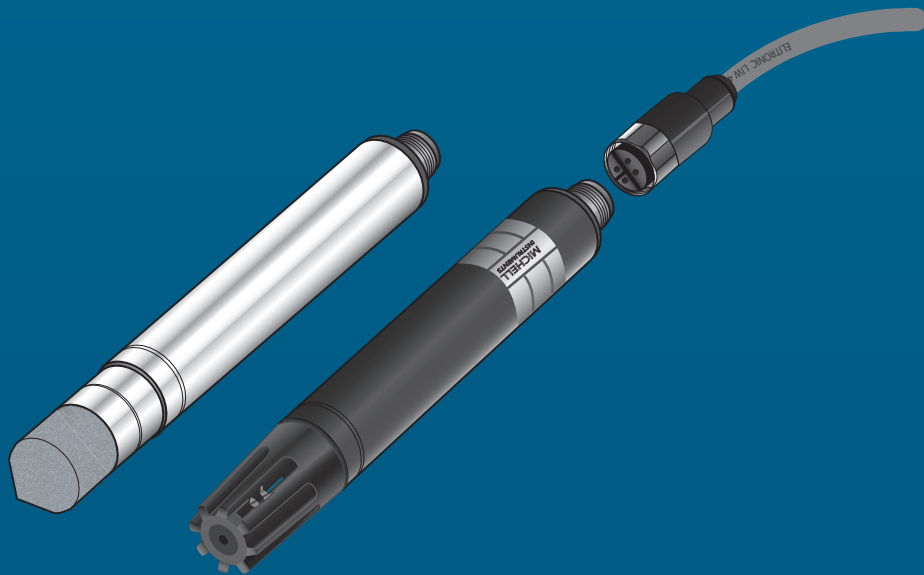




PC62 and PC62V RH & Temperature Transmitters User's Manual



97222 Issue 2
April 2015

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	



PC62 & PC62V

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 qualified personnel and good engineering practice for all procedures in this manual.

Electrical Safety

The instrument is designed to be completely safe when used with options and accessories supplied by the manufacturer for use with the instrument.

Toxic Materials

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

Repair and Maintenance

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

Calibration

Michell Instruments recommends an annual calibration for an accuracy requirement of $\pm 2\%$ RH under ambient conditions where temperature is 0 to $+50^{\circ}\text{C}$ ($+32$ to $+122^{\circ}\text{F}$) and relative humidity is 0 - 70% RH. For environments with airborne chemicals or for high humidity and high temperature conditions, Michell recommends more frequent calibration.

Safety Conformity

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

EMC Compatibility

The series PC62 humidity and temperature transmitters are designed to meet the following European standards:

EN61326 (1997) + A1 (1998) + A2 (2001)
Emission: Class B, Immunity: Industrial
EN61000-3-2 (1995) + A1 (1998) + A2 (1998)
EN61000-3-3- (1995)

Abbreviations

The following abbreviations are used in this manual:

AC	alternating current
ABsH	absolute humidity
°C	degrees Celsius
°F	degrees Fahrenheit
DC	direct current
g/m ³	grams per cubic meter
m	meter(s)
mA	milliampere
mm	millimetres
oz	ounce(s)
RH	relative humidity
RS232	serial data transmission standard
RS485	serial data transmission standard
T	temperature
V	volts
Ω	ohms
%	percentage

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 PC62 and PC62V transmitters measure relative humidity and temperature. They also calculate dew point and absolute humidity.

The PC62 has a digital output and the PC62V has an analog volt output.

The PC62's digital output can be connected directly to a two-wire RS485 network or a standard serial RS232 interface, depending on the version ordered. The main features include digital zero and span adjust, robust housing and a connector for quick and easy installation. For more information on the PC62 refer to Sections 2 and 3.

The PC62V provides a 0-1 V, 0-5 V, 0-10 V analog output.



Figure 1 PC62

2 INSTALLATION

2.1 Wall Mounting

The PC62 and PC62V can be used for wall mounting and must always be installed with the sensing element facing downwards so as to minimize the propagation of heat between the transmitter and the sensitive element. They should be attached to the wall with a mounting clip which can be ordered from Michell Instruments.

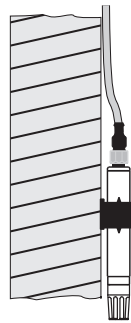


Figure 2 *Wall Mount Position*



Figure 3 *Wall Mount Clip*

2.2 Duct Mounting

The PC62 and PC62V can be used for duct mounting and must be installed so that the end of the sensor body (the filter) comes into contact, perpendicularly, with the flow of air from which the relative humidity is to be measured.

An extra opening should be made in the air duct close to the opening for the installation of the sensor in order that checks and further calibration may be performed, when required.

Whenever necessary, it is very important to create an appropriate form of thermal insulation between the walls of the duct and the transmitter housing.

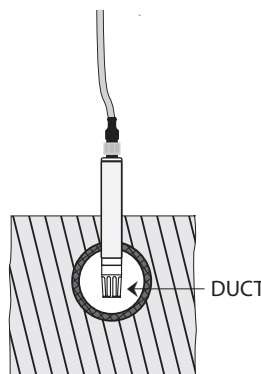


Figure 4 *Duct Mount Position*

2.3 PC62V

2.3.1 Electrical Connections

Connect the supplied cable connector to the sensor.

Use the following table to make cable connections to the appropriate hardware.

CONNECTIONS		
CONNECTOR	FUNCTION	CABLE
PIN 1	Supply VDC + (8 - 35 V DC)	WHITE
PIN 2	Output temperature (V)	YELLOW
PIN 3	Common ground (0 V)	BROWN
PIN 4	Output RH (V)	GREEN

Volt Output

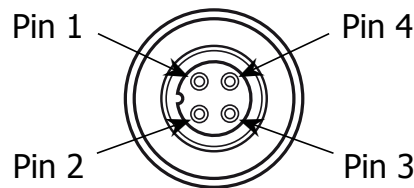


Figure 5 PC62V Electrical Connections



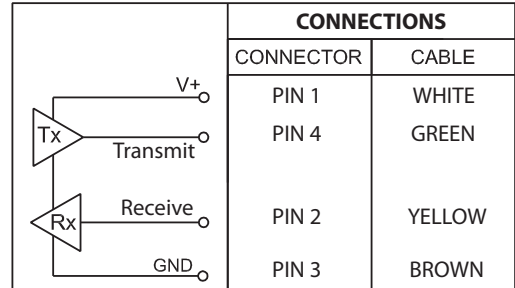
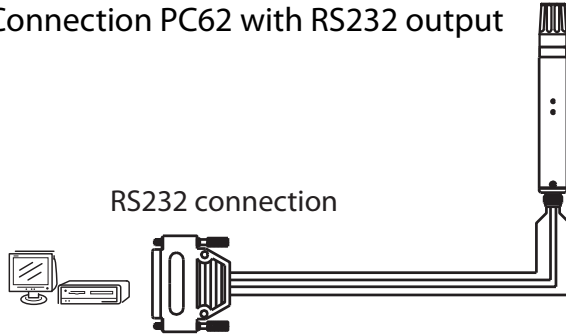
Make sure that electrical connections are correct before powering up

2.4 PC62 WITH RS232 OUTPUT

The PC62 communicates with any computer or PLC equipped with an RS232 interface.

2.4.1 Electrical Connections

Connection PC62 with RS232 output



Pin 1 and Pin 3 require a minimum of 8V (18 mA)

Figure 6 RC62 Connection With RS232 Output

Below is a HyperTerminal screenshot showing the output right after supplying power to the probe: The first line shows specific information about the probe.

RH=46.4%, T=23.1°C, Tdew=11.0°C, AbsH=9.6g/m³

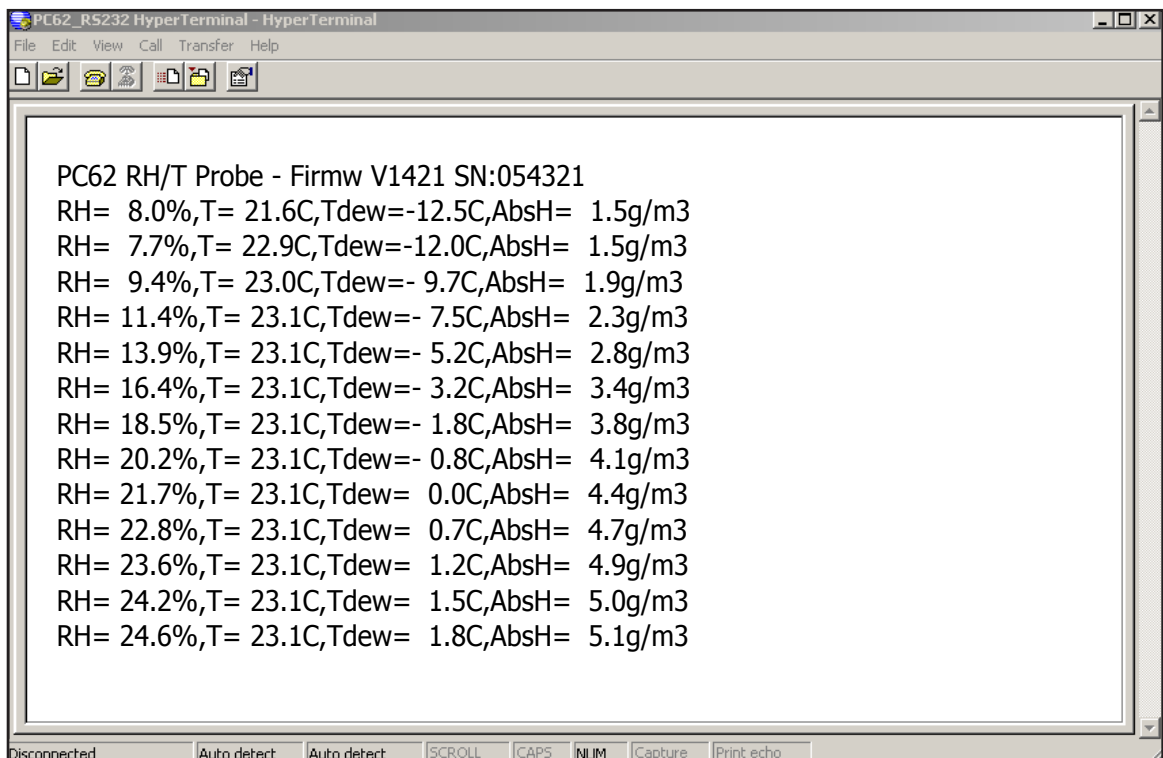


Figure 7 HyperTerminal Screen

A terminal program is an application that will enable a PC to communicate directly with a modem, for example, an RH transmitter. This can be useful to test the modem's availability and diagnose problems. If Windows 2000 or Windows XP is being used, the Windows HyperTerminal program is included as part of the operating system.

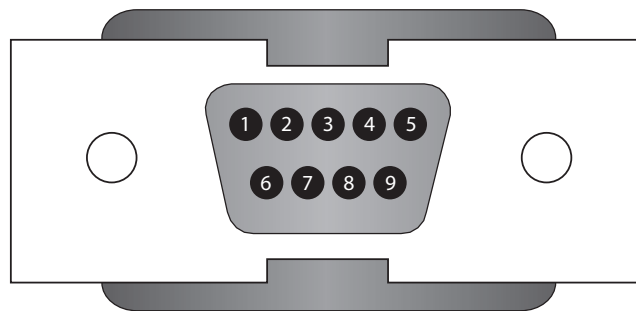
When the PC62 is correctly connected with the PC and a terminal program is used, the RH information is visible on the screen.

In the terminal program use the next parameters for communication:

Baud-rate 9600
 Data bits 8
 Parity none
 Stop bit 1

2.4.2 Connecting the 9-pin RS232 Sub-D Connector

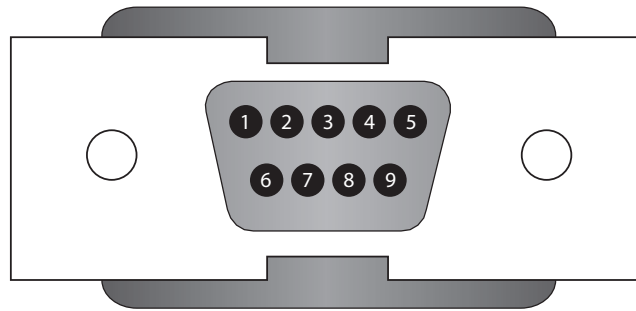
In order to connect the PC62 to a PC with a 9-pin serial interface, a 9-pin female Sub-D connector is needed.



Pin	Signal	Pin	Signal
1	Data Carrier Detect	6	Data Set Ready
2	Received Data	7	Request to Send
3	Transmitted Data	8	Clear to Send
4	Data Terminal Ready	9	Ring Indicator
5	Signal Ground		

Figure 8 9-pin Female Sub-D Connector

The wires of the PC62 cable should be connected as follows:



WHITE	Pin 4 (+ supply)
YELLOW	Pin 3 (Rx)
BROWN	Pin 5 (ground)
GREEN	Pin 2 (Tx)

Figure 9 *PC62 with RS232 Output*

NOTE: The 8V to power the instrument could be supplied by the RS232 port of a PC. (See schematic below). RS232 is getting more scarce and USB is seen more often. In this case a USB to RS232 converter could be used utilizing the same connections. However, most converters lack enough power and an external power supply would be necessary if this was the case.

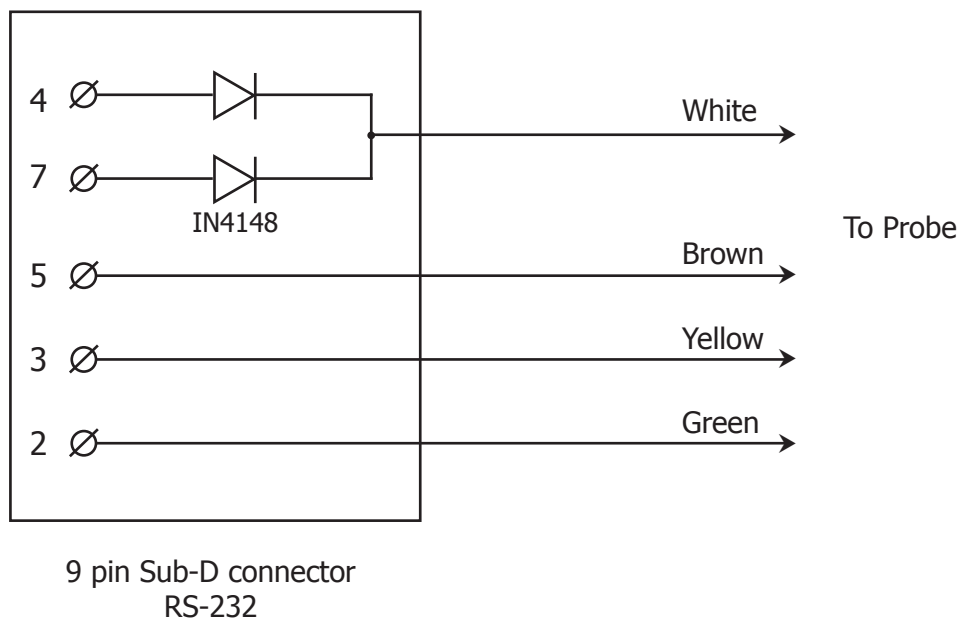
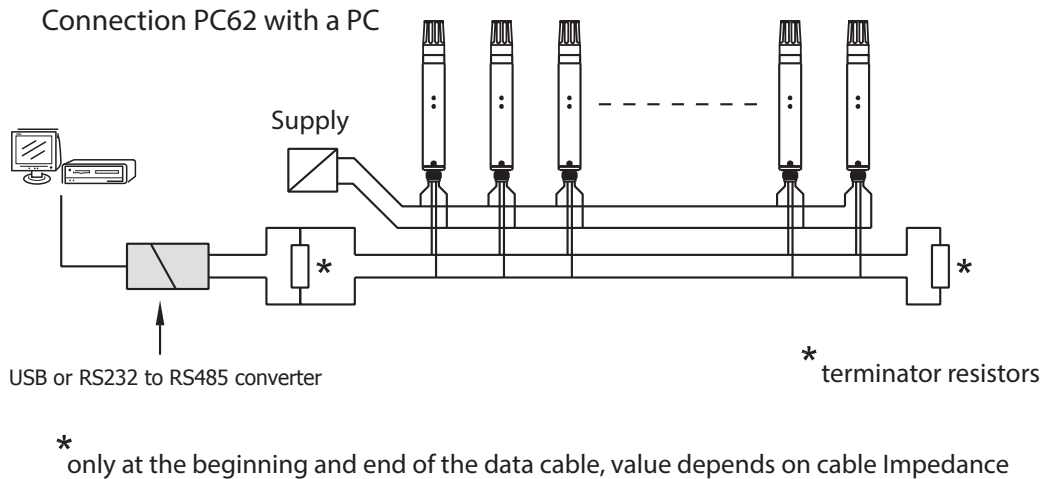


Figure 10 *PC62 Diode Connection*

2.5 PC62 WITH RS485 OUTPUT

When the PC62 is ordered with an RS485 it becomes an addressable transmitter enabling a maximum of 32 units to be connected to a single two-wire bus. The transmitter acts as a slave and will only provide data output when requested by the system.



WHITE	Pin 1 (+ supply)
YELLOW	Pin 2 (B)
BROWN	Pin 3 (ground)
GREEN	Pin 4 (A)

Figure 11 PC62 with RS485 Output

- The address (0 to 255) is stored in ASCII format in the memory of the transmitter. It is possible to change the address and adjust the calibration parameters.
- The information on the command set is available by contacting your local Michell Instruments' office (www.michell.com).
- The RS485 transmitters are, by default, set to address '01'.
- Below is an example string of ASCII coded data::
Addr:01,RH= 26.8%,T= 22.6C,Tdew= 2.6C,AbsH= 5.3g/m3

The PC62 starts up in normal operation mode. The instrument must be in this mode before requesting data from the PC62 with a RS485 output. The COM port parameters are:

9600 Baud rate; 8 data bits; No Parity; 1 Stop bit

Command string format: 0x02 0x1D 0x?? 0x?? 0x03

(STX cmnd Addr Byte 1 Addr Byte 2 ETX)

Addr Byte 1 and 2 form the ASCII coded address of the sensor.

Example:

The probe should respond to a query command sent to address "10".
ASCII code for "10" is 0x31 and 0x30.

Sending the following string will give a response of the probe with address "10".

0x02 0x1D 0x31 0x30 0x03

Below is an example string:

Addr:10,RH= 19.3%,T= 23.0C,Tdew=- 1.3C,AbsH= 4.0g/m3

3 CALIBRATION

Each unit is calibrated against our working factory standard which is traceable to 'NMI' Netherlands or National Physics Laboratory, UK.

In addition to the normal calibration procedure, each transmitter can be supplied with its own traceable calibration certificate. Please ask your local supplier for more information.

Michell Instruments recommends an annual calibration for an accuracy requirement of $\pm 2\%$ RH under ambient conditions where temperature is 0 - 50°C and relative humidity is 0 - 70% RH.

If the measured environment contains chemicals or the measurement is at high humidity and high temperature conditions, Michell Instruments recommends a recalibration after 6 months.

For questions about whether your application requires a more frequent recalibration please contact the local Michell Instruments' distributor.

Appendix A

Technical Specifications

Appendix A Technical Specifications

Performance	
Measurement Range (RH)	0–100% RH
Measurement Range (T)	-20 to +80°C (-4 to +176°F)
Accuracy at 23°C (73°F) Humidity	<±2% RH (10–90% RH)
Accuracy at 23°C (73°F) Temperature	±0.2°C (±0.36°F)
Stability – RH Sensor	±1% RH/year
Response Time – RH Sensor	<10 sec typical (for 90% of the step change)
Electrical Output/Input	
Output Signal	PC62 - RS232, RS485 PC62V - 0-1, 0-5, 0-10 V
Supply Voltage	14–30 V DC, 5–30 V DC (0–1 V)
Operating Conditions	
Operating Humidity Probe, Housing, Storage	5-95% RH
Operating Temperature Probe, Housing Storage	-30 to +85°C (-22 to +185°F) -40 to +85°C (-40 to +185°F)
Mechanical Specification	
Ingress Protection	IP65
Housing Material	Molded polymer housing or stainless steel
Dimensions	L=130mm, ø19mm (L=5.11", ø0.74")
Weight	30g (1.06oz) without cable (molded polymer housing version)
Electrical Connections	M12 binder 99 0430 10 04
Output Configuration	
Voltage Output	RH and temp, Dew point and temp, Absolute humidity and temp OR Wetbulb temp and temp
Digital Output (RS232 and RS485)	RH, T, Tdew, AbsH, TW

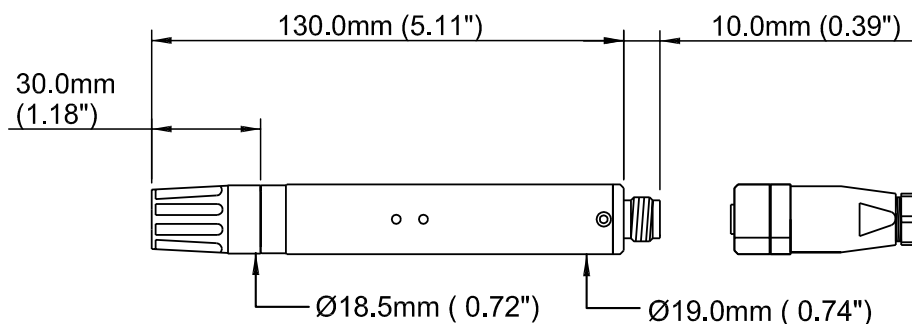


Figure 12 PC62 Dimensions

Appendix B

Commands for PC62 Probes

Appendix B Commands For PC62 Probes



Commands for the PC62 Humidity probes are explained within this Appendix.

Read this carefully - sending commands other than those than stated could damage the device or erase calibration information stored in the probe.

B.1 Programming the Device

When programming the device please ensure that the power supply is as stated in the specifications.

When commands are used to recalibrate the device, precautions should be taken to assure that the data integrity is guaranteed.

B.2 Addressing

RS485 devices respond to a unique address.

Programming an address into the probe is normally done in the factory but can also be done by the customer.

It is essential to record an address scheme list. Make sure that every probe on the data bus has a different address in order to prevent data collision.

A typical program cycle consists of the following command strings:

Calibration mode (cmd 0x98)

RH / Temperature / address adjustment command (on next pages)

Make changes permanent in non-volatile memory (Flash) (cmd 0x9F)

Reset command (0xFF) to put probe back into normal operating mode.

The commands are explained on the following pages.

PC62

Command - 'Calibration Mode'

For calibration purposes the PC62 has a special mode during which it ceases to give a normal output and is able to communicate with an external (**Master-**) device which enables data-exchange.

The probe always expects 5 bytes with 'STX' as the starting character and 'ETX' as the ending character. (Without these, the string is not valid and is purged. *)

General Data format (always 5 bytes)

STX	Cmnd	Identifier/Data byte A	Data byte B	ETX
-----	------	------------------------	-------------	-----

The command for calibration = '0x98'

The value of the 2 data bytes is a safety code (0x44,0x33)

Example:

Master sends:

STX	Cmnd=0x98	Data byte A (0x44)	Data byte B (0x33)	ETX
-----	-----------	--------------------	--------------------	-----

After the calibration command, several other commands are valid.

Allow 500ms for the probe to finish current tasks and change from normal mode to calibration mode.

When the power supply is interrupted the probe will change back to normal operation mode. The same result can be obtained with the '**Reset**'- command. It has the same format as the calibration command. The Hex-code for this command = '0xFF'

* (STX = 0x02; ETX = 0x03)

PC62

Command - 'Calibrate RH-input'

Probe in calibration mode

After the atmosphere in the calibration chamber is stabilized the probe can be (re)calibrated. It is a two- point calibration which involves one calibration in the lower part and one in the higher part of the measuring range. The probe only needs the two corresponding (reference) values of the Relative Humidity in the calibration chamber.

The calibration cycle for Humidity involves the following commands:

- Send calibration command (0x98)
- Send actual low part Relative Humidity value (coded) to the probe (Cmnd=0x10)
- Send actual high part Relative Humidity value (coded) to the probe (Cmnd=0x11)
- Send Flash 'program' command (0x9F)
- Reset probe (Cmnd=0xFF)

Calibrating the low part of the RH range:

The RH-calibration values are stored with a 0.01 point resolution.

The calibration range for the low part is 5 to 35.50% RH.

The data is stored as a non-signed integer (2753 = 27.53%RH). Likewise the calibration of the high RH part must take place in the range 70 to 95.5% RH. (Also equivalent to 2 bytes value eg. 78.62% = 7862 = 0x1E B6 - see example below.)

1st cycle: Set calibration mode

STX	Cmnd=0x98	Data byte A (0x44)	Data byte B (0x33)	ETX
-----	-----------	--------------------	--------------------	-----

2nd cycle: Master sends low value Relative Humidity (e.g. 27.53% RH => 2753 = 0x0AC1)

STX	Cmnd=0x10	Data byte A (0x0A)	Data byte B (0xC1)	ETX
-----	-----------	--------------------	--------------------	-----

3rd cycle: Master sends high value Relative Humidity (e.g. 78.62% RH => 0x1E B6)

STX	Cmnd=0x11	Data byte A (0x01E)	Data byte B (0xB6)	ETX
-----	-----------	---------------------	--------------------	-----

4th cycle: Program parameters in permanent memory (Flash)

STX	Cmnd=0x9F	Data byte A = 0x44	Data byte B = 0x33	ETX
-----	-----------	--------------------	--------------------	-----

PC62

Command - 'Calibrate Temperature-input'**Probe in Calibration Mode**

After the atmosphere in the calibration chamber has stabilized the probe can be calibrated. It is a one-point calibration at a reference temperature. The probe only needs this (reference) value of the temperature.

There are two calibration methods:

One-point temperature adjustment at about 23°C.

Three-point T calibration with two extra (low and high) adjustment points.

In order for the probe to show correct data, both the low and high points must be adjusted. A one point calibration at 23°C is also valid without having to perform a calibration and adjustment on the other two points. Most probes are delivered with three-point calibration and re-adjusting only one value is allowed in most cases.

The three-point calibration cycle for Temperature involves the following commands:

- Set probe to calibration mode (Cmnd=0x98)
- Send actual Temperature value (A-coded) to the probe (Cmnd=0x15) for the mid T-range
- Send actual Temperature value (B-coded) to the probe (Cmnd=0x1B) for the low T-range
- Send actual Temperature value (B-coded) to the probe (Cmnd=0x1C) for the high T-range
- Store parameters in non volatile memory (Cmnd=0x9F)

The order of commands 15, 1B and 1C is not important. The only restriction is that whenever parameters are changed they will not be valid until Command 9F is issued and the probe has been reset.

The data at the actual temperature is formatted for degrees Celsius (Centigrade). It is, however, different for the mid-range adjustment (A-coded versus B-coded).

A-coded : The temperature in units of 0.01°C divided over 2 separate bytes:

Byte A = the part preceding the decimal point. Byte B = the value after the decimal point (0 to 9).

The calibration window for the mid-range temperature is 5 to 35°C.

1st cycle: Set probe to calibration mode (see example: 'Calibration-Mode')

STX	Cmnd=0x98	Data byte A 0x44	Data byte B 0x33	ETX
-----	-----------	------------------	------------------	-----

2nd cycle: Send value mid-range T in 0.01° Celsius (e.g. 23.84°C => 23 = 0x17) (84 = 0x54)

STX	Cmnd=0x15	Data byte A 0x17	Data byte B 0x54	ETX
-----	-----------	------------------	------------------	-----

3rd cycle: Send value low-range T in 0.01° Celsius

STX	Cmnd=0x1B	Data byte A 0x08	Data byte B 0x55	ETX
-----	-----------	------------------	------------------	-----

Low range adjustment B-coded: The temperature as unsigned integer in units of 0.01°C with an offset of 40°C (4000) e.g. -18.67°C becomes 2133 (-1867 + 4000) = 0x08 55.

4th cycle: Send value high-range T in 0.01° Celsius

STX	Cmnd=0x1C	Data byte A 0x25	Data byte B 0x3B	ETX
-----	-----------	------------------	------------------	-----

High range adjustment B-coded: The temperature as unsigned integer in units of 0.01°C with an offset of 40°C (4000) e.g. 55.31°C becomes 9531 (5531 + 4000) = 0x25 3B.

5th cycle: Store parameters

STX	Cmnd=0x9F	Data byte A 0x44	Data byte B 0x33	ETX
-----	-----------	------------------	------------------	-----

PC62

Command - 'Request Data'

Probe in normal operation mode

Communication parameters:

9600 baud, 8 data bits, No parity, 1stopbit

Master sends :

STX	Cmnd 1 st	Byte Address (ASCII-Hex)	2nd Byte Addr. (ASCII-Hex)	ETX
-----	-----------	--------------------------	----------------------------	-----

The Command for requesting data = '0x1D'

Address: valid bytes = 0x30 to 0x39 and 0x41 to 0x46 (ASCII 0 to 9 - A to F)

Example:

0x02 0x1D 0x35 0x37 0x03

The reply from the probe is fully ASCII coded.

It reads (for example):

Addr =57, RH=46.4%, T=23.1C, Tdew=11.0C, AbsH= 9.6gr/m ³

PC62 with RS485 Protocol**Command - 'RESET'**

To abort a calibration cycle or to put the probe back into a known status apply the **RESET** command.

When a calibration is done it is possible to return the probe to normal operation with the **RESET** command.

Reset Probe (Cmnd=0xFF)

STX	Cmnd=0xFF	Data byte A = 0x00	Data byte B = 0x00	ETX
-----	-----------	--------------------	--------------------	-----

Appendix C

Quality, Recycling & Warranty Information

Appendix C Quality, Recycling & Warranty Information

C.1 Pressure Equipment Directive (PED) 97/23/EC

The above Directive has been implemented in United Kingdom Law by the Pressure Equipment Regulations 1999.

The Regulations require that all pressure equipment and assemblies within the scope of the Pressure Equipment Directive must be safe when placed on the market or put into service.

Michell Instruments' products have been assessed and, as referenced against the Classification Charts detailed in Annex II of the Directive, do not fall into the requirements for CE marking compliance with the Pressure Equipment Directive.

Article 3, paragraph 3 states that any product containing a pressurized fluid that does not qualify for compliance should, nevertheless, be constructed with Sound Engineering Practice (SEP).

Michell Instruments attests here that its products have been designed, manufactured & tested to assure safe operation, and in accordance with Sound Engineering Practices.

C.2 Recycling Policy



Michell Instruments is concerned with the protection of the environment. It is our commitment to reduce and eliminate from our operations, wherever possible, the use of substances which may be harmful to the environment. Similarly, we are increasingly using recyclable and/or recycled material in our business and products wherever it is practical to do so.

To protect natural resources and to promote material reuse, please separate batteries from other types of waste and recycle responsibly. If batteries are not properly disposed of, these substances can cause harm to human health and the environment.

The product that you have purchased may contain recyclable and/or recycled parts and we will be happy to provide you with information on these components if required. For further information please see the following sections.

C.3 WEEE Compliance

Directive 2012/19/EU 4 July 2012 on Waste Electronic and Electrical Equipment (WEEE)

The Waste Electronic and Electrical Equipment (WEEE) Directive places rules upon European manufacturers of electrical and electronic equipment. The directives' aim is to reduce the impact that electronic devices have on the environment.

Michell Instruments is in full compliance with the WEEE Directive and is registered with an approved recycler (Registration No. WEE/JB0235YW) and treats the requirement of the directive and the protection of the environment with the utmost importance. All Michell Instruments' products are appropriately marked indicating their requirement for recycling.

It may be required to return certain instruments for treatment at the end of their working life.

Feb 2013

C.4 RoHS2 Compliance

Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011

The Restriction of Hazardous Substances (RoHS) Directive places rules upon European manufacturers of electrical and electronic equipment. The directives' aim is to reduce the impact that electronic devices have on the environment.

According to the EC Directive 2002/95/EC, Michell Instruments' products qualify as Category 9, Control and Monitoring Equipment. Under the 2002/95/EC Directive, Category 9 products are exempt from compliance with the Directive.

However, the careful design of all Michell Instruments' products takes into consideration the requirements of the Directive and, wherever possible, compliance is achieved. All future products will be developed entirely using compliant materials. Furthermore, Michell Instruments is taking active steps to remove non-compliant materials and components from existing products wherever these may occur. Presently, none of the non-compliant materials are known to occur in Michell Instruments' products.

The new Directive 2011/65/EU (RoHS2) entered into force on 21 July 2011 and required all Member States to transpose the provisions into their respective national laws by 2 January 2013.

Under the provisions of the RoHS2 EU Directive 2011/65/EU (Article 3, [24]) defines 'Control and Monitoring Equipment' specifically as 'monitoring and control instruments designed exclusively for industrial or professional use'.

RoHS2 EU Directive 2011/65/EU states the closing date for compliance of any Control and Monitoring Equipment product sold into the EU market place as 22nd July 2017.

However, the careful design policy of all Michell Instruments' products continues to attain compliance in the shortest practical timescales and strives to ensure that less than 0.1% of total mass per product, of all non-compliant materials, appear within them. Michell Instruments continues to monitor suppliers and material sources to ensure that compliance of goods provided is maintained.

January 2013

C.5 Warranty

Unless otherwise agreed, the Supplier warrants that, as from the date of delivery for a period of 12 months, the goods and all their component parts, where applicable, are free from any defects in design, workmanship, construction or materials.

The Supplier warrants that the services undertaken shall be performed using reasonable skill and care, and be of a quality conforming to generally accepted industry standards and practices.

Except as expressly stated, all warranties whether express or implied, by operation of law or otherwise, are hereby excluded in relation to the goods and services to be provided by the Supplier.

All warranty services are provided on a return to base basis. Any transportation costs for the return of a warranty claim shall reside with the Customer.

C.6 REACH Compliance

Regulation (EC) No. 1907/2006

Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)

Michell Instruments is a manufacturer of moisture measurement and gas analysis instrumentation and is a 'downstream' user of chemicals, as described by the EU Council Directive 76/769/EEC. The products we supply are not raw chemical products (goods).

Under normal and reasonably foreseeable circumstances of application, the goods supplied to you shall not contain or release any prohibited chemicals. No listed SVHC (Substances of Very High Concern) appear within products manufactured by Michell Instruments. Therefore the 0.1% mass per product, or total usage of 1 tonne/year, will never be exceeded. For these reasons we are neither required by obligation for registration nor for the creation of material safety data sheets (MSDS) for our products.

Our continued review of the SVHC Candidate List and latest additions is to ensure we remain compliant.

Michell Instruments maintains a hazardous material register in which MSDS data sheets are collated, and we will check that our suppliers will comply to REACH requirements for all materials and substances we use in the processes of our manufacturing.

In the unlikely event that any chemicals of concern appear in our products in quantities greater than 0.1% of total mass per product we will immediately inform you by correspondence according to the REACH Article 33 requirements. Our current appraisal is, however, that we do not expect or foresee such an incidence.

January 2013

C.7 Calibration Facilities

Michell Instruments' calibration facilities are among the most sophisticated in the world and have been recognized for their excellence.

Traceability to the National Physical Laboratory (NPL) UK is achieved through our UKAS Accreditation (Number 0179). This covers dew point over the range -90 to +90°C (-130 to +194°F) and also Relative Humidity.

Dew-point calibrations are also traceable to the National Institute for Standards & Technology (NIST) USA over the range -75 to +20°C (-103 to +68°F).

NOTE: Standard traceable calibration certificates for instruments and sensors are not issued under our UKAS accreditation. UKAS certificates are usually to special order and are clearly identified.

C.8 Return Policy

If a Michell Instruments' product malfunctions within the warranty period, the following procedure must be completed:

1. Notify a Michell Instruments' distributor, giving full details of the problem, the model variant and the serial number of the product.
2. If the nature of the problem indicates the need for factory service then the instrument should be returned to Michell Instruments, carriage prepaid, preferably in the original packaging, with a full description of the fault and the customer contact information.
3. Upon receipt, Michell Instruments will evaluate the product to determine the cause of the malfunction. Then, one of the following courses of action will be taken:
 - If the fault is covered under the terms of the warranty, the instrument will be repaired at no cost to the owner and returned.
 - If Michell Instruments determines that the fault is not covered under the terms of the warranty, or if the warranty has expired, an estimate for the cost of the repairs, at standard rates, will be provided. Upon receipt of the owner's approval to proceed, the product will be repaired and returned.

C.9 Manufacturing Quality

Michell Instruments is registered with the British Standards Institute for Quality Assurance to:

BS EN ISO 9001: 2008

Rigorous procedures are performed at every stage of production to ensure that the materials of construction, manufacturing, calibration and final test procedures meet the requirements laid down by our BSI approved Quality System.

Please contact Michell Instruments (www.michell.com) if the product does not arrive in perfect working order.

Appendix D

Recommended Practices in Humidity Measurement

Appendix D Recommended Practices in Humidity Measurements

The following text is reproduced with kind permission from the National Physical Laboratory. It is originally published in the booklet, *A Guide to the Measurement of Humidity*.

Definition of Relative Humidity

Relative Humidity - The ratio of the actual vapor pressure to the saturation vapor pressure over a plane liquid water surface at the same temperature, expressed as a percentage. This is commonly understood when the term 'X percent relative humidity' is used.

For actual vapor pressure, e , and saturation vapor pressure, e_s

$$\text{relative humidity (in \%)} = \frac{e}{e_s} \times 100$$

USAGE: The phrase 'relative humidity' is commonly abbreviated RH although this is not a recognized abbreviation. Values of relative humidity are commonly expressed in units of percent relative humidity (% RH).

Recommended practices in humidity measurements

General practical recommendations

- Where relative humidity is of interest, a direct measurement of relative humidity is usually best. Where an absolute measure of humidity is needed, choose dew point, vapor pressure or similar measurements.
- Establish the measurement requirements at the purchasing stage in order to have the right instrument for the job.
- Allow hygrometers to equilibrate in any new environment. This is particularly necessary after changes in temperature due to transportation or storage. Depending on the instrument and on how great the change in conditions, this may require from only a few minutes to many hours.
- Follow Michell Instruments' care instructions for the instrument. Some instruments need routine cleaning or other maintenance. Before using any solvent cleaner, check with Michell Instruments that this will not harm the sensor or other materials of construction.
- Wherever possible, ensure that hygrometers are calibrated under the conditions of use, i.e. at similar values of humidity and temperature, and (if relevant) in similar conditions of pressure, airflow, etc.
- Keep a record of calibrations and any adjustments to the hygrometer. This will show the long-term stability of the instrument and allow the associated uncertainty to be assessed.
- Check instruments, if possible, at intervals between calibrations, by comparison with another (stable) instrument, to monitor for long-term drift. Routine checks are also useful before and after subjecting an instrument to transportation or other stress, which might lead to a shift in its performance. Where the check is against two (or more) instruments this is even better: not only does this add confidence, but in the event of one instrument drifting among a set of three, it can be seen which reading is most suspect.

- Cleanliness of the environment will affect different hygrometers in different ways. Dust and airborne droplets should be avoided or filtered out if possible. Contaminants can come from the most surprising sources, ordinary urban pollution, for example.
- The readings given by some types of hygrometer are sensitive to gas type. For any Instrument which reads in terms of mass per unit volume, e.g. in grams per cubic metre, it must be confirmed whether the calibration is valid for the gas in use.
- Avoid using instruments in direct sunlight or near any other source of heat, unless they are suitably shielded to prevent measurement errors.

Sampling in general

- Relative humidity measurements should be carried out at a representative temperature. Failure to allow temperature equilibration will lead to a false indication of the relative humidity.
- Variations in vapor pressure from place to place can occur where an environment is subject to any addition or removal of water. If so, care must be taken over where to make a measurement in order to obtain a representative result.
- Sources and sinks of water vapor should be avoided in any sampling system. Invasion of stray water can be minimised by attention to leaks, hygroscopic materials, droplets and condensation. The lower the humidity, the more critical these precautions are.
- Hygroscopic materials should be avoided. Many materials contain moisture as part of their structure, particularly organic materials (whether natural or synthetic), salts (or anything which contains them), and anything which has small pores. Temperature changes can increase the tendency of these materials to affect the humidity of the surrounding air.
- Condensation in a sampling process can invalidate humidity measurements by reducing the water content of the gas being measured. What is more, condensed liquid may alter the humidity elsewhere by dripping or running to other locations and evaporating there. In these circumstances, measurement results may be misleading if hygrometer location is not considered carefully.
- Water droplets or mist must be avoided. These can result in overestimates of the humidity of the air between the droplets. Such results may exceed 100% RH, or may be impossible to interpret meaningfully. Droplets of liquid also damage some electrical types of humidity sensor. Filtering the air sample can eliminate droplets.
- If pumps are used for sampling gas, these should be located after the hygrometer, to avoid contaminating the measurement environment. Where possible, oil free pumps should be used, or filters employed. Oscillations in pressure due to pumping can sometimes be reduced or buffered using a needle valve or a reservoir of large volume.
- Special treatments such as filtration can change the amount of moisture in a gas. Some drying agents take out other gases too.
- When sealing any sensor or probe into a port or manifold in a duct or chamber, leaks through the probe or electrical cable should be considered. These are not always sealed against passage of ambient air.
- Where sampling involves a step change in temperature, pressure or gas flow rate, relative to the process being sampled, results may need to be converted or interpreted. For example 'pressure dew point' will differ from the value found after expanding the gas sample to atmospheric pressure. Care should be taken to distinguish between 'gauge' and absolute values of pressure.

Dew point in general

- The measuring environment and all parts of the sampling pathway must be kept above the dew point if condensation is to be avoided. Electrical trace heating or other heating methods should be used if necessary. An excess temperature of 10°C above the dew point is usually a safe margin.
- For measurements in the region below 0°C it must be clear whether the condensate is dew or frost. Failure to distinguish between these can result in errors of about 1°C for every 10°C below zero.

Relative humidity in general

- Due care must be taken of temperature. The effect of temperature on humidity is highly significant. Failure to take this into account can sometimes lead to errors so large that the measurement is meaningless. In many situations, the largest single source of uncertainty in a humidity measurement is the effect of temperature differences from place to place in the process, room or chamber. The importance of considering the temperature effects carefully cannot be overstated when relative humidity is the parameter of interest.
- Care must be taken when expressing uncertainties, changes or fractional differences in relative humidity. For example, the difference between 50% RH and 52% RH is 2% RH. This can also be expressed as a difference of 4% of value. It is important to distinguish clearly between these two kinds of statement.

Recommendations specific to ranges of measurements

- Ambient humidity - Avoid using hygrometers near the body, which is a source of heat and moisture. Do not breathe close to the measurement.
- High humidity, above the ambient range - sample lines should be maintained above the dew point of the gas being measured, to avoid condensation. Electrical trace heating is often the most practical method.
- Low humidity, and very dry gases - If possible, prepare for measurements by flushing sample lines and hygrometers with dry gas, or by evacuating to low pressure. Drive off stray residual water by baking assemblies if possible (but not instruments - unless designed for this!). The lower the moisture content to be measured, the more dramatically the required drying time multiplies.
- Avoid hygroscopic materials. At low humidity (anything much below a dew point of 0°C) the amounts of water given off by organic and porous materials can dramatically affect the value of humidity. The lower the level of moisture, the more significant the effects.
- Choose impermeable materials, to avoid inward diffusion of moisture through sampling tubes and enclosures. Steel and other metals are practically impermeable. PTFE ('Teflon') is only slightly permeable and will usually be satisfactory for dew points above -20°C, and sometimes below this level. Materials such as PVC and rubber are relatively permeable and so totally unsuitable at low humidity, and not really satisfactory in any humidity range.
- Surface finish of pipework is important for very dry gases. Even the tiny quantities of water adsorbed on the surfaces of non-hygroscopic materials can have significant effect. Polished or electropolished steel is recommended for the best results.

- Clean environments are always best for humidity measurements, but this is especially critical at very low humidity. Even fingerprints harbour water. High purity cleaning agents are recommended: Analytical Reagent (AR) quality solvents for oil-based contaminants, and purified water (distilled or de-ionised) for salts. Cleaning should be followed by thorough drying by a clean method.
- Sample tubing should be as short in length as possible. The surface area should be minimised by using the narrowest tubing that the flow conditions will permit.
- Avoid leaks. Minimising the number of connections (elbows, tees, valves, etc.) helps with this.
- Adequate flow of the gas sample should be ensured, to minimise the influence of sources of stray water in the flow path.
- 'Dead ends' should be avoided, as they cannot easily be flushed.
- Back-diffusion of moisture should be minimised, e.g. by fast flow rates of gas, long exhaust tubes after the sensor, or by valves which isolate the low-humidity region from ambient air.

Practical recommendations for specific types of hygrometer

Relative humidity capacitive sensor

- Care should be taken to avoid mechanical shock (impact) or thermal shock (sudden temperature changes). Sensors should be protected from steam or water sprays, and from direct sunlight.
- Where a sensor is at risk of exposure to dust, droplets, or the occasional knock during handling, the appropriate guard or filters for the sensor head should be used.
- Any temptation to breathe on the sensor, or to wave it over cups of tea, etc. should be resisted. Filters and saturation guarding may protect the sensor, but these actions carry a risk of damage by condensation or other contamination.
- Protective filters can slow the response time of sensors. This can be avoided by removing any filter, but the benefit must be weighed against the risk of damage to the sensor.
- Sensors should not normally be submerged in liquids. In the case of a resistive (electrolytic) sensor, water or other liquids would certainly damage the sensor beyond repair.
- Salt solutions are especially commonly used for calibration of electrical sensors, and should be provided with traceability directly or via a calibrated hygrometer. Protection of sensors from direct contact with salt or solution is most important as contamination would destroy or seriously impair the sensing element.

Appendix E

Return Document & Decontamination Declaration

Appendix E 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	





<http://www.michell.com>