point Value – Lo Word	R		N	HUMIDITY_LO
3	0003	Ambient Temperature – Hi Word	R		N	AMBTEMP_HI
4	0004	Ambient Temperature – Lo Word	R		N	AMBTEMP_LO
5	0005	RH	R		A	RH
6	0006	Pressure Value	R		J	PRESSURE
7	0007	Ppm_V – Hi Word	R		N	PPMV_HI
8	0008	Ppm_V – Lo Word	R		N	PPMV_LO
9	0009	Ppm_W(sf6) – Hi Word	R		N	PPMWSF_HI
10	000A	Ppm_W(sf6) – Lo Word	R		N	PPMWSF_LO
11	000B	g/m^3 - Hi Word	R		N	GM3_HI
12	000C	g/m^3 - Lo Word	R		N	GM3_LO
13	000D	g/kg – Hi Word	R		N	GKG_HI
14	000E	g/kg – Lo Word	R		N	GKG_LO
15	000F	Flow Value	R		H	FLOW_RATE
16	0010	Mirror Condition	R		J	MIRROR_COND
17	0011	Heat Pump Drive	R		H	HP_DRIVE
18	0012	Status	R		D	STATUS
19	0013*	DCC period + Hold Time Duration minutes	R/W		K	DCC_HOLD_TIME
20	0014*	DCC Interval Hours + Minutes	R/W		K	MEASURE_TIME
21	0015	Phase Time Hours	R		L	PHASE_TIME_HRS
22	0016	Phase Time Minutes + Phase Time Seconds	R		K	PHASE_TIME_ MIN_SEC
23	0017*	Film thickness setting	R/W		A	FILM_THICKNESS

24	0018	Live film thickness value	R		A	LIVE_FILM_ THICKNESS
25	0019*	Analog 1 output maximum value	R/W		M	MAX_MA1
26	001A*	Analog 1 output minimum value	R/W		M	MIN_MA1
27	001B*	Analog 2 output maximum value	R/W		M	MAX_MA2
28	001C*	Analog 2 output minimum value	R/W		M	MIN_MA2
29	001D*	Analog 3 output maximum value	R/W		M	MAX_MA3
30	001E*	Analog 3 output minimum value	R/W		M	MIN_MA3
31	001F*	Analog output configuration 1	R/W		B	OP_SELECTION1
32	0020*	Analog output configuration 2	R/W		B	OP_SELECTION2
33	0021*	Logging Interval	R/W		H	LOG_INTERVAL
34	0022*	Units/ Command	R/W		E	UNITSCOMMAND
35	0023*	Mirror Temp Set-Point during DCC	R/W		A	MIRROR_TEMP _SETP
36	0024*	Emitter Drive	R/W		H	EMITTERDRIVE
37	0025	Stability Time	R/W		H	STABILITY_TIME
38	0026	RTC Year(val1) + Month (val2)	R/W		K	YEARMONTH
39	0027	RTC Date (val1) + Hours(val2)	R/W		K	DATEHRS
40	0028	RTC Mins(val1) + Secs (val2)	R/W		K	MINSSECS
41	0029*	Display Setting 1	R/W		F	DISPLAY_ SETTING1
42	002A*	Display Setting 2	R/W		F	DISPLAY_ SETTING2
43	002B	N/A				
44	002C	N/A				
45	002D	N/A				
46	002E	Filename DDMM or MMDD	R		L	FILENAME_DDMM
47	002F	Filename HHMM	R		L	FILENAME_HHMM
48	0030*	Firmware Version Number	R		A	FIRM_VER
49	0031	N/A				
50	0032	N/A				
51	0033*	N/A				
52	0034*	Process Alarm Configuration / Display Brightness.	R/W		P	ALARMCONFIG_ DISPCONT
53	0035*	Process Alarm Set Point	R/W		M	PROCESSALARM_ SP_HI
181		IP Address – octets 1 and 2	R/W	n/a	T	IPADDR1
182		IP Address – octets 3 and 4	R/W	n/a	T	IPADDR2

183		Default Gateway– octets 1 and 2	R/W	n/a	T	DGADDR1
184		Default Gateway – octets 3 and 4	R/W	n/a	T	DGADDR2
185		Subnet Mask – Hi Word - octets 1 and 2	R/W	n/a	T	NMASK1
186		Subnet Mask – Lo Word - octets 3 and 4	R/W	n/a	T	NMASK2
187		Ethernet Status	R/W	0x0000	U	ETHSTATUS

Table 19 *Register Map*

Register Configuration A

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r

Value

Sign bit = 1 for –ve values (signed int)
7FFF = 327.67
8000 = -327.68
The value in bits (15 to 0) + 1 is divided by 100 to give 0.01 resolution for dew point and temperature values

Register Configuration B - Analog Output Configuration 1

<table>
<tr><td>15</td><td>14</td><td>13</td><td>12</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td colspan="8">Analog O/P 2</td><td colspan="8">Analog O/P 1</td></tr>
<tr><td>r/w</td><td>r/w</td><td>r/w</td><td>r/w</td><td>r/w</td><td>r/w</td><td>r/w</td><td>r/w</td><td>r/w</td><td>r/w</td><td>r/w</td><td>r/w</td><td>r/w</td><td>r/w</td><td>r/w</td><td>r/w</td></tr>
<tr><td colspan="8">DP = 00000000
temp = 00000001
Ppm(V) = 00000010
Ppm(W) sf6 = 00000011
g/kg = 00000100
g/m³ = 00000101
pressure = 00000110
flow = 00000111
rh = 00001000
temp difference = 00001001</td><td colspan="8">DP = 00000000
temp = 00000001
Ppm(V) = 00000010
Ppm(W) sf6 = 00000011
g/kg = 00000100
g/m³ = 00000101
pressure = 00000110
flow = 00000111
rh = 00001000
temp difference = 00001001</td></tr>
</table>

Register Configuration B - Analog Output Configuration 2

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
								Analog O/P 3							
r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w
		Analog O/P 3 00 = 0- 20mA 01= 4-20mA 10 = 0-1V		Analog O/P 2 00 = 0- 20mA 01= 4-20mA 10 = 0-1V		Analog O/P 1 00 = 0- 20mA 01= 4-20mA 10 = 0-1V		DP = 00000000 temp = 00000001 Ppm(V) = 00000010 Ppm(W) sf6 = 00000011 g/kg = 00000100 g/m^3 = 00000101 pressure = 00000110 flow = 00000111 rh = 00001000 temp difference = 00001001							

Register Configuration D - Status Word

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
r/w	r/w	r/w	r/w	r/w	r	r	r	r/w	r/w	r	r	r	r	r	r
1= Optics Reset	1= Display hold	1= Max Cool Initiate	1= DCC initiate (toggle ON/OFF)	1= Start Logging 0= Stop Logging	1= FAST (Frost Assurance)	1= Fault Alarm	1= Humidity Alarm	1= External PRT	1= Initiate Standby	In-control = 00 Heating = 01 Cooling = 10		Measurement = 0000 DCC = 0001 Data Hold = 0010 Max Cool = 0100 Standby = 1000			

Register Configuration E - Units

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w
Language ENGLISH 0 GERMAN 1 SPANISH 2 FRENCH 3 ITALIAN 4 PORTUG 5 USA 6 RUSSIAN 13 CHINESE 15				Reset defaults	1 = FAST Enable	1 DP = 00H 2 DP = 01H 3 DP = 10H		N/A	SENSOR COOLER AUTO/MANUAL M → 1, A → 0	Psig = 00H Bara = 01H Kpa = 10H Mpag = 11H		Moisture Content Calculation 0 = dry basis; 1 = wet basis	%rh calculation over water/ice 0= over water	N/A	°C = 0 °F = 1

Register Configuration F - Display Setting A & B

A

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Display 2								Display 1							
r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w
DP = 00000000 temp = 00000001 Ppm(V) = 00000010 Ppm(W) sf6 = 00000011 g/kg = 00000100 g/m^3 = 00000101 pressure = 00000110 flow = 00000111 rh = 00001000 temp difference = 00001001								DP = 00000000 temp = 00000001 Ppm(V) = 00000010 Ppm(W) sf6 = 00000011 g/kg = 00000100 g/m^3 = 00000101 pressure = 00000110 flow = 00000111 rh = 00001000 temp difference = 00001001							

B

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Main Value to Log								Display 3							
r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w
DP, Temp, Press and Flow are logged by default Ppm(V) = 00000010 Ppm(W) sf6 =00000011 g/kg = 00000100 g/m^3 = 00000101 rh = 00001000 temp difference = 00001001								DP = 00000000 temp = 00000001 Ppm(V) = 00000010 Ppm(W) sf6 = 00000011 g/kg = 00000100 g/m^3 = 00000101 pressure = 00000110 flow = 00000111 rh = 00001000 temp difference = 00001001							

Register Configuration H

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w

Unsigned integer. Range = 0 to 65535

Register Configuration J

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r

Value

Sign bit = 1 for –ve values (signed int)
7FFF = 3276.7
8000 = -3276.8
The value in bits (15 to 0) + 1 is divided by 10 to give 0.1 resolution for dew point and temperature values.

Register Configuration K

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w

Val 1 Val 2

Val 1 & 2 are in BCD, therefore 10H = 10, 58H = 58 and 09H = 9 etc., so as a result A to F are not valid values

Register Configuration L

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w	r/w

Val 1 Val 2

Values in HEX i.e. 17th March = 11H for Val1 and 03H for Val2

Register Configuration M - signed int

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
r	r	r	r	r	r	r	r	r	r	r	r	r	r	r	r

Value

Sign bit = 1 for –ve values (signed int)
7FFF = 32767
8000 = -32768

Register Configuration N - Floating Point Representation.

The humidity values for sensors 1 & 2 are represented in IEEE-754 single precision floating point format, in order to cater for the wide range in the value of ppm(v). This format is 'Big Ended' which means that the Hi byte is at a lower address in memory than the Lo byte, and is represented as such in the register memory map. The IEEE-754 format is shown below:

Bit 31	**Bits 30 to 23**	**Bits 22 to 0**
Sign Bit 0 = + 1 = -	Exponent Field Has a +127 bias value	Mantissa Decimal representation of binary Where 1.0 ≤ value < 2.0

Examples of floating point to HEX are shown below:

Example 1 +10.3

Sign bit = 0
Exponent = 3, therefore exponent field = 127 + 3 = 130, and bits 30 to 23 =10000010

The mantissa = 1.2875 which in binary representation = 1.01001001 1001 1001 1001 101

Adjusting the mantissa for the exponent moves the decimal point to the right if positive and to the left if negative

As the exponent is = 3 then the mantissa becomes = 1010.0100 1100 1100 1100 1101, therefore:-

1010 = (1x23 + (0x22) + (1x21) + (0x20) = 10 and
0100 1100 1100 1100 1101 = (0x2-1) +(1x2-2) +....+ (1x2-20) = 0.3

Therefore the word value = 0100 0001 0010 0100 1100 1100 1100 1101 = 4124CCCD

Consequently for sensor 1, register 0001 = 4124 and register 0002 = CCCD

Example 2 - 0.0000045

Sign bit = 1
Exponent = -18, therefore exponent field = 127 + (-18) = 109, and bits 30 to 23 = 01101101

The mantissa = 1.179648 which in binary representation = 1.00101101111111010110101

i.e. (1x2-18) +(1x2-21) + (1x2-23) etc = 0.0000045

Therefore the word value = 1011 0110 1001 0110 1111 1110 1011 0101 = B696FEB5

Consequently for sensor 1 register 0001 = B696 and register 0002 = FEB5

Appendix D

Quality, Recycling & Warranty Information

Appendix D Quality, Recycling & Warranty Information

Michell Instruments is dedicated to complying to all relevant legislation and directives. Full information can be found on our website at:

www.michell.com/compliance

This page contains information on the following directives:

- ATEX Directive
- Calibration Facilities
- Conflict Minerals
- FCC Statement
- Manufacturing Quality
- Modern Slavery Statement
- Pressure Equipment Directive
- REACH
- RoHS3
- WEEE2
- Recycling Policy
- Warranty and Returns

This information is also available in PDF format.

Appendix E

Analyzer Return Document & Decontamination Declaration

Appendix E Analyzer Return Document & Decontamination Declaration

Decontamination Certificate

IMPORTANT NOTE: Please complete this form prior to this instrument, or any components, leaving your site and being returned to us, or, where applicable, prior to any work being carried out by a Michell engineer at your site.

Instrument			Serial Number	
Warranty Repair?	YES	NO	Original PO #	
Company Name			Contact Name	
Address				
Telephone #			E-mail address	
Reason for Return /Description of Fault:				

Has this equipment been exposed (internally or externally) to any of the following? Please circle (YES/NO) as applicable and provide details below		
Biohazards	YES	NO
Biological agents	YES	NO
Hazardous chemicals	YES	NO
Radioactive substances	YES	NO
Other hazards	YES	NO
Please provide details of any hazardous materials used with this equipment as indicated above (use continuation sheet if necessary)		
Your method of cleaning/decontamination		
Has the equipment been cleaned and decontaminated?	YES	NOT NECESSARY

Michell Instruments will not accept instruments that have been exposed to toxins, radio-activity or bio-hazardous materials. For most applications involving solvents, acidic, basic, flammable or toxic gases a simple purge with dry gas (dew point <-30°C) over 24 hours should be sufficient to decontaminate the unit prior to return.
Work will not be carried out on any unit that does not have a completed decontamination declaration.

Decontamination Declaration

I declare that the information above is true and complete to the best of my knowledge, and it is safe for Michell personnel to service or repair the returned instrument.

Name (Print)		Position	
Signature		Date	

MICHELL Instruments

F0121, Issue 2, December 2011

MICHELL
Instruments

http://www.michell.com