Liquidew EExd
Process Moisture Analyzer
User's Manual

97097 Issue 14.1
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Please fill out the form(s) below for each instrument that has been purchased.

Use this information when contacting Michell Instruments for service purposes.

Analyzer	
Code	
Serial Number	
Invoice Date	
Location of Instrument	
Tag Number	

Analyzer	
Code	
Serial Number	
Invoice Date	
Location of Instrument	
Tag Number	

Analyzer	
Code	
Serial Number	
Invoice Date	
Location of Instrument	
Tag Number	

Liquidew EExd

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

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Safety

This manual contains all the required information to install, operate and maintain the Liquidew EExd. Prior to installation and use of this instrument, this entire manual should be read and understood. Installation and operation of this product should be carried out by suitably competent personnel only. The operation of this product must be in accordance with the terms of this manual and associated safety certificates. Incorrect installation and use of this product for other than its intended purpose will render all warranties void.

This product is intended for use in a Hazardous Area and is awarded an ATEX, IECEx and CSA Certificate. The relevant certificates should be fully examined prior to installation or use of this product.

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 and where particular attention to personal and personnel safety must be observed.

Electrical Safety

The instrument is designed to be completely safe when used with options and accessories supplied by the manufacturer for use with the instrument. The input power supply voltage limits are 90 to 260 V AC, 47/63 Hz.

Pressure Safety

DO NOT permit pressures greater than the safe working pressure to be applied directly to the instrument. 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 only 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 (factory validation)

Prior to shipment, the analyzer undergoes stringent factory calibration to internationally traceable standards, NPL (UK) and NIST (USA). Due to the inherent stability of the instrument, only periodic calibration is required under normal operating conditions.

Michell Instruments recommends that calibration of the sensor should be maintained on a 12 monthly basis to ensure optimum operation. Michell Instruments offers a calibration exchange program, where a refurbished and re-certified sensor is supplied as an operational replacement and the original item returned to Michell to complete the exchange.

NOTE: This interval may need to be reduced if the operation of the sensor is within potentially aggressive or corrosive sample media (such as sour natural gas). The calibration interval may therefore need to be shortened to 6 months (or lower in extreme cases) in order to maintain satisfactory analyzer performance.

Safety Conformity

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

Abbreviations

The following abbreviations are used in this manual:

AC	alternating current
atm	pressure unit (atmosphere)
barg	pressure unit (=100 kP or 0.987 atm) gauge
°C	degrees Celsius
°F	degrees Fahrenheit
dp	dew point
EU	European Union
GPM	gallons per minute
Hz	Hertz
IEC	International Electrotechnical Commission
kg	kilogram
l/min	liters per minute
ml/min	milliliters per minute
l/min	normal liters per minute
lb	pound
mA	milliampere
max	maximum
min	minute(s)
mV	millivolt(s)
N/C	normally closed
N/O	normally open
No	number
ppm_w	parts per million (by weight)
psig	pound(s) per square inch (gauge)
RH	relative humidity
RTU	Remote Terminal Unit
temp	temperature
V	Volts
"	Inch

Warnings

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

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

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

1 INTRODUCTION

1.1 General

The Liquidew EExd is designed for continuous, automatic measurement of the moisture content in hydrocarbon solutes, utilizing the Michell Ceramic Moisture Sensor. It is the result of more than 30 years' experience in the supply of analyzers to the worldwide oil, gas and petrochemical industry.

The analyzer comprises either a single or a dual channel moisture measurement sensor cell, control electronics and a display interface housed in an Exd enclosure. The analyzer is ATEX Directive, IECEx or cCSAus compliant for use in a Zone 1 or 2 Hazardous Area and Class I, Div 1 Hazardous Location. See marking label located on right hand side of analyzer to identify approvals. An accompanying sample handling panel, designed to be positioned close to the process sample point to prepare the sample prior to entry into the Liquidew EExd, can also be supplied.

The instrument offers several user-selectable display options based on a calibrated dew-point measurement range of -100 to +20°C (-148 to +68°F), traceable to the humidity metrology standards of NPL (UK) and NIST (USA). The instrument provides indication in moisture in liquids (ppm_W).

The requirements for operation are a 90 to 260 V AC, 47/63 Hz power supply of 180W and field communications Modbus RTU and/or 4-20 mA. Refer to the System Wiring Diagram in Appendix B.3.

1.2 Liquid Sample Path

The Liquidew EExd analyzer system must be supplied with a liquid sample at a pressure up to 80 barg (1160 psig), via a sample handling panel providing filtration & flow control. Sufficient differential pressure will be required (typically greater than 0.5 barg (7.2 psig)) between the process sample source and return points. This should enable a flow between 0.1 and 0.3 l/min (0.03 and 0.08 GPM) through the Liquidew EExd and its associated sampling system. Sample entry and exit ports direct the liquid through flame arrestors which, along with the Exd enclosure, provide the explosion proof protection.

The measurement system components are housed within a cast aluminum Exd rated enclosure. The enclosure has a screw cover incorporating a sealed window. It is chromate primed, polyester coated in black, and provides environmental protection to IP66/NEMA 4. An enclosure breather is fitted in the form of an additional flame arrestor. It is important that no pipe connection is made to this breather and that no restriction is allowed to occur.

For accuracy and long term reliability, the temperature of the sample entering the Liquidew EExd should be less than +40°C (+104°F) and higher than +10°C (+50°F). The sample and operating temperature must not exceed the T ambient rating of +60°C (+140°F).

All sample wetted metallic parts are manufactured in AISI 316L stainless steel with Viton soft parts that comply with the NACE standard MR-01-75 (latest edition). Tube fittings are twin ferrule compression type. All electrical and liquid connections are made through the base of the enclosure. Refer to the Mounting Drawing in Appendix A.1.

Flow components for Channels 1 & 2 comprise the following:

Flow Meter: Provides indication of low, OK or high flow that is present throughout the sample measurement stream.

Measurement Cell: The point of measurement that incorporates the Michell Ceramic Moisture Sensor.

1.3 Operating Overview

The system continually measures moisture and temperature in an uninterrupted liquid sample flow rate. Moisture content is determined in part per million by weight (ppm_W) through Henry's Law, from the measured dew-point temperature and liquid temperature. It uses an extensive list of saturation concentration data pre-programmed for a variety of petrochemical liquids, with provision for easy entry of 'custom' characteristics data by the user.

Moisture and temperature for each channel are logged at a user-defined interval. The logs are available through the user interface or via the serial communications. Two 4–20 mA outputs for each channel are available to remotely read the humidity and temperature in real time.

1.4 User Display and Interface

The Liquidew EExd User Display and Interface Unit is presented via the circular window of the enclosure. Operation is achieved by a unique system, which allows full control through the glass of the enclosure cover. The cover is fully detachable for greater access into the enclosure during the installation and initial set-up of the instrument. During normal operation of the instrument the cover must remain fully secured.

1.5 Advanced Sensor Technology

Liquidew EExd utilizes the Michell Ceramic Moisture Sensor, an advanced impedance sensor technology, with integrated temperature measurement. This sensor is used in more than 1,000 natural gas and petrochemical installations worldwide.

Semiconductor thick- and thin-film technologies combine in metallized ceramics, producing an exceedingly durable sensor with the physical resilience to provide long-term reliable service in liquid phase measurements.

The Ceramic Sensor responds to the partial pressure of water vapor in the fluid being measured, which is directly related to the dew-point temperature. Every Liquidew EExd sensor is calibrated against fundamental dew-point measurement systems in Michell's laboratory, which is internationally accredited and directly traceable to both NPL(UK) and NIST(USA) metrology standards.

1.6 Measurement Units

The hygrometric unit can be set by the user to °C/°F dew point or moisture content in ppm_W.

The advanced firmware of the Liquidew EExd provides moisture measurements in ppm_W through the application of Henry's Law. It uses pre-programmed saturation concentration (Cs) values for the following common pure hydrocarbon liquid applications:

Hexane, Propane, Isopropylbenzene, Benzene, Butane, Isobutane, Propylene, Cyclohexane, 1-Butene and Octene. See Appendix B for instrument display names.

Four user-programmable tables enable the Liquidew EExd to be applied to virtually any immiscible solute. For simple mixtures of hydrocarbons, a proportional combination of the Cs values for two or three individual substances can be applied, although with increased measurement uncertainty. For applications with complex mixture fluids, customers can enter their own Cs values (in ppm_w for temperatures from 0 to +50°C (+32 to +122°F)) from their own library sources or from actual laboratory titration analysis of the fluid concerned.

1.7 Elimination of Temperature Effects

To ensure continuous optimum analysis conditions the Liquidew EExd Main Unit is temperature controlled (internally) at a stable level. The control temperature level is selected to suit the climate at the point of installation, being set to the normal maximum temperature. Such steady state control within the analyzer greatly reduces the effects of diurnal (day-night) swings in temperature. These temperature changes could otherwise induce transitional adsorption and desorption effects of the flowing sample and result in erroneous measurements.

In addition, the Liquidew EExd features an advanced temperature compensation algorithm that automatically maintains best possible measurement accuracy in the event of heater failure or if the prevailing climate exceeds the set temperature level.

1.8 Calibration

Maintenance of calibration is essential to the lifetime performance of all analyzers. To ensure that all customers worldwide can maintain the performance of their Liquidew EExd, the unique Michell Calibration Exchange Service offers freshly calibrated replacement Ceramic Sensors certified traceable to NPL and NIST. The calibration characterization data for each Liquidew EExd Sensor is programmed into on-board non-volatile memory. Fitting the Calibration Exchange Sensor refreshes the calibration, returning the measurement performance to day-one. This takes only a few minutes of downtime while the interchange is made. No programming or data input is required by the user to complete this.

The calibration exchange is available globally, typically taking less than two weeks, with comparable cost of a traditional 'return to manufacturer' re-calibration service.

The recommended calibration maintenance interval is 12 months.

1.9 Liquidew EExd Sampling System

(Optional – see separate manual if you have purchased this item)

Figure 1 *Liquidew EExd Sampling System*

Good sample conditioning and handling is particularly important in the field of moisture measurement. As the moisture sensor has to be exposed directly to the process liquid stream in order to detect the dissolved moisture present, key sampling issues such as the avoidance of particulate contamination are imperative to successful operation. Michell's 30 years of expertise in on-line process moisture analyzers are used to optimize the design of the Liquidew EExd Sampling Systems. Contact Michell Instruments for further details: www.michell.com.

2 INSTALLATION

2.1 Electrical Safety

WARNING:
During the installation of this product ensure that all applicable national and local electrical safety regulations are observed.

WARNING:
Isolate the power prior to installation.

WARNING:
Always ensure that power is switched off prior to accessing the product for any purpose other than normal operation or prior to disconnecting any cables.

2.1.1 Equipment Ratings and Installation Details

The mandatory statements contained within refer to the Ex certified Liquidew EExd Analyzer only (not including the sampling system).

This equipment must be supplied with a voltage between the range of 90 to 260 V AC, 47/63 Hz. Maximum power rating is 180W.

The power is connected via PL1 on the mains connector PCB.

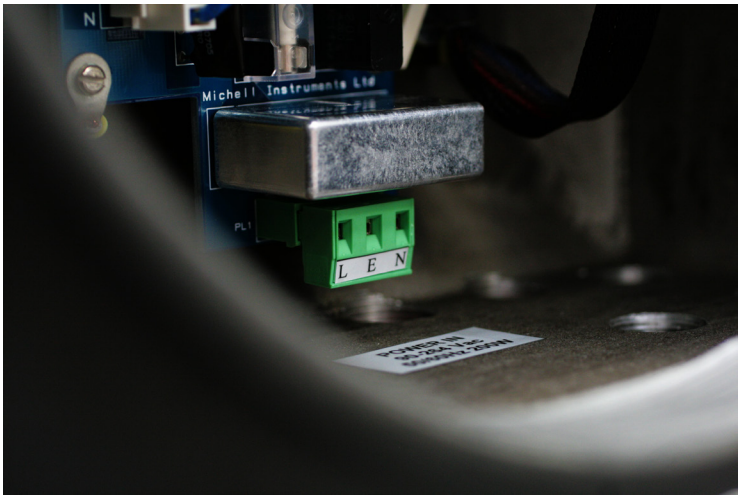


Figure 2 *Power Connection Connector*

All input and output connectors are 2-part PCB mounted type, rated at 300 V 10 A.

The detachable, screw terminal half of each connector is designed to accept 0.5 to 2.5mm^2 [24 -12 AWG] stranded or solid conductors.

Any power connection cable should be 3 core over sleeved, with minimum 0.5mm insulation and rated at 300 V. Cables should have Live (L), Neutral (N) and Earth [Ground] (E) conductors. Ensure suitably rated power supply cables and glands are used to ensure that electrical safety is maintained. Connect each of the Live (L), Neutral (N) and Earth [Ground] (E) conductors to the similarly marked terminals (L, N, E) on the Power In connector shown in *Figure 3*. Ensure the power supply can deliver sufficient power consumption requirement.

Any power supply terminals and voltages must be suitably separated from the other I/O requirements of this product.

Before applying power, perform a continuity test to ensure that the power supply cable and product are effectively connected to the protective Earth.

The Protective Earth terminal is mounted internally and the Earth wire connected to it should never be disconnected. The product enclosure is supplied with an external earth stud at the lower right hand side. At installation, connect this earth stud to plant earth by a minimum 4mm^2 earthing bonding. M6 stud and 2 off M6 nuts and washers, all nickel plated.

Figure 3 *Earthing Stud And Nut Washer Assembly*

Fuse: A replacement fuse can be obtained by contacting Michell Instruments' technical support. Fuse rating = 5 x 20mm 2.5 A anti-surge to IEC 60127-2.

This product is designed to be safe at least under the following conditions: between a temperature range of -40 to +60°C (-40 to +148°F), in maximum 80% relative humidity for temperatures up to +31°C (+88°F) decreasing linearly to 50% RH at +50°C (+122°F). Supply voltages of ±10% and transient over voltages up to Overvoltage Category II. Pollution Degree 2. Altitudes up to 2000m. Outdoor mounting is permitted using suitably rated glands equivalent to NEMA 4 / IP66. See Appendix A, Technical Specification, for full operating parameters.

Do not remove or exchange any of the cables or electrical components supplied with this product. Doing so will invalidate all warranties.

There are no additional or special electrical safety requirements other than those referred to in this manual.

Location and mounting arrangements - refer to the relevant sections of this manual for the location and mounting details.

Installation of this equipment must include the provision of a suitable and locally positioned power isolation switch or circuit breaker. Indication of the purpose of the switch or circuit breaker is strongly recommended. An over-current protection device should be rated to a maximum of 10 A.

This equipment and all power isolation devices must be installed in a location and position that allows safe and easy access to their operation and is able to rigidly support the equipment.

Do not install this equipment in a location that would expose it to impact or high levels of vibration.

Operation of this equipment, other than in a manner specified by the manufacturer, may impair the safety protections provided.

The safe installation of this equipment and any system incorporating this equipment is the responsibility of the installer. Ensure local regulations and requirements are referred to prior to any installation commencing.

2.2 Hazardous Area Safety

Refer to Appendix H for the Hazardous Area Certification of this product.

This product is fitted with a marking label that contains Hazardous Area information pertinent to the suitable location and installation.

During all installation and operation activities, local regulations and permitted working routines must be observed. Installation should only be performed by competent personnel and in accordance with the latest version of IEC/EN60079-14 or local equivalent.

Repair and servicing of this equipment must only be carried out by the manufacturer.

An Installation and Maintenance Information Sheet is supplied separately to the manual.

WARNING:
This product is certified safe for use in a Zone 1 and Zone 2 area only. This product must not be installed or used within a Zone 0 area.

WARNING:
This product must not be operated within an explosive atmosphere greater than 1.1 bara.

WARNING:
This product must not be operated with enriched oxygen gas samples (more than 21% oxygen content).

WARNING:
This product must not be operated outside of the temperature range of -40 to +60°C (-40 to +140°F).

WARNING:
The enclosure of this product provides Exd protection, partly through the threads used for mounting the lid, stopping plugs and cable gland. At all times effort should be made to ensure these threads are suitably protected from damage and that only appropriately rated mating parts are applied to them, in accordance with the certifying requirements.

2.3 Pressure Safety

WARNING:
This product is used in conjunction with pressurized gases.
Observe pressurized gas handling precautions.

WARNING:
Pressurized gas is dangerous.
Pressurized gas should only handled by suitably trained personnel.

This product requires pressurized gas to be connected to it. Observe pressurized gas handling regulations. Only suitably trained personnel should carry out tasks that include the use of pressurized gas mediums.

2.4 Lifting and Handling

WARNING:

This instrument is in excess of 18kg (40lbs).

Personnel must observe suitable lifting and handling precautions.

This product is not designed as portable or transportable equipment. It should be rigidly fixed in position as per the full installation instructions.

The weight of the analyzer is in excess of 18kg (40lbs). Therefore, appropriate lifting and handling techniques should be used during the installation process. Before commencing any lifting or handling ensure that its intended location is suitable and appropriately prepared. Make sure that mounting point design considerations have employed locally approved safety factors.

When handling and installing this product (particularly after removal from its packaging) ensure that it is not dropped, impacted or subjected to high levels of vibration or environmental conditions that may impair its operation.

2.5 Analyzer System

Refer to the Installation & Maintenance Information sheet (supplied separately) and the System Drawings in Appendix A.

The instrument is housed in an aluminum EExd enclosure suitable for wall or panel mounting. Four mounting points are available with M12 clearance holes on fixing centres of X = 270mm x Y = 318mm.

Height:	355mm (13.9") 500mm (19.68") including installation clearance
Width:	310mm (12.20") 500mm (19.68") including installation clearance
Depth:	245mm (9.64")

The enclosure provides environmental ingress protection IP66 and should be mounted vertically in a location free of any appreciable vibration. It should be placed in a shaded position to prevent heating effects through sun radiation.

The weight of the analyzer is 21kg (46lbs).

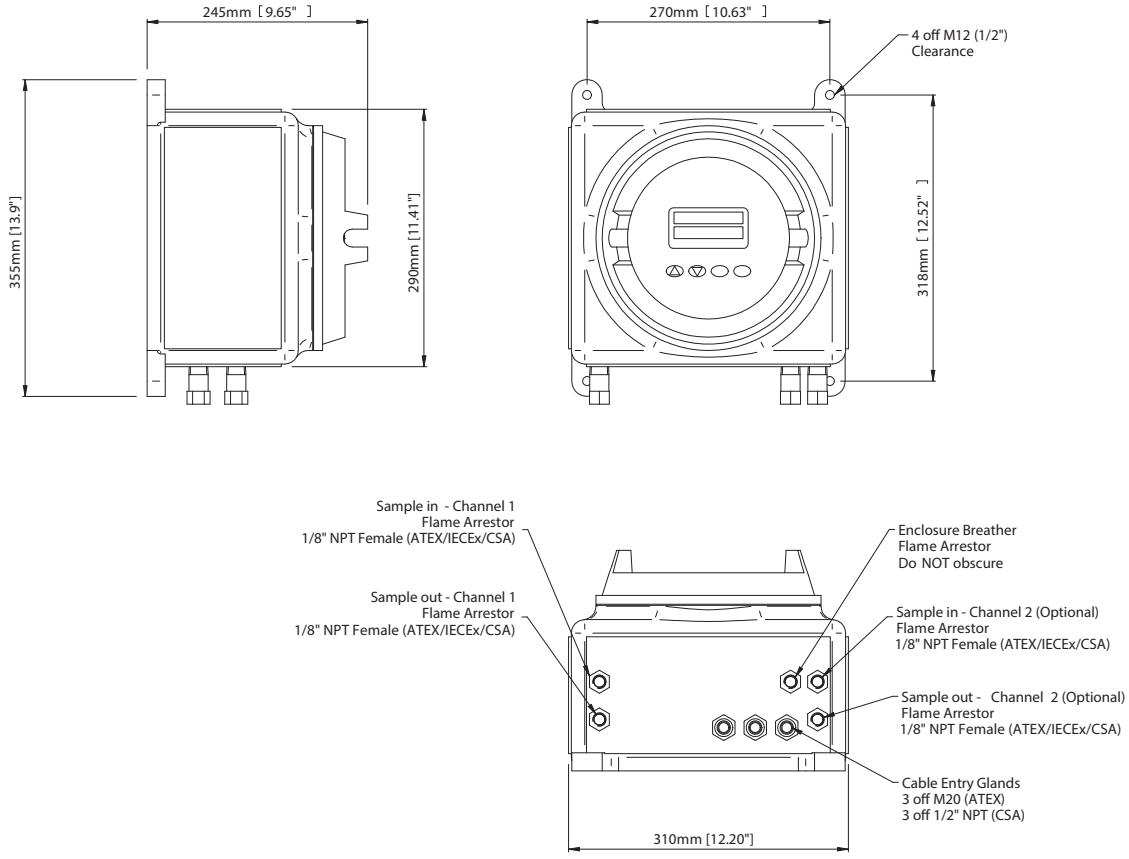


Figure 4 *Liquidew EExd Dimensions*

2.5.1 Pipework

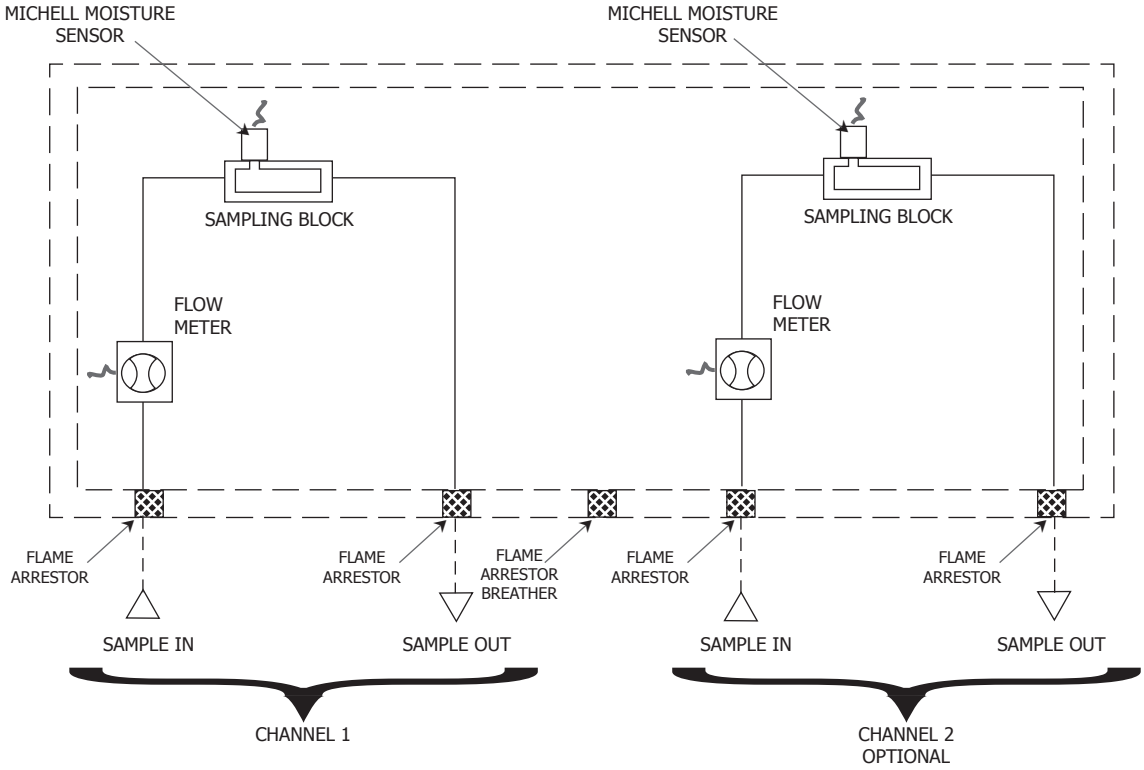


Figure 5 *Pipework Connections*

NOTE: Ensure that the process sample gas supply line is well flushed through to clear any debris present, prior to connection to the instrument. A sample handling system must prepare the liquid in terms of filtration and temperature reduction (if greater than +40°C (+104°F) before entering into the measurement system.

In accordance with the Certification requirements, the Liquidew EExd must have, as a minimum, those components described in the Sample System Flow Diagram shown in *Figure 6.*

The pipework connections are:

Moisture Channel 1 Sample inlet (Maximum pressure of 80 barg (1160 psig))	1/8" NPT(F)
Moisture Channel 1 Sample outlet	
Moisture Channel 2 Sample inlet (Maximum pressure of 80 barg (1160 psig))	
Moisture Channel 2 Sample outlet	

The following points should be considered when installing the sample liquid supply line:

PTFE tape is recommended for pipe connections. Solvent based pipe thread sealant should not be used, as condensable components or contaminates can be leached during the curing period.

It is recommended that Viton is used for all O-rings.

Filtration is critically important to avoid particulate contamination. For process fluids with high levels of particulates present, two-stage filtration may be required.

For elevated temperature processes, the sample flow temperature should be moderated, preferably to less than +40°C (+104°F) (max. +60°C (+140°F)), prior to entering the Liquidew EExd Main Unit.

There should be sufficient differential pressure between sample source and return points to enable a flow of between 0.1 and 0.3 l/min (0.03 and 0.08 GPM) through the analyzer.

The internal volume of the impulse tubing between the process line and any sampling system should be as low as possible (sample lines should be kept as short as possible) to minimize response lag time to changing process conditions.

Piping should be lagged and/or trace heated if ambient temperatures could cause the sample liquid to fall below its saturation temperature.

It should be standard procedure to isolate the measurement system during shutdowns or when plant problems are being experienced. The supply lines must be fully purged before restarting.

2.5.2 Power Connections

A single-phase AC power connection is required.

The power supply can accommodate voltages from 90 to 260 V AC, 47/63 Hz. The unit requires a maximum of 180W to function correctly.

The connection is made via a two-part connector mounted at the base of the unit. See Appendix A.

Cable entry into the measurement system is made through the bottom of the enclosure.

- For ATEX/IECEx compliant versions of the product, 3 off ISO M20 tapped holes are provided.
- For cCSAus compliant version of the product, 3 off ½" NPT entries are provided.

NOTE: EExd Stopping Glands MUST be used for ATEX/IECEx installations. Refer to the separate installation & maintenance information sheet supplied.

The terminals are marked:

L = Live
N = Neutral
E = Earth

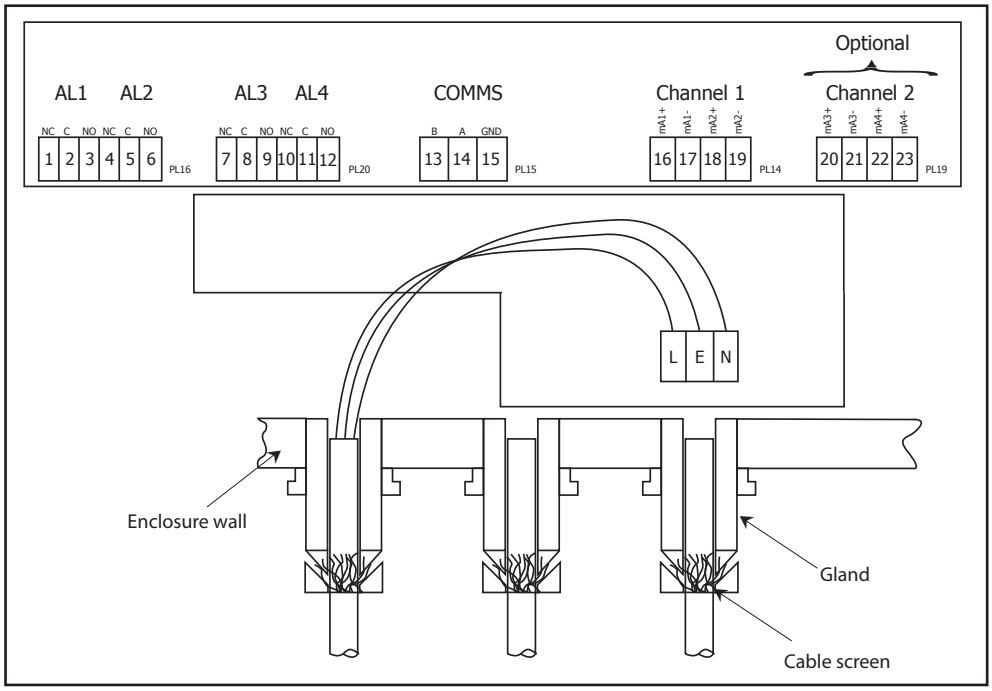


Figure 6 *Hook-up Wiring Diagram*

2.5.3 Analog and Digital Communications

Two active 4-20 mA outputs and a Modbus RS485 digital interface (see Appendix F for details) are provided with the Liquidew EExd. mA1 and mA3 output the moisture or dew-point values. mA2 and mA4 output the sample temperature values of Channels 1 & 2 respectively.

NOTE: The maximum output resistance for the 4-20 mA outputs is 500Ω.

See Section 3.7 on the setting of the 4-20 mA outputs via the user interface and Appendix F on setting the outputs via the Modbus interface.

Refer to *Figure 7* for cable wiring.

2.5.4 Process Alarms and Analyzer Status Alarms

Each channel has an associated process and fault alarm, as shown below:

AL1: Channel 1 process alarm
AL2: Channel 1 analyzer status alarm
AL3: Channel 2 process alarm (Optional)
AL4: Channel 2 analyzer status alarm (Optional)

The process alarm contacts can be set as either Normally Closed (**N/C**) or Normally Open (**N/O**).

The process alarm contacts change from **N/C** to **N/O** when the moisture value becomes greater than the alarm set point.

The fault alarm contacts change from **N/C** to **N/O** when an error associated with the channel occurs or when there is a supply failure.

2.6 Liquidew EExd Start-up Purge Procedure

This is a mandatory procedure stipulated in the ATEX/IECEx certification of the product. The procedure must be fully carried out prior to the Liquidew EExd having any power or signal connections applied. It must also be fully carried out after the Liquidew EExd and associated sample handling equipment has been installed and leak checked. Always refer to Appendix H.4 - Special Conditions of Safe Use.

This procedure must be carried out at any time following service or maintenance periods that cause any of the Liquidew EExd or associated sample handling equipment pipe work to be disconnected.

It is not necessary to carry out this procedure if power or signal connections only have been disconnected.

1. Before start-up ensure that all power and signal connections to the Liquidew EExd are fully isolated.
2. Ensure that all Inlet & Outlet liquid connections to the Liquidew EExd are made correctly and are leak tight checked.
3. Fully open the sample Inlet & Outlet isolation valves.
4. Allow the sample to purge the system for the period of time indicated in the table below:

TOTAL PURGE TIME
must be a minimum of 1 minute at 1 l/min (0.26 GPM)

Assumes total system pipe length is 3m (9.8') and internal pipe bore is the recommended 4mm (0.16") internal bore.

For every additional 1m (3.3') of pipe work, continue the sample purge for an additional 15 seconds at 1 l/min (0.26 GPM).

5. After the appropriate purge duration, close the sample Inlet & Outlet isolation valves.
6. Ensure the window is replaced and fully secured before applying the power.

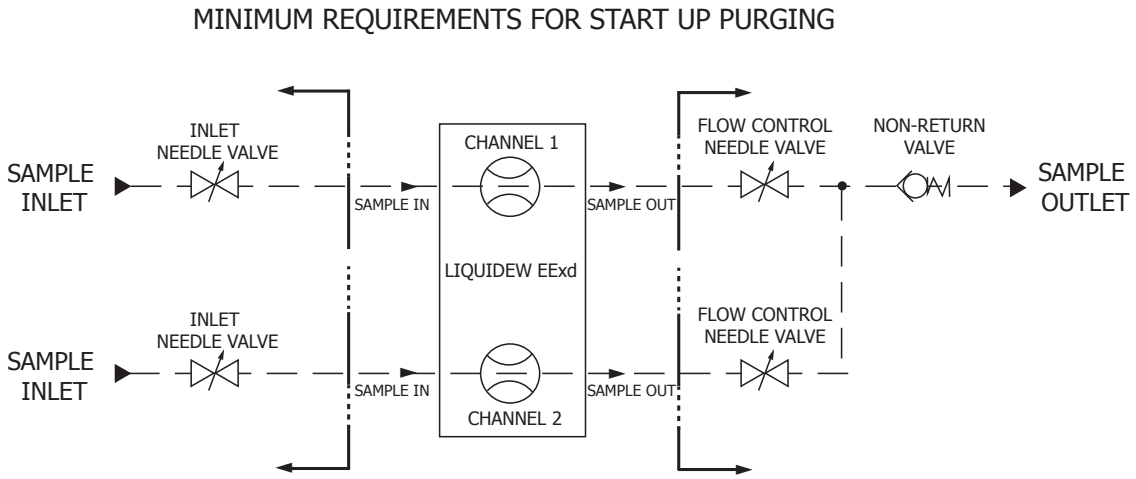


Figure 7 *Minimum Requirements for Start-up Purging*

2.7 Sample Flows

The flow meter provides the user with an indication of the sample flow status via a message displayed on the STATUS Page. The three states available are **LOW**, **OK** and **HIGH** flow.

LOW	Flow rate of <0.1 l/min (<0.03 GPM)
OK	Flow rate of between 0.1 and 0.3 l/min (0.03 and 0.08 GPM)
HIGH	Flow rate of >0.3 l/min (>0.08 GPM)

OK is the recommended setting during normal operation.

3 OPERATION

3.1 System Operation

At switch-on, the instrument will display the MAIN Page. It will synchronise itself to the on-board real time clock, in order to begin logging data at the next minute that is a multiple of 5, i.e. 5, 10, 15 etc. The MAIN Page will show the moisture and temperature readings of either 1 or 2 sensors and a countdown to the time when it will take the next data log. *Figure 9* below shows the MAIN Page for both 1 and 2 sensor configurations.

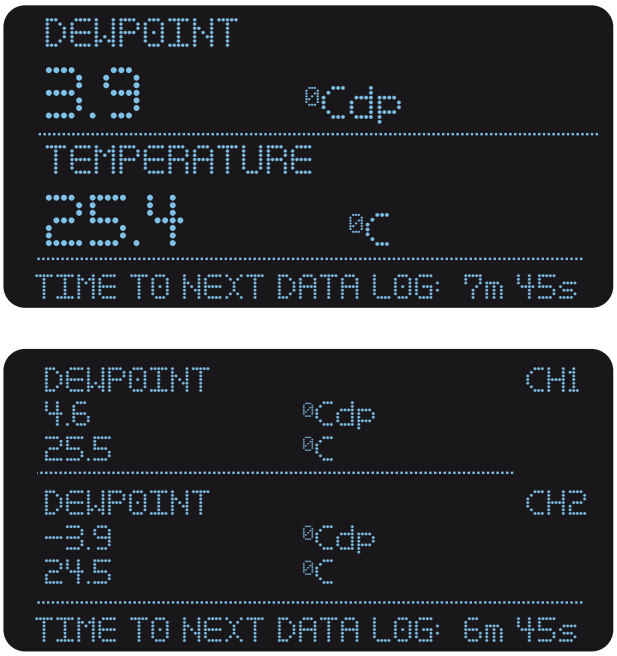


Figure 8 *MAIN Page in Single Channel (top) and Dual Channel Modes*

3.2 User Interface

3.2.1 Interface Controls

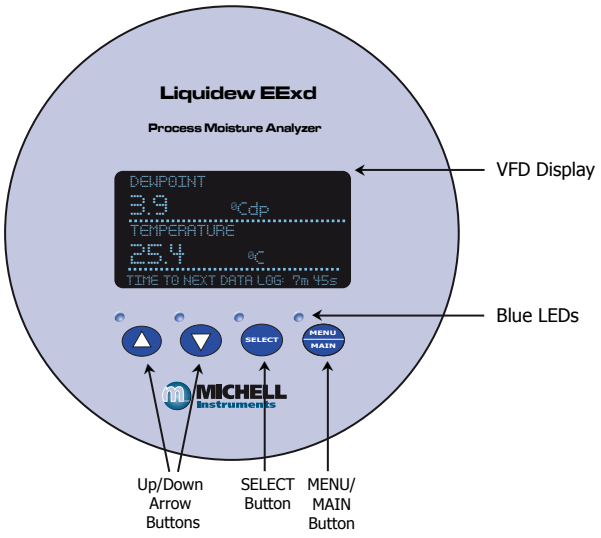


Figure 9 *User Interface*

Figure 10 illustrates the user interface. It has a vacuum fluorescent display and four touch sensitive pads that facilitate user interaction through the glass of the enclosure.

3.2.2 'Up/Down Arrow' Buttons

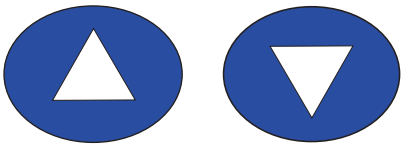


Figure 10 *Up/Down Arrow Buttons*

The **Up** (▲) and **Down** (▼) buttons are used to change pages, scroll through lists and adjust values.

3.2.3 'SELECT' Button

Figure 11 *'SELECT' Button*

The **SELECT** button is used to select or de-select a highlighted item in a menu list.

3.2.4 'MENU/MAIN' Button

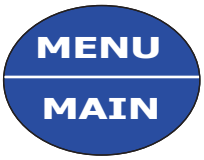


Figure 12 *'MENU/MAIN' Button*

The **MENU/MAIN** button is used to toggle between the MAIN Page and the MAIN MENU Page, or return to the MAIN Page from any location within the menu structure.

3.3 Menu Structure

Figure 14 below shows a map of the menu structure.

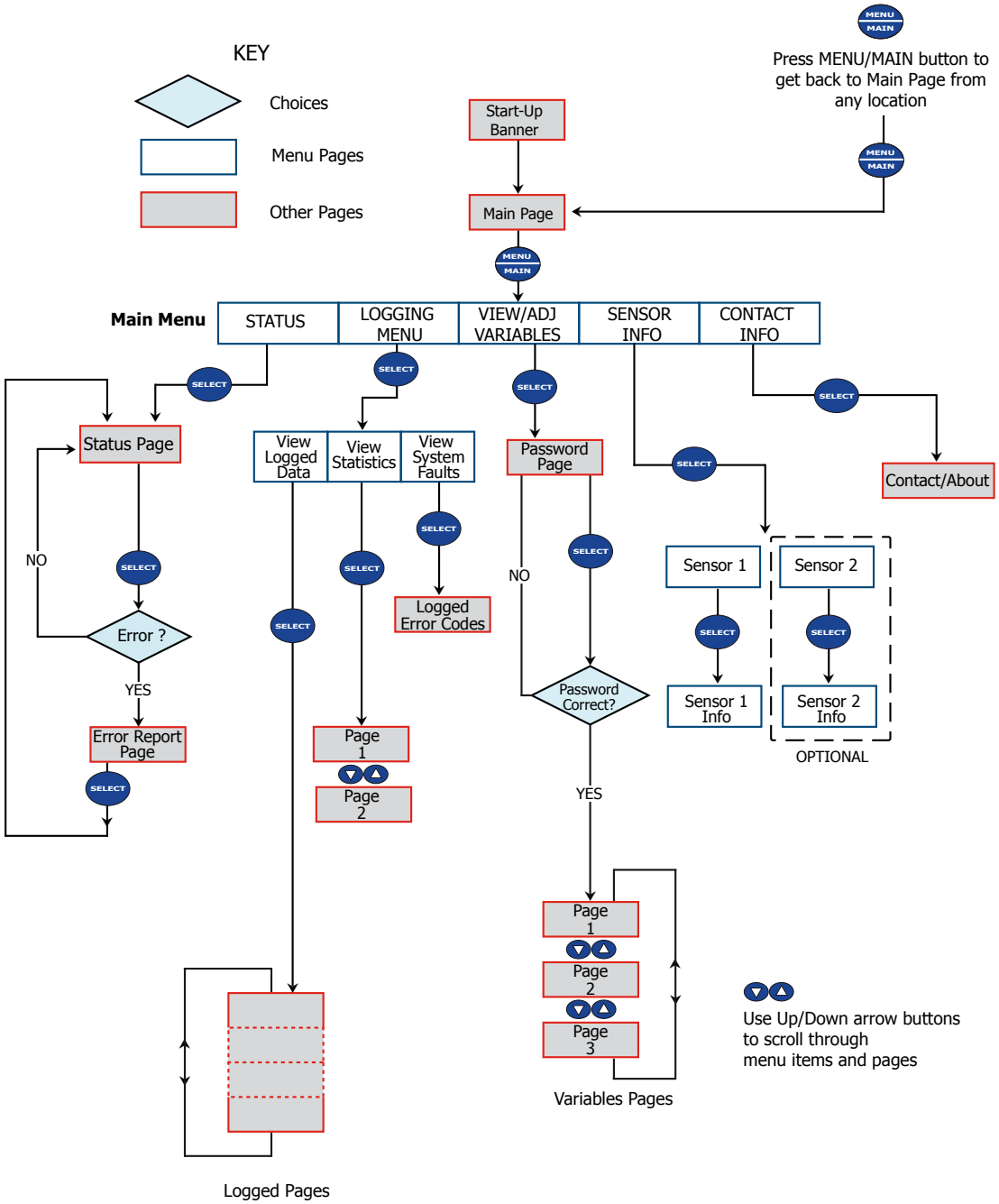


Figure 13 *Menu Structure*

3.4 MAIN MENU Page

This page is accessed by pressing the **MAIN/MENU** button from the MAIN Page. The instrument's status, variables, logged data and system information are available through this page. Use the **Up** (▲) and **Down** (▼) buttons to highlight the page of interest and press the **SELECT** button to access.

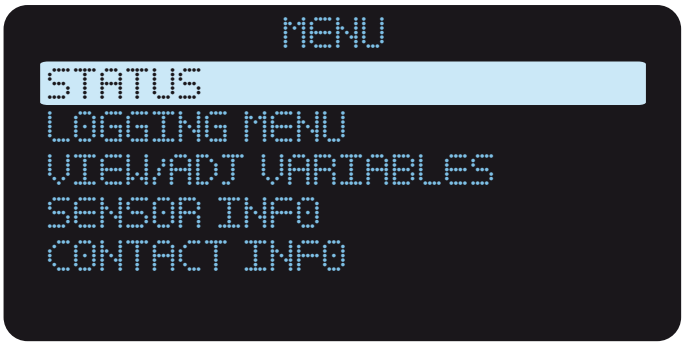


Figure 14 *MAIN MENU Page*

3.5 STATUS Page

This page shows the status of the process alarm and flow for one or both channels depending upon the configuration. When the measured moisture or dew-point value rises above the alarm set-point, the alarm condition will be displayed as **ON**. Flow rates are shown as **LOW**, **HIGH** or **OK**. See Section 2.7 for more information on the flow meter.

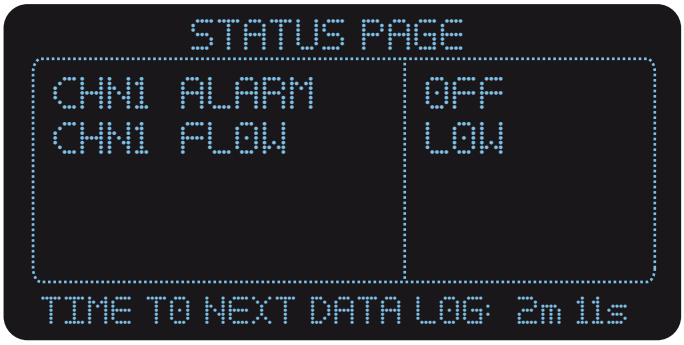


Figure 15 *STATUS Page*

Press the **MAIN/MENU** button to return to the MAIN Page.

3.6 LOGGING MENU Page

This page allows the viewing of data or statistical information on the logged data. Press the **SELECT** button to see the following options:

View Logged Data
View Statistics
View System Faults

Press the **Up** (▲) and **Down** (▼) buttons and the **SELECT** button to enter these options pages. If there is no data available then **No Data Available** will be displayed and no access will be given to the other two options.

3.6.1 VIEW LOGGED DATA Page

This page allows access to the previous measurement results made by the instrument. A rolling total of a maximum of 150 samples can be logged, which represents a measurement history of 150 x (measurement time) in minutes. Sample 1 represents the most recent measurement taken. After 150 measurements have been logged, the oldest measurement will be deleted and replaced as each new measurement is logged. **Caution: Changing the moisture value, e.g. from dew point to moisture, will reset all the logged data and start a new file.**

Access to each measurement sample is via the **Up** (▲) and **Down** (▼) buttons, which may be used to scroll through each page of information. If faster scrolling is required (to quickly move to another sample) press the **SELECT** button and the sample number will increase by 10. When the sample number selected is greater than that acquired, or is greater than 150, Sample 1 will be selected and displayed.

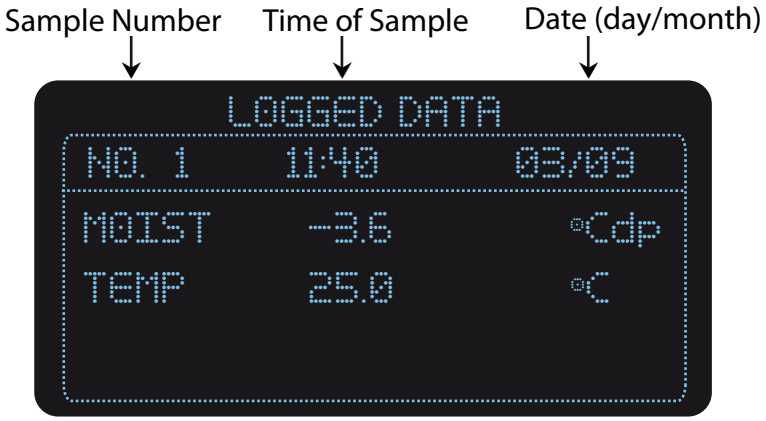


Figure 16 *LOGGED DATA Page*

Each page of logged data contains:

- Sample number — 1 to 150, 1 being the most recent
- Date of sample — dd/mm
- Time of sample — 24 hr format, hh:mm
- Values — Moisture content/dew point and temperature for 1 or 2 channels
- Units of measurement — °C / °F or ppm_w

Press the **MAIN/MENU** button to return to the MAIN Page.

3.6.2 VIEW STATISTICS

These pages display the maximum, minimum and average values for each measured parameter for up to 150 previous measurement samples. **RESET LOG** on the MAIN MENU Page re-sets the logging statistics.

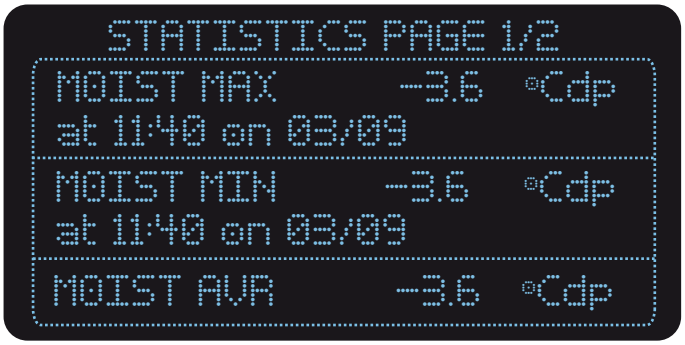


Figure 17 *STATISTICS Page*

Use the **Up** (▲) and **Down** (▼) buttons to scroll through the statistics.

Press the **MAIN/MENU** button to return to the MAIN Page.

3.6.3 VIEW SYSTEM FAULTS Page

This page displays a record of the last six system faults that have occurred and have subsequently been corrected. This assists in the diagnosis of any past anomaly in measured values. Any present system faults will be displayed in the bottom message line of the MAIN Page.

Figure 18 *SYSTEM FAULTS Page*

Refer to Section 4.4 for descriptions of the error messages and codes.

Press the **MAIN/MENU** button to return to the MAIN Page.

3.7 VIEW/ADJ VARIABLES Page

For more information on each variable refer to Appendix B.

3.7.1 Password

To safeguard against unauthorized adjustment of set-up parameters and variables, an entry lock is provided.

The user must first input the access code to enter the VIEW/ADJUST VARIABLES Pages.

The password is **7316.**

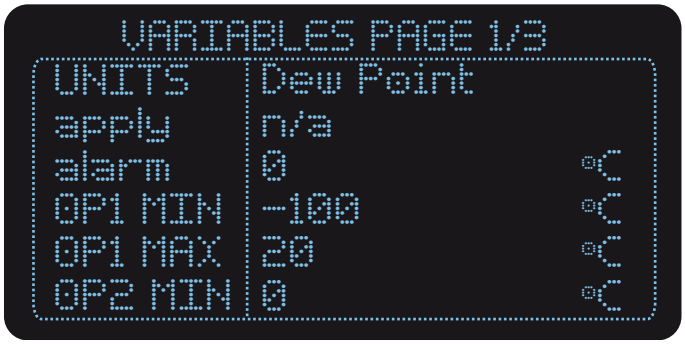
Figure 19 *PASSWORD Page*

Use the **Up** (▲) and **Down** (▼) buttons to change the highlighted digit and press the **SELECT** button to enter and move to the next digit. Inputting 4 correct digits will result in access to the Variables Pages as detailed in the following sections.

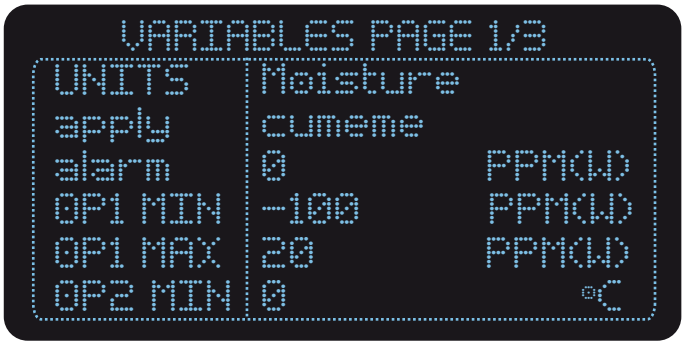
3.7.2 VARIABLES Pages

Three pages (four pages in the dual channel configuration) are used to display the system variables. They can be adjusted by using the **Up** (▲), **Down** (▼) and **SELECT** buttons.

Use the **Up** (▲) and **Down** (▼) buttons to scroll through the list and from page to page. To select a variable for adjustment, scroll to the desired variable and press the **SELECT** button**.** A small box will appear beside the value to indicate that it can be adjusted. Use the **Up** (▲) and **Down** (▼) buttons to change the value. **NOTE: Numerical values can be changed at a faster rate by extending the duration of the Up** (▲) **and Down** (▼) **button press.**



Variables Page in single channel configuration with Dew Point selected



Variables Page in single channel configuration with Moisture & Solute Cumene selected

Figure 20 *VARIABLES Pages (Examples)*

3.7.3 Single Channel Configuration Variables Pages

For more information on each variable refer to Appendix B.

Variables Page 1

Variable	Brief Description
UNITS	Measurement, either moisture content or dew point
apply	When calculating moisture content, this variable is used to select the sample solute type or user-defined solute
alarm	Moisture content or dew-point value that trips the process alarm
OP1min	Moisture content or dew-point value that gives 4 mA on mA1 output
OP1max	Moisture content or dew-point value that gives 20 mA on mA1 output
OP2min	Temperature value that gives 4 mA on mA2 output

Variables Page 2

Variable	Brief Description
OP2max	Temperature value that gives 20 mA on mA2 output
°C/°F	Temperature units selection
INT TEMP	Set-point temperature of the internal heater
TIME	System time
DATE	System date
ADDR	Sets the instrument address for serial communications

Variables Page 3

Variable	Brief Description
LOG INT'VAL	Time interval between data logs
RESET LOG	Clears the logged data
SET DEFAULT	Sets the system defaults

3.7.4 Dual Channel Configuration Variables Pages

For more information on each variable see Appendix B.

Variables Page 1

Variable	Brief Description
CHN1	Moisture content or dew-point value for Channel 1
apply	When calculating moisture content, this variable is used to select the sample solute type or user-defined solute for Channel 1
alarm	Moisture content or dew-point value that trips the process alarm for Channel 1
CHN2	Moisture content or dew-point value for Channel 2
apply	When calculating moisture content, this variable is used to select the sample solute type or user-defined solute for Channel 2
alarm	Moisture content or dew-point value that trips the process alarm for Channel 2

Variables Page 2

Variable	Brief Description
OP1min	Moisture content or dew-point value that gives 4 mA on mA1 output
OP1max	Moisture content or dew-point value that gives 20 mA on mA1 output
OP2min	Temperature value that gives 4 mA on mA2 output
OP2max	Temperature value that gives 20 mA on mA2 output
OP3min	Moisture content or dew-point value that gives 4 mA on mA3 output
OP3max	Moisture content or dew-point value that gives 20 mA on mA3 output

Variables Page 3

Variable	Brief Description
OP4min	Temperature value that gives 4 mA on mA4 output
OP4max	Temperature value that gives 20 mA on mA4 output
°C/°F	Temperature units selection
INT TEMP	Set-point temperature of the internal heater
TIME	System time
DATE	System date

Variables Page 4

Variable	Brief Description
INST ADDR	Sets the instrument address for serial communications
SET DEFAULT	Sets the system defaults
LOG INT'VAL	Time interval between data logs
RESET LOG	Clears the logged data

3.7.5 User-Defined Solutes

When selecting the sample solute type it is also possible to select up to four different user-defined solutes, labelled by default as U1, U2, U3 and U4. These are available by scrolling through to the end of the list of sample solute types. The table of saturation constants (or Cs values) of each user-defined solute can be edited by the user. From the Variables page, to edit your solute, scroll down the solute list and choose one of the user-defined solutes. Select the solute and it will show the the Cs value editor page. Each user-defined solute may also be given a customized label which will be appended to the end of the default labels.

3.7.5.1 Editing the Table of Cs Values

Variable	Brief Description
0°C	Cs Value at temp of 0°C
10°C	Cs Value at temp of 10°C
20°C	Cs Value at temp of 20°C
30°C	Cs Value at temp of 30°C
40°C	Cs Value at temp of 40°C
50°C	Cs Value at temp of 50°C

To view the table of Cs values, scroll to the desired user-defined solute using the **Up** (▲) and **Down** (▼) buttons, press the **SELECT** button and the relevant table will appear.

To edit any of the values use the **Up** (▲) and **Down** (▼) buttons to scroll up and down the list. Scroll to the desired temperature and press the **SELECT** button. A small box will appear beside the Cs value to indicate that it can be adjusted. Use the **Up** (▲) and **Down** (▼) buttons to change the value - these can be changed at a faster rate by extending the duration of the arrow button press. Press the **SELECT** button again when finished and to adjust another value.

Press the **MENU/MAIN** button to display the label editing page.

3.7.5.2 Editing the Label for the User-defined Solute

The custom label can be up to 8 characters in length and consists of any combination of letters from A-Z, space, hyphen and numbers from 0 to 9.

To enter the page, press the **MENU/MAIN** button from the page showing the table of Cs values. Use the **Up** (▲) and **Down** (▼) buttons to select the character and press the **SELECT** button to save and move to the next character position.

To exit back to Variables Page 1, press the **MENU/MAIN** button.

3.8 SENSOR INFO Page

This page contains the information relating to the water dew-point sensors.

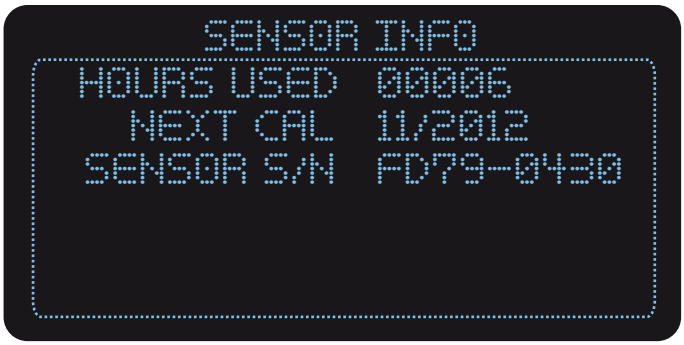


Figure 21 *SENSOR INFO Page*

Hours Used	Duration that the sensor has been in active use
Next Cal	Next recommended calibration date of sensor
Sensor S/N	Serial number of sensor

3.9 CONTACT INFO Page

This page contains contact information for Michell Instruments.

Figure 22 *CONTACT INFO Page*

4 MAINTENANCE

The power to the enclosure must be turned off before any work is carried out in the measurement system enclosure. Observe de-energize durations.

Sample line connections to the measurement system must be isolated and de-pressurized before any work commences.

Before powering up the instrument the "Start-up purge procedure" must be carried out. See Section 2.6.

To ensure the full requirement of this product's safety certificate is maintained, any loosened or disturbed tubework or couplings must be subject to a gas pressure test and appropriate leak check at 1.5x the max operating pressure before the full product is re-energized.

The design of the Liquidew EExd sensor cell and measurement system is such that no specific routine maintenance is required. If, however, a fault does occur with your system that is not covered within this manual, please contact Michell Instruments (www.michell.com) or your local representative.

4.1 Enclosure Cover and User Interface

The enclosure cover is part of the flameproof protection for the enclosure and has an IP66 rating. It should be firmly closed to ensure flameproof integrity and continued environmental protection. For prolonged and easy operation ensure that the threads are always lubricated with a light grease. A grub screw is used as a locking device. This should be loosened before unscrewing the cover counter-clockwise.

The user interface assembly uses two ¼ turn bayonet style fasteners to secure it. These are finger operated and should be turned clockwise to lock and counter-clockwise to release. The user interface, once disconnected from the two ¼ turn fasteners, can be temporarily re-positioned on the instrument by securing the right-hand fastener in the left-hand mount. This will situate the interface assembly in an overhanging position outside of the enclosure allowing greater access. If there is insufficient space to accommodate the overhanging user interface assembly on the left-hand side, it may be rotated 180° (upside down) and placed on the right-hand side.

Figure 23 *Ribbon Cable Connection*

Always keep the bayonet fittings lightly lubricated. If required, the user interface can be fully disconnected from the instrument by disconnecting the ribbon cable connection to the main processor PCB.

Unscrew the enclosure cover and remove the user interface assembly before carrying out the procedures below.

4.2 Replacement of the Sensor Assembly

DANGER
Electric
Shock Risk

The power to the enclosure must be turned off before any work is carried out in the measurement system enclosure.

Observe de-energize durations.

1. Isolate the incoming sample line by **CLOSING** the sample inlet isolation valve and allow the system to depressurize and drain. Isolate the power and observe the de-energize duration.
2. Remove the enclosure window and mount the user interface (see Section 4.1).
3. Using a 2.5mm hex key, remove the M3 cap head screw (1 in *Figure 25)* securing the moisture sensor assembly to the stay bracket.
4. Restrain the sensor assembly. Using an 14mm wrench, loosen and remove the 2 off 6mm water dew-point sensor sample pipe connections (2 in *Figure 25)*.

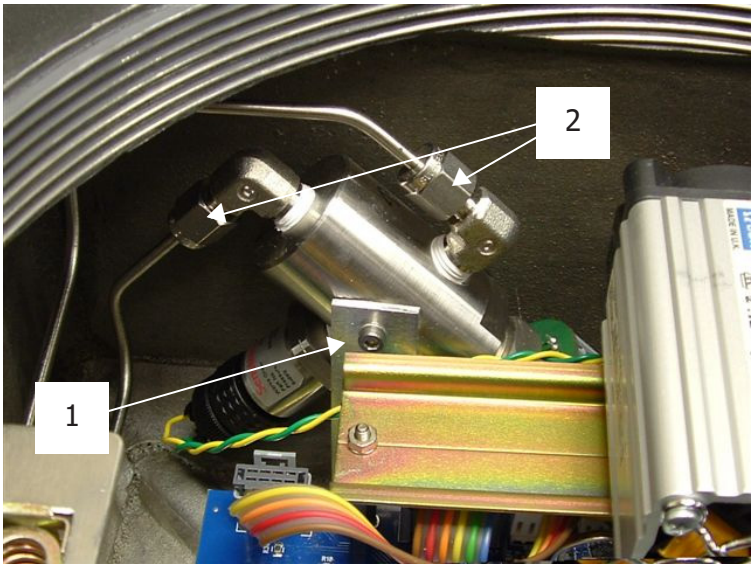


Figure 24 *Moisture Sensor Assembly Replacement*

5. Carefully pull the sensor block assembly out of the enclosure. This will allow access to the two sensor connections.
6. Disconnect the ribbon cable connectors from the sensor pcb.
7. Fully remove the sensor assembly from the enclosure.
8. Reconnect the sensor connections to the replacement moisture sensor assembly. Reposition the assembly on the stay bracket and secure with the M3 cap head screw.
9. Refit and fully tighten the 6mm moisture sensor sample pipe connections.
10. To ensure the full requirement of this product's safety certificate is maintained, any loosened or disturbed tubework or couplings must be subject to a gas pressure test and appropriate leak check at 1.5x the max operating pressure before the full product is re-energized.

4.3 Replacement of the Flow Meter

DANGER
Electric
Shock Risk

The power to the enclosure must be turned off before any work is carried out in the measurement system enclosure.

Observe de-energize durations

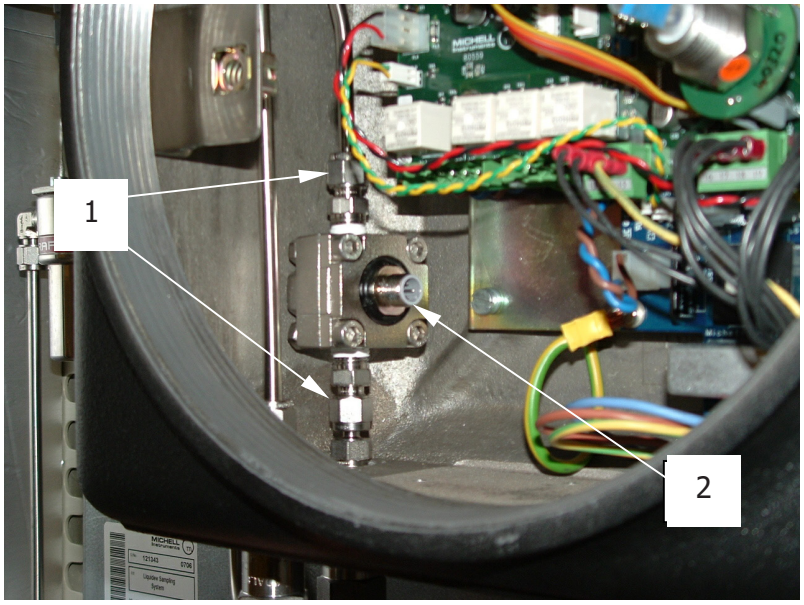


Figure 25 *Flow Meter Replacement*

1. Isolate the incoming sample line by **CLOSING** the sample inlet isolation valve and allow the system to depressurize. **NOTE: Always refer to Appendix H.4 - Special Conditions of Safe Use.**
2. Remove the enclosure window and mount the user interface (see Section 4.1).
3. Restrain the flow meter assembly (1) and use a 14mm wrench to loosen and remove the 2 off 6mm sample pipe connections.
4. Unscrew the 2-wire cable connector (2) from the flow meter.
5. Carefully withdraw the flow meter assembly out of the enclosure.
6. Replacement of the flow meter is simply a reversal of the above procedure.
7. To ensure the full requirement of this product's safety certificate is maintained, any loosened or disturbed tubework or couplings must be subject to a gas pressure test and appropriate leak check at 1.5x the max operating pressure before the full product is re-energized.

4.4 Troubleshooting

4.4.1 Error Messages

If a system errors occur, an error message will appear at the bottom line of the MAIN Page describing the problem. If more than one system error has occurred, the error messages associated with those faults will continually scroll in turn.

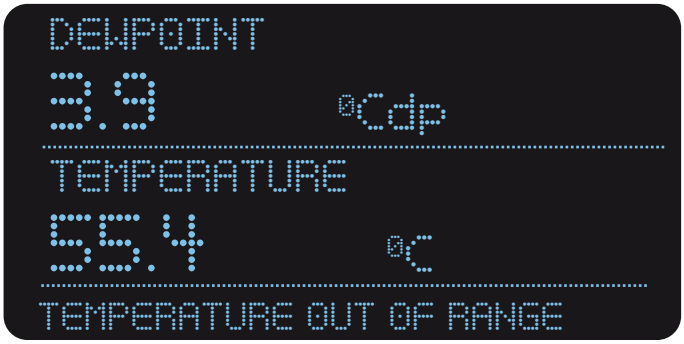


Figure 26 *Error Message Line*

Error Message	Description and Possible Causes
DEWPOINT UNDER RANGE	Dew point <-120°C (<-184°F) or sensor tile failure
DEWPOINT OVER RANGE	Dew point >+30°C (>+86°F) or sensor tile failure
TEMPERATURE OUT OF RANGE	Temperature >+50 or <0°C (>+122 or <32°F)
LOW FLOW	Flow through sensor measurement cell is <0.1 l/min (0.03 GPM) or flow meter has failed / disconnected
HIGH FLOW	Flow through sensor measurement cell is >2.6 l/min (0.69 GPM)
SATURATION	Dew point is greater than or equal to temperature
CAL TABLE ERROR	Fault with sensor calibration data
INTERNAL HEATER FAULT	Internal temperature set-point not achievable or fault with the internal temperature control devices

4.4.2 Error Messages Flashing over Displayed Values

A short message will flash over the displayed value in the MAIN Page, in certain conditions, as indicated below:

Flashing Message	Over Value	Condition
error	Dew-point or moisture content	Moisture saturation condition (dew point ≥ temperature)
error	Dew-point or moisture content	Calibration table error (checks sensor impedance values are increasing in the correct direction)
under	Dew-point or moisture content	Dew point under range <-120°C (<-184°F)
over	Dew-point or moisture content	Dew point over range >+30°C (>+86°F)
error	Temperature	Sensor temperature fault <-40 or >+70°C (<-40 or >+158°F)

4.4.3 Logged Error Codes

This page displays a record of the last six system error codes that have occurred in order to assist in the diagnosis of any past anomalies. Error codes are only logged at the end of every measurement cycle and indicate a change in status of single or multiple errors. For example, if an error code **0004** was logged, this would indicate **CHANNEL 1 TEMPERATURE ERROR**. If an error code of **0000** was logged next, this would indicate that the error had now cleared.

Figure 27 *Logged Error Codes*

Logged Error Codes and Error Indication (Modbus Register 35)

Also see Appendix G, Register Configuration C, for more details

Error Code	Error Relay Activated ?	Error Condition
0000	NO	All previous errors now cleared
0001	YES	Channel 1 dew-point sensor under range
0002	YES	Channel 1 dew-point sensor over range
0004	YES	Channel 1 temperature out of range
0008	YES	Channel 1 low flow
0010	YES	Channel 1 high flow
0020	YES	Channel 1 saturation condition
0040	YES	Channel 1 cal table error
0080	YES	Channel 2 dew-point sensor under range
0100	YES	Channel 2 dew-point sensor over range
0200	YES	Channel 2 temperature out of range
0400	YES	Channel 2 low flow
0800	YES	Channel 2 high flow
1000	YES	Channel 2 saturation condition
2000	YES	Channel 2 cal table error
4000	NO	Internal heater fault

The 4-digit error codes are hexadecimal numbers that are dependent upon the bits set within the error indication register.

If more than one error has occurred, then the error codes will be added together:

1 Error Code **0104** =
Error Code **0100** (Channel 2 dew-point sensor over range) plus
Error Code **0004** (Channel 1 temperature out of range) (**0100** + **0004** = **0104**)

2 Error Code **0C00** =
Error Code **0800** (Channel 2 high flow) plus
Error Code **0040** (Channel 1 cal table error) (**0800** + **0400** = **0C00**)

Note: In hexadecimal:

A = 10
B = 11
C = 12
D = 13
E = 14
F = 15

4.4.4 Analyzer Fault Alarm Relay

The process alarm contacts can be set as either Normally Closed (**N/C**) or Normally Open (**N/O**).

The process alarm contacts change from **N/C** to **N/O** when the moisture value becomes greater than the alarm set point.

The fault alarm contacts change from **N/C** to **N/O** when an error associated with the channel occurs or when there is a supply failure.

Appendix A

Technical Specifications

Appendix A Technical Specification

Main Unit – Measurement Parameters	
Channel Configuration	Single and dual channel
Moisture Content	ppm_W
Temperature	°C and °F
Water Dew Point	°C and °F
Sample Flow Rate	Status indication: LOW/OK/HIGH <0.1 to >0.3 l/min (<0.03 to >0.08 GPM)
Sensor Technology	
Moisture Sensor Technology	Michell Ceramic Moisture Sensor
Calibration Range	-100 to +20°Cdp (-148 to +68°Fdp)
Measurement Range	-120 to +30°C (-184 to +86°F) (0.001 ppm_W to saturation)
Accuracy Dew point: Moisture content: Analysis temperature:	 ±1°C between –59.9 & +20°Cdp (±1.8°F between -75.9 to +68°Fdp) ±2°C between –60 & -100°Cdp (±3.6°F between -76 to -148°Fdp) ±10% of reading ±20% of reading Accuracy ±0.2°C
Resolution	0.1°C between +20 & -80°Cdp (0.2°F between +68 & -112°Fdp) 1°C between -80 & -100°Cdp (2°F between -112 & -148°Fdp)
Temperature Coefficient	Algorithm compensation
Operating Pressure	Max. 80 barg (1160 psig)
Sample Flow	Up to 1 Nl/min (0.1 to 0.2 Nl/min recommended) (Up to 0.26 GPM (0.03 to 0.05 GPM recommended))
HMI	
Keypad/Interface	Capacitive touch-screen through glass
Display	Vacuum fluorescent
Datalogging	A rolling maximum of 150 data logs is available Each log records time, date, moisture and temperature values for each channel 5 minutes minimum and 60 minutes maximum logging intervals can be set by the user
Communications and Output	Two non-isolated 4-20 mA per measurement channel 500 Ω maximum load Range and parameter settable by user Modbus RTU @ 9600 baud-rate Alarms: two volt free contacts per channel; one process value and one instrument status Also available via Modbus communications
Enclosure	
Type	Flameproof EExd
Construction	Cast copper-free aluminum
Finish	Chromate primer, Polyester P9010 powder coated (black) - meets BS3900

General	
Sample Connections	1/8" NPT(F)
Weight	21kg (46lbs)
Operating Supply Voltage	90 to 260 V AC, 47/63 Hz, 180 W - Main Unit
Operating Environment	Indoor/Outdoor -20 to +60°C (-4 to +140°F) Max 95%RH
Hazardous Area Certification	
Certification Codes	See Appendix H

A.1 Mounting Drawing

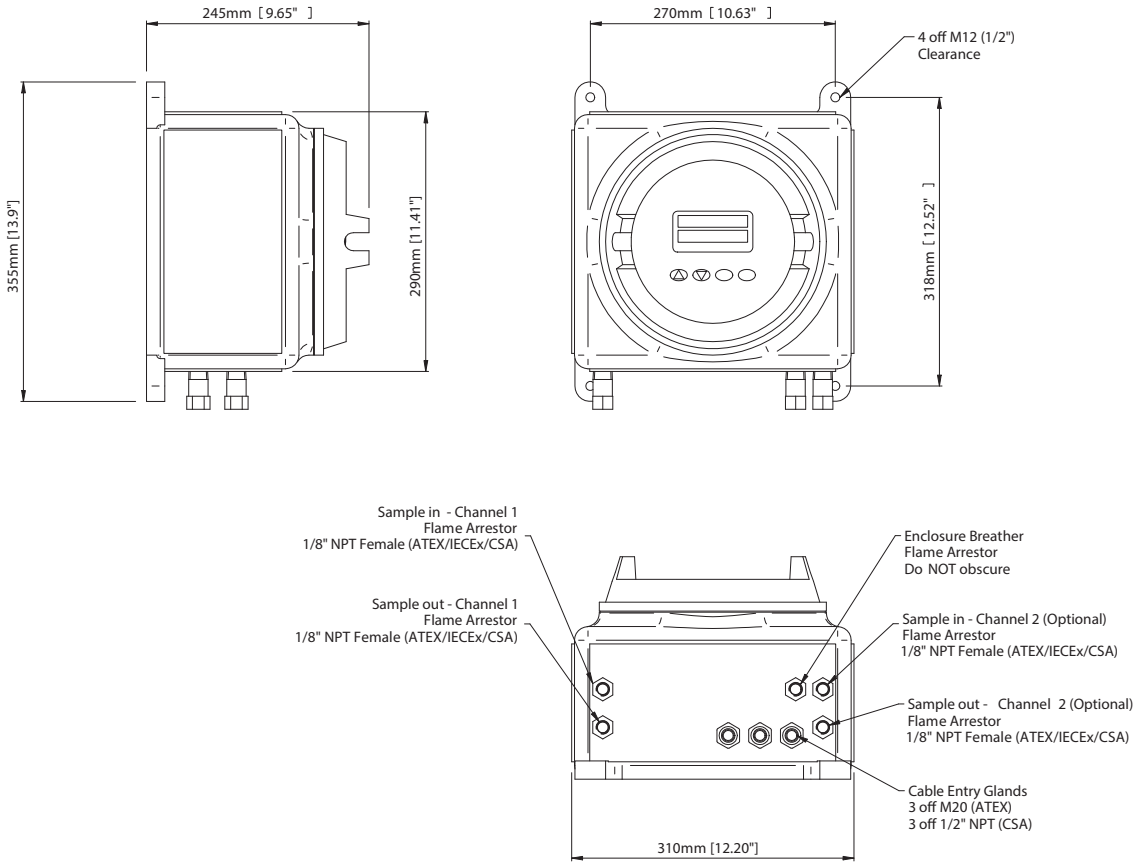


Figure 28 *Mounting Drawing*

A.2 Pipework Connections

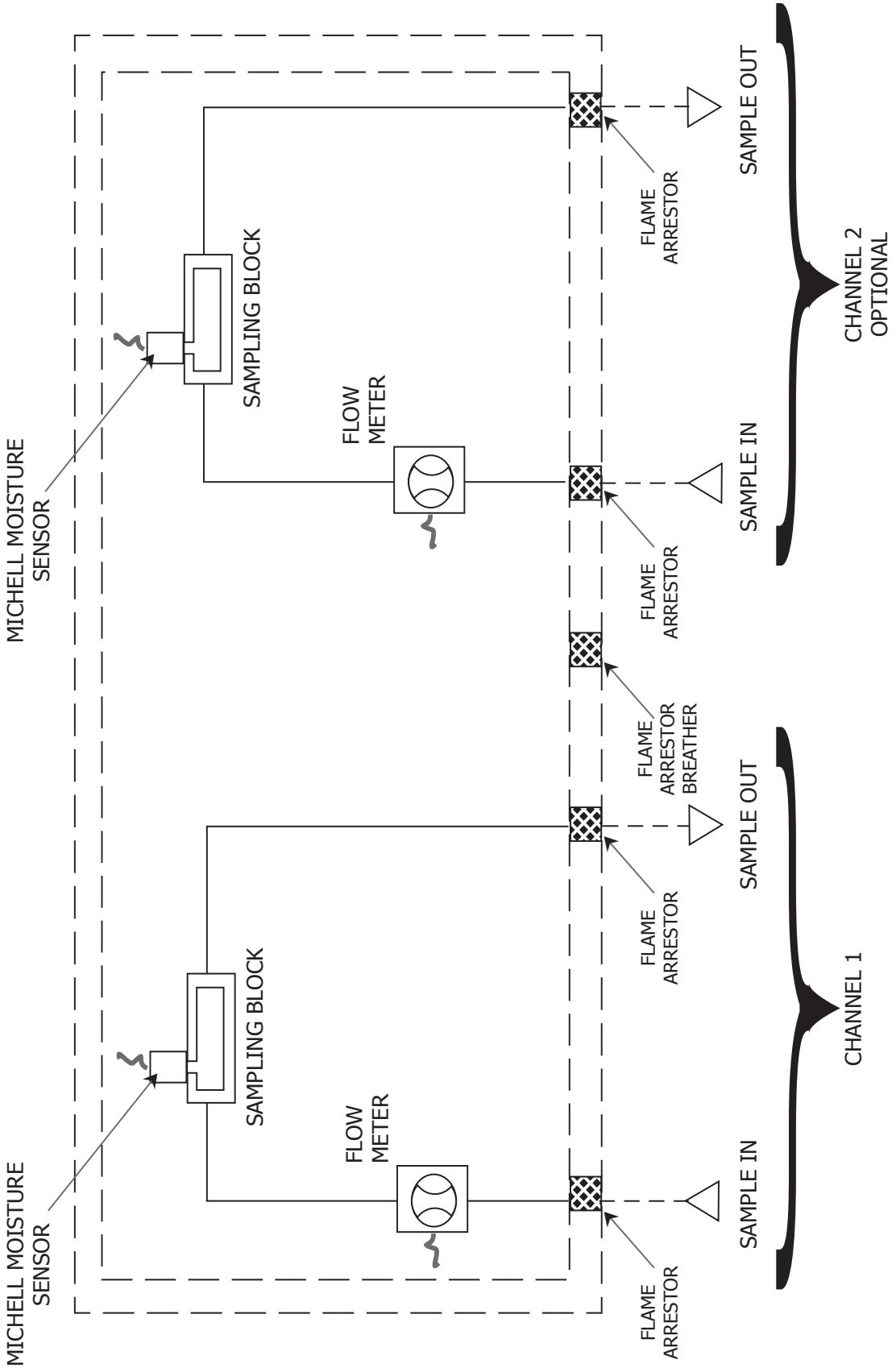


Figure 29 *Pipework Connections*

A.3 System Wiring Diagram

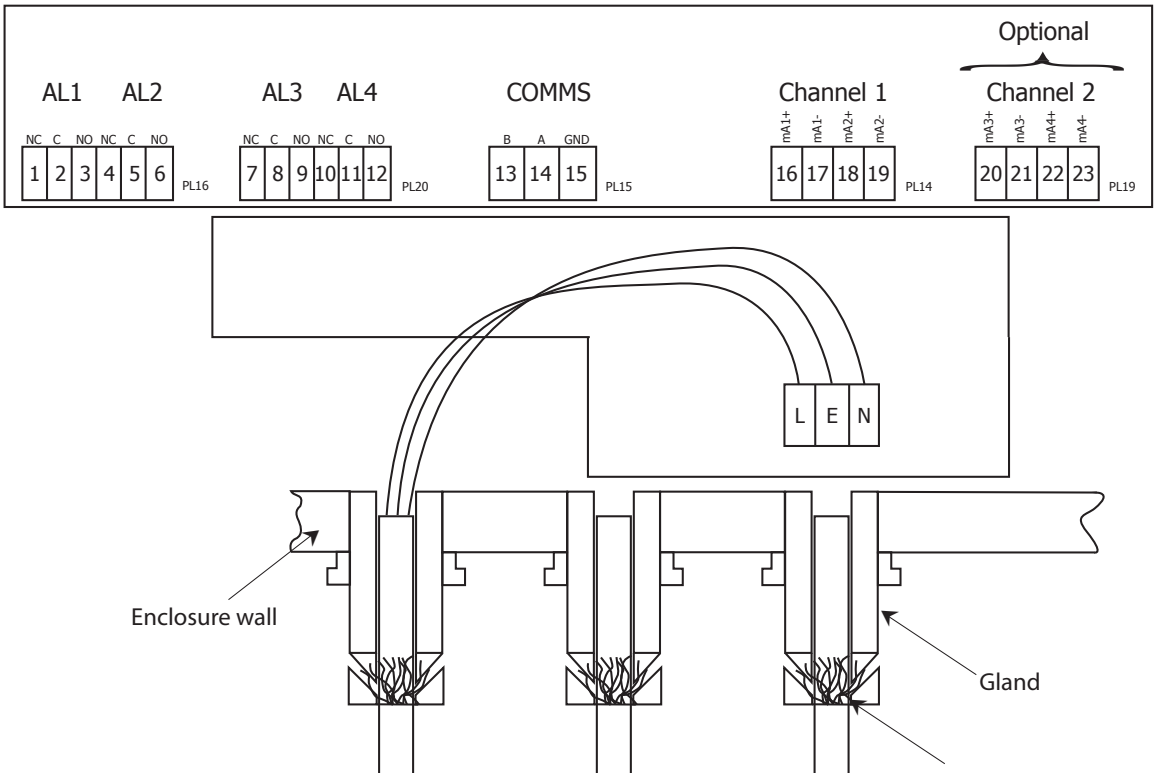


Figure 30 *System Wiring Diagram*

EExd Stopping Glands MUST be used for ATEX/IECEx installations.

Refer to the separate installation & maintenance information sheet supplied.

Appendix B

Variable Definitions

Appendix B Variable Definitions

From the Variables Page, press the **Up** (▲) or **Down** (▼) buttons to highlight the variable required. Press the **SELECT** button to enter the range/options area. Change the variable using the **Up** (▲) or **Down** (▼) buttons and press the **SELECT** button to set the new option. Scroll down to the next variable required. To return to the MAIN Page press the **MENU/MAIN** button.

Variable: **CHN1, CHN2**
Adjustable Range/Options: **DEW POINT, MOISTURE**

Description: The display units for Channels 1 and 2.

i. When **MOISTURE** is selected, the apply option below is enabled to allow the selection of the sample Solute.

ii. mA1 and mA3 outputs represent the setting of Channels 1 & 2 respectively.

NOTE: Changing the units clears the data logging memory and resets the analog outputs and alarm settings

Variable: **apply**
Adjustable Range/Options: **Range of 10 pre-set sample solutes and 4 user-defined sample solutes**

Description: The following samples are available for selection when **MOISTURE** is selected for Channels 1 and 2.

Common Name	Displayed Name
Hexane	n-hexane
Propane	n-propane
Isopropylbenzene	cumene
Benzene	benzene
Butane	n-butane
Isobutane	1-butane
Propylene	prop-1-ene
Cyclohexane	cyclohexane
1-Butene	but-1-ene
Octene	oct-3-ene
User-defined solute 1	U1
User-defined solute 2	U2
User-defined solute 3	U3
User-defined solute 4	U4

Variable: **alarm**
Adjustable Range/Options: **-100 to +20°C for Dew point, 0 to 5000 PPM(W) for Moisture**

Description: The set-point for the process alarm that activates the channel alarm relay when the moisture value exceeds it.

Variable: **OP1min, OP3min, OP1max, OP3max**
Adjustable Range/Options: **-100 to +20°C for Dew point, 0 to 5000 PPM(W) for Moisture**

Description: OP1min and OP3min are the moisture values that 4 mA represents for the respective output. OP1max and OP3max are the moisture values that 20 mA represents for the respective output.

Variable: **OP2min, OP4min, OP2max, OP4max**
Adjustable Range/Options: **0 to +70°C for temperature**

Description: OP2min and OP4min are the moisture values that 4 mA represents for the respective output. OP2max and OP4max are the moisture values that 20 mA represents for the respective output.

Variable: **INT TEMP SP**
Adjustable Range/Options: **-20.00 to +60.00°C**

Description: Sets the set-point for the internal heater.

Variable: **°C / °F**
Adjustable Range/Options: **Celsius, Fahrenheit**

Description: Dew point and temperature unit of measurement in °C or °F

Note: Changing temperature units will set the default values and clear the logged data

Variable: **TIME**
Adjustable Range/Options: **hh:mm; 00:00 to 23:59**

Description: The real-time clock in 24hr format. Minutes and hours may be adjusted. Pressing either the **Up** (▲) or **Down** (▼) button will increment or decrement the minute field and the corresponding hour field will change accordingly and automatically.

Variable: **DATE**
Adjustable Range/Options: **Day: 01-31, Month: 01-12, Year: 00-99**

Description: The date. Format: ddmmyy. To adjust the day, highlight the **DATE** field, press **SELECT** (a '**d**' should appear to the right of the year value). Use the **Up** (▲) or **Down** (▼) buttons to adjust. To adjust the month and year, press **SELECT** again (an '**m**' should appear to the right of the year value). Use the **Up** (▲) or **Down** (▼) buttons to adjust the month. As the month changes, the year field will change accordingly and automatically. Press **SELECT** to finish.

Variable: **INST ADDR**
Adjustable Range/Options: **01 to 31**

Description: Unique instrument address for networking. This address is used by the Modbus protocol to specify the location of the Liquidew EExd instrument in the network.

Variable: **SET DEFAULT**
Adjustable Range/Options: **NONE**

Description: Sets instrument to default configuration. The default values for all the variables and parameters are set. To initiate, select the variable and then press either the **Up** (▲) or **Down** (▼) button.

Variable: **LOG INT'VAL**
Adjustable Range/Options: **10 to 60 in intervals of 10 minutes**

Description: Sets the interval between the logged data readings.

Variable: **RESET LOG**
Adjustable Range/Options: **select, done**

Description: Resets the logging statistics so that the variation in measurements can be recorded from a user-defined start point. When the **RESET LOG** variable is highlighted press the **SELECT** button - the option will go from **select** to **done**.

Variable: **CS VALUES**
Adjustable Range/Options: **0 to 5000 PPM(W)**

Description: The Cs Values available to adjust or view in the user-defined Cs table pages.

Variable: **User-defined Solute CUSTOM LABEL CHAR**
Adjustable Range/Options: **A to Z, hyphen, space, 0 to 9**

Description: Characters that make up the user-defined solute custom label.

The default values are:

CHN 1 / 2	Dew point
Apply	N/A
Alarm	0°C
OP1 Min	-100°C (-148°F)
OP1 Max	+20°C (+68°F)
OP2 Min	0°C (+32°F)
OP2 Max	+70°C (+158°F)
OP3 Min	-100°C (-148°F)
OP3 Max	+20°C (+68°F)
OP4 Min	0°C (+32°F)
OP4 Max	+70°C (+158°F)
°C / °F	Celsius
Int Temp	+20°C (+68°F)
Cs Values	00
User Solute Labels	U1 U2 U3 and U4

Appendix C

Software

Appendix C Software

Software is available for the Liquidew EExd to provide full remote control of up to 31 instruments. It provides access to all readable and write-able registers as described in Appendix E along with charting and data logging facilities.

The Liquidew EExd application software provides the user with advanced acquisition, logging and charting features for full remote control and monitoring of the Liquidew EExd.

With this application software it is possible to:

- View all main parameters of interest
- Modify parameters
- Record parameters to a virtual chart recorder
- Record parameters to a file
- Acquire data from up to 31 process instruments
- Perform remote diagnostics
- Acquire OPC enabled remote access to all parameters and variables

C.1 System Requirements

For a desktop computer, the following specification applies:

- Microsoft Windows 7, 98SE, ME, 2000 or XP operating system
- Spare RS232 port (normally labelled COM1, COM2 etc)
- Minimum of 64 MB of RAM (128M or higher recommended)
- Minimum of 200 MB of free hard disk space (application approximately 3.5 MB, spare for log files)
- Intel Pentium II class processor, 200 MHz or higher

Appendix D

Calibration Correction

Appendix D Calibration Correction

D.1 Overview

The Liquidew EExd is delivered with a Calibration Certificate detailing the deviation at each measurement point from a known reference value. Data provided on the Calibration Certificate is normally arranged as shown in the following extracts:

Extract from a UKAS Calibration Certificate:

Generated Dew point °C	Test Hygrometer		
	Dew-point Temperature °C	Correction Required °C	Expanded Uncertainty °C
-39.89	-40.11	+0.22	±0.26
-20.10	-20.31	+0.21	±0.22
0.39	0.20	+0.19	±0.18

Extract from a Standard Calibration Certificate:

Generated Dew point °C	Instrument Display °C
-40.1	-40.2
-20.1	-20.1
0.2	0.1

From time to time the Liquidew EExd may be calibrated by an external calibration agency, and similar data will be provided.

D.2 Calibration Software

A calibration correction utility has been integrated into the Process Application Software. This allows authorized users to input calibration information in order to effect a real-time correction of the displayed dew point. This software facilitates the uploading and downloading of the instrument's calibration via the Modbus RTU interface.

The figure below shows the Calibration Correction window; two sets of data may be entered:

- **Ref DP** Dew-point data for the reference hygrometer (sometimes called the actual dew point or the standard)
- **Liquidew DP** Measured dew-point value of the Liquidew under test

Data can be entered for 13 calibration points between +20 and -100°Cdp (+68 and -148°Fdp). However, if no data is available then the **Ref DP** and **Liquidew DP** should remain equal and be exact for the calibration point as shown in the figure below.

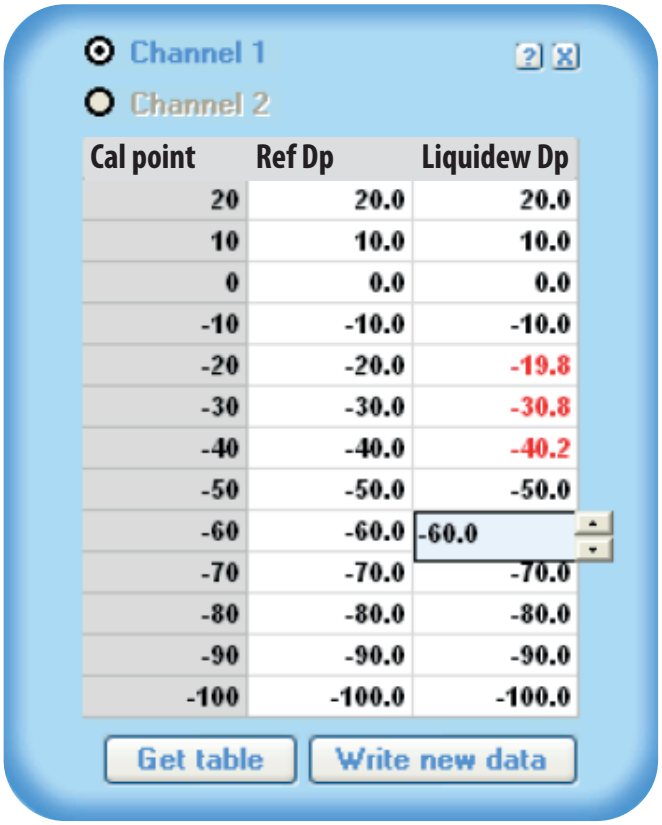


Figure 31 *Calibration Correction Data*

NOTE: The figure above shows calibration data for -20 to –40°Cdp only. The Ref Dp and Liquidew Dp are equal for points where no calibration data is available.

D.3 Calibration Procedure

Caution: A valid correction of the calibration can only be done by a recognized humidity calibration laboratory accredited by a standards institution such as UKAS or NIST. Any calibration performed by an unrecognized body will invalidate the calibration of the instrument.

1. Press the **Get Table** button to download the correction table for either Channel 1 or 2 and check to see if the values are equal and exact. If not, then the instrument has had its calibration adjusted previously. To simplify the correction procedure, reset the adjusted values back to their 'equal & exact' default values.

2. Connect the Liquidew EExd to a suitable dew-point generator with a reference hygrometer (preferably chilled-mirror type with traceable calibration). Purge the Liquidew for a minimum of 5 days with air that is drier than -100°Cdp (-148°Fdp) before commencing the calibration.

3. Increase the generator set-point in steps of 10°Cdp (18°Fdp), moving sequentially up the Liquidew's measurement range from –100 to +20°Cdp (-148 to +68°Fdp) and record the dew point measured by the reference and the Liquidew.

   Suitable stabilization periods should be allowed between changing the generator setting and taking the final sensor count and reference hygrometer values. Actual stabilization times will depend to a degree on the type of generator used, the gas flow rate and the integrity of the pipe work and sensor manifold. As a rule of thumb, it is strongly suggested that the following stabilization times are taken as a minimum requirement:

Dew-point Temperature °Cdp	Minimum Stabilization Time
-100	5 days
-90	12 hours
-80	10 hours
-70	8 hours
-60	4 hours
-50	2 hours
-40	1 hour
-30	1 hour
-20	1 hour
-10	1 hour
0	1 hour
+10	1 hour
+20	1 hour

If calibration is not being done to -100°Cdp (-148°Fdp) then the purge times can be reduced:

Drier than -70°Cdp (-94°Fdp)	5 days
-41 to -69°Cdp (-41.8 to -92°Fdp)	64 hours
+20 to -40°Cdp (+68 to -40°Fdp)	16 hours

The purge gas should be as dry as possible, ideally 10°Cdp (18°Fdp) drier than the driest dew point to be calibrated. The recommended stabilization times listed above should be followed when changing from one dew point to the next.

4. Enter the dew point values for the reference and the Liquidew that were recorded in item 1 above and leave the values 'equal and exact' for used calibration points.

5. To modify a data point, double click on the relevant cell and using the **Up** (▲) and **Down** (▼) buttons adjust the value or enter the value directly, as shown for the –60 calibration point in *Figure 32*. After amendment, the value will turn red to indicate its change of status.

6. After the data points have been changed press the **Write new data** button to upload the data into the Liquidew.

Appendix E

Modbus RTU Communications

Appendix E Modbus RTU Communications

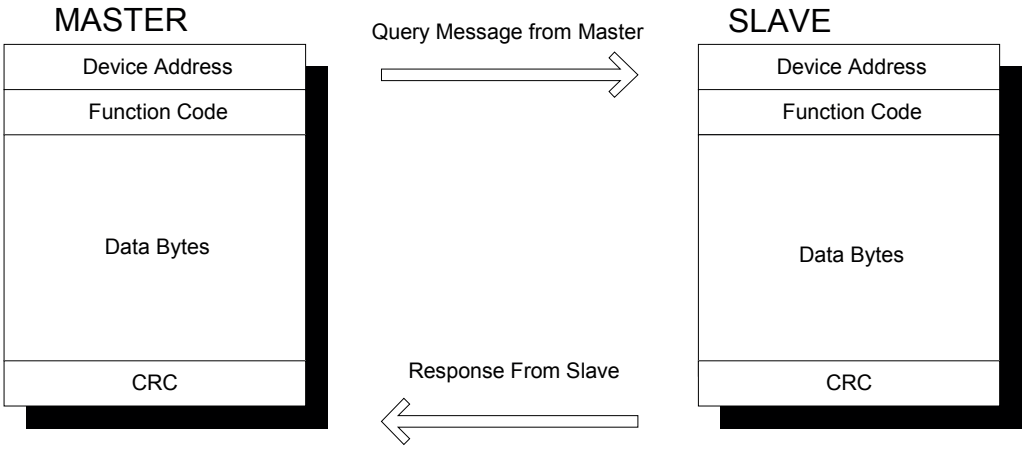
E.1 Introduction

Implemented within the Liquidew EExd are Modbus RTU communications that enable remote access to the instrument's configuration and data logging facilities. This protocol offers two-way communication between a PC or PLC known as the master, to one or more instruments known as slaves. Communication is achieved by the master reading or writing to registers within the slave. The slave acts upon information contained within the registers that can be written, and the master obtains measured values and status information from the register that can be read. Appendix E lists these registers and Appendix G specifies the number or data formats that apply to each register.

E.2 Modbus RTU Basics

Modbus RTU operates on a Query-Response Cycle (see the diagram below). The function code in the query tells the addressed slave device which actions to perform using the information contained in the data bytes. The error check field provides a method for the slave to validate the integrity of the message contents.

If the slave makes a normal response, the function code in the response is an echo of the function code in the query. The data bytes will contain data collected by the slave, such as register values or status information. If an error occurs, the function code is incremented by 80H. This indicates that the response is an error response, known as an exception, and the data bytes contain a code to describe the error. The error check field allows the master to confirm that the message contents are valid.



E.3 Physical Layer

The physical connection from the master to the Liquidew EExd uses 2-wire RS485 plus a ground connection. Data lines A, B and ground are connected to communication connectors within the instrument. The serial port protocol is as follows:

Baud Rate:	9600
Start Bit:	1
Data bits:	8
Parity:	None
Stop bit:	2

E.4 Termination Resistor

A 120R termination resistor is provided on the instrument's circuit board for systems that require it. To connect the resistor, place the link provided across JMP2.

E.5 Register Map

The following tables describe the instrument registers with their address location, Modbus function and the number format.

Address dec	Address hex	Function	Read/ Write	Default Value	Register Config-uration
0	0000*	Instrument Address	R/W		F
1	0001	Sensor 1 Humidity Value – Hi Word (dp/moisture)	R		L
2	0002	Sensor 1 Humidity Value – Lo Word (dp/moisture)	R		L
3	0003	Sensor 1 Ambient Temperature	R		H
4	0004	Status	R		D
5	0005	Sensor 2 Humidity Value – Hi Word (dp/moisture)	R		L
6	0006	Sensor 2 Humidity Value – Lo Word (dp/moisture)	R		L
7	0007	Time to next log Mins + Secs	R		I
8	0008	Sensor 2 Ambient Temperature	R		H
9	0009	Sensor 1 Flow Reading l/min	R		F
10	000A	Sensor 2 Flow Reading l/min	R		F
11	000B	Sensor 1 Humidity Setting (dp or moisture)	R/W		B
12	000C*	mA1 output maximum value (sensor 1 humidity)	R/W		K
13	000D*	mA1 output minimum value (sensor 1 humidity)	R/W		K
14	000E*	mA2 output maximum value (sensor 1 temp)	R/W		M
15	000F*	mA2 output minimum value (sensor 1 temp)	R/W		M
16	0010*	Sensor 2 Humidity Setting (dp or moisture)	R/W		B
17	0011*	mA3 output maximum value (sensor 2 humidity)	R/W		F
18	0012*	mA3 output minimum value (sensor 2 humidity)	R/W		K
19	0013*	Logging Interval	R/W		I
20	0014*	mA4 output maximum value (sensor 2 temp)	R/W		M
21	0015*	mA4 output minimum value (sensor 2 temp)	R/W		M
22	0016*	Sensor 1 Alarm Set Point	R/W		K
23	0017*	Sensor 2 Alarm Set Point	R/W		K
24	0018*	RTC Year (val1) + Month (val2)	R/W		I
25	0019*	RTC Date (val1) + Hours (val2)	R/W		I
26	001A*	RTC Mins (val1) + Secs (val2)	R/W		I
27	001B*	Sensor 1 Solute Ref Number	R/W		H
28	001C*	Sensor 2 Solute Ref Number	R/W		H
29	001D	Units/ Command	R/W		E
30	001E	Water DP Sensor 1 – Batch Number	R		I
31	001F	Water DP Sensor 1 – Serial Number	R		I
32	0020	Water DP Sensor 1 - Year	R		I
33	0021	Water DP Sensor 1 – Month and day	R		I
34	0022	Water DP Sensor 1– Hours Of Operation	R		F
35	0023	Error Indicator	R		C
36	0024	Not Used			

Address dec	Address hex	Function	Read/ Write	Default Value	Register Config-uration
37	0025	Internal Temperature	R		A
38	0026	Internal Temp Set Point	R/W		A
39	0027	Water DP Sensor 2 – Batch Number	R		I
40	0028	Water DP Sensor 2 – Serial Number	R		I
41	0029	Water DP Sensor 2 - Year	R		I
42	002A	Water DP Sensor 2 – Month and day	R		I
43	002B	Water DP Sensor 2 – Hours Of Operation	R		F
44	002C	Not Used			
45	002D	Humidity max – Hi Word – Sensor 1	R		L
46	002E	Humidity max – Lo Word – Sensor 1	R		L
47	002F	Occurred @ day (val1) + month (val2)	R		J
48	0030	Occurred @ hour (val1) + min (val2)	R		J
49	0031	Humidity min – Hi Word – Sensor 1	R		L
50	0032	Humidity min – Lo Word – Sensor 1	R		L
51	0033	Occurred @ day (val1) + month (val2)	R		J
52	0034	Occurred @ hour (val1) + min (val2)	R		J
53	0035	Humidity average Hi Word – Sensor 1	R		L
54	0036	Humidity average Lo Word – Sensor 1	R		L
55	0037	Not Used			
56	0038	Not Used			
57	0039	Instrument Type	R		I
58	003A	Firmware Version Number	R		I
59	003B	Not Used			
60	003C	Not Used			
61	003D	Humidity max – Hi Word – Sensor 2	R		L
62	003E	Humidity max – Lo Word – Sensor 2	R		L
63	003F	Occurred @ day (val1) + month (val2)	R		J
64	0040	Occurred @ hour (val1) + min (val2)	R		J
65	0041	Humidity min – Hi Word – Sensor 2	R		L
66	0042	Humidity min – Lo Word – Sensor 2	R		L
67	0043	Occurred @ day (val1) + month (val2)	R		J
68	0044	Occurred @ hour (val1) + min (val2)	R		J
69	0045	Humidity average Hi Word – Sensor 2	R		L
70	0046	Humidity average Lo Word – Sensor 2	R		L
71	0047	Not Used			
72	0048	Not Used			
73	0049	Temp max – Sensor 1	R		H
74	004A	Occurred @ day (val1) + month (val2)	R		J
75	004B	Occurred @ hour (val1) + min (val2)	R		J
76	004C	Temp min – Sensor 1	R		H
77	004D	Occurred @ day (val1) + month (val2)	R		J
78	004E	Occurred @ hour (val1) + min (val2)	R		J
79	004F	Temp average – Sensor 1	R		H
80	0050	Temp max – Sensor 2	R		H
81	0051	Occurred @ day (val1) + month (val2)	R		J
82	0052	Occurred @ hour (val1) + min (val2)	R		J
83	0052	Temp min – Sensor 2	R		H

Address dec	Address hex	Function	Read/ Write	Default Value	Register Config-uration
84	0053	Occurred @ day (val1) + month (val2)	R		J
85	0054	Occurred @ hour (val1) + min (val2)	R		J
86	0055	Temp average – Sensor 2	R		H
87	0056	Not Used			
88	0057	Not Used			
89	0058	Set-up access code - 7316	W		I
90	005A	Diagnostics/Set-up Command Register	W		G
91	005B*	CALZ WDP 0Ω calibration value – Sensor 2	R		F
92	005C*	CALS WDP 2nF calibration value – Sensor 2	R		F
93	005D*	CALT WDP thermistor cal value – Sensor 2	R		F
94	005E*	Not used			
95	005F*	Not used			
96	0060*	Not used			
97	0061*	mA1 calibration value high in % (100%=23 mA)	R/W		A
98	0062*	mA1 calibration value low in % (100%=23 mA)	R/W		A
99	0063*	mA2 calibration value high in % (100%=23 mA)	R/W		A
100	0064*	mA2 calibration value low in % (100%=23 mA)	R/W		A
101	0065	Force mA1 to a value in % of (100%=23 mA)	W		A
102	0066	Force mA2 to a value in % of (100%=23 mA)	W		A
103	0067*	CALZ WDP 0Ω calibration value – Sensor 1	R		F
104	0068*	CALS WDP 2nF calibration value – Sensor 1	R		F
105	0069*	CALT WDP thermistor cal value – Sensor 1	R		F
106	006A*	WDP Pressure cal LO value – Sensor 2	R		F
107	006B*	WDP Pressure cal HI value – Sensor 2	R		F
108	006C*	WDP Pressure cal LO value – Sensor 1	R		F
109	006D*	WDP Pressure cal HI value – Sensor 1	R		F
110	006E*	mA3 calibration value high in % (100%=23 mA)	R/W		A
111	006F*	mA3 calibration value low in % (100%=23 mA)	R/W		A
112	0070*	mA4 calibration value high in % (100%=23 mA)	R/W		A
113	0071	mA4 calibration value low in % (100%=23 mA)	R/W		A
114	0072	Force mA3 to a value in % of (100%=23 mA)	W		A
115	0073*	Force mA4 to a value in % of (100%=23 mA)	W		A
116	0074*	Not used			
117	0075	Not Used			
118	0076*	Sensor 2 pressure f.s.d.	R/W		F
119	0077*	Sensor 1 pressure f.s.d.	R/W		F
120	0078	Internal Thermistor Calibration Value	R/W		A
121	0079	Supply Voltage as % of 12V (1.00 = 12V)	R		A

Sensor 1 Calibration Correction					
Address dec	**Address hex**	**Function**	**Read/ Write**	**Default Value**	**Register Config-uration**
186		Sn1 20°Cdp Ref	R/W		H
187		Sn1 10°Cdp Ref	R/W		H
188		Sn1 0°Cdp Ref	R/W		H
189		Sn1 -10°Cdp Ref	R/W		H
190		Sn1 -20°Cdp Ref	R/W		H
191		Sn1 -30°Cdp Ref	R/W		H
192		Sn1 -40°Cdp Ref	R/W		H
193		Sn1 -50°Cdp Ref	R/W		H
194		Sn1 -60°Cdp Ref	R/W		H
195		Sn1 -70°Cdp Ref	R/W		H
196		Sn1 -80°Cdp Ref	R/W		H
197		Sn1 -90°Cdp Ref	R/W		H
198		Sn1 -100°Cdp Ref	R/W		H
199		Sn1 20°Cdp Cal	R/W		H
200		Sn1 10°Cdp Cal	R/W		H
201		Sn1 0°Cdp Cal	R/W		H
202		Sn1 -10°Cdp Cal	R/W		H
203		Sn1 -20°Cdp Cal	R/W		H
204		Sn1 -30°Cdp Cal	R/W		H
205		Sn1 -40°Cdp Cal	R/W		H
206		Sn1 -50°Cdp Cal	R/W		H
207		Sn1 -60°Cdp Cal	R/W		H
208		Sn1 -70°Cdp Cal	R/W		H
209		Sn1 -80°Cdp Cal	R/W		H
210		Sn1 -90°Cdp Cal	R/W		H
211		Sn1 -100°Cdp Cal	R/W		H

Sensor 2 Calibration Correction					
Address dec	**Address hex**	**Function**	**Read/ Write**	**Default Value**	**Register Config-uration**
213		Sn2 10°Cdp Ref	R/W		H
214		Sn2 0°Cdp Ref	R/W		H
215		Sn2 -10°Cdp Ref	R/W		H
216		Sn2 -20°Cdp Ref	R/W		H
217		Sn2 -30°Cdp Ref	R/W		H
218		Sn2 -40°Cdp Ref	R/W		H
219		Sn2 -50°Cdp Ref	R/W		H
220		Sn2 -60°Cdp Ref	R/W		H
221		Sn2 -70°Cdp Ref	R/W		H
222		Sn2 -80°Cdp Ref	R/W		H
223		Sn2 -90°Cdp Ref	R/W		H
224		Sn2 -100°Cdp Ref	R/W		H
225		Sn2 20°Cdp Cal	R/W		H
226		Sn2 10°Cdp Cal	R/W		H
227		Sn2 0°Cdp Cal	R/W		H
228		Sn2 -10°Cdp Cal	R/W		H
229		Sn2 -20°Cdp Cal	R/W		H
230		Sn2 -30°Cdp Cal	R/W		H
231		Sn2 -40°Cdp Cal	R/W		H
232		Sn2 -50°Cdp Cal	R/W		H
233		Sn2 -60°Cdp Cal	R/W		H
234		Sn2 -70°Cdp Cal	R/W		H
235		Sn2 -80°Cdp Cal	R/W		H
236		Sn2 -90°Cdp Cal	R/W		H
237		Sn2 -100°Cdp Cal	R/W		H

Data Logging					
Address dec	**Address hex**	**Function**	**Read/ Write**	**Default Value**	**Register Config-uration**
257	0101	Time Hours + Mins @ t 0	R		J
258	0102	Humidity 1 Hi Word @ t 0	R		L
259	0103	Humidity 1 Lo Word Pressure @ t 0	R		L
260	0104	Temperature 1 @ t 0	R		H
261	0105	Humidity 2 Hi Word @ t 0	R		L
262	0106	Humidity 2 Lo Word Pressure @ t 0	R		L
263	0107	Temperature 2 @ t 0	R		H
264	0108	Date Day + Month @ t 1	R		J
265	0109	Time Hours + Mins @ t 1	R		J
266	010A	Humidity 1 Hi Word @ t 1	R		L
267	010B	Humidity 1 Lo Word Pressure @ t 1	R		L
268	010C	Temperature 1 @ t 1	R		H
269	010D	Humidity 2 Hi Word @ t 1	R		L
270	010E	Humidity 2 Lo Word Pressure @ t 1	R		L
271	010F	Temperature 2 @ t 1	R		H
⋮	⋮	⋮	⋮	⋮	⋮
1449	05A9	Date Day + Month @ 149	R		J
1450	05AA	Time Hours + Mins @ t 149	R		J
1451	05AB	Humidity 1 Hi Word @ t 149	R		L
1452	05AC	Humidity 1 Lo Word Pressure @ t 149	R		L
1453	05AD	Temperature 1 @ t 149	R		H
1454	05AE	Humidity 2 Hi Word @ t 149	R		L
1455	05AF	Humidity 2 Lo Word Pressure @ t 149	R		L
1456	05B0	Temperature 2 @ t 149	R		H

User Cs tables					
Address dec	**Address hex**	**Function**	**Read/ Write**	**Default Value**	**Register Config-uration**
1461	05B5	User Cs Table 1, Cs Value at 10°C	R/W		F
1462	05B6	User Cs Table 1, Cs Value at 20°C	R/W		F
1463	05B7	User Cs Table 1, Cs Value at 30°C	R/W		F
1464	05B8	User Cs Table 1, Cs Value at 40°C	R/W		F
1465	05B9	User Cs Table 1, Cs Value at 50°C	R/W		F
1466	05BA	User Cs Table 2, Cs Value at 0°C	R/W		F
1467	05BB	User Cs Table 2, Cs Value at 10°C	R/W		F
1468	05BC	User Cs Table 2, Cs Value at 20°C	R/W		F
1469	05BD	User Cs Table 2, Cs Value at 30°C	R/W		F
1470	05BE	User Cs Table 2, Cs Value at 40°C	R/W		F
1471	05BF	User Cs Table 2, Cs Value at 50°C	R/W		F
1472	05C0	User Cs Table 3, Cs Value at 0°C	R/W		F
1473	05C1	User Cs Table 3, Cs Value at 10°C	R/W		F
1474	05C2	User Cs Table 3, Cs Value at 20°C	R/W		F
1475	05C3	User Cs Table 3, Cs Value at 30°C	R/W		F
1476	05C4	User Cs Table 3, Cs Value at 40°C	R/W		F
1477	05C5	User Cs Table 3, Cs Value at 50°C	R/W		F
1478	05C6	User Cs Table 4, Cs Value at 0°C	R/W		F
1479	05C7	User Cs Table 4, Cs Value at 10°C	R/W		F
1480	05C8	User Cs Table 4, Cs Value at 20°C	R/W		F
1481	05C9	User Cs Table 4, Cs Value at 30°C	R/W		F
1482	05CA	User Cs Table 4, Cs Value at 40°C	R/W		F
1483	05CB	User Cs Table 4, Cs Value at 50°C	R/W		F
1484	05CC	User Solute 1 Label Char 1	R/W		F
1485	05CD	User Solute 1 Label Char 2	R/W		F
1486	05CE	User Solute 1 Label Char 3	R/W		F
1487	05CF	User Solute 1 Label Char 4	R/W		F
1488	05D0	User Solute 1 Label Char 5	R/W		F
1489	05D1	User Solute 1 Label Char 6	R/W		F
1490	05D2	User Solute 1 Label Char 7	R/W		F
1491	05D3	User Solute 1 Label Char 8	R/W		F
1492	05D4	User Solute 2 Label Char 1	R/W		F
1493	05D5	User Solute 2 Label Char 2	R/W		F
1494	05D6	User Solute 2 Label Char 3	R/W		F
1495	05D7	User Solute 2 Label Char 4	R/W		F
1496	05D8	User Solute 2 Label Char 5	R/W		F
1497	05D9	User Solute 2 Label Char 6	R/W		F
1498	05DA	User Solute 2 Label Char 7	R/W		F
1499	05DB	User Solute 2 Label Char 8	R/W		F
1500	05DC	User Solute 3 Label Char 1	R/W		F
1501	05DD	User Solute 3 Label Char 2	R/W		F
1502	05DE	User Solute 3 Label Char 3	R/W		F
1503	05DF	User Solute 3 Label Char 4	R/W		F
1504	05E0	User Solute 3 Label Char 5	R/W		F

Address dec	Address hex	Function	Read/ Write	Default Value	Register Config-uration
1505	05E1	User Solute 3 Label Char 6	R/W		F
1506	05E2	User Solute 3 Label Char 7	R/W		F
1507	05E3	User Solute 3 Label Char 8	R/W		F
1508	05E4	User Solute 4 Label Char 1	R/W		F
1509	05E5	User Solute 4 Label Char 2	R/W		F
1510	05E6	User Solute 4 Label Char 3	R/W		F
1511	05E7	User Solute 4 Label Char 4	R/W		F
1512	05E8	User Solute 4 Label Char 5	R/W		F
1513	05E9	User Solute 4 Label Char 6	R/W		F
1514	05EA	User Solute 4 Label Char 7	R/W		F
1515	05EB	User Solute 4 Label Char 8	R/W		F

NOTE: To download logged data, calculate the start address by the following formula: (sample number x 8) + 256. Start addresses that do not coincide with the first register of a sample will generate an exception response. Due to the maximum limit of 125 data registers that can be read in one transmission, as defined by the Modbus RTU standard, only 20 samples can be downloaded at any one time. Therefore, eight reads are required to download all 150 samples.

Appendix F

Modbus RTU Details

Appendix F Modbus RTU Details

F.1 Message Framing

START	ADDRESS	FUNCTION CODE	DATA	CRC	END
3.5t	1 byte	1 byte	n x bytes	2 bytes	3.5t

Start and End

The message begins and ends with a silent delay of 3.5 character times at the baud rate of the network.

Address

The first byte transmitted is the address of the instrument, which has a range of 1 to 247 or 01H to F7H. The master addresses an instrument by placing the address in the address byte and, if matched, a Liquidew EExd will response to the message, otherwise it will be ignored. See Appendix E on setting the address.

Function Code

The function code tells the Liquidew EExd which operation is to be performed on the data in the following data bytes. The only valid codes are **03 (Read Holding Registers)** or **06 (Write To Single Register)** as these are the only two implemented.

An exception can occur if the message contains an unsupported function code, an illegal data address or an illegal data value. If this occurs, the function code is incremented by 80H and the data bytes returned are set to a value that describes the error. See Appendix F.2.

Data Bytes

The data bytes within the message from the master contain additional information that the Liquidew EExd must use to perform the action defined in the function code, such as the starting register address and the number of registers to be retrieved.

CRC

The CRC is a 2-byte error check value from the result of a Cyclical Redundancy Check calculation performed on the message contents. The CRC is appended to the message as the last field in the message. The low-order byte is appended first, followed by the high-order byte.

F.2 Implemented Functions

03 Read Holding Registers

This function code is used to read the contents of a contiguous block of holding registers, where the master specifies the starting address and the number of registers to be read. *Figure 33* shows the state diagram of how the message is processed with the exceptions that may be raised.

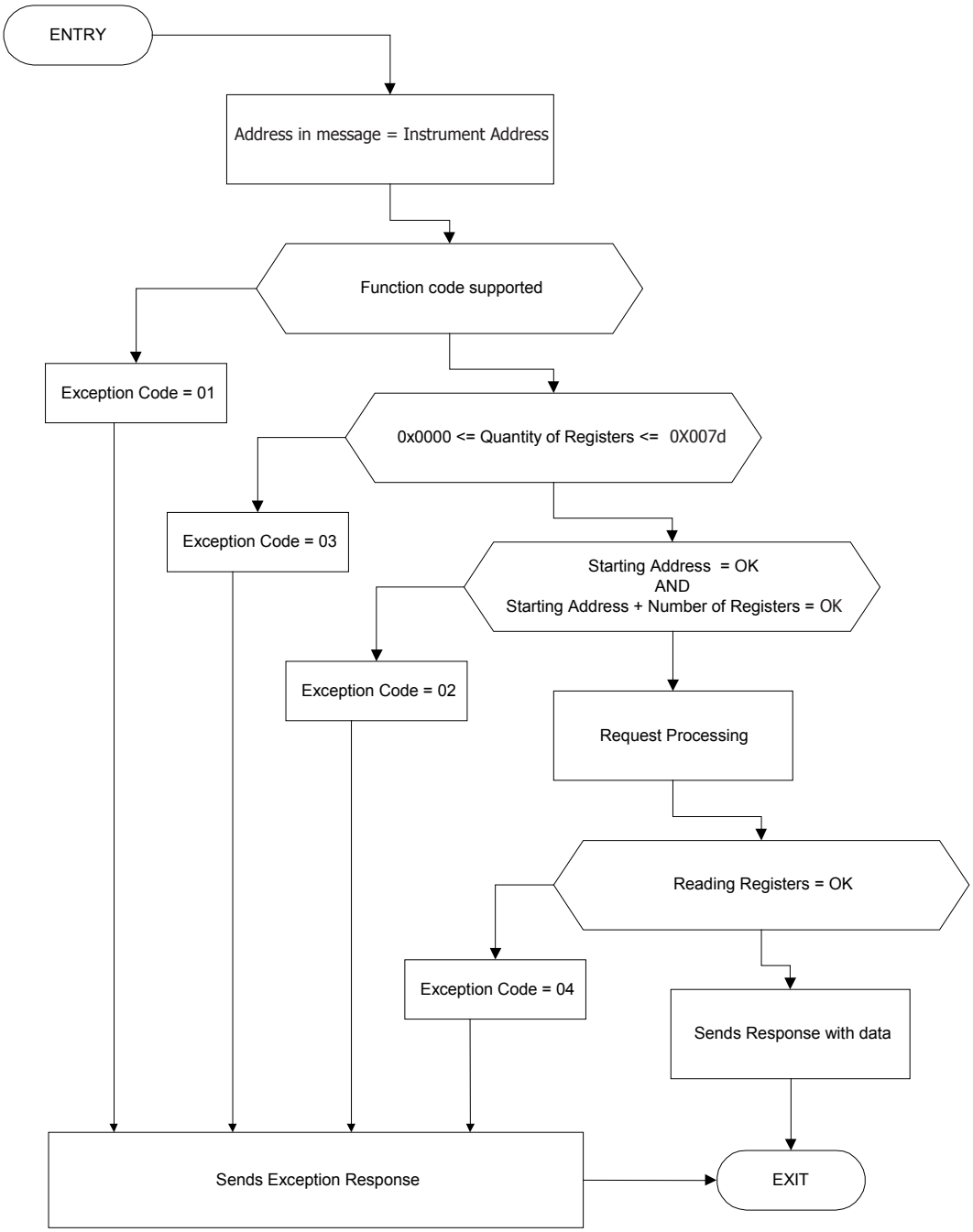


Figure 32 *Reading Holding Registers State Diagram*

The table below is an example of a message sent by the master, to read the time to the next log (register 7) and Channel 2 sample temperature (register 8). The message shows a master addressing a Liquidew EExd with a slave address of 01H and a Modbus function of 03H that informs the Liquidew EExd that it wishes to read two registers starting from address 07H. Bytes 3 & 4 hold the starting address and bytes 5 & 6 hold the number of registers to be read. Bytes 7 & 8 contain the CRC code that is calculated using bytes 1 to 6 as represented below.

Byte No	Meaning	Value
1	Slave Address	01H
2	Modbus function code	03H
3	Starting Address MSB	00H
4	Starting Address LSB	07H
5	No of points MSB	00H
6	No of points LSB	02H
7	CRC Lo Byte	??H
8	CRC Hi Byte	??H

Read Request Message

In response to the above message, the Liquidew EExd may transmit the following message:

Byte No	Meaning	Value
1	Slave Address	01H
2	Modbus function code	03H
3	Byte Count	04H
4	Data MSB	05H
5	Data LSB	26H
6	Data MSB	00H
7	Data LSB	FAH
8	CRC Lo Byte	??H
9	CRC Hi Byte	??H

Read Response Message

This response repeats the address of the Liquidew EExd and the function code, along with the byte count, the data and the CRC. In this example, the request asked for the values from two registers. Therefore, the number of bytes returned is four. The value of register 7 is contained in bytes 4 & 5 and the value of register 8 in bytes 6 & 7. Register 7 = 5m 26s and register 7 = 00FA = 252 = 25.2°C in this example. Any errors within the data of Read Request Message will result in an exception being raised.

06 Write to Single Register

This function code is used to write a 16 bit value into a single register. The master specifies the address and the value to be written. *Figure 34* shows the state diagram of how the message is processed with the exceptions that may be raised.

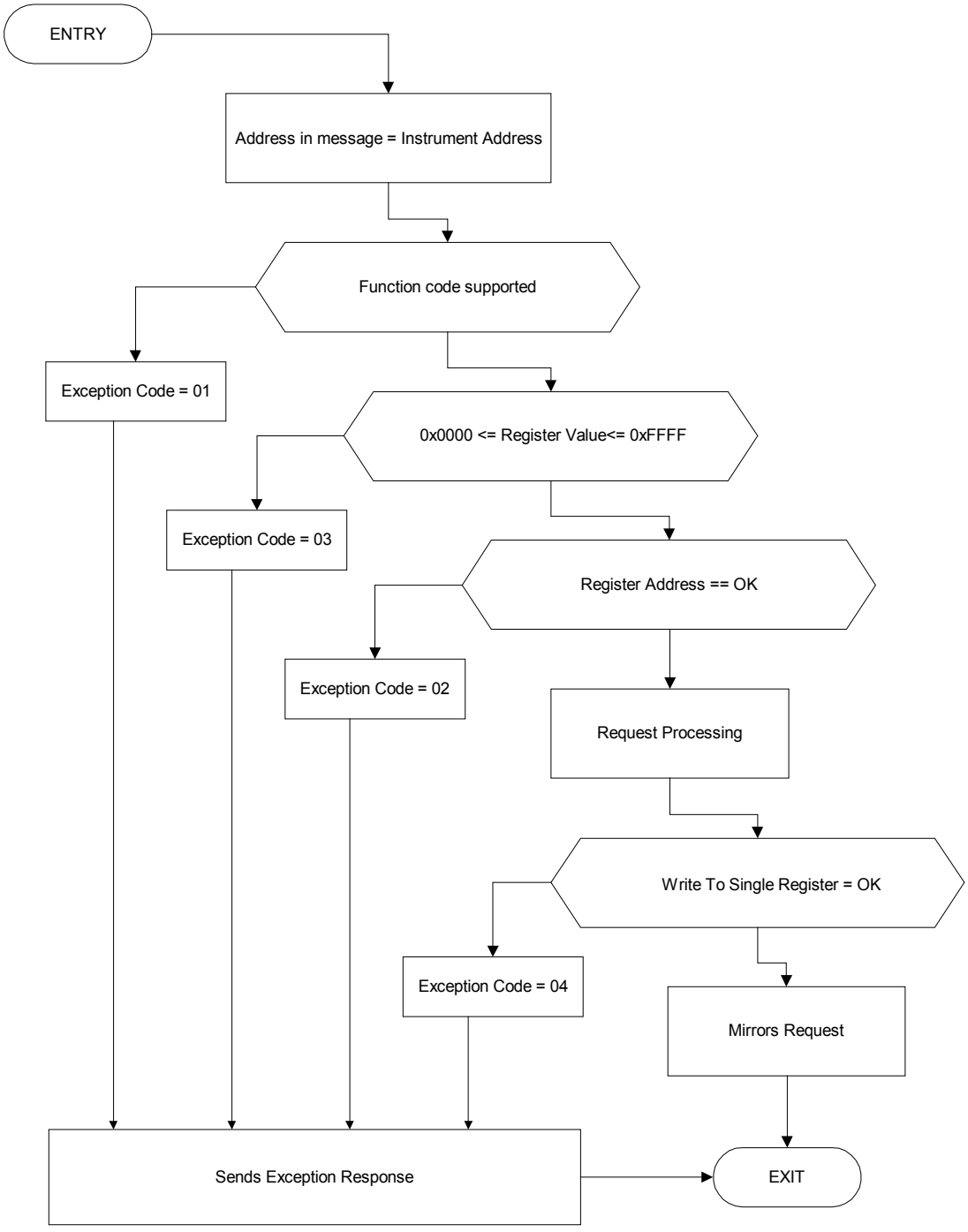


Figure 33 *Write Single Register State Diagram*

The table below shows the data bytes in a **Write To Single Register** message. Bytes 1 to 4 contain the address of the Liquidew EExd, Modbus function, starting register address and the data value to be written. In this example a master sends FC18H to address 0015H, to a Liquidew EExd with an address of 01H. The CRC is calculated using the data in bytes 1 to 6.

Byte No	Meaning	Value
1	Slave Address	01H
2	MODBUS function code	06H
3	Starting Address MSB	00H
4	Starting Address LSB	15H
5	Data MSB	FCH
6	Data LSB	18H
7	CRC Lo Byte	??H
8	CRC Hi Byte	??H

Write Single Register Request and Response

The normal response from the Liquidew EExd is to re-transmit the received message. However, if the data within the message is incorrect then an exception response will be transmitted.

F.3 Exceptions

A message request from the master will raise an exception response from the slave (Liquidew EExd) if:

i. the function code is unsupported

ii. the register quantity > 127 (0x007D)

iii. the register address is invalid

iv. the register address + the quantity of register is invalid

v. an error occurred while performing the function

The exception response will contain the function code incremented by 80H and the exception code.

The table below lists the codes supported, along with an explanation of each code.

Code	Name	Meaning
01	ILLEGAL FUNCTION	The function code received in the query is not an allowable action for the slave
02	ILLEGAL DATA ADDRESS	The data address received in the query is not allowable. More specifically, the combination of starting address and number of registers is invalid for the slave
03	ILLEGAL DATA VALUE	A value contained in the query data field is not an allowable value for the slave
04	SLAVE DEVICE FAILURE	An unrecoverable error occurred while the slave was attempting to perform the requested action

Example of an Exception Response that reads a discrete inputs message generating an illegal function exception.

Byte	Meaning	Value
1	Slave Address	01H
2	Function	82H
3	Exception Code	01H
4	CRC	??

The example above shows the function code (02H) sent in the request has been incremented by 80H with the exception code 01H included as the data within the message.

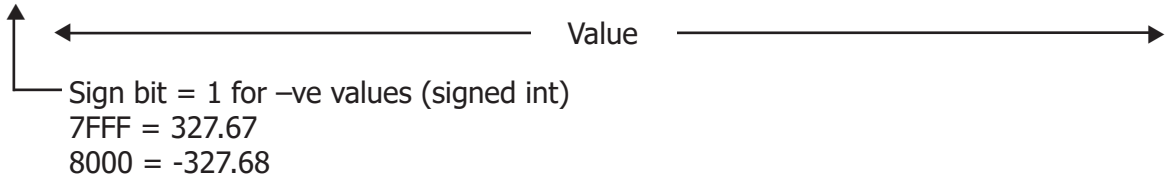
Appendix G

Register Number Formats

Appendix G Register Number Formats

Register Configuration A

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



The value in bits (15 to 0) + 1 is divided by 100 to give 0.01 resolution for dew-point and temperature values.

Register Configuration B – Sensor Humidity Setting

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

0x0000 = Dew point in degrees
0x0001 = Moisture in ppm_W

Register Configuration C – Error Register

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

Bit	HEX	Error Condition
0	0001	Channel 1 dew point under range <-120°C (<-184°F)
1	0002	Channel 1 dew point over range >+30°C (>+86°F)
2	0004	Channel 1 temperature out of range >+50 or <0°C (>+122 or <32°F)
3	0008	Channel 1 low flow (<0.1 l/min)
4	0010	Channel 1 high flow (>0.9 l/min)
5	0020	Channel 1 moisture saturation condition (dew point ≥ temperature)
6	0040	Channel 1 calibration table error (checks sensor impedance values are increasing in the correct direction)
7	0080	Channel 2 dew point under range <-120°C (<-184°F)
8	0100	Channel 2 dew point over range >+30°C (>+86°F)
9	0200	Channel 2 temperature out of range >+50 or <0°C (>+122 or <32°F)
10	0400	Channel 2 low flow (<0.1 l/min)
11	0800	Channel 2 high flow (>0.9 l/min)
12	1000	Channel 2 moisture saturation condition (dew point ≥ temperature)
13	2000	Channel 2 calibration table error (checks sensor impedance values are increasing in the correct direction)
14	4000	Internal heater fault (internal temperature set-point not achievable)

Register Configuration D - Status Word

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
						r	r	r	r	r	r	r	r	r	r
						Alarm Channel 2	Alarm Channel 1 (Alarm 1)	Flow Channel	Flow Channel	Heater	Sensor 1 Fitted	Sensor 2 Fitted	N/A	N/A	N/A

1 = ON or Fitted or ERROR
0 = OFF or Not Fitted or NO ERROR

Register Configuration E - Units Command

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

0 = °C
1 = Initiate

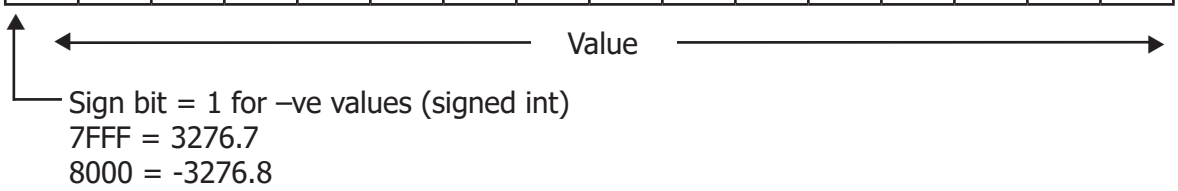
Register Configuration F

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

Unsigned integer Range = 0 to 65535
Unsigned Integer /100 for flow value in l/min

Register Configuration H

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



The value in bits (15 to 0) + 1 is divided by 10 to give 0.1 resolution for dew-point and temperature values.

Register Configuration I

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

Val 1 Val 2

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

Values for Cycle Time and Max Cool Time are in units of 5 mins.

Register Configuration J

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

Day or Hours Minutes or Month

Values in HEX i.e. 17th March = 1103H

Register Configuration K – signed int

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

Value

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

Register Configuration L - Floating Point Representation

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

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

Examples of floating point to HEX are shown below.

1) +10.3

sign bit = 0
Exponent = 3, therefore exponent field = 127 + 3 = 130, and bits 30 to 23 = 1000 0010
Mantissa = 1.2875 which in binary representation = 1010 0100 1100 1100 1100 1101

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

As the exponent is = 3 then the mantissa becomes = 1010 0100 1100 1100 1100 1101, therefore:-

1010 = (1x23) + (0x22) + (1x21) + (0x20) = 10 and
0100 1100 1100 1100 1101 = $(0x2^{-1}) + (1x2^{-2}) + \text{ -- } + (1x2^{-20})$ = 0.3

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

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

2) - 0.0000045

sign bit = l
Exponent = -18, therefore exponent field = 127 + (-18) = 109, & bits 30 to 23 = 0110 1101
Mantissa = 1.179648 which in binary representation = 1001 0110 1111 1110 1011 0101

i.e. $(1x2^{-18}) + (1x2^{-21}) + (1x2^{-23})$ etc = 0.0000045

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

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

Register Configuration M

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

Unsigned integer / 10
Range = 0 to 6553.5

Appendix H

Hazardous Area Certification

Appendix H Hazardous Area Certification

The Liquidew EExd is certified compliant to the ATEX Directive (2014/34/EU) and IECEx for use within Zone 1 and Zone 2 Hazardous Areas and has been assessed so by ELEMENT ROTTERDAM BV (Notified Body 2812).

The Liquidew EExd is certified compliant to North American Standards (USA and Canada) for use within Class I, Division 1, Groups B, C and D Hazardous Locations and has been assessed so by CSA.

H.1 Product Standards

This product conforms to the Standards:

EN60079-0:2012/A11:2013	IEC60079-0:2011
EN60079-1:2014	IEC60079-1:2007
C22.2 No. 142-M1987	UL508
C22.2 No. 30-M1986	UL1203

H.2 Product Certification

This product is attributed with the product certification code:

ATEX
II2G Exd IIB + H2 Gb T5 (Tamb -40°C to +44°C)
T4 (Tamb -40°C to +60°C)

IECEX
Exd IIB + H2 Gb T5 (Tamb -40°C to +44°C)
T4 (Tamb -40°C to +60°C)

cCSAus
Class I, Division 1, Groups B, C & D T5 (Tamb -40°C to +44°C)
T4 (Tamb -40°C to +60°C)

H.3 Global Certificates/Approvals

ATEX	TRAC11ATEX21322X
IECEx	TRC 11.0012X
cCSAus	1701657

These certificates can be viewed or downloaded from our website at:
http://www.michell.com

Special attention should be paid to the *Special Conditions for Safe Use* and the *Conditions of Certification* listed in the certificates shown on our website.

H.4 Special Conditions of Use

1. Do not open when an explosive gas atmosphere may be present.
2. External cables shall be compatible with a temperature of 93°C (T5) or 109°C (T4).
3. Maximum process pressure shall not exceed 80 barg. Maximum permissible process pressure is marked on the equipment.
4. Maximum permitted sample flow rate into the enclosure shall not exceed 0.3LPH.
5. All process lines shall be purged to ensure the process gas or liquid is above its upper explosive limit before applying power.
6. Where painted or powder coated, the enclosures could present an electrostatic hazard. Clean only with a damp or anti-static cloth.
7. The enclosure is to be earthed externally using the earth point provided.
8. Only suitably ATEX / IECEx certified (as appropriate) cable glands and blanking elements shall be used.

Refer to the relevant sections within this manual for the connection, wiring and cable glanding requirements.

H.5 Maintenance and Installation

The Liquidew EExd must only be installed by suitably qualified personnel and in accordance with the instructions provided and the terms of the applicable product certificates.

Maintenance and servicing of the product must only be carried out by suitably trained personnel or returned to an approved Michell Instruments' Service Center.

Flame paths are not intended to be repaired.

Appendix I

Quality, Recycling & Warranty Information

Appendix I 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/uk/compliance

This page contains information on the following directives:

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

This information is also available in pdf format.

Appendix J

Return Document & Decontamination Declaration

Appendix J 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:

http://www.michell.com