



# Technical Documentation

## **Thermal Comfort Data Logger –1221 User Manual**

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# 1221 Thermal Comfort Data Logger

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From Serial number: 1 823 408

December 2007

## Safety Considerations

This apparatus has been designed and tested in accordance with IEC IEC 1010-1 *Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use* (see specifications), and has been supplied in safe condition. This User Manual contains information and warnings which must be followed to ensure safe operation and to retain the apparatus in safe condition. Special note should be made of the following:

### Powering the Apparatus

Verify that the correct fuse is inserted.

### Safety Symbols

⚠ The apparatus will be marked with this symbol when it is important to refer to the associated warning statements given in this User Manual.

### Warnings

- Switch off all power to equipment and remove power cable before connecting or disconnecting their digital interface. Failure to do so could damage the equipment.
- Whenever it is likely that the correct function or operating safety of the apparatus has been impaired. It must be made inoperative and be secured against unintended operation.
- Any adjustment maintenance and repair of the open apparatus under voltage must be avoided as far as possible and, if unavoidable, must be made only by trained service personnel.
- Contains a lithium battery which may only be changed by trained service personnel.
- INNOVA cables WL 0945 or WL 0946 *must* be used. Other cables may not have the proper current/ground configuration, and might cause system damage (1221 or PC).

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# Chapter 1

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## Introduction

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## 1.1 1221 Thermal Comfort Data Logger

The Thermal Comfort Data Logger enables you to evaluate the thermal comfort of indoor climates and heat stress at the work place.

The data logger is a black box thermal platform built up modularly with up to four input modules with a number of transducer sockets in each.



*Fig. 1.1 Front – 1221 Thermal Comfort Data Logger*

The 1221 can be used in two different modes: Offline to collect data in the field, and Online via its serial interface connection with a PC and 7701 software to view data.

The 1221 is supplied with a battery pack for use in the field. A mains powered DC supply ZG 0342 is also available.



*Fig. 1.2 Back – 1221 Thermal Comfort Data Logger*

## 1.2 About this Manual

General information regarding how to set-up and configure a system using the 1221 and its associated Applications Software is provided in chapter 2.

Chapter 3 provides information specific to the 1221 Thermal Comfort Data Logger and its installation, start-up and power requirements.

## Chapter 2

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# System Configuration

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## 2.1 Power Requirements

The 1221 Thermal Comfort Data Logger comes with Battery Box ZG 0146 for which either six NiCd or alkaline batteries must be purchased. Typically, the 1221 can run for about 9 hours before battery re-charging (NiCd) or about 18 hours before replacement (alkaline) is required. For more information about the battery box (see section 3.2).

Power supply ZG 0342 can be ordered for the 1221. This cassette is slipped into the back of the 1221 instead of the battery box. The 1221 can then be connected to any main power supply from 100 to 240 V (see section 3.2)

## 2.2 Serial Interface

Serial communication between PC and 1221 is carried out at 9600 baud, 8 data bits, 1 stop bit, Parity = None, Handshake = Hardwired, switched line.

It is not possible to change these parameters.

The cable length (see section 3.3) between PC and 1221 must not be longer than 17 metres.

⚠ LUMASENSE cables WL 0945 or WL 0946 *must* be used (zero modem type). Other cables may not have the proper ground configuration, and might cause system damage to the 1221 or PC. When using USB Port on the PC, the JV0901 RS-232 to USB adapter should be used.

## 2.3 Selecting Modules

### 2.3.1 Introduction

Modules for the 1221 are installed before delivery, based on your measurement requirements. The modules are installed in the back of the 1221 as shown in Fig. 3.1.

**Note:** the module configurations described in this chapter are standard configurations for 1221 modules. Other parameters than those described in this chapter can also be measured. The UA 1276 Comfort Module can for example be configured to measure heat stress if required.

### 2.3.2 Comfort Module UA 1276

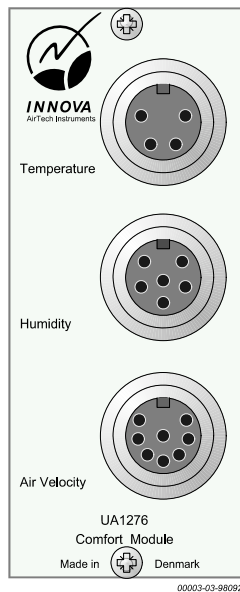


Fig. 2.1 Comfort Module UA 1276

This module enables the connected transducers to provide measurement data for the majority of the physical parameters used in evaluating thermal comfort such as (in accordance with ISO 7730) PMV, PPD and DR.

The module has three sockets for the following transducer types:

- Temperature (MM 0034, MM 0035, MM 0060)
- Humidity (MM 0037)
- Air Velocity (MM 0038)

The input sockets for temperature and humidity transducers have a measurement range from  $-20$  to  $100^{\circ}\text{C}$ , with a resolution of  $0.1^{\circ}\text{C}$ .

For further specifications see the Product Data Sheet for the relevant transducer(s).

### 2.3.3 Heat Stress Module UA 1277

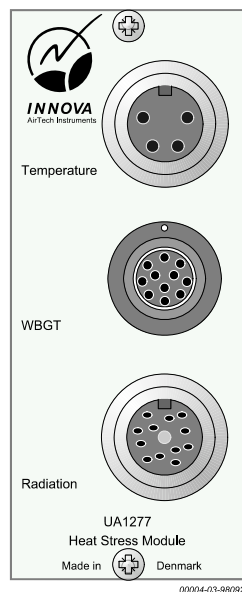


Fig. 2.2 Heat Stress Module UA 1277

This module enables the connected transducers to provide data for the evaluating heat stress such as WBGT (in accordance with ISO 7243) and Radiant Temperature Asymmetry (in accordance with ISO 7730).

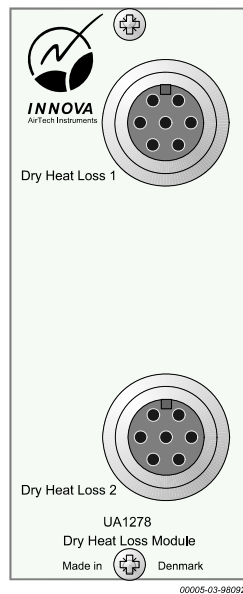
The module has three sockets for connecting the following transducer types:

- Temperature (MM 0034, MM 0035, MM 0060)
- WBGT (MM 0030)
- Radiation (MM 0036)

The input sockets for temperature and WBGT transducers have a measurement range from  $-40$  to  $150^{\circ}\text{C}$ , with a resolution of  $0.1^{\circ}\text{C}$ .

For further specifications see the Product Data Sheet for the relevant transducer(s).

### 2.3.4 Dry Heat Loss Module UA 1278



*Fig. 2.3 Dry Heat Loss Module UA 1278*

This module enables the connected transducers to provide Dry Heat Loss data for PMV, PPD, etc. (in accordance with ISO 7730).

The module has two sockets for the transducer type:

- Dry Heat Loss (MM 0057)

The sockets have a measurement range from  $-20$  to  $50^{\circ}\text{C}$ , with a resolution of  $0.1^{\circ}\text{C}$ , and a Dry Heat Loss range from  $0$  to  $205 \text{ W/m}^2$ , with a resolution of  $0,1 \text{ W/m}^2$ .

For further specifications see the Product Data Sheet for the MM 0057.

**Note:** Installing more than three modules is not recommended because of the power requirements for the UA 1278 and the power limitation on ZG0342, see section 3.7.

## 2.3.5 Analog Interface Module UA 1346

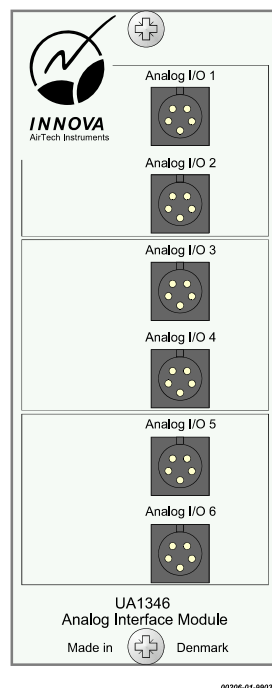


Fig. 2.4 Analog Interface Module UA 1346

This module enables the connected transducers to provide measurement data for the majority of the physical parameters used in evaluating thermal comfort such as (in accordance with ISO 7730) PMV, PPD and DR.

The module enables up to 6 analog signals to be sampled from six non-specific measuring instruments. The data is sampled, stored and displayed just like the data from the other measurement modules.

The module has six sockets, each of which has an analog input. The principle behind the calculated values is described in Fig. 2.5.

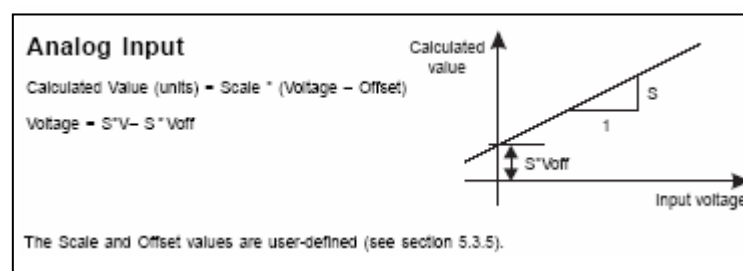


Fig. 2.5 Offset for analog Inputs and Outputs

A 5-pole connector (part no. JP0500) is used to connect equipment to the Analog Interface Module UA 1346. The connector consists of three parts. These are shown in Fig. 2.6.

The configuration of the pins in the JP 0500 connector is shown in Fig. 2.7.

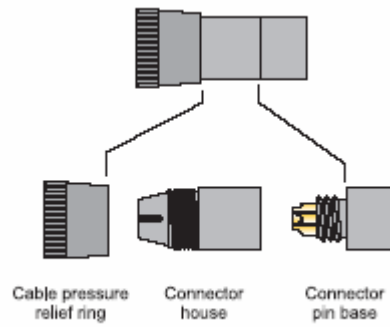


Fig. 2.6 Component parts of the JP0500 connector

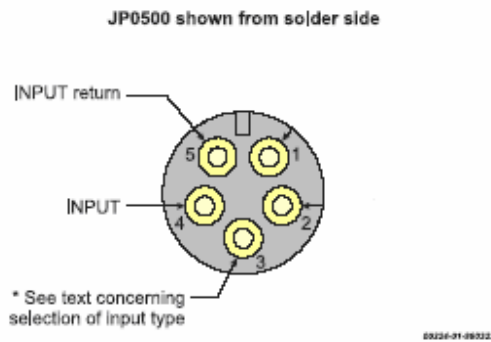


Fig. 2.7 Pin configuration in a JP 0500 Connector

Before soldering the cables to the pins in the JP 0500 connector, you must consider the type of input required:

- Voltage input: do not connect to pin 3.
- 0-20mA input: connect pin 3 to pin 4.

## 2.4 Selecting Transducers

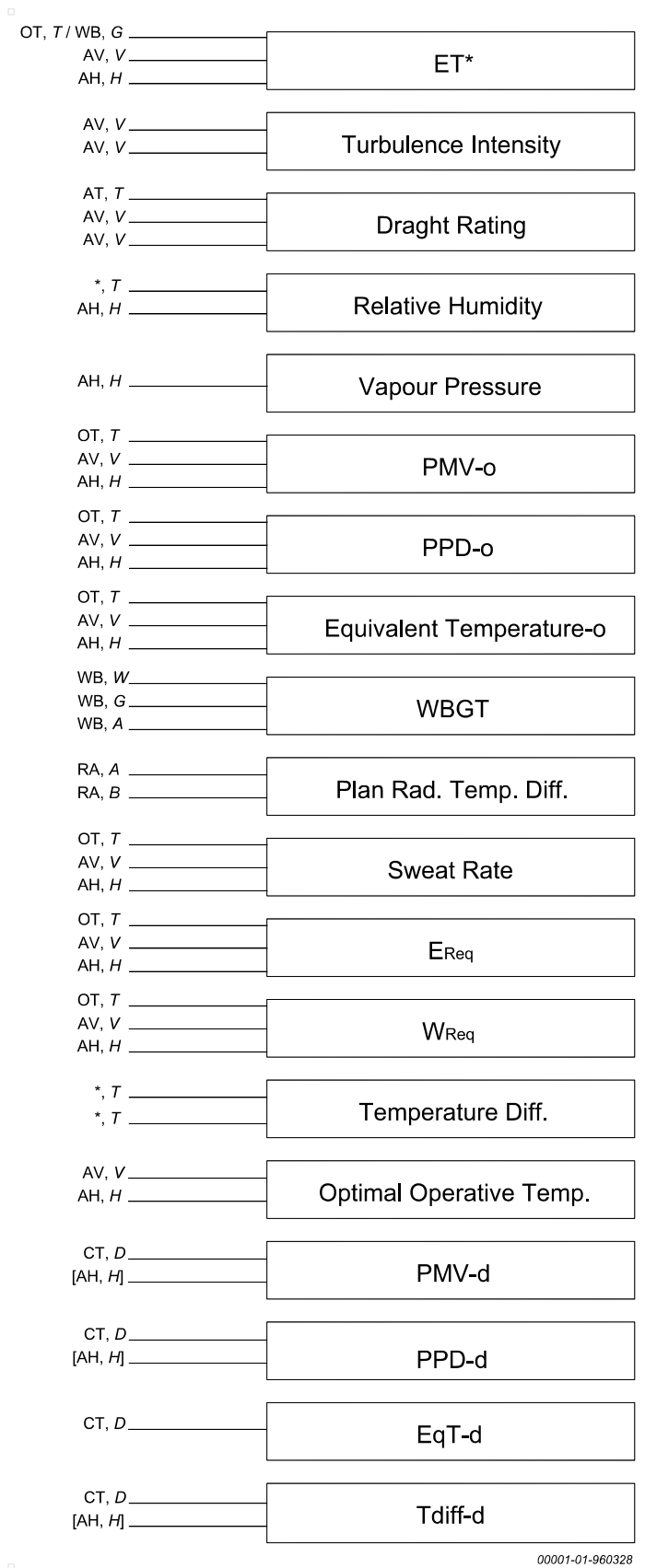
The module you select determines the transducers you can use.

Sampling times are determined by the input to which the transducer is attached, as shown in Table 2.1

	Input Name	Transducer	Sampling Time (minimum)
Comfort Module UA 1276	Temperature (Input 1)	MM 0034 MM 0035 MM 0060	1 s
	Humidity (Input 2)	MM 0037	Humidity: 3 min. Dry Temp.: 3 min. Mirror Temp: 1 s
	Air Velocity (Input 3)	MM 0038	0.05 s
Heat Stress Module UA 1277	Temperature (Input 1)	MM 0034 MM 0035 MM 0060	1 s
	WGBT (Input 2)	MM 0030	1 s
	Radiation (Input 3)	MM 0036	1 s
Dry Heat Loss Module UA 1278	Dry Heat Loss (Input 1)	MM 0057 C MM 0057 O	1 s
	Dry Heat Loss (Input 2)	MM 0057 C MM 0057 O	1 s

*Table 2.1 Transducer sampling times*

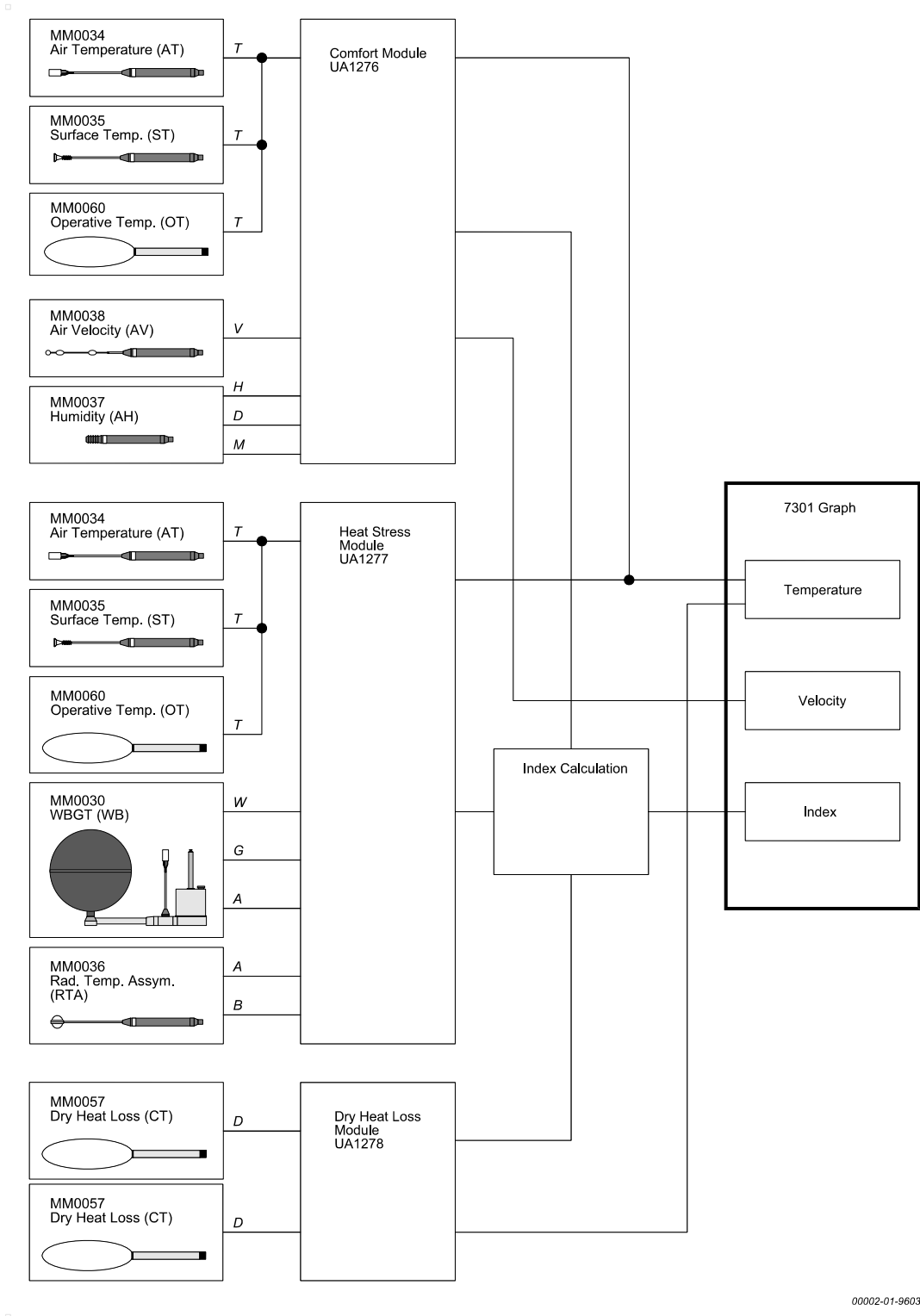
The modules and transducers you select depend on your application. A summary of the relationship between module, transducer and thermal parameters are shown in Fig. 2.8.



00001-01-960328

Figure 2.8 Relationship between thermal transducer, module and measurement type





00002-01-960328

Figure 2.9 Overview of transducer types used with each 1221 module

## Chapter 3

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# Hardware Installation

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### 3.1 Connecting Transducers

Depending on the module type installed in your 1221 (see chapter 2) you will have various options for transducers connection. Each transducer type has its own socket type with a specific number of pins, and all transducer inputs are labelled:

- Temperature (MM 0034, MM 0035, MM 0060): 4 pins
- Humidity (MM 0037): 8 pins
- Air Velocity (MM 0038): 6 pins
- WBGT (MM 0030): 11 pins
- Radiation (MM 0036): 12 pins
- Dry Heat Loss (MM 0057): 7 pins
- Analog Input/Out: 5 pins (see section 2.3.5)

From the back, the 1221 modules are numbered from left to right and from 1 to 4; transducer inputs are named, but also, for the sake of clarity the top input is always referred to as "Input 1", with additional inputs taking ascending values from top to bottom. For example, a transducer with three inputs will be numbered from 1 to 3 as shown in Fig. 3.1.

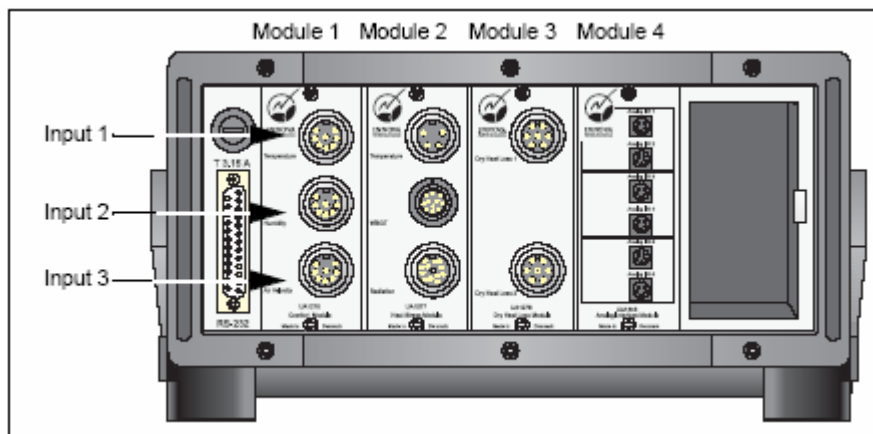


Figure 3.1 Module/transducer input position numbers on 1221

### 3.2 Connecting the Power Supply

If you will be using the 1221 in a location where a mains outlet is readily available, you can install the plug-in Power Supply ZG 0342. This power supply has a voltage range of 100 to 240 V.

If you are going to use the 1221 in the field, you can choose to install the Battery Box ZG 0146.

To install the Battery Box ZG 0146:

1. If the Power Supply ZG 0342 is installed:
  - a. Switch OFF the power to the 1221 by pressing the power ON/OFF switch on the front of the data logger.
  - b. Switch off the mains power.
  - c. Remove the power cable from the two pronged socket in the Power Supply.
  - d. Using a flat-blade screw, turn the release screw so that the module pops out.
2. Insert the battery pack into the slot, and turn the release screw so that it catches under the flange on the 1221 and is held in place.
3. Power on the 1221 as usual.

To remove the battery pack:

1. Switch off the power to the 1221.
2. Turn the release screw so that the battery box pops out.

To install or remove the Power Supply ZG 0342, follow the same procedure as described above, removing (if necessary) the battery pack, and inserting the two pronged plug *before* switching the 1221 ON.

### 3.2.1 Battery Lifetime

With one UA 1276 and one UA 1277 installed, the lifetime of the batteries in Battery Box ZG 0146 has been measured at about 18 hours with alkaline batteries.

With one UA 1278 installed, the lifetime of the batteries has been measured at about 10 hours with alkaline batteries.

This measured duration was based on the following:

- Use of alkaline batteries of a professional quality
- Two installed modules on the 1221 with transducers in all inputs
- Air with a velocity of 0,5 m/s and a dew point of 18°C below  $t_a$

**Note:** When using UA 1278, the battery lifetime is much more dependant on the number of modules in use, as well as ambient measuring conditions.

### 3.3 Connecting the 1221 to your PC

To connect the 1221 to a PC with a 9-pin serial interface connection, use cable WL 0945, with a 9-pin female connector on the end and a 25-pin serial interface connection, use cable WL 0946.

#### Notes:

- Maximum cable length is 17 metres
- LUMASENSE cables *must* be used

**⚠ Warning:** Turn off the PC and the 1221, and remove the power cable, before connecting or disconnecting the interface cable. Failure to do so could damage the equipment.

Gently push the 25-pin connector into place onto the 25-pin serial outlet on the back of the 1221 (see Fig. 1.2) and hand-tightening the screws.

Choose one of the 9-pin (or 25 pin) COM (1 or 2) outlets on the back of your PC and push in the 9-pin connector, hand-tightening the screws.

Re-connect the power cable.

The COM port selected is set-up from within the 7701 software as described in the 7701 manual.

### 3.4 Powering up the 1221

#### 3.4.1 Introduction

Once you have installed your power supply, you can power up the 1221. If you will be using the 1221 in connection with the 7701 software, either for online measurements or to set up the 1221 for off-line measurements, you must also have connected the serial interface as described in section 3.3.

To turn on the power, press the ON/OFF button on the front of the data logger into the ON position.

While the 1221 is performing self-tests, the red Error LED will flicker on and off. When these tests have successfully been performed, the Error LED will go out and the green Power LED will remain lit. If an error is detected, the Error LED will light continuously red. In this case, remove the processor card from the 1221 or call INNOVA Technical Support.

#### 3.4.2 Start-up Self-tests

When the 1221 is powered ON, a series of self-tests are run to determine that the current set-up parameters in the 1221 memory are properly located and have legitimate values.

## 3.5 Front Panel LEDs

### 3.5.1 Power

If you have inserted a power supply as described in section 3.2, the green Power LED will go on when you press the power ON/OFF switch on the front of the 1221. If the LED does not go on, then one of the following may be true:

- The power supply (either Power Supply ZG 0342 or Battery Box ZG 0146) is not properly installed. See section 3.2.
- The data logger is not plugged in (in the case of ZG 0342).
- The batteries are not charged (if you are running off ZG 0146)
- A fuse may be blown. See section 3.6 for information on changing fuses.

### 3.5.2 Battery Low

If you are running the 1221 off the Battery Box ZG 0146, the Battery Low LED will come on and the 1221 will stop any measurement, turning off automatically.

### 3.5.3 Communication Talk/Listen

The Talk/Listen LED lights green when the 1221 is sending or receiving data over the RS-232 interface.

### 3.5.4 Measuring

The measuring LED blinks (green) when the 1221 is set up and waiting for the programmed time for the start of a measurement. When this time arrives, the measurement starts. The LED is lit constantly during the measurement.

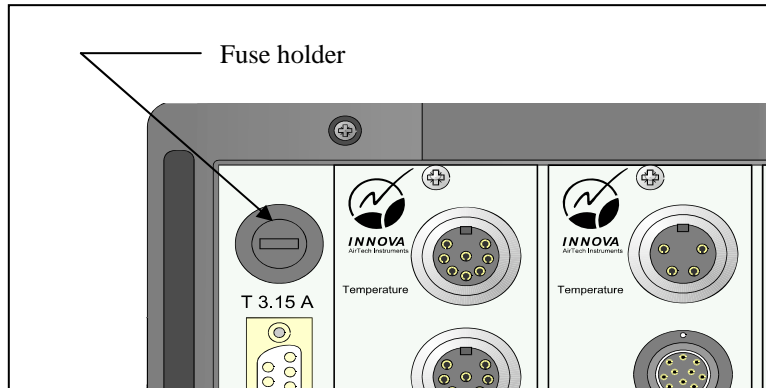
### 3.5.5 Error

The Error LED blinks during self-test, or, if an error has been detected, lights constant (red).

### 3.6 Changing Fuses

In the event that a fuse blows on the 1221, you can change the fuse as follows:

1. Locate the fuse holder as shown in Fig. 3.2.



*Fig 3.2 The fuse holder*

2. Use a small screwdriver to unscrew the fuse holder.
3. Replace the fuse with a new one of the same rating: 3.15 A, time-lag.

## 3.7 Transducer Operation

### 3.7.1 MM 0030 – WBGT Transducer

The validity of the wet bulb temperature measurements is dependent on the cotton sock (wick) being clean and wet. Therefore, the protection cover should always be placed over the wet bulb sensor when not in use. You should ensure that there is sufficient distilled water in the reservoir before commencing measurements. The cotton sock should also be replaced as soon as it begins to get dirty.

The water reservoir for the wet bulb sensor should only be filled with distilled water.

The reservoir has a capacity of approximately 40 ml and has a water level indicator to show when the reservoir is half empty. The centre core of the water level indicator appears black when there is sufficient distilled water in the reservoir, and reflects light when a refill is recommended. Under most measurement conditions there should be sufficient water in a full reservoir for at least 8 hours of measurements.

To fill the water reservoir proceed as follows, referring to Fig. 3.3:

1. Unscrew the protection cover of the wet bulb sensor.
2. Unscrew the water level indicator.
3. Fill the water reservoir with distilled water using supplied plastic bottle fitted with the nozzle cap.
4. If the cotton sock has been replaced or is completely dry, drip some distilled water onto the top of and around the sides of the sock to ensure complete wetting of the sock.



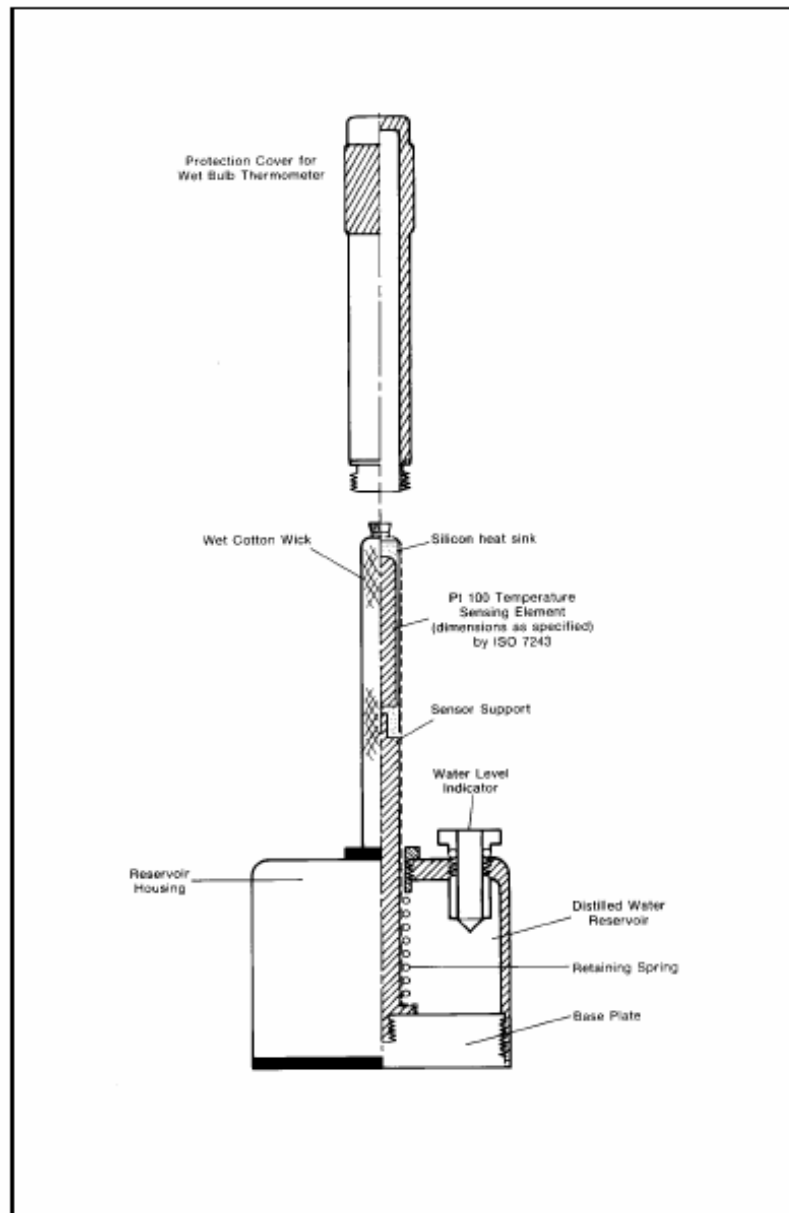


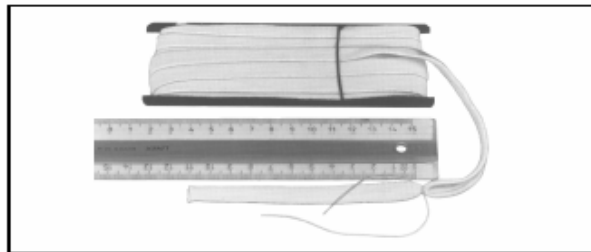
Fig 3.4 Details of wet bulb sensor of the MM 0030 WBGT Transducer

5. Screw the water level indicator into its socket, and wipe off any excess water.
6. Screw on the protection cover of the wet bulb sensor and return the WBGT Transducer to the carrying case if it is not to be used immediately.

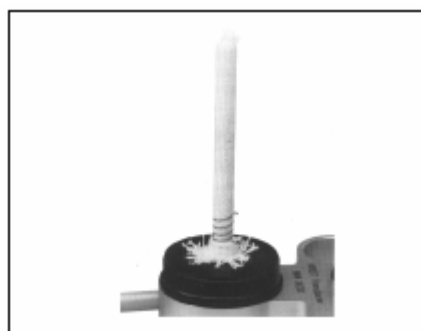
To replace the cotton sock proceed as follows, referring to Fig. 3.5:

1. Disconnect the WBGT Transducer MM 0030 from the 1221.
2. Ensure the protection cover is fixed over the wet bulb sensor.
3. Unscrew the water level indicator and empty as much of the distilled water as possible from the reservoir of the wet bulb sensor.

4. Unscrew the reservoir housing from the base plate of the Transducer.
5. Slide the old cotton sock together with the retaining spring up over the wet bulb sensor.
6. Remove the retaining spring from the old cotton sock
7. Unravel a length of the supplied cotton socking (reorder code QA 0143). A length of at least 10 mm is required, enabling the end to be frayed and spread out around the base of the sensor. Using the thread supplied, tie a knot in the sock before cutting the sock (Fig. 3.5)
8. Carefully slide the cotton sock over the wet bulb sensor.
9. Fray the end of the sock as shown in Fig. 3.6.
10. Slide the retaining spring over the sock and down towards the base of the sensor.
11. Screw the reservoir housing back onto the base plate of the transducer and refill the reservoir with distilled water.



*Fig 3.5 Preparation of cotton sock for the wet bulb sensor*



*Fig 3.6 Fitting the cotton sock over the wet bulb sensor*

12. Wipe off any surplus water from the reservoir housing and screw in the water level indicator.

### 3.7.2 MM 0036 – Radiant Temperature Asymmetry Transducer

The sensitive elements of the Radiant Temperature Asymmetry Transducer are protected by radiation-transparent windshields. Under normal circumstances these windshields will not reduce the transmission of radiant heat. However, the windshields should be checked, before measurements are made, to ensure that they have not become scratched. Damaged windshields should be replaced as follows:

1. Unscrew the retaining ring which holds the windshield in position.
2. Remove the damaged windshield and replace with a new windshield.
3. Replace the retaining ring and screw tight.
4. Repeat for the windshield on the other side of the transducer if necessary.

A set of 16 windshields is supplied with the Radiant Temperature Asymmetry Transducer. Additional sets can be ordered using LumaSense order number UA 0851.

### 3.7.3 MM 0037 – Humidity Transducer

The MM 0037 Transducer is a high precision and very reliable transducer, when treated correctly. Very little maintenance is necessary. It is only important to inspect and eventually clean the small mirror in the top of the transducer. This should be done on a regular basis, depending on the amount of use, and the concentration of dust and contamination in the air. If the mirror is dirty, you can expect a dew point result very far from the correct measurement. Cleaning should be done with a clean, soft and dry cloth. Alcohol can be used as detergent but this is normally not necessary.



*Fig 3.7 Disassembling the MM 0037 Transducer*

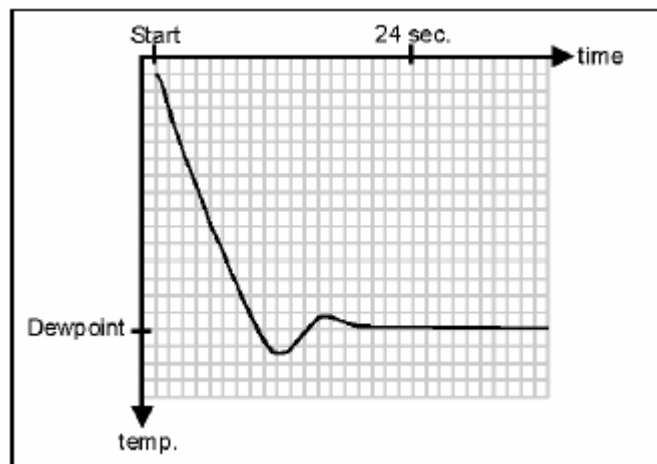
The MM 0037 is a very fast responding sensor. During the active part of the measuring cycle, it responds within 1 to 2 seconds, as opposed to more conventional humidity transducers which typically have response times of many minutes. This very fast reaction time can often come as a surprise if you are not aware of the fact that humidity may be very varying both in time and space. This is particularly true close to the body and breath. The message "DEW POINT UNSTABLE" should not be misinterpreted in this regard. What is actually meant by this message is that the dew point is fluctuating and the number given in the display is a correct average value. It is not necessarily an error message telling that the sensor is defective. The electronic regulation circuit in 1221/MM 0037 has been optimized for zero or moderate air velocities around the sensor. If you need to measure

in places with high air velocity, you may see the "DEWPOINT UNSTABLE" message often. This doesn't mean that the dew points is wrong, but if you want to avoid this message, use a suitable windscreen.

Never try to adjust the small potentiometer on the top of the sensor. It is not used to adjust the humidity value. The potentiometer is adjusted in the factory calibration of the sensor, to obtain the correct sensitivity of the photo sensor.

#### Testing the transducer:

The electronic regulation of the mirror temperature can be tested by selecting "Mirror Temp." for the MM 0037 transducer in the 7701 set-up. This gives a continuous display of the mirror temperature during the cooling cycle. Before you start, verify that the mirror is clean. If not, clean in. Place the transducer in a calm place, well away from your body. Every third minute, the curve will show the temperature decreasing from the start value to the dew point value. This should appear as shown in Fig. 3.8.



*Fig 3.8 Correct variation of temperature from start of cooling to stabilization at dew point*

If the temperature curve does not look like the one in Fig. 3.8, try to clean the mirror once again. If this doesn't help, the transducer should be returned to the factory for recalibration/repair.

#### 3.7.4 MM 0057 – Dry Heat Loss Transducer

##### **Dry heat loss transducer priority**

The higher the measured value for dry heat loss, the more power is required by the transducer. The number of active dry heat loss transducers, the ambient conditions, and the setup of CLO and MET values, effect whether or not the dry heat loss transducers can be supplied with the required power.

These power limitations are summarized as follows:

1. If a transducer requires more power than about 5W, the power is reduced to this value.
2. If the total amount of power required by the transducers exceeds the power supply limit, the power of several transducers may be reduced by the following priority scheme:

All transducers in sockets designated "Dry Heat Loss 1" are allocated power before transducers in "Dry Heat Loss 2" sockets starting from module location number 1.

**Example:**

UA 1278 modules are installed in locations 1, 2 and 3. All 6 transducers are set up for dry heat loss measurement. The priority is:


	Module	Transducer
<b>Highest Priority</b>  <b>Lowest Priority</b>	1	1
	2	1
	3	1
	1	2
	2	2
	3	2

Table 3.1 Priority rating for power supply to dry heat loss transducers

Whenever a transducer is supplied with less power than required, the read out dry heat loss is based on an extrapolated estimate.

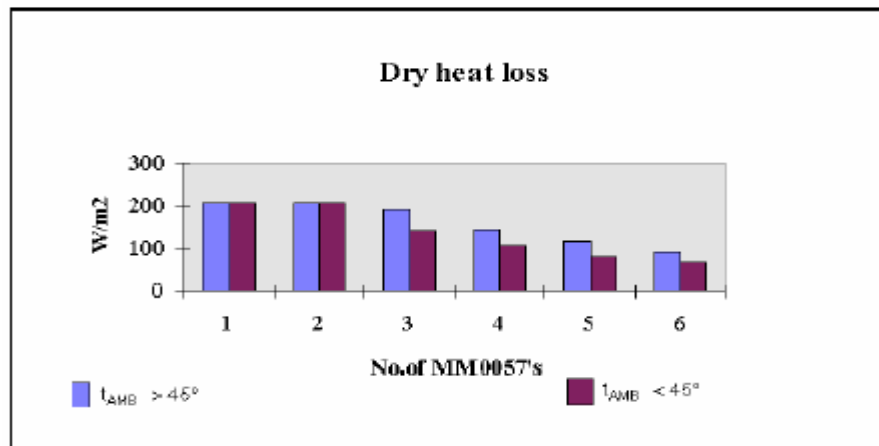


Fig. 3.9 Maximum available Dry Heat Loss in W/m<sup>2</sup> with ZG 0342

When more than 3 UA1278 modules and 6 MM0057 Dry Heat Loss Transducers are used the ZG0403, 12DC to 12V DC Power Supply must be used.

### 3.8 1221 Internal Memory

#### Size Limits on Data Sets for off-line measurements.

The maximum number of bytes of measurements data the the internal memory of 1221 can handle is: 102 400.

For a single line of data, with n measured values (that is the number of transducers times the number of I, m, s, h, l values selected for each transducer). Table 3.2 can be used to calculate the number of bytes the line will require.

Data Type	No. of Bytes
CRC	1
Sample No.	4
Flag	2
n values	n*2
N flags	n
Total	7+3n

*Table 3.2 Total number of bytes required for each data sample*

To calculate the number of lines available in the data file use:

$$102\ 400 / ( 7 + 3n)$$

For example, for a measurement data line which includes 10 values (n=10), the number of allowable measurement data lines is 2767

#### Size Limits on Data Sets for on-line measurements.

The maximum number of measurements with different time stamps is limited by the number of lines which can be imported into Excel.