Hygrosmart HS3
Advanced RH & Temperature Probe
User's Manual

97516 Issue 5
July 2017

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

Use this information when contacting Michell Instruments for service purposes.

Instrument	
Code	
Serial Number	
Invoice Date	
Location of Instrument	
Tag No	

Instrument	
Code	
Serial Number	
Invoice Date	
Location of Instrument	
Tag No	

Instrument	
Code	
Serial Number	
Invoice Date	
Location of Instrument	
Tag No	

HygroSmart HS3 Probe

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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.

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

HS3 Probes are adjusted in the factory prior to delivery. Recalibration is recommended after one year of operation, depending on application. New, freshly calibrated sensors can be supplied quickly by Michell Instruments, or recalibration can be carried out on site using one of the Michell humidity calibration systems. Refer to Section 6.2 regarding calibration checking and adjustment of probes.

Safety Conformity

This product meets the essential protection requirements of the relevant EU standards and directives.

Abbreviations

The following abbreviations may be used in this manual:

barg	pressure unit (=100 kP or 0.987 atm) gauge
°C	degrees Celsius
°F	degrees Fahrenheit
EU	European Union
g	grams
g/m^3	grams per cubic metre
kg	kilograms
Kj/kg	kilojoules per kilogram
lb	pound
mm	millimetre
oz	ounce
RH	relative humidity
RS485	serial data transmission standard
RTU	Remote Terminal Unit
T	temperature
V	Volts
V DC	Volts of direct current
%	percentage
"	inch
ø	diameter

Warnings

The following general warning listed below is applicable to this instrument. It is 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.

1 INTRODUCTION

The HygroSmart HS3 is an accurate, stable and user configurable probe designed to provide reliable relative humidity measurement for process control in a wide range of applications. The HS3 Probe features interchangeable sensor technology ensuring minimal process downtime and a low cost of ownership.

Figure 1 *HygroSmart HS3 Probe and Interchangeable Sensor*

1.1 Operating Flexibility

The HS3 Probe has been developed to be 100% customer configurable. One stock unit can be set up by a customer into an application specific configuration to cover any RH demands on site. This flexibility saves time and budget.

- Adjustable zero/span ranging of the RH, Temperature and Calculated Hygrometric Outputs
- Selectable 0 to 1, 2.5, 5, 10 V output signals
- 2 selectable output voltage measured (RH & T) parameters or a choice of 5 calculated parameters (eg dew point)
- Addressable Modbus RTU over RS485 communications for up to 32 probes
- Probe digital Zero/Span calibration trimming

Alternatively, the HS3 Probe can be configured at the factory at time of ordering for customers who want a simple fixed configuration solution.

2 INSTALLATION

2.1 Unpacking

Open the cardboard box and remove the plastic tray inside.

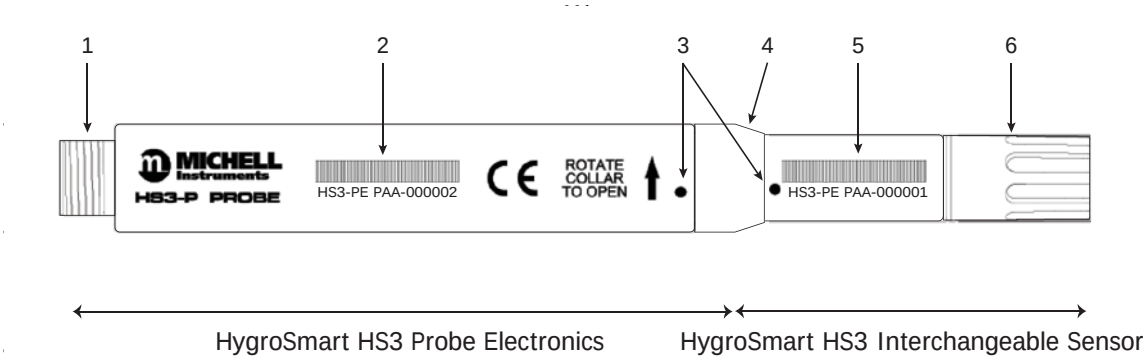
Figure 2 *HygroSmart HS3 Probe Packaging*

Please check that the following components are present:

- HygroSmart HS3 Probe (with the interchangeable HygroSmart HS3 sensor)
- Certificate of Calibration
- Quick Start Guide
- User Manual

2.2 Probe Layout

The HS3 Probe with its constituent parts and physical features is detailed in the layout below:



1	M12 5-pin probe electrical connector
2	Probe serial number
3	Probe to sensor connector alignment marks
4	Rotating probe cuff
5	Sensor serial number
6	Filter assembly

Figure 3 *HygroSmart HS3 Probe Layout*

2.3 Maintenance Kits

HS3-SCK
HS3 Probe Simulator Kit

Includes:
- Desk-mounted configuration kit with 1.8m cable
- 3 sensor simulators (25%, 50%, 75%RH at 23°C (73°F))
- Spare probe electronics
- Carry case

HS3-CK
HS3 Probe Configuration Kit

Includes:
- Desk-mounted configuration kit with 1.8m cable
- Spare probe electronics
- Carry case

HS3-CKL
HS3 Logger/Configuration Converter Cable 1.8 meters

Includes:
- 1.8 meter USB to RS485 converter cable with M12 connector

2.4 Installation Instructions

2.4.1 Recommended Installation Environment

When choosing an installation site for the probe, consider the environment around it. Ensure that the site:

- is clear of nearby obstructions which could limit air circulation to the probe
- is away from any hot or cold spots - i.e. air conditioning or heater vents
- is not adjacent to any high power sources
- is representative of the surrounding environment at the point of interest

The acceptable operating conditions for the sensor are detailed in *Figure 4*.

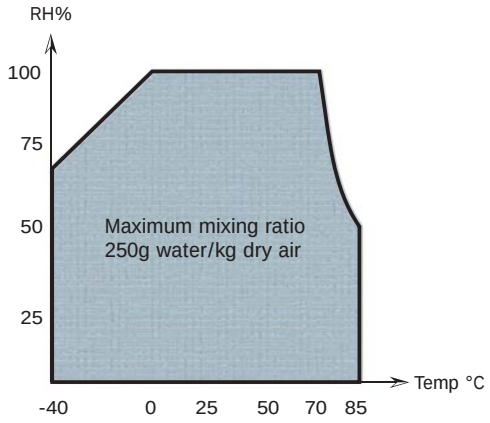


Figure 4 *Acceptable Operating Conditions*

2.4.2 Element Filter Assembly Environment

The PVDF filter element protects the sensor against particulate contamination and the effects of high velocity air-flow.

To ensure good air-flow to the sensor it is recommended to regularly clean the filter element. See Section 6.1 for more details.

The HS3 Probe can be equipped with the following filter model

- F1 - PVDF (12mm diameter) black cap assembly
- F2 - 13mm (0.51") HDPE protection cap

2.4.3 Probe Wall Mounting

A mounting clamp for the HS3 Probe (HS3-PMC) can be ordered as an accessory.

Figure 5 *Mounting Clamp (HS3-PMC)*

The clamp can be used to securely hold the probe body, and provides a 1/4" 20 UNC thread to mount it to a fixed surface.

It is recommended that the HygroSmart HS3 Probe is installed with the sensor and filter assembly facing downwards.

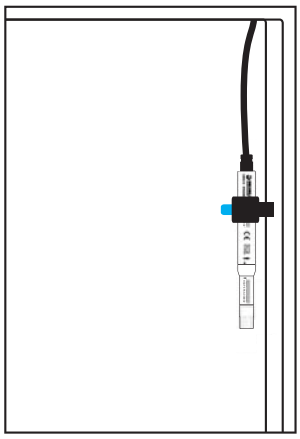


Figure 6 *Probe Wall Mounting*

2.4.4 Duct Mounting

When installing the HS3 Probe into a duct, ensure that the probe is inserted as far as possible into the environment to be measured.

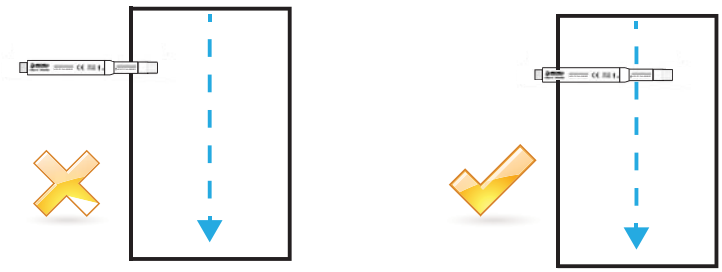


Figure 7 *Duct Mounting*

If the measurement environment is pressurized, then follow the guidelines in 2.4.5.

2.4.5 Pressurized Environment Installation

The HS3 Probe is a solid assembly with no internal air cavities; this ensures that an external pressure of up to 10 barg will cause no damage to the probe.

The probe can be installed into pressurized environments by two different methods:

1. Through a vessel or duct wall using the Probe Metal Gland sealing accessory.
2. Mounted entirely within the pressurized vessel.

The Probe Metal Gland (HS3-PMG) is shown in *Figure 6.* It is designed to be installed in the wall of the pressure vessel by the M25 x 1.5 thread on the rear (1). The O-ring (2) provides the pressure seal. The probe can then be installed, and the gland tightened until the shaft of the probe rotates with the turn of the nut.

Figure 8 *Probe Metal Gland*

For safety, always ensure that the probe is tethered to the vessel wall or the gland itself. A tether can be attached to the probe around the base of the M12 mating connector, see *Figure 7 f*or details.

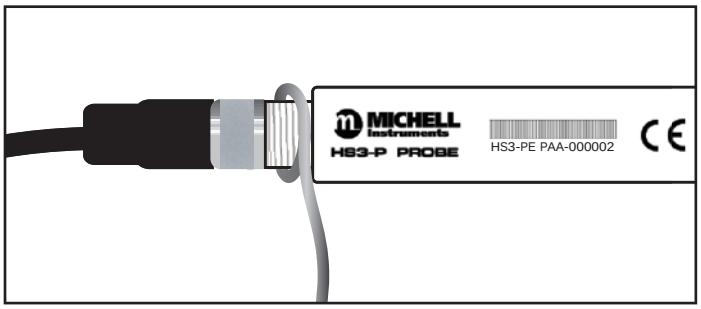


Figure 9 *Securing Tether*

When installing probe using the sealing gland, always ensure that the securing tether is fitted before applying pressure!

2.4.6 Electrical Requirements

The HygroSmart HS3 Probe requires a supply voltage from 5 to 28 V DC.

2.4.7 Electrical Connections

The electrical connections, as seen when looking at the base of the probe, are shown in the following schematic:

	Modbus	Analog	Cable Color
1	Comms A	Output 1	Brown
2	Comms B	Output 2	White
3	0 V	N/C	Blue
4	+5 V to +28 V	+5 V to +28 V	Black
5	0 V	0 V	Gray

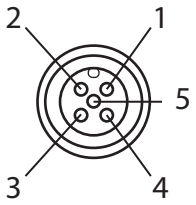


Figure 10 *Electrical Connections*

Note: M12 mating connector/cables are not supplied with the Probe, but can be ordered as an accessory. They are available in 2, 5 & 10 meter lengths.

2.4.8 Digital Serial Output

The connections for Modbus RTU over RS485 communications are detailed in *Figure* 10. In order to enable digital comms, both pins 3 & 5 should be grounded. See Appendix B for mire details.

NOTE: The probe will not output digital and voltage signals simultaneously.

2.4.9 Analog Voltage Outputs

The HS3 Probe will be set up, when ordered, to one of the following selection of voltage outputs:

0 - 1 V
0 - 2.5 V
0 - 5 V
0 - 10 V

These voltage outputs can be reconfigured at any time using one of the available Maintenance Kits, in conjunction with the HS3 Probe Application Software.

2.4.10 Probe Ordered Configuration

The configuration code of the HS3 Probe, when ordered, defines its precise set up. This is detailed on the order acknowledgement & invoice documents.

2.4.11 Probe Reconfiguration

If at any point in time the HS3 Probe needs reconfiguration, this can be achieved quickly and easily by using any of the available Maintenance Kits, in conjunction with the HS3 Probe Application Software.

2.4.12 Probe & Sensor Serialization Tracking

The HS3 Probe and associated interchangeable sensor have a unique serial number and bar code identification on the body of the devices. These serial numbers are also stored within the sensor and probe electronics and can be accessed using the HS3 Application Software.

3 PROBE MAINTENANCE KIT OPERATION

The available Probe Maintenance Kits are detailed in Section 2.3. The operation of the Maintenance Kits is as follows:

HS3-SCK **HS3-CK**	Connect the probe to the connector on the desk-mounted configuration kit, connect the USB cable to the PC, then follow the setup procedure detailed in Section 3.3.
HS3-CKL	Connect the M12 connector to the probe, and the USB cable to the PC before following the setup procedure.

3.1 Application Software Overview

The HS3 Application Software is downloadable from the Michell website (www.michell.com).

3.2 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.

3.3 Establishing Communications

On launching the software the connection console will appear.

The connection console *(Figure 9)* allows you to establish a communications connection between the software and HS3 Probe. Choose the Modbus slave address and communications port from the drop-down lists and then click the **Connect**... button.

After a few seconds the software will report a successful connection, or not. If the connection is successful, the word **Connected** and a green tick will appear above the **Quit** button and the **Continue** button will enable.

If the software is unable to connect, check the physical connection between the probe and PC, check which com port the adaptor is connected to and try again.

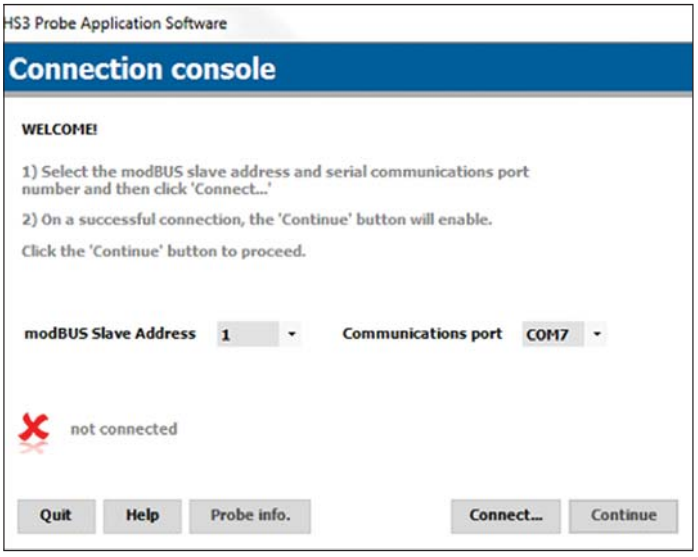


Figure 11 *Connection Console Screen Shot*

From this window the probe and sensor information can be viewed by clicking the **Probe info.** button. Alternatively click the **Continue** button on the console window to open the **Options** window.

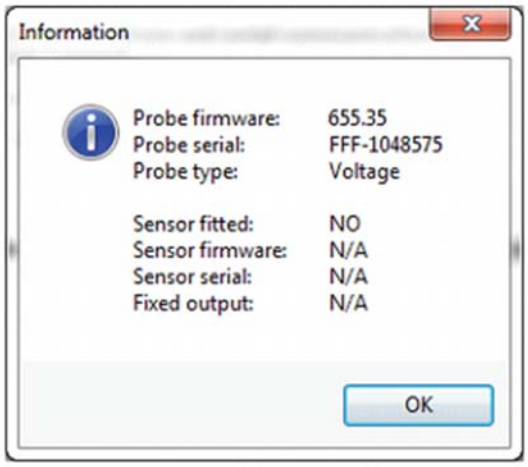


Figure 12 *Probe and Sensor Information Screen Shot*

Click **OK** to close the probe information window.

Click the **Continue** button on the console window to continue on to the **Options** window.

3.4 Measurement Data Acquisition

This window can be opened from the **Options** window. As soon as it is opened, the software automatically begins collecting, displaying and charting live data from the HS3 Probe.

Data collection occurs approximately twice a second. The chart update rate is two seconds but this may be changed through the chart options window.

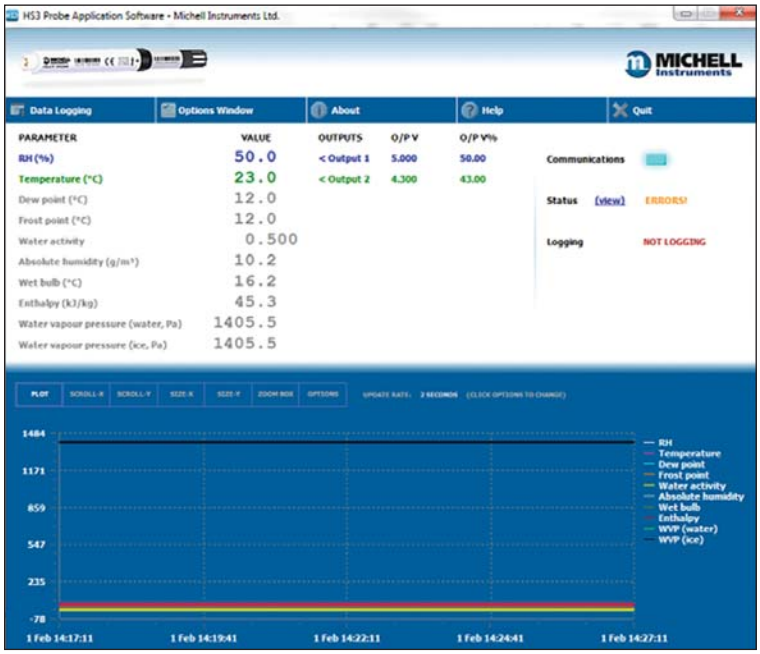


Figure 13 *Measurement Data Acquisition Screen Shot*

The two output (Output 1 and Output 2) channel units are highlighted in blue and green.

In the example in *Figure 14*, Output 1 (in blue) is set to RH and Output 2 (in green) is set to Temperature.

The expected output volts and volts percentage (of full scale) is also displayed here.

Figure 14 *Output Channel Example Screen Shot*

Errors and Warnings

When probe errors or warnings are encountered they will be highlighted in the **Status** section and a link will appear.

Click the **View** link to launch a new window which details the errors and warnings.

3.5 Probe Configuration

This screen can be opened from the **Options** window. Upon opening, the 'current settings' column is updated with the parameters within the probe.

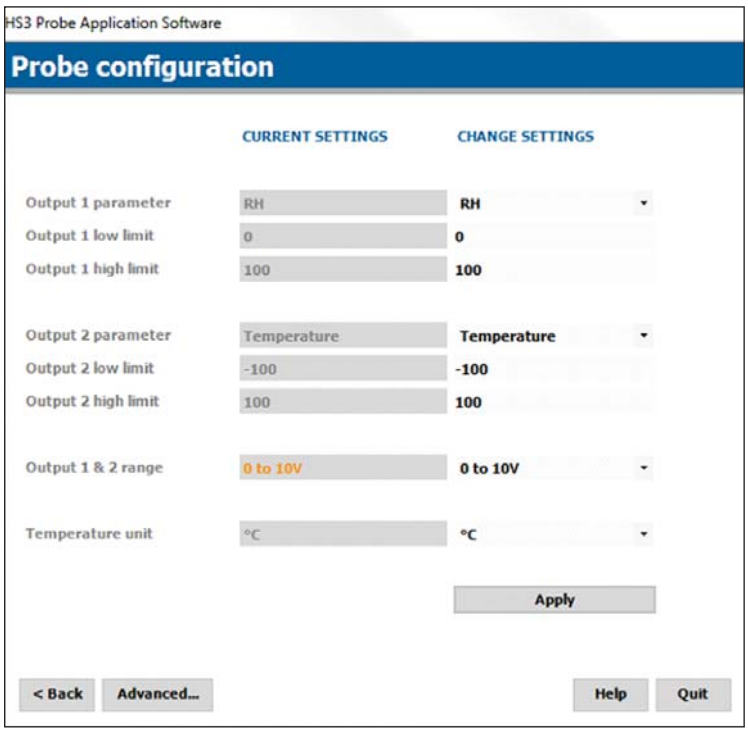


Figure 15 *Probe Configuration Screen Shot*

To change a setting, either choose defined values from the drop-down lists or enter values into the text boxes under the **Change settings** column and then click the **Apply** button to apply the settings.

After applying new settings, the software automatically reads back the probe configuration and displays it on screen in the left (current settings) column.

The **Advanced** button takes you to the Probe Adjustment window via a password entry box. Enter the password **7316** to continue.

3.6 Probe Adjustment

This window provides access to both the RH and temperature calibration tables, and the probe Modbus address.

Picture below showing the default (factory) settings.

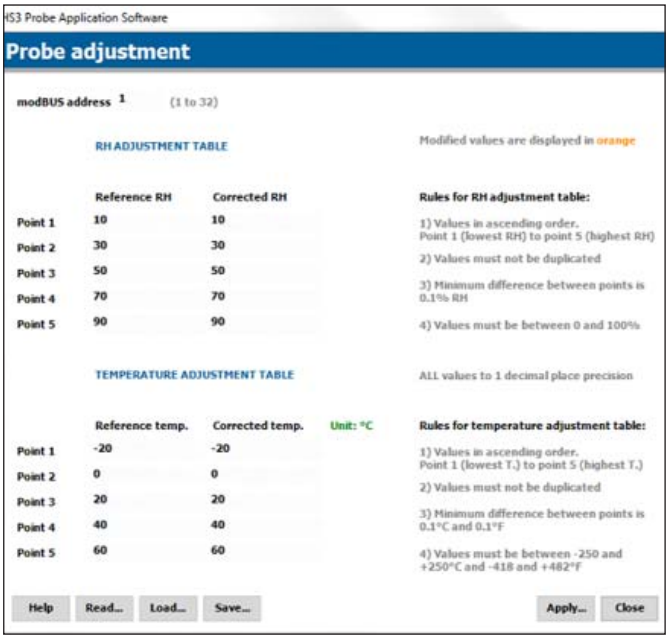


Figure 16 *Probe Adjustment Screen Shot*

To change a value, type within the text boxes provided and click the Apply... button to apply the new value(s) to the HS3 Probe.
Important : the values in point 1 to 5 must be in ascending order!

Values are checked before they are applied to the HS3 Probe according to a set of rules. The rules are displayed on the right hand side of the window. The software will display a warning if any values do not comply with the rules.

Clicking the **Read**... button reads and display the tables from the HS3 Probe.
Clicking the **Save**... button saves the tables to a file.
Clicking the **Load**... button loads the previously saved file.xxxxxxx

RECOMMENDATION: It is a good idea to save the tables before editing them. You can then Load (retrieve) the saved table in case any mistakes are made.

NOTE: If the Modbus address is changed, the software will continue communicating with the probe under the new address.

The next example will demonstrate a 3 point humidity adjustment.
In this example 30, 50 and 70%RH , but any other point is also possible.
(%RH and Temperature adjustment are done in the same way)

1st Adjustment Point.

1. Place the HS3-Probe together with a reference in a controlled and stable environment of 30%RH.
2. Check the readings of the HS3-probe and the reference.
   - The Humidity reference is reading 30.8%RH.
   - The HS3-probe reads 28.0%RH.

Figure 17 *Probe readings prior to adjustment*

3. Find the nearest point in the RH Adjustment table (in this example 30) and change it into the measured reference value. (in this example 30.8).
4. Subtract the Humidity value of the HS3-probe from the reference value (30.8 - 28.0 = 2.8).
5. Add the outcome to the reference value (30.8 + 2.8 = 33.6).
6. Enter this value in the corresponding field of Corrected RH.

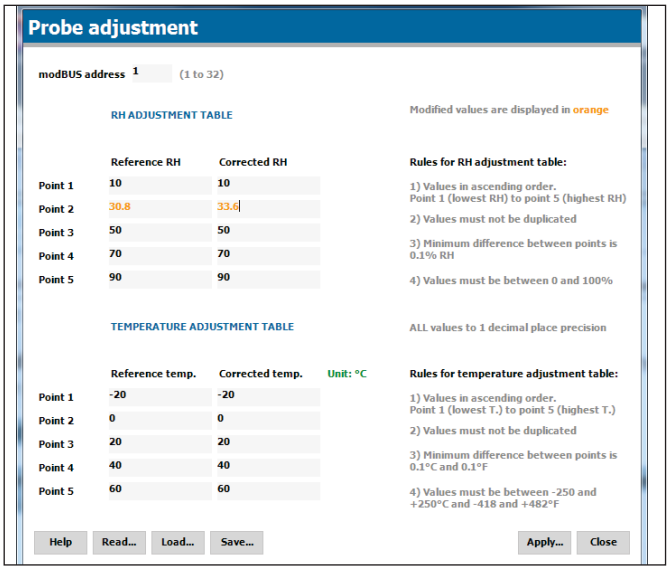


Figure 18 *Editing the Adjustment Table*

After Correction:

Figure 19 *Probe readings post-adjustment*

2nd Adjustment Point

1. Place the HS3-Probe together with a reference in a controlled and stable environment of ± 50%RH.

2. Check the readings of the HS3-Probe and the reference.
   - The Humidity reference is reading 50.2%RH.
   - The HS3-Probe reads 51.3%RH.

Figure 20 *Probe readings prior to adjustment*

3. Find the nearest point in the RH Adjustment table (in this example 50) and change it into the measured reference value. (in this example 50.2).
4. Subtract the Humidity value of the HS3-Probe from the reference value (50.2 – 51.3 = -1.1).
5. Add the outcome to the reference value (50.2 – 1.1 = 49.1).
6. Enter this value in the corresponding field of Corrected RH.

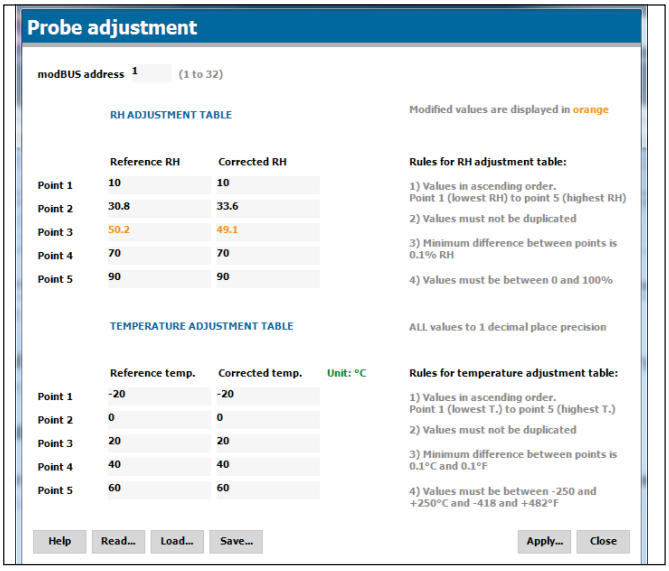


Figure 21 *Editing the Adjustment Table*

After Correction:

Figure 22 *Probe readings post-adjustment*

3rd Adjustment Point.

1. Place the HS3-Probe together with a reference in a controlled and stable environment of ± 70%RH.

2. Check the readings of the HS3-Probe and the reference.
   - The Humidity reference is reading 69.6%RH.
   - The HS3-Probe reads 71.3%RH.

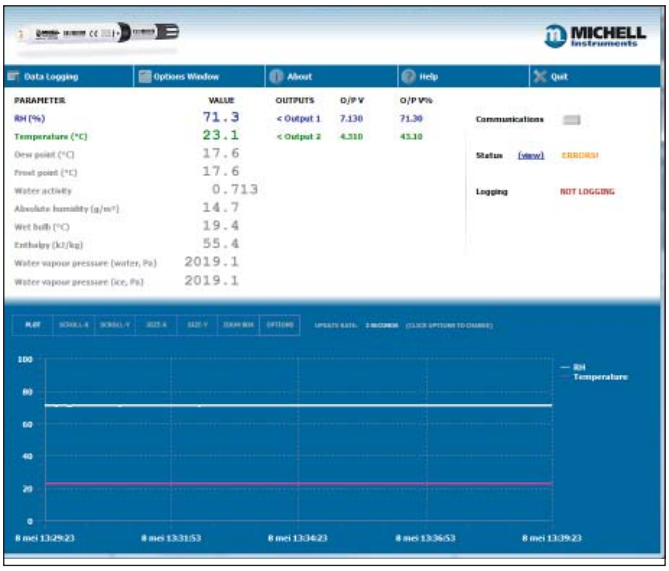


Figure 23 *Probe readings prior to adjustment*

3. Find the nearest point in the RH Adjustment table (in this example 70) and change it to the measured reference value (in this example 69.6%RH).

4. Subtract the Humidity value of the HS3-Probe from the reference value (69.6 – 71.3 = -1.7).
   - Add the outcome to the reference value (69.6 -1.7 = 67.9).
   - Enter this value in the corresponding field of Corrected RH.

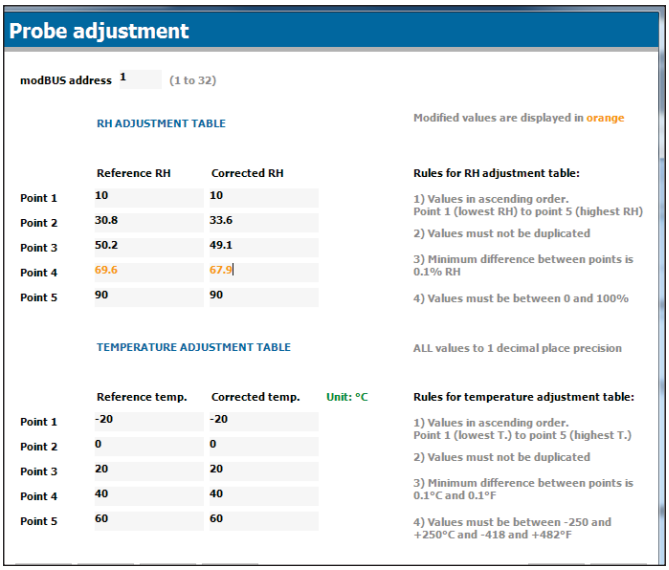


Figure 24 *Editing the Adjustment Table*

After Correction:

Figure 25 *Probe readings post-adjustment*

3.7 Loop Checking Simulation

The simulator window provides a way to change the defined outputs on both the RH and temperature channel.

Figure 26 *Simulator Window Screen Shot*

Enter the desired, simulated value(s) into the RH and/or temperature input text boxes and click the relevant **Apply** button to apply the value. The analog output(s) should change accordingly.

The values shown on the left under **Probe values** are read from the probe.

To read (refresh the screen) probe values, click the **Read** button.

4 SENSOR REPLACEMENT

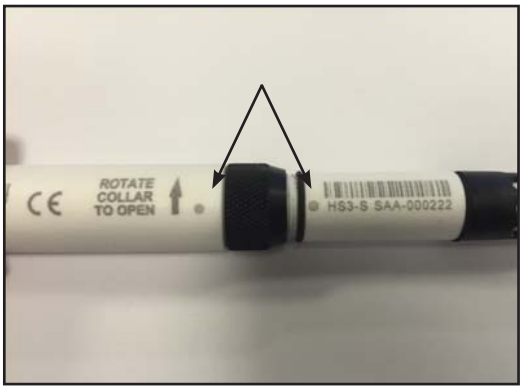
1. Remove the probe from its mounting position.
2. Remove the M12 connector from the probe.

3. Rotate the knurled collar in the direction indicated by the ↑ arrow, until the sensor separates from the probe.

4. Remove the old sensor, and prepare the replacement.

5. Align the dot on the probe with the dot on the sensor and gently place the two together.

   NOTE: Do not use force!



6. Rotate the knurled collar in opposite direction to the ↑ arrow until finger tight.

   NOTE: No force should be needed to fit the probe.

5 LOOP CHECKING SIMULATION

When the HS3-SCK is ordered, 3 fixed output sensors will be provided. These sensors can be identified by the blue cap.

Figure 27 *Sensor Simulator*

Each sensor is factory set with a RH and T output. The 3 supplied will be:

25% @ 23°C (73°F)
50% @ 23°C (73°F)
75% @ 23°C (73°F)

These simulators can be connected to a signal loop and used to check its functionality and accuracy.

5.1 Simulator Connection

A probe electronics assembly is provided with the Simulator Kit.

A sensor simulator module can be connected to the probe in the same manner as a sensor. See Section 4 for detailed instructions.

The simulator and probe assembly can then be connected to the loop which requires testing.

5.2 Checking /Programming the Simulators

The application software can be used to change the output range of any of the sensor simulators. Ensure that the simulator to be re-ranged is attached to a probe, then establish communications with the software as per the instructions in Section 3.3.

Section 3.7 details the functionality within the Application Software for re-ranging the simulators.

6 MAINTENANCE

6.1 Cleaning the Filter Element

It is necessary to keep the filter clean to ensure good airflow around the sensor element, and to prevent a buildup of contamination which could cause harm to the sensor.

The cleaning procedure is as follows:

1. Carefully remove the filter cap from the HS3 sensor.

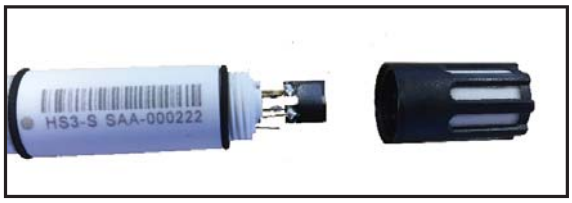


Figure 28 *Filter Cap Removal*

2. Flow distilled water through the filter element from the inside out.

Figure 29 *Filter Element Cleaning*

3. Flow alcohol through the filter element from the inside out.
4. Using compressed air, dry the filter element from the inside out.

If there is any doubt about the cleanliness of the filter after cleaning, a replacement can be ordered - order code A000018.

6.2 Probe Adjustment Procedure

The probe electronics provide a functionality which allows the user to apply a 5 point correction table to the reading received from the sensor module, and adjust the probe accordingly.

The usage of the adjustment tool in the application software is covered in Section 3.6. This section specifically relates to the method of generating the known conditions required to make accurate adjustments.

In order to make a valid adjustment, the probe should be exposed to a environment of stable humidity and temperature, which is also measured by an authoritative traceable reference instrument. Michell Instruments offers a number of devices suitable for the purpose, either with or without temperature control.

HygroCal100

The HygroCal100 enables quick and convenient generation of a known humidity condition at ambient temperatures.

Its chamber allows seven relative humidity probes of various diameters to be installed into the chamber simultaneously. The probes can be powered directly from the HygroCal100, and monitored via the intuitive touch screen user interface.

This interface also allows the programming of a calibration profile, so that a series of humidity values can be generated and held automatically for a set time period. The readings from all probes under test and the built-in reference can also be logged for completely autonomous operation. The system is entirely self-contained, and weighs just 3.2kg (7lbs) (including the battery pack), so is easily portable for making multiple on-site checks.

OptiCal

For calibration at a variety of temperatures, the OptiCal humidity calibrator provides a stable and accurate calibration environment over the 10 to 90% RH and +10 to +50°C (+50 to +122°F) range. The stand-alone, transportable calibrator requires no external services other than mains power, and features an integrated chilled mirror reference instrument to enable the operator to perform calibrations that are traceable to national standards.

Appendix A

Technical Specifications

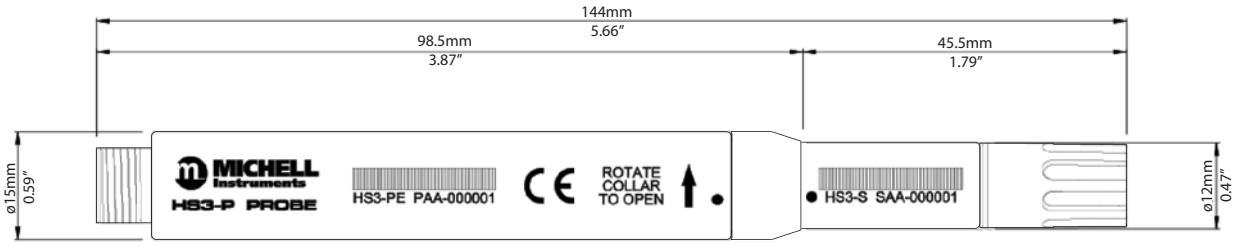
Appendix A Technical Specifications

Performance Specifications		
RH Measurement Range	0 to 100% RH	
RH Accuracy @ 23°C (73°F)	± 0.8% RH (5 to 95%RH)	
RH Thermal Coefficient	<0.03% RH/°C typical	
RH Measurement Response Time	< 1 sec to RH event	
RH Element	Michell H8000	
RH Long Term Stability	±1% RH per year	
Temperature Measurement Range	-40 to +85°C (-40 to +185°F)	
Temperature Accuracy	±0.2°C (0.36°F)	
Temperature Resolution	±0.01°C (±0.018°F)	
Temperature Technology	PT1000 1/3 DIN Class B	
Recommended Storage Range	+10 to +40°C (+50 to +104°F)	
Calibration	Traceable 5-point calibration certificate	
Application Software	Downloadable from www.michell.com	
Electrical Specifications		
Voltage Output Signals	0-1 V, 0-2.5 V, 0-5 V, 0-10 V	
Digital Output Signal	Modbus RTU over RS485 2-wire	
Electrical Thermal Coefficient	0.0004%/°C	
Load Resistance	0-1, 0-2.5 V : 0-5, 0-10 V :	10K Ω 50K Ω
Supply Voltage Range	5 to 28 V DC	
Supply Current Consumption	5 V : 28 V :	4 mA 7 mA
Supply Protection	Protected against reverse voltage and overvoltage	
Configurable Calculated Scales/ Ranges	Dew point -40 to +100°C (-40 to +212°F) Water activity 0 to 1 Absolute humidity 0 to 200 g/m^3 Specific enthalpy 0 to 800 KJ/kg Frost point -50 to +10°C (-58 to +50°F)	
Configurable Temperature Scales/ Range	°C, °F : -20 to 80°C, 0 to 50°C, -40 to +60°C, -30 to +70°C, 0 to 100°C	
CE Conformity	2004/108/EC heavy industrial immunity	
Operating Specifications		
Probe Operating Temperature	Probe: Interchangeable sensor: Recommended storage:	-40 to +85°C (-40 to +185°F) -40 to +120°C (-40 to +248°F) +10 to +40°C (+14 to +104°F)

Mechanical Specifications		
Ingress Protection	IP67 (NEMA 6)	
Material	Probe & sensor body: Interconnect ring: Filter assembly:	Solid glass filled PBT Anodized aluminum HDPE or Molded polymer & PVDF
Dimensions	Probe: Interchangeable sensor:	L=145mm, ø15mm (5.7", ø 0.6") L= 56mm, ø12mm (2.2", ø 0.47")
Weight	31g (1.09oz) approx (packed weight 45g (1.59oz)	
Electrical Connector	M12 5 pin (A coded)	
Mating connector/cable (optional)	M12 Connector/cable 2, 5, 10 meter assembly	
Product Marking	Indelible laser etched alphanumeric/bar coded identification	
Maintenance Kits (Optional)		
HS3 Probe Simulator Kit	Desk-mounted configuration kit, 3 x sensor simulators (25%, 50%, 75%RH at 23°C (73°F)), spare probe electronics, carry case	
HS3 Probe Configuration Kit	Desk-mounted configuration kit, spare probe electronics, carry case	
HS3 logger/configuration converter Cable	1.8 meter USB to RS485 converter cable with M12 connector	

A.1 Dimensions

HygroSmart HS3 Probe - HS3-P



HygroSmart HS3 Probe Replacement Sensor - HS3-S-R

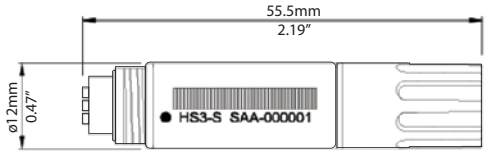


Figure 30 *Dimensional Drawings*

Appendix B

HS3 Modbus Communications & Register Map

Appendix B HS3 Modbus Communications and Register Map

B.1 Communications

	Modbus	Cable Color
1	Comms A	Brown
2	Comms B	White
3	0 V	Blue
4	+5 V to +28 V	Black
5	0 V	Gray

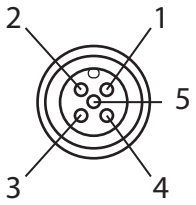


Figure 31 *Pinout*

Parameter	Value
Baud Rate	9600 bps
Stop Bits	1
Data Bits	8
Parity Check	None
Flow Control	None

Figure 32 *Serial Port Parameters*

The HS3 uses the Modbus RTU protocol to communicate.

All data is accessed by using Function Code 3 - Read Holding Registers, the byte order of the data in the responses is Big Endian (AB).

B.2 Code examples

This example shows the raw bytes to send to the probe to request relative humidity and temperature. In this example there is one probe in the loop on address 1.

Request Relative Humidity:

Address	Function code	Start address Hi	Start address Lo	Length Hi	Length Lo	CRC 16 Lo	CRC 16 Hi
X01	X03	X00	X01	X00	X01	X25	XCA

Reply HS3 Probe:

Address	Function code	Byte count	Data0 Hi	Data0 Lo	CRC Lo	CRC Hi
X01	X03	X02	X01	xC5	X79	X87

Request temperature:

Address	Function code	Start addrss Hi	Start address Lo	Length Hi	Length Lo	CRC 16 Lo	CRC 16 Hi
X01	X03	X00	X01	X00	X01	xD5	X15

Reply HS3 Probe:

Address	Function code	Byte count	Data0 Hi	Data0 Lo	CRC Lo	CRC Hi
X01	X03	X02	X00	xEA	x39	xCB

Useful resources:

www.simplymodbus.ca/FAQ.htm - excellent and easy to understand resource explaining the Modbus protocol

www.scadacore.com/field-applications/programming-calculators/online-hex-converter/ - convert raw data into various data-types, useful for troubleshooting Modbus connections

www.baseblock.com/PRODUCTS/comtestpro.htm - free Modbus master-client for PC

B.3 Register Map

Addr: Gives the (base 10) address of each 16 bit register stored in the instrument.

R/W: Refer to R/W key following this table

Type: Indicates the data type of the register. For complex types, a letter is indicated which corresponds to a description of the type found following this table.

Div: Some register values with a fixed number of decimal places are stored internally as integers, which must then be divided by the number in this column to give the real value.

Addr	Description	R/W	Type	Div	Internal Name	Comment
0	Instrument Modbus address	R/W	UInt16		REG_OWN_ADDR	1-32
Measured & Calculated Parameters						
1	Temperature	R	Int16	10	REG_TEMPERATURE	-250.0C TO 250.0C
2	%RH	R	UInt16	10	REG_RH	0.0 to 100.0
3	Dew Point	R	Int16	10	REG_DEWPOINT	-364.0C to 364.0C
4	Frost Point	R	Int16	10	REG_FROSTPOINT	-364.0C to 364.0C
5	Water-Activity	R	UInt16	100	REG_WATER_ACTIVITY	0.000 to 1.000
6	Absolute Humidity (g/m^3)	R	UInt16	10	REG_ABS_HUMIDITY	0.0 to 6553.5
7	Wet Bulb	R	Int16	10	REG_WET_BULB	-364.0C to 364.0C
8	Enthalpy	R	Int16	10	REG_ENTHALPY	-3000.0 to 3000.0
9	water vapour pressure over water	R	UInt16		REG_WVP_WATER_INT	0 to 65535
10	water vapour pressure over ice	R	UInt16		REG_WVP_ICE_INT	0 to 65535
11	water vapour pressure over water HI	R	IEEE754 single		REG_WVP_WATER_F_HI	
12	water vapour pressure over water LO				REG_WVP_WATER_F_LO	
13	water vapour pressure over ice HI	R	IEEE754 single		REG_WVP_ICE_HI	
14	water vapour pressure over ice LO				REG_WVP_ICE_LO	
15-31	Reserved					
Miscellaneous						
32	Status	R	TYPE_A		REG_STATUS	

33	Temperature Units	R/W	UInt16		REG_TEMPERATURE_UNITS	See Note 1
34	Reserved					
35	Customer Password	R/W	UInt16		REG_CUSTOMER_PASSWORD	See Note 2
36-63	Reserved					
Voltage Outputs						
64	Full Scale Voltage	R/W	UInt16	1000	REG_VOUT1_RANGE	1000 / 2500 / 5000 / 10000
65	Output 1 Type	R/W	UInt16		REG_OUT1_TYPE	See Note 3
66	Output 2 Type	R/W	UInt16		REG_OUT2_TYPE	
67	Output 1 Min	R/W	*	*	REG_VOUT1_MIN	See Note 4
68	Output 1 Max	R/W	*	*	REG_VOUT1_MAX	
69	Output 2 Min	R/W	*	*	REG_VOUT2_MIN	
70	Output 2 Max	R/W	*	*	REG_VOUT2_MAX	
71	Output 1 %FS	R	Int16	10	REG_VOUT1_FS_THOU	
72	Output 2 %FS	R	Int16	10	REG_VOUT2_FS_THOU	
73-79	Reserved					
Temperature & Relative Humidity Calibration Correction Tables						
80	Temperature table in1	RC/ WC	Int16	10	REG_TEMP_CORR_IN1	
81	Temperature table out1	RC/ WC	Int16	10	REG_TEMP_CORR_OUT1	
82	Temperature table in2	RC/ WC	Int16	10	REG_TEMP_CORR_IN2	
83	Temperature table out2	RC/ WC	Int16	10	REG_TEMP_CORR_OUT2	
84	Temperature table in3	RC/ WC	Int16	10	REG_TEMP_CORR_IN3	
85	Temperature table out3	RC/ WC	Int16	10	REG_TEMP_CORR_OUT3	
86	Temperature table in4	RC/ WC	Int16	10	REG_TEMP_CORR_IN4	
87	Temperature table out4	RC/ WC	Int16	10	REG_TEMP_CORR_OUT5	
88	Temperature table in5	RC/ WC	Int16	10	REG_TEMP_CORR_IN5	
89	Temperature table out5	RC/ WC	Int16	10	REG_TEMP_CORR_OUT5	
90	RH table in1	RC/ WC	UInt16	10	REG_RH_CORR_IN1	
91	RH table out1	RC/ WC	UInt16	10	REG_RH_CORR_OUT1	
92	RH table in2	RC/ WC	UInt16	10	REG_RH_CORR_IN2	
93	RH table out2	RC/ WC	UInt16	10	REG_RH_CORR_OUT2	

94	RH table in3	RC/ WC	UInt16	10	REG_RH_CORR_IN3	
95	RH table out3	RC/ WC	UInt16	10	REG_RH_CORR_OUT3	
96	RH table in4	RC/ WC	UInt16	10	REG_RH_CORR_IN4	
97	RH table out4	RC/ WC	UInt16	10	REG_RH_CORR_OUT4	
98	RH table in5	RC/ WC	UInt16	10	REG_RH_CORR_IN5	
99	RH table out5	RC/ WC	UInt16	10	REG_RG_CORR_OUT5	
100-109	Reserved					
Probe & Sensor Data						
110	Probe Firmware version	R	UIny16	100	REG_FIRMWARE_VERSION	
111	Probe Serial number HI	R	TYPE_B		REG_PROBE_SERIAL_HI	
112	Probe serial number LO				REG_PROBE_SERIAL_LO	
113	Reserved					
114	Probe first cal (MMYY)	R	TYPE_C		REG_PROBE_FIRST_CAL	
115	Probe last cal (MMYY)				REG_PROBE_LAST_CAL	
116-119	Reserved					
120	Sensor Firmware version HI	R	TYPE_D		REG_SENSOR_FIRMWARE_HI	
121	Sensor Firmware version LO				REG_SENSOR_FIRMWARE_LO	
122	Sensor serial number HI	R	TYPE_B		REG_SENSOR_SERIAL_HI	
123	Sensor serial number LO				REG_SENSOR_SERIAL_LO	
124-127	Reserved					

R/W Key

Value	Description
R	Always readable
W	Always writeable
RC	Can only be read when REG_CUSTOMER_PASSWORD (register 35) contains 4660, otherwise returns 0
WC	Can only be written when REG_CUSTOMER_PASSWORD (register 35) contains 4660, otherwise write operation is ignored

Note 1 - Temperature Register

Value	Description
1	Temperature units = °C
2	Temperature units = °F

All parameters that sue temperature unit (temperature/dew-point/frost-point/wet bulb/output settings/temperature correction table) will be automatically converted into the newly selected temperature unit.

Note 2 - Customer Password

Writing **4460** to this register unlocks all registers marked as RC or WC.

Note 3 - Output 1 & 2 Type

Value	Quantity to output
1	Temperature
2	%RH
3	Dew Point
4	Frost Point
5	Water Activity
6	Absolute Humidity (g/m^3)
7	Wet Bulb
8	Enthalpy
9	water vapour pressure over water (Int16)
10	water vapour pressure over ice (Int16)

See also notes 1 & 4.

Note 4 - Output 1 & 2 Min/Max

The register type and divider for Output 1 Min and Output 1 Max are inherited from the parameters selected in Output 1 Type. For example, if Water Activity is selected, then the type is UInt16, and the divider is 100 as per the register map entry.

The register type and divider for Output 2 Min and Output 2 Max are inherited from the parameters selected in Output 2 Type.

Register TYPE_A (Status Register)

Bit	Flag
0	Output 1 under range
1	Output 1 over range
2	Output 2 under range
3	Output 2 over range
4	Thermistor open-circuit
5	Thermistor short-circuit
6	RH element open-circuit
7	RH element short-circuit
8	Sensor communications error
9	Input volts too low
10	Logic volts too low
11	Temperature out-of-range
12	RH out-of-range
13	Not Used
14	Customer extended access
15	Diagnostic mode enabled

One or more bits are set to '1' to indicate an error or alternative mode of operation.

Register TYPE_B (Serial Number Registers)

Two consecutive 16-bit registers form a 32-bit unsigned integer, X, that stores the serial number. The displayed serial number has the format HH-DDDDDD, where H is a hex digit & D is a decimal digit.

HH = (X & 0x0FF00000) >> 20 (displayed as 2 hexadecimal digits)
DDDDDD = X & 0x000FFFFF (displayed as a decimal number)

Example: If REG_PROBE_SERIAL_HI = 0x0AA5 and REG_PROBE_SERIAL_LO = 0x464E, then the probe serial number is displayed as "AA-345678"

Register TYPE_C (Date Registers)

The calibration dates are stored as 4 BCD digits in a word, 0xMMYY, where MM is a 2-digit BCD month number & YY is a 2-digit Year.

Example: 0x112 = November 2025

Register TYPE_D (Sensor Firmware)

The firmware is displayed as "A.B.C", where A, B & C are integers in the range 0-255.

A = REG_SENSOR_FIRMWARE_HI & 0x00FF
B = (REG_SENSOR_FIRMWARE_LO & 0xFF00) >> 8
C = REG_SENSOR_FIRMWARE_LO & 0x00FF

Example: If REG_SENSOR_FIRMWARE_HI = 0x0001 and REG_SENSOR_FIRMWARE_LO = 0x0203, the the sensor firmware version is displayed as "1.2.3"

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:

- ATEX Directive
- Calibration Facilities
- Confl ict Minerals
- FCC Statement
- Manufacturing Quality
- Modern Slavery Statement
- Pressure Equipment Directive
- REACH
- RoHS2
- 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	

MICHELL Instruments

F0121, Issue 2, December 2011

NOTES:

EU Declaration of Conformity

MICHELL Instruments

Manufacturer: **Michell Instruments Limited**
48 Lancaster Way Business Park
Ely, Cambridgeshire
CB6 3NW. UK.

CE

On behalf of the above named company, I declare that, on the date that the equipment accompanied by this declaration is placed on the market, the equipment conforms with all technical and regulatory requirements of the above listed directives.

HygroSmart HS3
Advance Interchangeable Relative Humidity Temperature Probe

complies with all the essential requirements of the EU directives listed below.

2004/108/EC **EMC Directive**

and (effective from 20th April 2016)
2014/30/EU **EMC Directive**

and (effective from 22nd July 2017)
2011/65/EU **Restriction of Hazardous Substances Directive (RoHS2)**
RoHS2 EU Directive 2011/65/EU (Article 3, [24]) states, *"industrial monitoring and control instruments means monitoring and control instruments designed exclusively for industrial or professional use".* (mandatory compliance effective date 22nd July 2017).

and has been designed to be in conformance with the relevant sections of the following standards or other normative documents.

EN61326-1:2006	Electrical equipment for measurement, control and laboratory use – EMC requirements –Class B (emissions) and Industrial Locations (immunity).
EN61010-1:2010	Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use - Part 1: General Requirements

Andrew M.V. Stokes, Technical Director

Date of Issue: Jan 2016

http://www.michell.com