MICHELL Instruments
A PST BRAND

S8000 -100
Chilled Mirror Hygrometer
User Manual

97606 Issue 1
June 2021

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

Use this information when contacting Michell Instruments for service purposes.

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Serial Number	
Invoice Date	
Installation Location	
Tag Number	

S8000 -100

For Michell Instruments' contact information please go to
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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 competent personnel using 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.

Pressure Safety

DO NOT permit pressures greater than the safe working pressure to be applied to the instrument. The specified safe working pressure is 0.06 MPa (0.6 barg / 8.7 psig). Refer to the Technical Specifications in Appendix A.

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

Calibration

The recommended calibration interval for this instrument is 12 months. The instrument should be returned to the manufacturer, Michell Instruments Ltd, or one of their accredited service agents, for re-calibration.

Safety Conformity

This product meets the essential protection requirements of the relevant EU and US standards and directives. Further details of applied standards may be found in the Technical Specifications in Appendix A.

Abbreviations

The following abbreviations are used in this manual:

barg	bar gauge (100 kPa or 0.987 atm)
ºC	degrees Celsius
ºF	degrees Fahrenheit
DC	direct current
g	grams
in	inch(es)
µm	micrometer
m/sec	meters per second
mA	milliampere
mm	millimetres
MPa	megapascal
Nl/min	normal liters per minute
Nm	Newton meter
oz	ounces
psig	pounds per square inch
RH	relative humidity
scfh	standard cubic feet per hour
fps	feet per second
T	temperature
V	Volts
Ω	Ohms
ø	diameter

Warnings

The 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 -100 is a high-precision laboratory reference instrument 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 0.06 MPa (0.6 barg / 8.7 psig).

The S8000 -100 is capable of measuring dew points as low as -100 °C (-148 °F), and up to a maximum of +20 °C (+68 °F).

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 Thermo-electric cooler (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 Thermo-electric cooler 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 Thermo-electric cooler, by cooling it to an appropriate temperature. This supplements the depression capabilities and enables measurement of very low dew points.

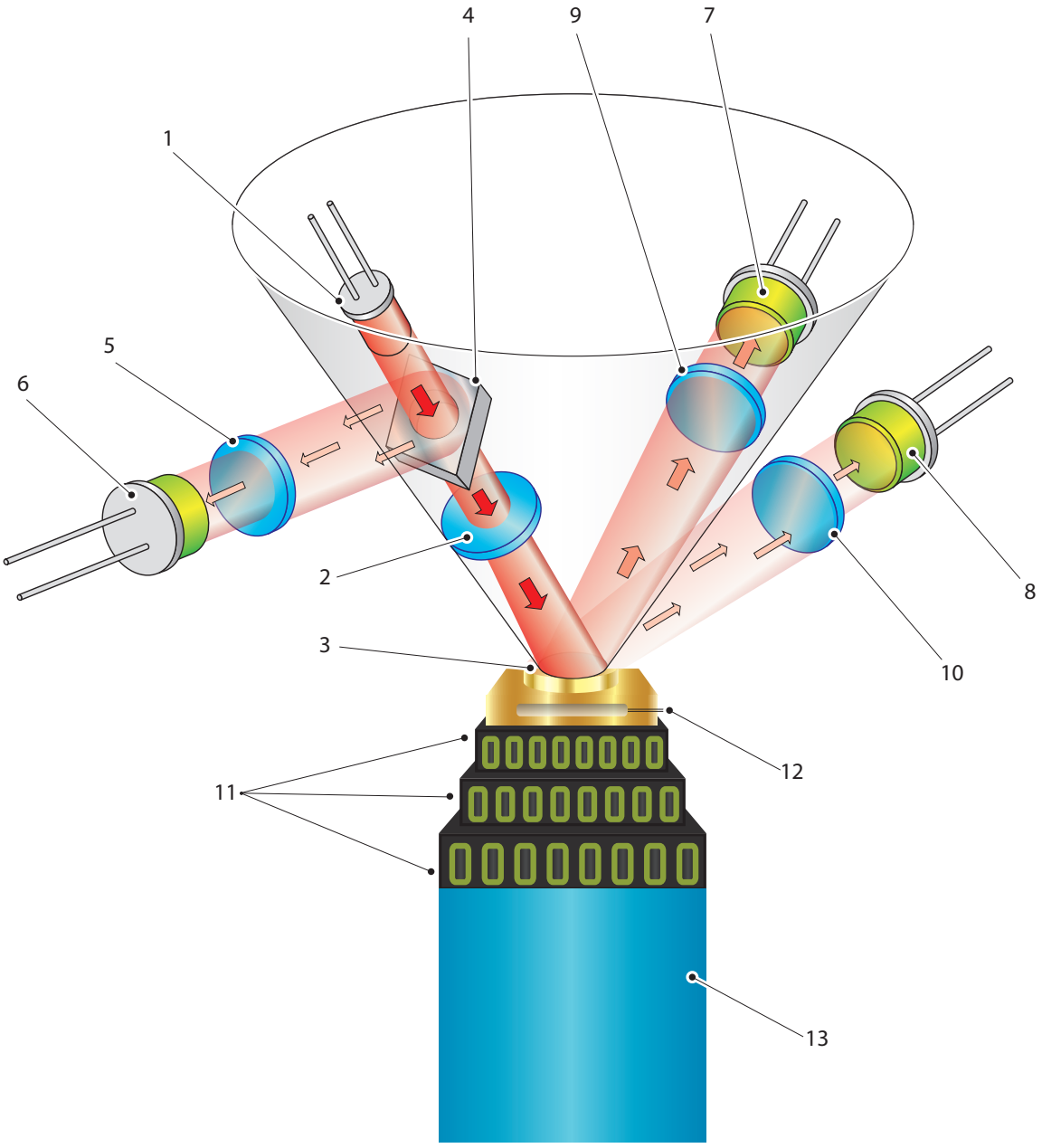


Figure 1 *Operating Principle*

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 S8000 -100 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 removing the instrument.

Carefully lift the unit out, holding the case and not the foam.

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 bolts engaged, may result in warranty claims being denied.

The accessories crate should contain the following items:

- UKAS Accredited calibration certificate
- Pressure transmitter calibration certificate
- SD card
- USB or Ethernet communications cable
- IEC power cable
- Microscope + lens cover
- Remote Pt100 temperature probe (optional)
- Optics cleaning kit (optional)

If there are any shortages, please notify the supplier immediately.

2.3 Transit Bolts

WARNING: The sensor assembly is equipped with transit bolts to prevent vibration damage during shipping. These must be released prior to operation.

To release:

1. Open enclosure door.
2. Insert 5mm Allen key through each access hole in the insulation in turn (see Figure 2).
3. Rotate clockwise until lock bolts reach their end stops.

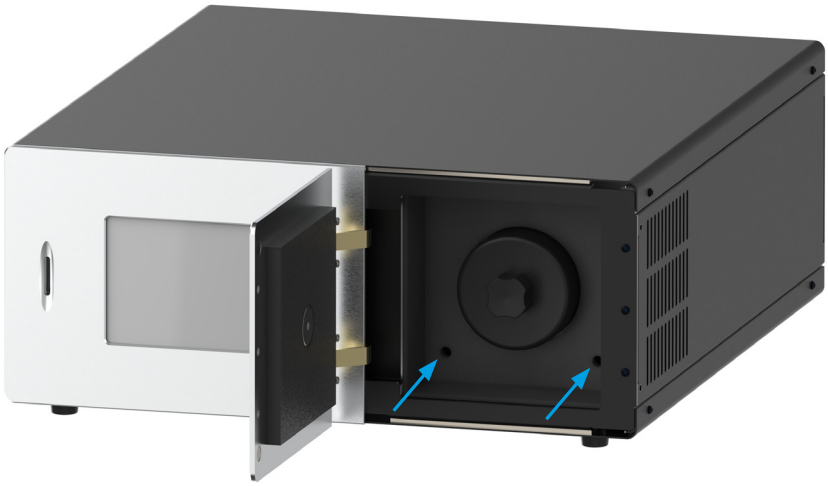


Figure 2 *Transit Bolt Locations*

If the instrument needs to be shipped, then the transit bolts should be engaged before placing into the original packaging.

To engage:

1. Open the enclosure door.
2. Insert 5mm Allen key through each access hole in the insulation in turn (see Figure 2).
3. Rotate anti-clockwise until lock bolts reach their end stops.

2.4 Operating Requirements

2.4.1 Environmental Requirements

It is important to operate the S8000 -100 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 -100 requires the following electrical supply:

- 85...264 V AC, 47/63 Hz, 185 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 30 V, 1A. NOTE: THIS RATING MUST NOT BE EXCEEDED.

2.4.2.1 Front Panel

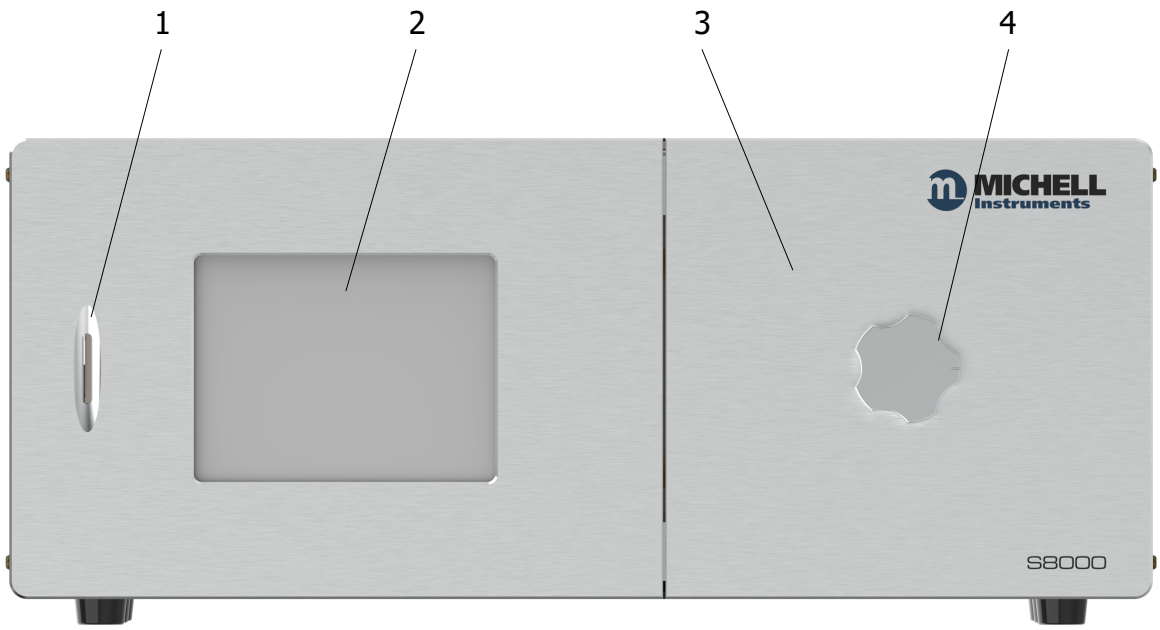


Figure 3 *Front Panel*

No	Name	Description
1	SD Card Slot	Takes an SD card used to store logged data See Section 3.5.8 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 3.5 for information about the touch screen and menu system
3	Sensor Housing	Door covering the sensor chamber See Section 5.1 for instructions on how to open the sensor and clean the mirror
4	Microscope port cap	Cap covering the microscope port when not in use. Also used as the key to open the sensor window. See Section 5.1 for further details.

Table 1 *Front Panel Controls*

2.4.2.2 Rear Panel Connections

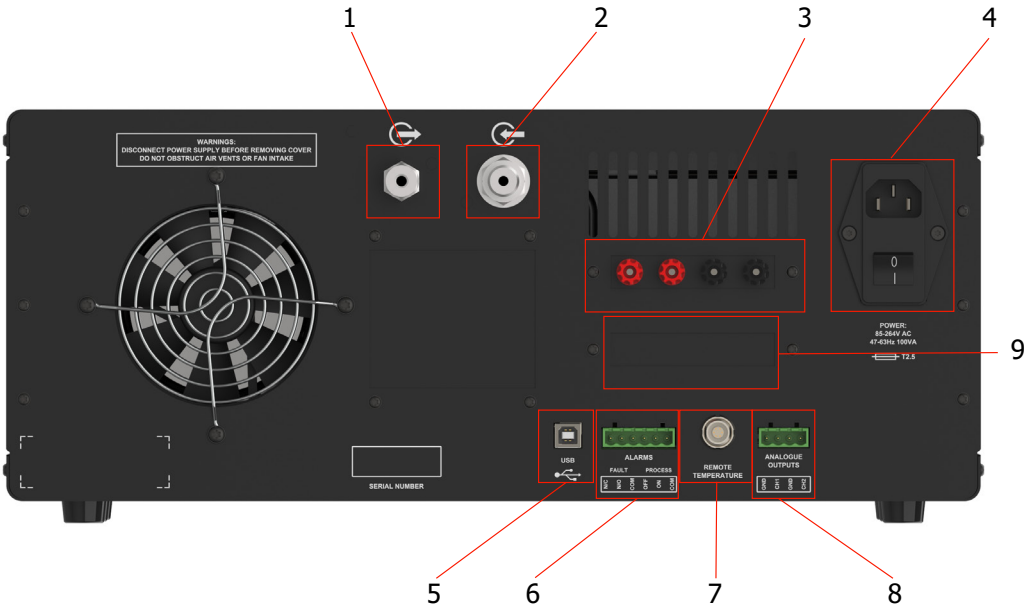


Figure 4 *Rear Panel*

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 2.4.8 for more information.
4	Mains power IEC Socket	Universal power input 85...264 V AC, 47/63 Hz Fuse - 3.15 A, Anti-Surge, Glass, 20mm x 5mm Features integrated power **ON/OFF** switch
5	USB Type B socket	Used for communication with the instrument via the application software
6	6-Way Alarm Relay Connector	Process and Fault alarm outputs See Section 2.4.6 for general information on the alarm relays See Section 3.5.10 for instructions on how to configure the process alarm
7	Remote Temperature Probe Connector	6-Pin Lemo socket for connection of remote Pt100 temperature probe
8	4-Way Analog Output Connector	Two configurable 2-wire channels providing 0...20 mA or 4...20 mA output. The outputs are active (sourcing) and must be connected to a passive (sinking) input on the receiving equipment. See Section 3.5.9 for instructions on how to configure the analog outputs
9	Additional Comms Socket (Optional)	Either a DB9 socket (RS232 or RS485 comms option), or RJ45 (ethernet comms option). Used for digital communication. See Section 2.4.10 for details on how to configure the network settings

Table 2 *Rear Panel Connections*

These tasks should only be undertaken by competent personnel.

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.

2.4.3 Power Supply Input

The AC power supply is a push fit into the IEC C13 power input socket.

Ensure the power switch is OFF before connecting the cable.

The voltage range is 85...264 V AC, 47/63 Hz.

2.4.4 Microscope installation

To prevent any disturbance to the frost formation on the mirror, when required the microscope should be installed prior to starting a measurement. The microscope lens cover should be placed over the eyepiece when the mirror is not being observed.

1. Remove the gas block key from the enclosure door by rotating it until the retaining lugs align with the slots in the panel.
2. Open the enclosure door.
3. Remove the microscope blanking plug from the sensor cap and close the enclosure door.
4. Install the microscope in the sensor cap by inserting through the opening in the enclosure door.
5. Place the lens cover over the eyepiece.

Figure 5 *Microscope Installation Procedure*

2.4.5 Analog Output Connections

The two 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 provide a current loop signal (4...20 mA or 0...20 mA). The 0/4...20 mA 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 3.5.5).

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, -100...+20ºC
Channel 2: ppm_v, 0...3000

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 two analog output port connections are made via a single 4-way push fit connector block. 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.

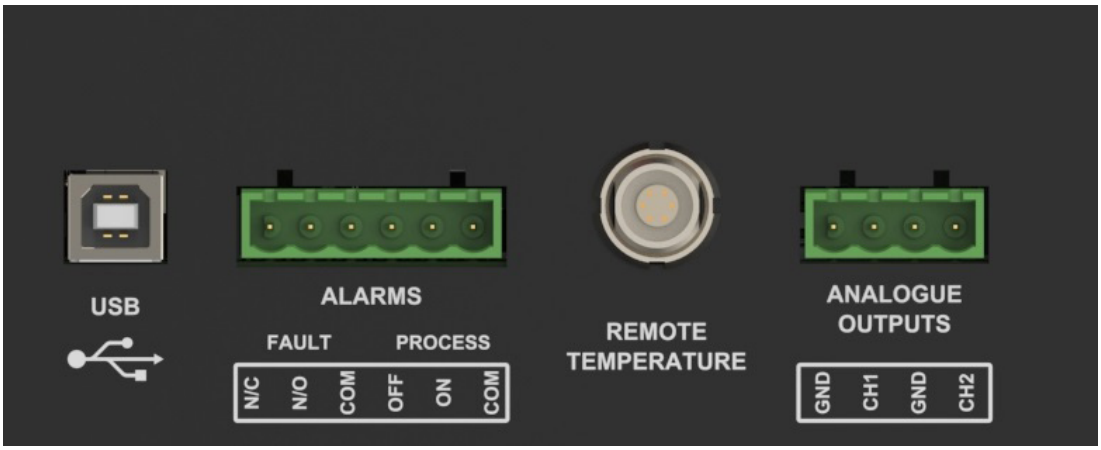


Figure 6 *Alarm and Analog Output Connection*

2.4.6 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 3.5.5), 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 two alarm output ports are connected to the instrument via a single 6-way, push-fit connector block as shown in Figure 6. 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.

DANGER
Electric
Shock Risk

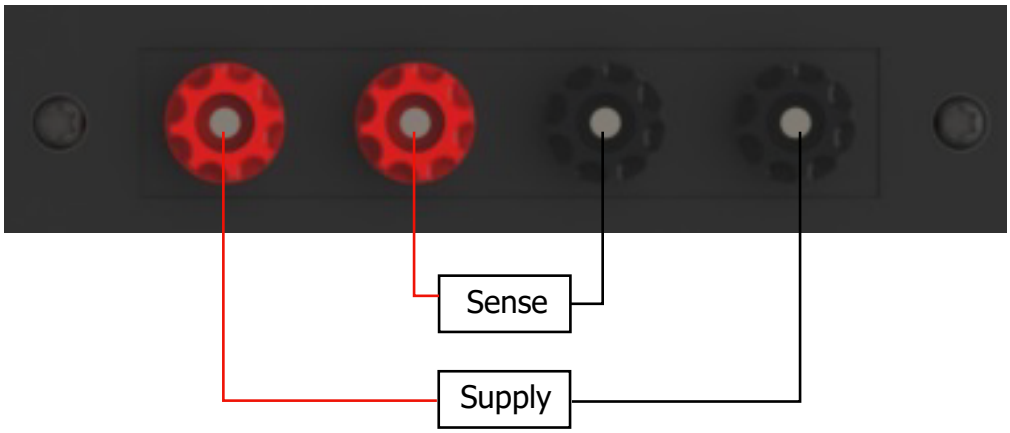
WARNING: Alarm leads MUST be potential free when wiring to the connector block. Both sets of contacts are rated at 30 V, 1A. THIS RATING MUST NOT BE EXCEEDED.

2.4.7 Remote Temperature Probe

1. Align the red dot on the body of the temperature probe connector with the red dot on the socket labelled **REMOTE TEMPERATURE** (see Figure 6).
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 released first.**

2.4.8 Remote Pt100 connections

External connections are provided to allow direct impedance measurement of the mirror Pt100 by an external device. The connections are as follows:



Note that during DCC cycles, the instrument electronics will temporarily switch back to Internal monitoring. Once the measurement phase resumes, the connections will be switched back to External.

The Pt100 can be toggled between Internal and External monitoring in the Extended Settings screen (see Section 3.5.16).

2.4.9 USB Communications Port Connector

The instrument features a USB 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 6 and 7)*.
2. To remove the connector, pull it out of the socket by holding the connector body. **Do not attempt to remove the connector from the socket by pulling on the cable.**

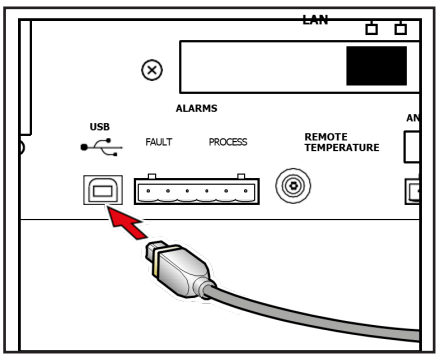


Figure 7 *USB Port Connection*

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 B for the Modbus register map.

2.4.10 Ethernet/RS232/RS485 Port (optional)

The instrument features an optional additional digital communication point. If Ethernet is selected, then an RJ45 socket is present. The protocol used is Modbus TCP.

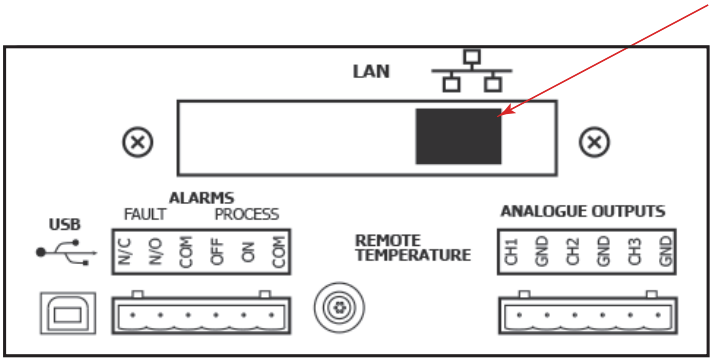


Figure 8 *Ethernet Port*

If RS232 or RS485 are selected, then a standard 9-pin D-sub connector is fitted. The communications protocol used is Modbus RTU. Refer to Appendix B for the Modbus register map.

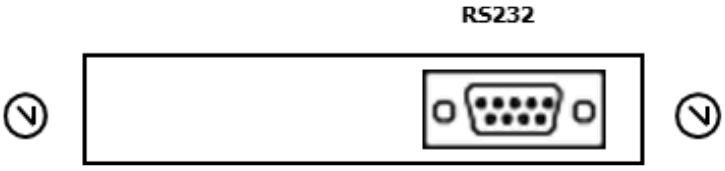
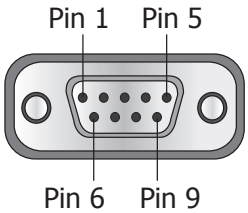


Figure 9 *RS232/485 Port (optional)*

RS232

Pin 2	TXD
Pin 3	RXD
Pin 5	GND

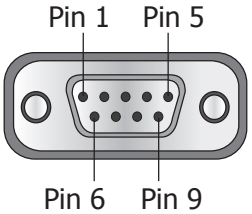
RS232 Pinout (9-pin female)



RS485

Pin 3	A
Pin 5	GND
Pin 8	B

RS485 Pinout (9-pin female)



3 OPERATION

As supplied, the S8000 -100 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, 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 -100 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.
- The recommended flow setting is 750 ml/min (1.6 scfh).
- The sample flow can be adjusted by the installation of a valve in the sample line. Ideally the valve should be installed downstream of the sensor to avoid any influence of moisture ingress on the readings; however, in this configuration care needs to be taken to ensure the flow rates in the system are balanced, otherwise differences in pressure are possible between the hygrometers in the system.
- If the flow control valve needs to be installed upstream of the sensor, a bellows-type valve should be used.

3.2 Operational Functions

3.2.1 Operating Cycle

The default parameters set up for the instrument define an operating cycle, see *Figure 10.*

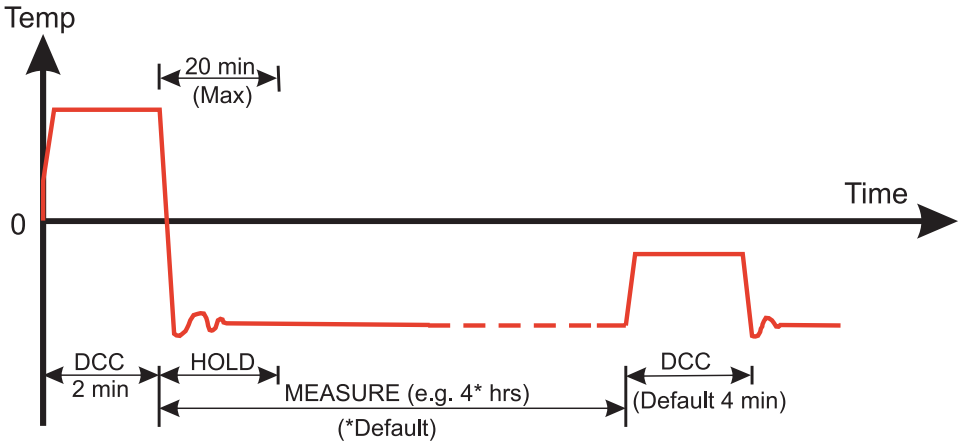


Figure 10 *Typical Operating Cycle*

At initial switch-on, the instrument enters a DCC cycle for 2 minutes. By default, 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**.

If the sensor cooler is in automatic mode, the set point will automatically be adjusted if the dew point is determined to be outside of the mirror's current measurement range.

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**.

3.3 Operating Guide

3.3.1 Automatic Mode

3.3.1.1 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). 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) and repeat the process of cooling the mirror until condensation is detected.

The instrument will attempt to maintain the sensor temperature around +30 °C (54 °F) above the dew point, increasing or decreasing the sensor temperature set point as appropriate.

If the sensor temperature is less than the 10 °C (18 °F) above the dew point, the sensor cooler set point will increase by 10 °C (18 °F).

If the sensor temperature is greater than 30 °C (54 °F) below the dew point, the cooler set point will decrease by 10 °C (18 °F).

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.

3.3.1.2 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 3.3.1.3, Flood Recovery, for more detail.

Purge Times

When measuring very dry frost points, the instrument needs to be adequately purged with the sample while the sensor is in standby mode. If a measurement is attempted before the instrument internal sample path and associated inlet tubing are close to equilibrium, then a poor frost formation may result. Recommended purge times are as follows:

Frost Point (°C)	Time (hours)
-80	12
-90	24
-100	48

3.3.1.3 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 displaying **Flood** as the Mode in the Operational Status Display.

3.4 Manual Mode

3.4.1 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.

3.4.1.1 Operating Practice

The S8000 -100 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, the 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 -100 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 the dew point.
        ii. The S8000 -100 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...-65 °C (-67...-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.

Purge Times

When measuring very dry frost points, the instrument needs to be adequately purged with the sample while the sensor is in standby mode. If a measurement is attempted before the instrument internal sample path and associated inlet tubing are close to equilibrium, then a poor frost formation may result. Recommended purge times are as follows:

Frost Point (°C)	Time (hours)
-80	12
-90	24
-100	48

3.4.2 Shutdown Procedure

To prevent damage to the instrument, follow this procedure each time the unit needs to be powered off:

1. Set the instrument to Standby.
2. Set the sensor temperature control to manual.
3. Set +20 °C (+68 °F) sensor temperature.
4. Allow the sensor temperature to reach +20 °C (+68 °F) before powering the instrument off.

3.4.3 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 (36 °F) 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 3.5.7.

3.4.4 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.

3.4.5 Pressure Input

The S8000 -100 is 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. The internal pressure transducer is ranged 0...1.6 bara (0...23.2 psia).

3.4.6 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 3.5.8.

3.4.7 Frost Assurance 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 (+32 °F) taken over water will read approximately 10% lower than the same measurement taken over ice.

When turned on and **FAST** is enabled, the S8000 -100 makes an initial dew-point measurement. If the initial measurement is between 0 °C and -40 °C (+32 °F and -40 °F) then the mirror is driven down to below -40 °C (-40 °F) 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 3.5.7.

3.4.8 STANDBY Mode

In **STANDBY** mode, drive to the Thermo-electric cooler is removed. While **STANDBY** mode is enabled, the sensor temperature will remain constant.

The main use for this feature is to allow the instrument to dry down and set the sensor temperature before beginning a measurement.

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.

3.5 User Interface

The S8000 -100 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.

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

3.5.1 Main Screen

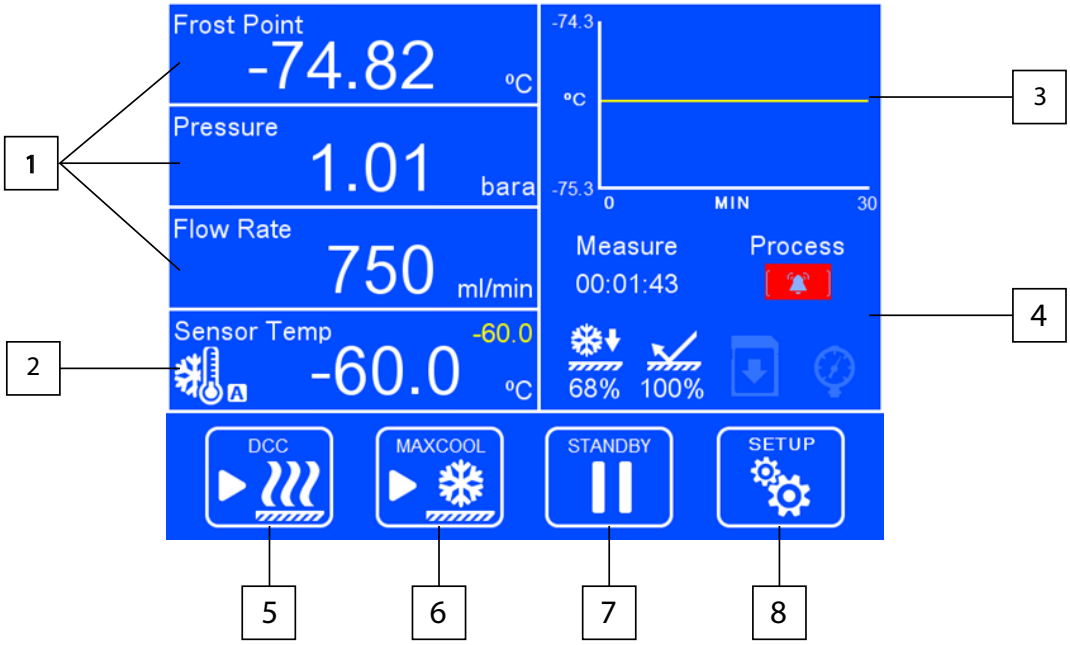


Figure 11 *Main Screen*

No	Name	Description
1	Readouts (Customizable)	Display measured and calculated parameters. See Section 3.5.2 for additional information
2	Sensor Temperature Readout	The main figure in this display is the measured sensor body temperature. The 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 on the left. Refer to Section 3.5.4 for cooler setup parameters. Touch the readout once to display the cooler setup menu.
3	Stability Graph	Plots measured dew point over time. Time base can be changed in display settings. 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 3.5.3.

5	DCC Button	Initiates or cancels a DCC. See Section 3.4.3 for a detailed explanation of the DCC function. See Section 3.5.7 for DCC setup parameters.
6	**MAXCOOL** Button	Initiates or cancels **MAXCOOL** mode. See Section 3.4.4 for a detailed explanation of the **MAXCOOL** function.
7	Measure/STANDBY Button	Toggles between Measure and Standby mode. See Section 3.4.8 for a detailed explanation of standby mode.
8	SETUP Button	Access the Setup Menu. See Section 3.5.6 for information on the menu structure and options.

Table 3 *Main Screen Description*

3.5.2 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
- Pressure
- % Relative Humidity
- g/m^3
- g/kg
- ppm_v
- %Vol
- Twb
- wvp (water vapor pressure)
- Dew Point (pressure corrected)

The parameters displayed by default are Dew point, Pressure 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.

3.5.2.1 Full-Screen Mode

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

3.5.3 Operational Status Display

The Operational Status display includes the following:

Mode	Reports current operational mode. This will either be **Measure, Standby, DCC, Hold**, **Maxcool** or **Flood**.
Next Mode	Shows the time (in Hours: Minutes: Seconds) remaining until the transition to the next mode of operation. If DCC is configured for manual activation only, then this countdown will display --:--:--.
Process	This notification indicates whether a parameter process alarm is either **ON** or **OFF**. The process alarm can be set on any parameter (refer to Section 3.5.10).
Film Thickness 	This figure indicates the quantity of condensate present on the mirror on a % scale. 0% indicates condensate has not yet formed. 100% is the target level, and ±1% indicates the instrument is stable and controlling on the dew/frost point.
TEC Drive 	This symbol changes to indicate that the mirror is either being heated or cooled. The figure indicates the % of the total available cooling or heating power currently being used.
Logging 	Indicates data logging to SD is enabled. Refer to Section 3.5.8.
Pressure compensation 	Indicates dew point is being calculated to atmospheric pressure. Refer to Section 3.5.13.

Table 4 *Operational Status Display*

3.5.4 Cooler Setup

The Cooler Setup screen is accessed by touching **Sensor Temp readout** on the Main Screen. Refer to Section 3.4 for detailed information on the operation of the sensor cooling system.

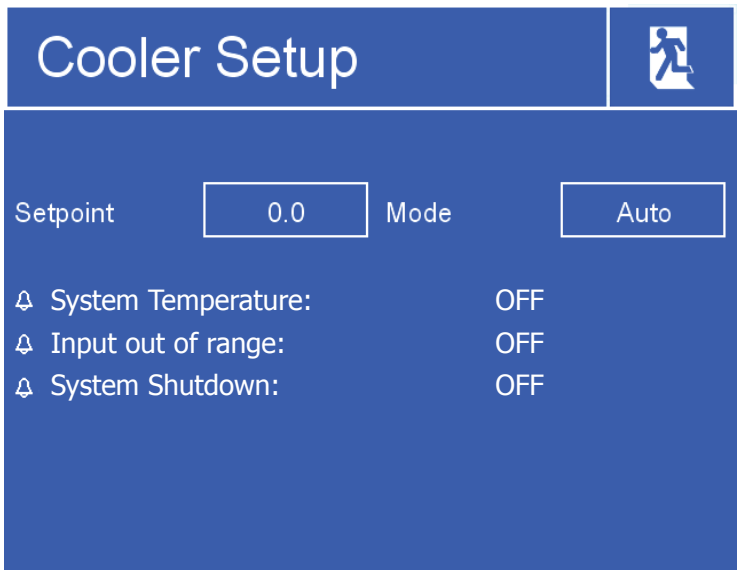


Figure 12 *Cooler Setup Screen*

Parameter	Description
Set-point	Controls the sensor temperature **Limits:** -80…+20
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 (18 °F) 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 -100 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*

3.5.5 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.

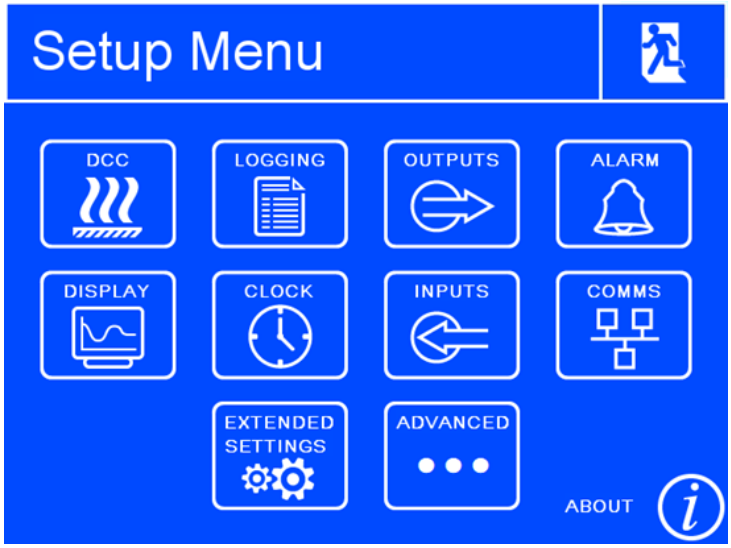


Figure 13 *Setup Menu Screen*

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).

3.5.5.1 Numeric Input

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

Figure 14 *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

3.5.5.2 Leaving Menus

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

3.5.6 Menu Structure

DCC	LOGGING	OUTPUTS	ALARM	DISPLAY	CLOCK	INPUTS	COMMS	EXTENDED SETTINGS
Type Setpoint Mode Interval Period Output Hold FAST FAST SP	Interval	Output Select Output Type Parameter Alarm Minimum Maximum	Type Parameter Setpoint Hysteresis Low Setpoint High Setpoint Contamination Warning Calibrate Optics	Resolution Stability Temp Unit Display Hold Pressure Unit Language Timebase Brightness	Date Time	Temperature input source Value Pressure Compensation	Modbus Address IP Address Subnet Mask Default Gateway	PRT Mode Flood Recovery

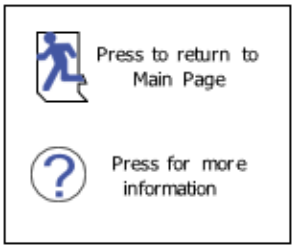


Figure 15 *Menu Structure*

3.5.7 DCC

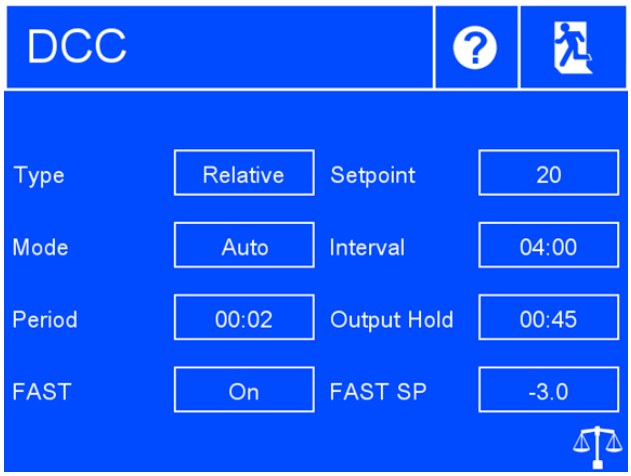


Figure 16 *DCC Screen*

Parameter	Description
Type	DCC heating temperature can either be relative to last measured dew point or an absolute temperature. Actual temperature or Δ is defined by 'Setpoint'. **Available Input:** Relative, Absolute
Setpoint	Mirror heating temperature during DCC, either absolute or relative to last measured dew point. See 'Type' option above. **Available Input:** 1...120 °C
Mode	DCCs can either be triggered automatically at every interval or they can be manually triggered only. **Available Input:** Manual, Auto
Interval	Time between automatic DCCs **Input format:** hh:mm **Limits:** 01:00...99:00
Period	Duration of the DCC **Input format:** hh:mm **Limits:** 00:01...00:59
Output Hold	Minimum time to hold analog outputs after finishing a DCC **Input format:** hh:mm **Limits:** 00:04...00:59
FAST	Turns frost assurance on or off. See Section 3.4.7 for further information **Available Input:** On, Off
FAST SP	Passing this mirror temperature will trigger the frost assurance function without a DCC **Available Input:** -28...-3 °C

Table 7 *DCC Parameters*

3.5.8 LOGGING

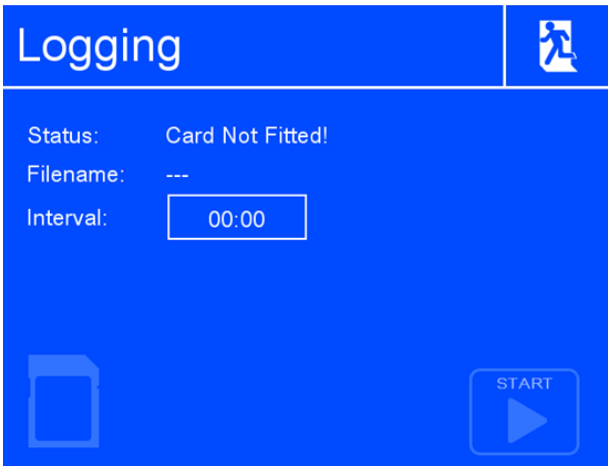


Figure 17 *Logging Screen*

Parameter	Description	
Interval	Changes the interval at which data is recorded **Input format:** mm:ss – **Limits:** 00:05...10:00	
SD status indicator	Indicates status of inserted SD card:	
		No SD Card inserted
		Ready to log
		Initialising card
		Error occurred
		SD Card is write protected
		Logging
START/STOP	Begins a new log (file name is generated automatically) or ends a log in progress.	

Table 8 *Logging Parameters*

3.5.9 OUTPUTS

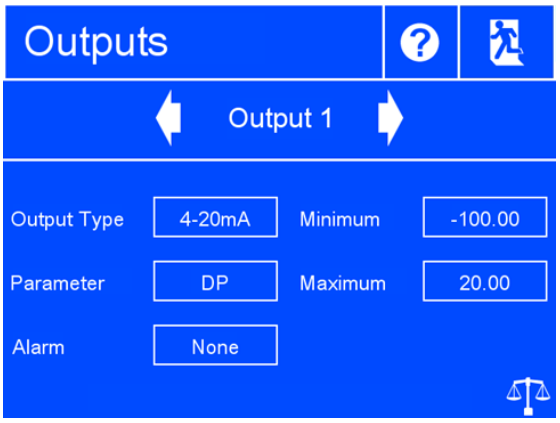


Figure 18 *Outputs Screen*

Parameter	Description
Output Selector Arrows	Selects the output to be adjusted
Output Type	Determines the mA output range **Available Input:** 4...20 mA/0...20 mA
Parameter	Assigns the chosen calculated or measured parameter to this output channel **Available Input:** Dew Point, Temperature, Pressure, % Relative Humidity, g/m^3, g/kg, ppm$_v$, %Vol, Twb, wvp (water vapor pressure), Dew Point (pressure corrected)
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 9 *Outputs Parameters*

3.5.10 ALARM

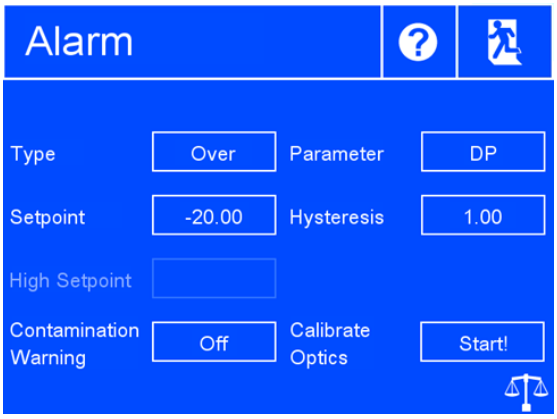


Figure 19 *Alarm Screen*

Parameter	Description
Type	Sets the trip criteria for the process alarm. **Available Input:** Over, Under, In. Band, Out. Band, Off
Parameter	Sets the parameter associated with the process alarm. **Available Input:** Dew Point, Temperature, Pressure, % Relative Humidity, g/m^3, g/kg, ppm_V, %Vol, Twb, wvp (water vapor pressure), Dew Point (pressure corrected)
Setpoint	Sets the trip point for Over or Under alarm types. **Available Input:** Dependent on parameter
Low Setpoint	Sets the low trip point for Band alarm types. **Available Input:** Dependent on parameter
High Setpoint	Sets the high trip point for Band alarm types. **Available Input:** Dependent on parameter
Hysteresis	Sets the deviation from trip point before the alarm deactivates. **Available Input:** Dependent on parameter
Contamination Warning	Sets whether an Optics Warning trips the process alarm. Refer to Section 4.2 for information about the optics warning. **Available Input:** On, Off
Calibrate Optics	It is necessary to run this function whenever the mirror is cleaned, or if a different dew-point sensor is installed. Following this, a DCC will begin.

Table 10 *Alarm Parameters*

3.5.11 DISPLAY

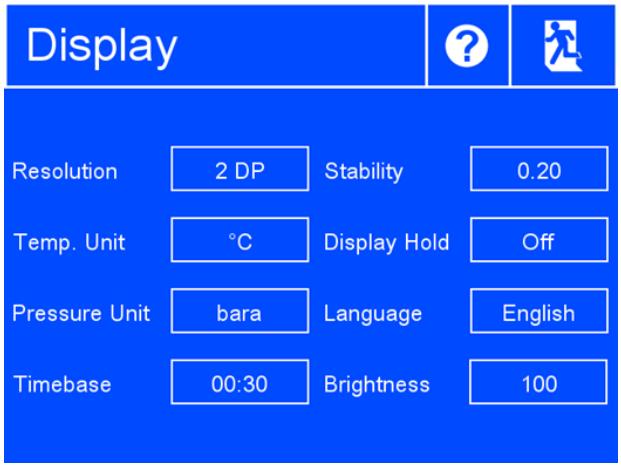


Figure 20 *Display Screen*

Parameter	Description
Resolution	Changes the number of decimal places for all displayed parameters. **Available Input:** 1 DP, 2 DP
Temperature Unit	Measurement unit for temperature values **Available Input:** ºC, ºF
Pressure Unit	Measurement unit for pressure values **Available Input:** kPa, psig, psia, barg, bara
Timebase	X axis span for trend graph on main screen **Input Format:** hh:mm **Limits:** 00:01...10:00
Stability	Determines a stable measurement following DCC, which is conditional to release Data Hold. Entered value is ΔDP over 30s. **Available Input:** 0.2...20
Display Hold	When enabled, values on display are also held during Data Hold. **Available Input:** Off, On
Language	Sets user interface language **Available Input:** English
Backlight	Display backlight control **Available Input:** 0...100%

Table 11 *Display Parameters*

3.5.12 CLOCK

Figure 21 *Clock Screen*

Parameter	Description
Date	Current date
Time	Current time

Table 12 *Clock Parameters*

3.5.13 Inputs

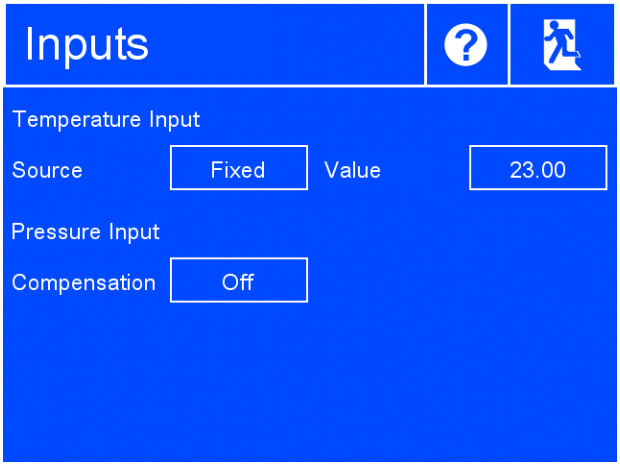


Figure 22 *Inputs Screen*

Parameter	Description
Source (Temperature Input)	Changes between temperature input from external Pt100 or a fixed value. **Available Input:** Fixed, External
Value (If 'Fixed' selected)	Sets temperature used for internal calculations.
Compensation	Recalculate dew point to atmospheric pressure based on measured pressure. **Available Input:** Off, On

Table 13 *Inputs Parameters*

3.5.14 Comms

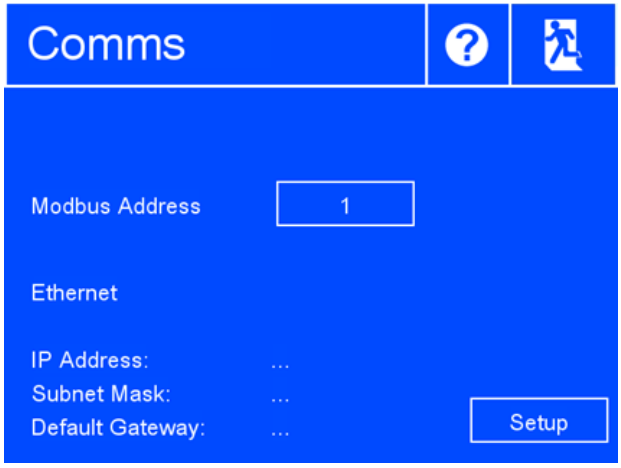


Figure 23 *Comms Screen*

Parameter	Description
Modbus Address	Sets the Modbus slave address
Setup	Access the TCP/IP Network Settings page

Table 14 *Comms Parameters*

3.5.15 Network Settings

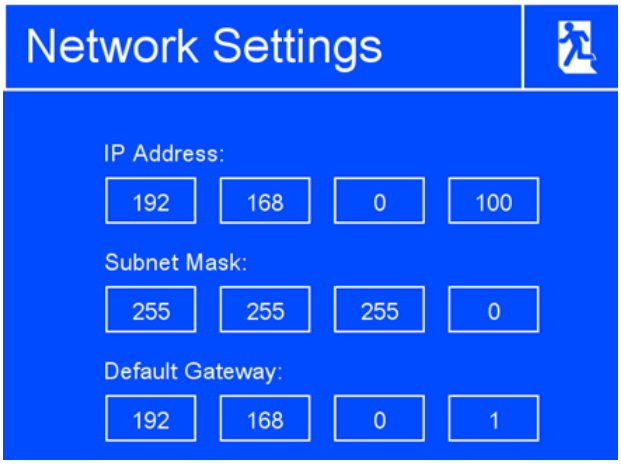


Figure 24 *Network Settings Screen*

This page is accessible when using an S8000 -100 that is fitted with an Ethernet module.

Parameter	Description
IP Address	The IP address of the instrument
Subnet Mask	Determines network subnet address
Default Gateway	Default gateway address

Table 15 *Network Parameters*

3.5.16 Extended Settings

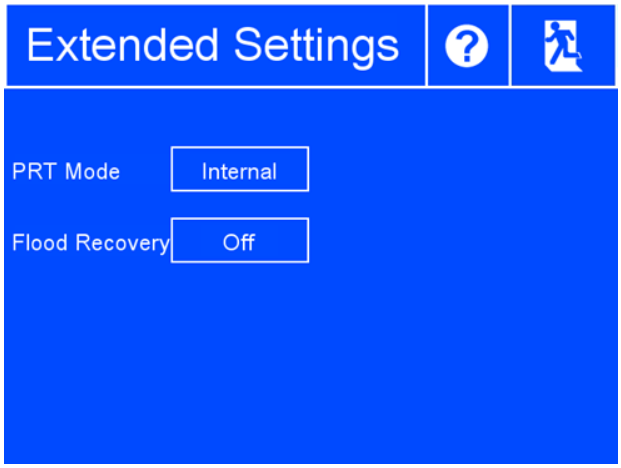


Figure 25 *Extended Settings Screen*

Parameter	Description
PRT Mode	If required for the calibration process or for external monitoring, the internal Pt100 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 Pt100 measurement circuit of the instrument. **Available Input:** Internal, External
Flood Recovery	Sets sensor temperature to +20 °C and initiates an extended DCC if mirror temperature exceeds sensor temperature. See section 3.3.1.3 for further information. **Available Input:** Off, On

Table 16 *Extended Settings Parameters*

4 WARNINGS AND FAULTS

The S8000 -100 contains a comprehensive self-diagnosis system to alert the user whenever there is an issue which could affect the measurement. These alerts are divided into two categories:

Warnings: A problem which is not currently affecting the measurement but requires attention.

Faults: A problem which requires immediate attention. Whenever a fault is triggered, the S8000 -100 will switch to 'Standby' and remain in this mode until the operator intervenes.

When a Fault is present, the System Alarm symbol will appear over the sensor status display on the main screen. Pressing the System Alarm symbol will display all current faults and warnings. At any other time, active warnings can be viewed by pressing the right-hand side of the sensor status display. A system fault will usually be accompanied by one or more warnings, which describe the problem in more detail.

Once a fault has been resolved, it is necessary to run a DCC cycle to return the instrument to normal operation.

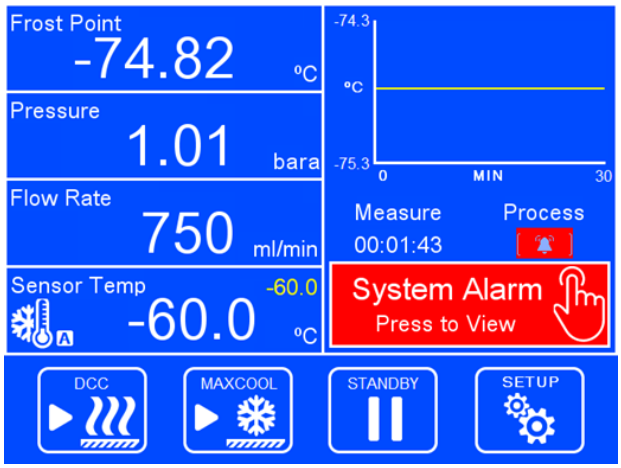


Figure 26 *System Alarm Screen*

4.1 Fault Codes

No.	Name	Description
1	Mirror PRT Failure	Chilled Mirror sensor Pt100 resistance out of range
2	Ambient PRT Failure	Remote Temperature probe Pt100 resistance out of range
3	Chiller PRT Failure	Cold finger Pt100 resistance out of range
4	RESERVED	
5	Mirror temperature too high	Mirror temperature exceeded 130 °C
6	Stirling emergency error	Sensor Cooler control PCB emergency alarm
7	Optics setpoint search failed	Optics calibration failed during DCC
8	Optics outside max. operating limit	Optics reflected signal out of range (high)
9	Optics outside min. operating limit	Optics reflected signal out of range (low)
10	Cooling Saturated timeout	TEC drive in maximum cooling mode beyond allowable time limit
11	Heating Saturated timeout	TEC drive in maximum heating mode beyond allowable time limit
12	RESERVED	
13	Pressure input failure	Pressure transmitter signal <3.6mA or >21 mA
14	Optics contamination	Mirror requires cleaning followed by Optics Calibration
15	Sensor over temperature	Cold finger temperature exceeded 50 °C for >30s.

4.2 Optics Warning

Throughout the life of the instrument, periodic cleaning of the mirror surface and optics window will be required. The frequency of this depends upon operating conditions and the potential in the application for contaminants to be deposited on the mirror.

The S8000 -100 will notify the user on the state of mirror contamination. The instrument will initially give a warning in the sensor status display when contamination is detected but will continue to operate. Cleaning the mirror then pressing the **Calibrate Optics** button is necessary when this warning is displayed. If the contamination reaches levels which will drastically affect performance, a fault alarm will trip, causing the instrument to switch to standby mode until action is taken.

For remote indication of an optics warning, the process alarm contact can be set to trip whenever the optics warning is active. See Section 3.5.10 for further information.

See Section 5.1 for mirror cleaning instructions.

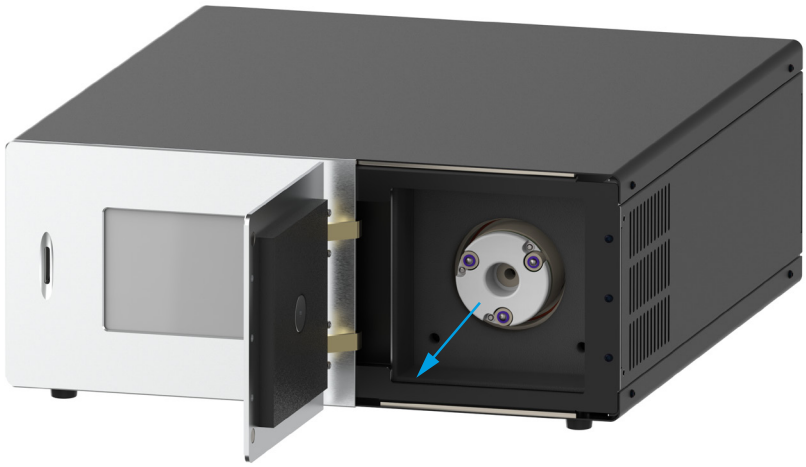
5 MAINTENANCE

5.1 Sensor Mirror Cleaning

The mirror should be cleaned on a regular basis, and prior to any critical measurements. The procedure is as follows:

1. Ensure the instrument is in Standby mode and the sensor temperature is at +20 °C (+68 °F).
2. Open the sensor enclosure door and unscrew and remove the sensor cap.

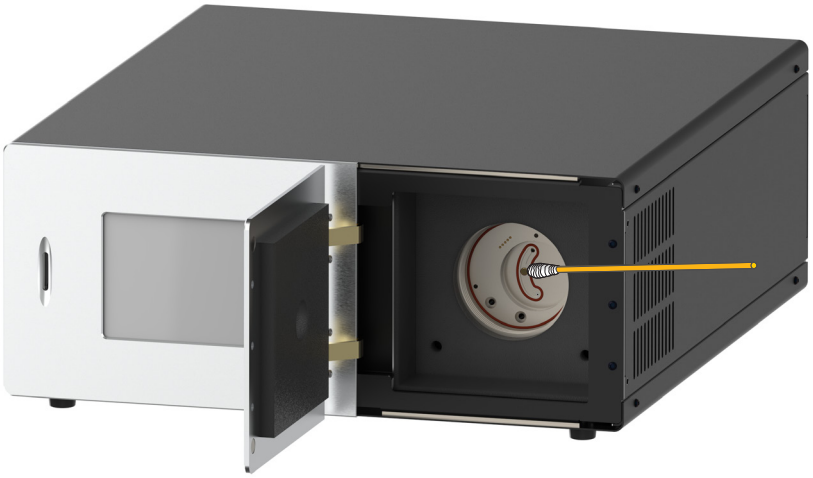
3. Remove the optics assembly by gently pulling it away from the instrument.



4. Remove the gas block key from the sensor enclosure door by rotating it until the retaining lugs align with the slots in the panel. The key is then inserted into the collar of the gas block window. A 5mm Allen key can be used to loosen and remove the window from the sensor. Take care not to touch the interior surface of the window.

5. Clean the mirror surface and interior surface of the gas block window with a laboratory-grade cotton bud soaked in 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 when cleaning. Allow the cleaning solvent to fully evaporate.

6. Finally, clean the surfaces again using a fresh cotton bud moistened with distilled water. This last step is necessary to remove any dry residue left by the alcohol and is an important part of the cleaning process.



7. Reinstall the gas block window using the key. **DO NOT use the Allen key to tighten the window** – sufficient torque can be applied by gripping the lugs on the key with your fingers.

8. Reinstall the optics assembly, onto the location pins, paying attention to the orientation of the contacts.

9. Reinstall the cap and close the enclosure door.

10. Press the 'Calibrate Optics' button in the 'Alarms' screen.

5.2 Fuse Replacement

If the instrument fails to operate after it has been connected to an AC power supply (85... 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, remove the plug, check and, if necessary, replace the fuse. If the instrument still fails to operate after fitting the fuse and switching the power supply on, follow steps 2 to 6 (see *Figure 27).*

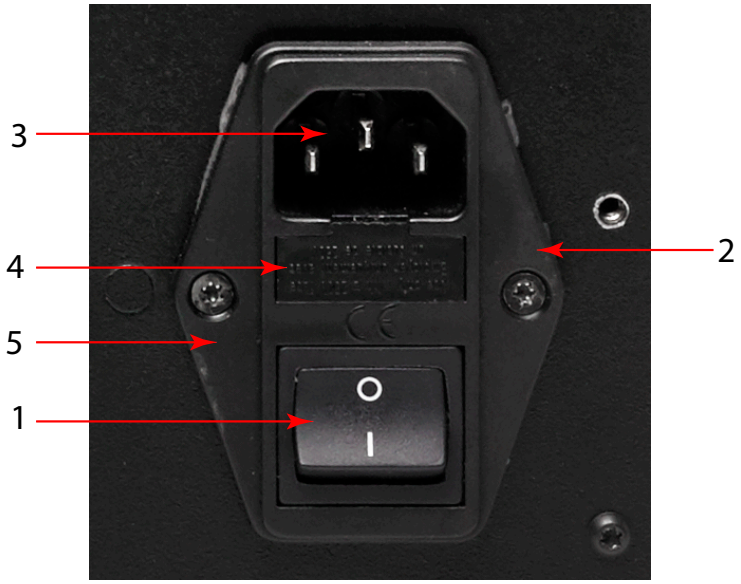


Figure 27 *Power Supply Fuse Replacement*

2. Switch the ON/OFF switch (1) to OFF, isolate the external power supply and remove the IEC power connector (2) from the power socket (3). **NOTE: If access to the rear of the instrument is restricted, e.g. if the instrument is a rack-mounted model, it may be necessary to remove the instrument from the rack.**

3. Locate the fuse carrier (4) and pull it out of the connector housing (5). A small screwdriver inserted under the lip may be useful in order to lever it out.

4. Replace the fuse cartridge (6). **NOTE: It is essential that a fuse of the correct type and rating is fitted to the instrument (20 mm, T-type (2.5 A anti-surge).**

5. Fit a new fuse cartridge (6) into the fuse carrier (4) and push the fuse carrier (4) back into the power connector housing (5).

6. Push the IEC power connector (2) back into the power socket (3), turn on the external power supply and switch on the instrument (1). 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.**

6 APPLICATION SOFTWARE

Application software which can be used for remote monitoring and data logging is available on the Michell Instruments website. A help file is included within the software for guidance on operation.

Appendix A

Technical Specifications

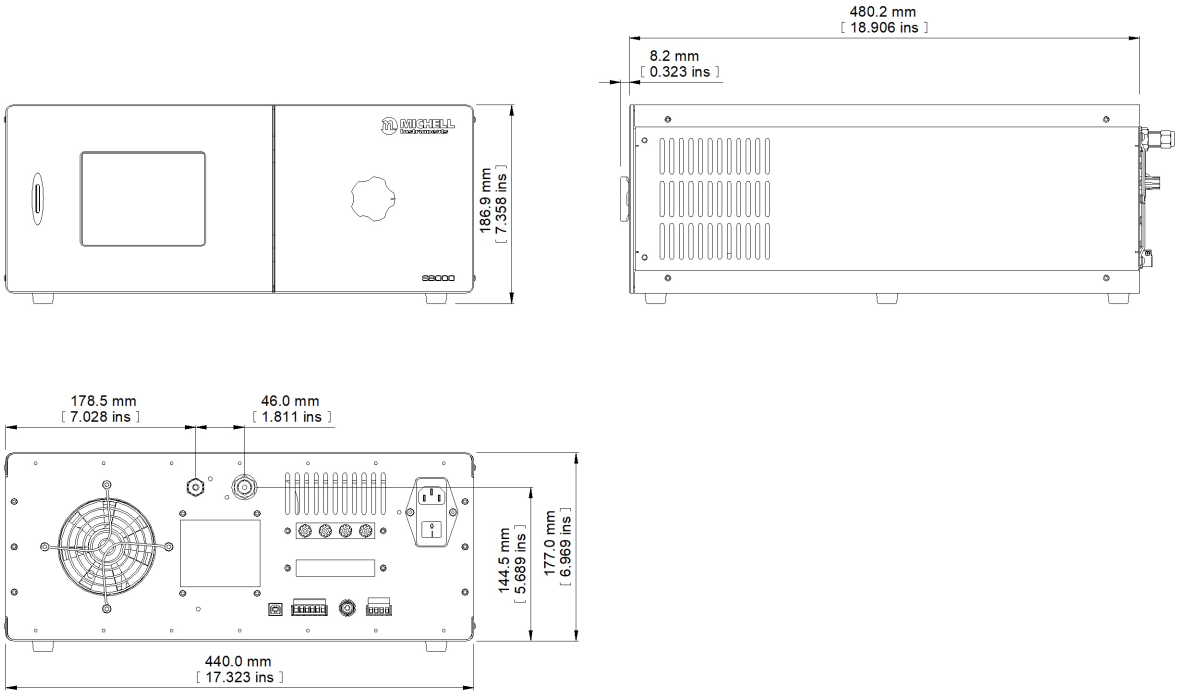
Appendix A Technical Specifications

Dew-Point Sensor	
Measurement Range	-100...+20 °C (-148...+68 °F) frost/dew point
Measurement Accuracy*	±0.1 °C (±0.18 °F)
Reproducibility at -100 °Cfp (-148 °Ffp)	±0.15 °C (±0.27 °F)
Stability at -100 °Cfp (-148 °Ffp)	±0.05 °C (±0.09 °F)
Speed of Response	<2 hrs to ±0.25 °C (±0.45 °F) stability @ -90 °Cfp (-130 °Ffp) <6 hrs to ±0.25 °C (±0.45 °F) stability @ -100 °Cfp (-148 °Ffp)
Temperature dependence at -100 °C (-148 °F)	±0.15 °Cfp (±0.27 °Ffp) per 1 °C (1.8 °F) environmental temperature change
Mirror	Gold plated copper
Temperature Measurement	4-wire Pt100, 1/10 DIN class B
Sample Flow Rate	500...1000 ml/min (recommended 750 ml/min)
Sample Gas Pressure	1.6 bara (23.2 psia) max.
Pressure Sensor	
Measurement range	0...1.6 bara (23.2 psia)
Measurement Accuracy	Accuracy 0.25% FS Typical Thermal error 1.5% FS Typical Drift 0.2% FS/p.a non-cumulative Temp Comp -20 °C...+80 °C (-4 °F...+176 °F)
Flow Sensor	
Measurement range	0...1000 ml/min
Measurement Accuracy	±1.5% FS (10...100% of rated flow)
Monitor	
Resolution	User selectable to 0.001 °C (0.0018 °F), depending on parameter
Measurement units	°C dew/frost point, °C temperature, ml/min flow, bara pressure
Calculated units	Relative humidity – %, Absolute humidity – g/m^3, ppm$_v$, Mixing Ratio – g/kg, Wet Bulb Temperature (Twb) – °C, °F, Water Vapor Pressure (wvp) – Pa, °F, Pressure converted DP – °C, °F, Pressure – kPa, Barg, Psia, Psig
Outputs	**Analog:** 2x active mA outputs, configurable 0...20 mA or 4...20 mA **Digital:** Modbus RTU over USB Optional: Modbus RTU over RS485/RS232, Modbus TCP **Alarm:** 1x Process Relay 1x Alarm Relay Both Form C, 1 A, 30 V DC
User Interface	5.7" LCD with touchscreen
Data Logging	SD Card (8GB 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 °C...+30 °C (+41 °F...+86 °F)
Power Supply	85...264 V AC
Power Consumption	185 VA

Mechanical Specification	
Dimensions (W x H x D)	440 mm x 185 mm x 515 mm (17.32" x 7.28" x 20.28")
Weight	22 kg (48.5 lb)
Sample gas connections	Inlet: ¼" VCR Outlet: ¼" Swagelok tube
General	
Optional Remote Temperature Probe	4-wire Pt100, 1/10 DIN class B, 2m cable
Calibration	5-point UKAS calibration to -90 °Cfp (-130 °Ffp) + -100 °Cfp (-148 °Ffp)

* 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.

A.1 Dimensions



Appendix B

Modbus Register Map

Appendix B Modbus Register Map

Register Types	
Type	**Description**
uint16	unsigned 16 bit value
uint32	unsigned 32 bit value over two registers Register names ending with _MS contain the upper 16 bits Register names ending with _LS contain the lower 16 bits
flags	unsigned 16 bit value where each bit represents a flag, value can be a combination of flags
float	IEEE754 binary32 compatible floating point number Register names ending with _MS contain the upper 16 bits including the sign and exponent Register names ending with _LS contain the lower 16 bits
boolean	unsigned 16 bit value with only two valid values, 0 = off/disabled/no, 1 = on/enabled/yes

Address	Access	Data Type	Register Map Definition	Max.	Min.	Default
Instrument Info						
0	R|W|F	uint16	MODBUS_ADDRESS	255	1	1
1	R	uint16	INSTRUMENT_ID	42251	42251	42251
2	R	uint32	INSTRUMENT_SERIAL_MS	4294967295	0	0
3	R		INSTRUMENT _SERIAL_LS			
4	R	uint16	INSTRUMENT_FIRMWARE_VERSION	65535	0	
			Version * 1000 (1012 = 1.012)			
5	R	uint16	REGISTER_MAP_VERSION	65535	0	
			Version * 1000 (1012 = 1.012)			
Measured and Calculated Values						
6	R	float	DEWPOINT_MS [°C/°F]	1000	-1000	N/A
7	R		DEWPOINT_LS [°C/°F]			
8	R	float	AMBIENT_TEMP_MS [°C/°F]	1000	-1000	N/A
9	R		AMBIENT_TEMP_LS [°C/°F]			
10	R	float	PRESSURE_MS [P]	1000	-1000	N/A
11	R		PRESSURE_LS [P]			
12	R	float	RH_MS	100	0	N/A
13	R		RH_LS			
14	R	float	PPMV_MS	999999.9	0	N/A
15	R		PPMV_LS			
16	R	float	PPMW_MS	999999.9	0	N/A
17	R		PPMW_LS			
18	R	float	ABSOLUTE_HUMIDITY_MS	999999.9	0	N/A
19	R		ABSOLUTE_HUMIDITY_LS			
20	R	float	MIXING_RATIO_MS	2	0	N/A
21	R		MIXING_RATIO_LS			
22	R	float	WETBULB_MS [°C/°F]	1000	-1000	N/A
23	R		WETBULB_LS [°C/°F]			
24	R	float	WVP_MS	1000	-1000	N/A
25	R		WVP_LS			
26	R	float	FLOW_MS	2000	0	N/A
27	R		FLOW_LS			
28	R	float	PERCENT_VOLUME_MS	100	0	N/A
29	R		PERCENT_VOLUME_LS			
36	R	uint16	TEMPERATURE_UNIT	1	0	0
			0 = °C 1 = °F			

Address	Access	Data Type	Register Map Definition	Max.	Min.	Default
37	R	uint16	PRESSURE_UNIT	4	0	3
			0 = PSIG 1 = PSIA 2 = BARG 3 = BARA 4 = KPA			
38	R	uint16	DECIMAL_PLACES	3	1	2
Instrument Status						
45	R	uint16	OPERATING_MODE	14	0	N/A
			0 = NO_CHANGE 1 = SYSTEM_FAILURE 2 = STANDBY 3 = MEASURE 4 = DCC 5 = HOLD 6 = FAST 7 = MAXCOOL 8 = FLOOD_RECOVER 9 = PRT_SWITCH			
46	R	uint16	MODE_HRS_LEFT	100	0	N/A
47	R	uint16	MODE_MINS_LEFT	60	0	N/A
48	R	uint16	MODE_SECS_LEFT	60	0	N/A
49	R	uint16	SENSOR_STATUS	4	0	N/A
			0 = Unknown 1 = Cooling 2 = Heating 3 = In-Control 4 = Idle			
50	R	flags	FAULT_STATUS_1	65535	0	0
			32768 = Mirror PRT failure 16384 = Ambient PRT failure 8192 = Chiller PRT failure 4096 = Sensor thermistor failure 2048 = Mirror temperature too high 1024 = Stirling emergency error 512 = Optics setpoint search failed 256 = Optics outside max. operating limit 128 = Optics outside min. operating limit 64 = Cooling saturated timeout 32 = Heating saturated timeout 16 = RESERVED 8 = Pressure input failure 4 = Optics contamination 0 = No flags (OK)			
51	R	flags	FAULT_STATUS_2	65535	0	0
			32768 = AMBIENT_PRT_OPEN_CIRCUIT 16384 = PRESSURE_INPUT_OPEN_CIRCUIT 2048 = FLASH_LOADING_FAILED 1024 = FLASH_SAVING_FAILED 0 = NO FLAGS (OK)			
			RESERVED			
53	R	flags	ALARMS_STATUS	3	0	0
			0 = No Alarm 1 = System 2 = Process			
			RESERVED			

Address	Access	Data Type	Register Map Definition	Max.	Min.	Default
Additional Operating Values						
55	R	uint16	LOGGING_STATUS	9	0	0
			0 = Not Fitted 1 = No Card 2 = Ready 3 = Logging 4 = Writing 5 = Mount Error 6 = Write Error 7 = Mounting 8 = Write Protected 9 = Unknown			
56	R	boolean	DATA_HOLD_ACTIVE	1	0	0
57	R	boolean	DISPLAY_HOLD_ACTIVE	1	0	0
58	R	uint16	PRT_MODE	1	0	0
			0 = Internal PRT Measurement 1 = External PRT Measurement			
80	R	float	FILM_THICKNESS_MS	16777215	0	N/A
81	R		FILM_THICKNESS_LS			
82	R	uint16	OPTICS_CONDITION	200	0	N/A
			200% = double film 100% = correct film 0% =zero film			
83	R	int16	PELTIER_DRIVE_PERCENT	100	-100	N/A
84	R	float	CFNG_TEMP_MS [°C/°F]	80	-100	N/A
85	R		CFNG_TEMP_LS [°C/°F]			
86	R	flags	CFNG_STATUS	7	0	N/A
			0 = OK 1 = emergency alarm (chiller shutdown) 2 = input out of range alarm 4 = temperature / vibration alarm (temporary chiller shutdown)			
87	R	uint16	CFNG_MODE	1	0	N/A
			0 = Automatic setpoint 1 = Manual setpoint			
88	R	float	CFNG_SETPOINT_MS [°C/°F]	[40 °C]	[-100 °C]	N/A
89	R		CFNG_SETPOINT_LS [°C/°F]			
User Configuration – Calculation Parameters						
200	R|W|F	uint16	SET_TEMP_UNIT	1	0	0
			0 = °C 1 = °F			
201	R|W|F	uint16	SET_PRESSURE_UNIT	4	0	3
			0 = PSIG 1 = PSIA 2 = BARG 3 = BARA 4 = KPA			
202	R|W|F	float	ATMOSPHERIC_PRESSURE_MS [P]	999999.9	0	1.01325
203	R|W|F		ATMOSPHERIC_PRESSURE_LS [P]			
204	R|W|F	boolean	PRESSURE_CORRECTION_ENABLED	1	0	0
			0 = off 1 = on			
205	R|W|F	boolean	FORCE_WATER	1	0	0
			0 = off 1 = on			

Address	Access	Data Type	Register Map Definition	Max.	Min.	Default
206	R|W|F	boolean	RH_WMO	1	0	0
			0 = off 1 = on			
207	R|W|F	boolean	PPM_V_ON_WET	1	0	0
			0 = off (dry) 1 = on (wet)			
208	R|W|F	float	MOL_WEIGHT_MS	999999.9	0	28.9645
209	R|W|F		MOL_WEIGHT_LS			
User configuration – DCC/FAST						
220	R|W|F	boolean	DCC_SETPOINT_MODE	1	0	1
			0 = absolute 1 = relative			
221	R|W|F	int16	DCC_TEMPERATURE [°C/°F**]	25000	0	2000
			setpoint in degrees = value / 100			
222	R|W|F	boolean	DCC_INTERVAL_MODE	1	0	0
			0 = manual dcc's 1 = auto (timed) dcc's			
223	R|W|F	uint16	DCC_INTERVAL_MINS	65535	0	240
224	R|W|F	uint16	DCC_DURATION_MINS	65535	0	2
225	R|W|F	float	FAST_SETPOINT_MS [°C/°F]	[-2 °C]	[-22 °C]	[-3 °C]
226	R|W|F		FAST_SETPOINT_LS [°C/°F]			
227	R|W|F	boolean	FAST_ENABLE	1	0	1
			0 = disabled 1 = enabled			
			RESERVED			
229	R|W|F	uint16	STABILITY_BAND [°C/°F]	[20.0 °C]	[0.1 °C]	[0.2 °C]
			band (degrees) = value / 1000			
User configuration – Chiller						
232	R|W|F	float	CFNG_MANUAL_SETPOINT_MS [°C/°F]	[40.0 °C]	[-100.0 °C]	[0.0 °C]
233	R|W|F		CFNG_MANUAL_SETPOINT_LS [°C/°F]			
234	R|W|F	boolean	CFNG_MODE	1	0	1
			0 = Automatic setpoint 1 = Manual setpoint			
User configuration – Hold Settings						
238	R|W|F	uint16	DATA_HOLD_TIMEOUT_MINS	60	20	45
239	R|W|F	boolean	ENABLE_DATA_HOLD	1	0	1
			0 = disabled 1 = enabled			
User configuration – Temperature Sensor						
240	R|W|F	boolean	AMBIENT_SENSOR_SOURCE	1	0	0
			0 = External 1 = Manual			
241	R|W|F	float	MANUAL_AMBIENT_MS [°C/°F]	[150.0 °C]	[-60.0 °C]	[23.0 °C]
242	R|W|F		MANUAL_AMBIENT_LS [°C/°F]			
User configuration – Pressure Sensor						
			RESERVED			
			RESERVED			
			RESERVED			
			RESERVED			

Address	Access	Data Type	Register Map Definition	Max.	Min.	Default
User configuration – Analog Output Settings						
270	R|W|F	uint16	ANALOG_1_TYPE	2	0	1
			0 = 0-20mA 1 = 4-20mA 2 = 0-1V			
271	R|W|F	uint16	ANALOG_1_PARAMETER	9	0	0
			0 = Dewpoint 1 = Temperature 2 = Pressure 3 = %rh 4 = Water content: ppm_V 5 = Water content: ppm_W 6 = Mixing ratio 7 = Absolute humidity 8 = Wetbulb 9 = Water vapour pressure 10 = Water content: percent volume 11 = Flow			
272	R|W|F	float	ANALOG_1_RANGE_LOW_MS	1999999.9	-300	-50
273	R|W|F		ANALOG_1_RANGE_LOW_LS			
274	R|W|F	float	ANALOG_1_RANGE_HIGH_MS	1999999.9	-300	50
275	R|W|F		ANALOG_1_RANGE_HIGH_LS			
276	R|W|F	uint16	ANALOG_1_ALARM_SOURCE	3	0	0
			0 = None 1 = System 2 = Process 3 = System & Process			
			RESERVED			
279	R|W|F	uint16	ANALOG_2_TYPE	2	0	1
			0 = 0-20mA 1 = 4-20mA 2 = 0-1V			
280	R|W|F	uint16	ANALOG_2_PARAMETER	9	0	1
			0 = Dewpoint 1 = Temperature 2 = Pressure 3 = %rh 4 = Water content: ppm_V 5 = Water content: ppm_W 6 = Mixing ratio 7 = Absolute humidity 8 = Wetbulb 9 = Water vapour pressure 10 = Water content: percent volume 11 = Flow			
281	R|W|F	float	ANALOG_2_RANGE_LOW_MS	1999999.9	-300	0
282	R|W|F		ANALOG_2_RANGE_LOW_LS			
283	R|W|F	float	ANALOG_2_RANGE_HIGH_MS	1999999.9	-300	100
284	R|W|F		ANALOG_2_RANGE_HIGH_LS			
285	R|W|F	uint16	ANALOG_2_ALARM_SOURCE	3	0	0
			0 = None 1 = System 2 = Process 3 = System & Process			

Address	Access	Data Type	Register Map Definition	Max.	Min.	Default
User configuration – Process Alarm Settings						
290	R|W|F	uint16	PROCESS_ALARM_PARAMETER	11	0	0
			0 = Dewpoint 1 = Temperature 2 = Pressure 3 = %rh 4 = Water content: ppm_v 5 = Water content: ppm_w 6 = Mixing ratio 7 = Absolute humidity 8 = Wetbulb 9 = Water vapour pressure 10 = Water content: percent volume 11 = Flow			
291	R|W|F	uint16	PROCESS_ALARM_TYPE	4	0	1
			0 = Off 1 = Over setpoint 2 = Under setpoint 3 = Inside band 4 = Outside band			
292	R|W|F	float	PROCESS_ALARM_HYSTER_MS	300	0	0.2
293	R|W|F		PROCESS_ALARM_HYSTER_LS			
294	R|W|F	float	PROCESS_ALARM_SETPOINT_A_MS	1999999.9	-300	-10
295	R|W|F		PROCESS_ALARM_SETPOINT_A_LS			
296	R|W|F	float	PROCESS_ALARM_SETPOINT_B_MS	1999999.9	-300	0
297	R|W|F		PROCESS_ALARM_SETPOINT_B_LS			
298	R|W|F	boolean	PROCESS_ALARM_OPTICS	1	0	0
			0 = Off 1 = Optics warning activates process alarm			
User configuration – System Alarm Settings						
301	R|W|F	boolean	NOT_MEASURE_ALARM	1	0	0
			0 = Off 1 = System alarm activated when not in measurement mode			
			RESERVED			
304	R|W|F	uint16	SET_SERIAL_TYPE	65535	0	0
			737 = Activate legacy serial comms mode (replaces Modbus)			
User configuration – Ethernet						
310	R	uint16	ETH_STATUS	2	0	0
			0 = Error / Not fitted 1 = OK 2 = Configuring			
311	R|W	uint16	ETH_IP_1	255	0	0
312	R|W	uint16	ETH_IP_2	255	0	0
313	R|W	uint16	ETH_IP_3	255	0	0
314	R|W	uint16	ETH_IP_4	255	0	0
315	R|W	uint16	ETH_SUBNET_1	255	0	0
316	R|W	uint16	ETH_SUBNET_2	255	0	0
317	R|W	uint16	ETH_SUBNET_3	255	0	0
318	R|W	uint16	ETH_SUBNET_4	255	0	0
319	R|W	uint16	ETH_GATEWAY_1	255	0	0
320	R|W	uint16	ETH_GATEWAY_2	255	0	0
321	R|W	uint16	ETH_GATEWAY_3	255	0	0
322	R|W	uint16	ETH_GATEWAY_4	255	0	0

Address	Access	Data Type	Register Map Definition	Max.	Min.	Default
User configuration – RTC						
330	R|W	uint16	RTC_YEAR	99	17	N/A
331	R|W	uint16	RTC_MONTH	12	1	N/A
332	R|W	uint16	RTC_DAY	31	1	N/A
333	R|W	uint16	RTC_HOURS	24	0	N/A
334	R|W	uint16	RTC_MINUTES	59	0	N/A
User configuration – Display Parameters						
0	R|W|F	uint16	LANGUAGE	9	0	0
			0 = English 1 = German 2 = Spanish 3 = French 4 = Italian 5 = Portuguese 6 = USA 7 = Russian 8 = Japanese 9 = Chinese			
336	R|W|F	uint16	DECIMAL_PLACES	3	1	2
337	R|W|F	boolean	ENABLE_DISPLAY_HOLD	1	0	0
			0 = Disabled 1 = Enabled			
338	R|W|F	uint16	PARAMETER_1	11	0	0
			0 = Dewpoint 1 = Temperature 2 = Pressure 3 = %rh 4 = Water content: ppm_V 5 = Water content: ppm_W 6 = Mixing ratio 7 = Absolute humidity 8 = Wetbulb 9 = Water vapour pressure 10 = Water content: percent volume 11 = Flow			
339	R|W|F	uint16	PARAMETER_2	11	0	1
			as PARAMETER_1 above			
340	R|W|F	uint16	PARAMETER_3	11	0	11
			as PARAMETER_1 above			
			RESERVED			
400	R|W|F	boolean	FLOOD_DETECT_ENABLE	1	0	0
401	R|W|F	float	DP_SEARCH_TEMP_LIMIT_MS [°C only]	120	-150	-100
402	R|W|F		DP_SEARCH_TEMP_LIMIT_LS [°C only]			
410	R|W|F	uint16	PRT_MODE	1	0	0
			0 = Internal PRT Measurement 1 = External PRT Measurement			
Advanced User Debug						
800	R	uint16	OPTICS_DRIVE	65535	0	N/A
801	R	uint32	REFLECTED_READING_MS	16777215	0	N/A
802	R		REFLECTED_READING_LS			
803	R	uint32	SCATTERED_READING_MS	16777215	0	N/A
804	R		SCATTERED_READING_LS			
805	R	float	RATIO_READING_MS	100	-100	N/A
806	R		RATIO_READING_LS			
807	R	uint32	DCC_REFLECTED_MS	16777215	0	N/A

Address	Access	Data Type	Register Map Definition	Max.	Min.	Default
808	R		DCC_REFLECTED_LS			
809	R	uint32	DCC_SCATTERED_MS	16777215	0	N/A
810	R		DCC_SCATTERED_LS			
811	R	float	DCC_RATIO_MS	100	-100	N/A
812	R		DCC_RATIO_LS			
813	R	uint32	CLEAN_REFLECTED_MS	16777215	0	N/A
814	R		CLEAN_REFLECTED_LS			
815	R	uint32	CLEAN_SCATTERED_MS	16777215	0	N/A
816	R		CLEAN_SCATTERED_LS			
817	R	uint16	CLEAN_DRIVE_LEVEL	65535	0	N/A
User configuration – Feature Unlock						
900	R	uint32	SECURITY_CODE_MS	4294967295	0	~
901	R		SECURITY_CODE_LS			
902	W	uint32	FEATURE_CODE_MS	4294967295	0	N/A
903	W		FEATURE_CODE_LS			
904	R	uint16	FEATURE_FEEDBACK / RESERVED	65535	0	N/A
Instrument Control						
1000	W	uint16	SET_MODE	16	0	N/A
			1 = Standby 2 = DCC 4 = Maxcool 8 = Cancel maxcool 16 = Calibrate optics (optics reset)			
Debugging / Live Calibration – Ethernet						
2770	R	uint16	REG_ETH_DEBUG_CODE	0	0	N/A
			0 = OK 1 = IDLE 2 = CONFIGURING 3 = FAIL_CONFIG_TIMEOUT 4 = FAIL_CONFIG_RESPONSE 5 = FAIL_MENU_TIMEOUT 6 = FAIL_MENU_RESPONSE 7 = FAIL_DISCARD_MENU_TIMEOUT 8 = FAIL_SETTINGS_TIMEOUT 9 = FAIL_WAIT_IP_TIMEOUT 10 = FAIL_WAIT_IP_RESPONSE 11 = FAIL_WAIT_GATEWAY_TIMEOUT 12 = FAIL_WAIT_GATEWAY_RESPONSE 13 = FAIL_WAIT_SUBNET_TIMEOUT 14 = FAIL_WAIT_SUBNET_RESPONSE 15 = FAIL_WAIT_TELNET_TIMEOUT 16 = FAIL_WAIT_TELNET_RESPONSE 17 = FAIL_WAIT_SAVE_TIMEOUT 18 = FAIL_WAIT_SAVE_RESPONSE 19 = FAIL_WAIT_SAVED_TIMEOUT 20 = FAIL_DISCARD_SAVE_TIMEOUT 21 = FAIL_GET_SETTINGS			

Appendix C

Quality, Recycling & Warranty Information

Appendix C 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:

- Anti-Facilitation of Tax Evasion Policy
- 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 D

Return Document & Decontamination Declaration

Appendix D 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		

Notes

MICHELL Instruments
A PST BRAND

http://www.michell.com