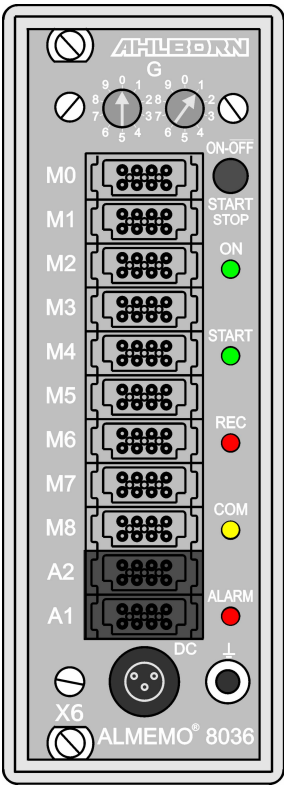
# Operating instructions



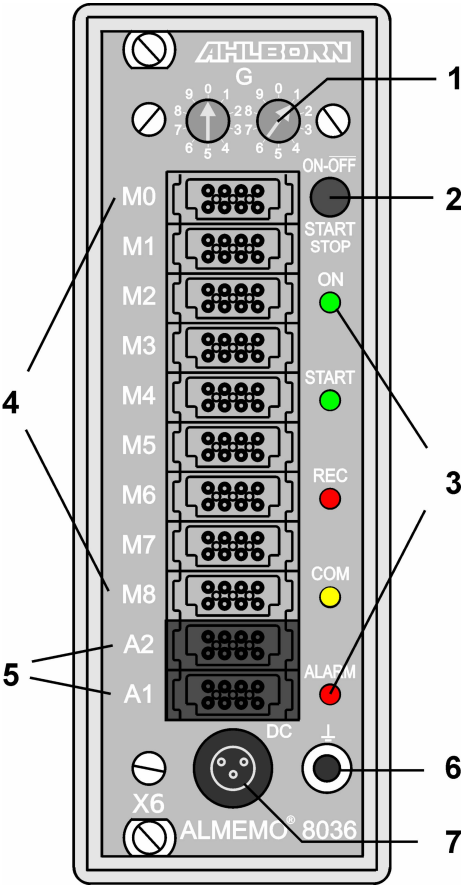

# X6

# ALMEMO® 8036-9

## High-precision measured data acquisition module for Pt100 sensors and psychrometers

V1.2
11.09.2015

# 1. OPERATING CONTROLS




**(1) Code switches**

**G:** Device address 00 to 99

**(2) Key ON/OFF, START/STOP**

**ON** Power ON
**START** Start the measuring operation
**STOP** Stop the measuring operation
**OFF** Power OFF, hold key pressed down

**(3) Status LEDs**

**ON** Device switched ON
**START** Meas. operation started
**REC** Meas. with results saved
**COM** Measuring with output
**ALARM** Sensor breakage, battery low

**(4) Measuring sockets M0 to M8**

**M0 ... M8** ALMEMO Pt100 sensors
**M09** internal atmospheric pressure
**M10...M18,** Additional channels for
**M30...M38, ..** humidity variables

**(5) Output sockets A1, A2**

**A1** USB interface (ZA1919-DKU)
RS 232/LWL (ZA1909-DK5/DKL)
Ethernet (ZA 1945-DK)
Trigger input (ZA 1000-ET/EK)
**A2** Network cable (ZA1999-NK5/NKL)
SD plu (ZA1904-SD)
Trigger input (ZA 1000-ET/EK)

**(6) Ground socket**

**(7) DC supply socket 12VDC**

Mains adapter
(ZB 1212-NA10, 12V, 2A)
Cable, electrically isolated
(ZB 3090-UK, 10-30V)

# 2. TABLE OF CONTENTS

# 3. GENERAL

We should like to congratulate you on your purchase of this new and innovative measured data acquisition module; this outstanding instrument provides high-precision measurements from Pt100 sensors at a resolution of 0.001 K; it is thus also ideally suitable for highly accurate humidity measurement using Pt100 psychrometers.

## 3.1 Warranty

Each and every device, before leaving our factory, undergoes numerous quality tests. We provide a guarantee, lasting two years from delivery date, that your device will function trouble-free. Before returning your device to us, please observe the advisory notes in Chapter 11, 'Trouble shooting'. In the unlikely event that a device does prove defective and you need to return it, please wherever possible use the original packaging materials for dispatch and enclose a clear and informative description of the fault and of the conditions in which it occurs.

This manufacturer's guarantee will not apply in the following circumstances :

- Any form of unauthorized tampering or alteration inside the device
- Use of the device in environments or conditions for which it is not suited
- Use of the device with an unsuitable power supply and / or in conjunction with unsuitable peripheral equipment
- Use of the device for any purpose other than that for which it is intended
- Damage caused by electrostatic discharge or lightning
- Failure to properly observe these operating instructions

The manufacturer reserves the right to change the product's characteristics in the light of technical progress or to benefit from the introduction of new components.

## 3.2 Standard delivery

When you unpack the device please check carefully for any signs of transport damage and ensure that delivery is complete:

- ALMEMO® 8036-9 measuring instrument
- Mains adapter ZA1212-NA10
- CD with ALMEMO® Control software and various useful accessories
- Operating instructions, ALMEMO® Manual

In the event of transport damage please retain the packaging material and inform your supplier immediately.

## 3.3 Waste disposal

The pictogram showing a waste bin crossed through means that the product is subject to European Union regulations covering segregated waste disposal.

This applies both to the product itself and to any accessories marked with the same symbol. Disposal of any such item as unsorted domestic waste is strictly forbidden.

- Please dispose of all packaging materials in accordance with the applicable national waste management regulations.
- Please dispose of cardboard boxes, protective plastic packaging materials, and all preservative substances separately and in the proper manner.
- The disposal of the device itself (also of device parts, accessories, and consumables) is subject to the applicable national and local waste management regulations and to the environmental protection legislation in force in the country of use.
- Please dispose of all parts and materials constituting a risk to the environment in the proper recommended manner. This includes inter alia plastics, batteries, and rechargeable battery packs.
- For the dispatch of such goods please wherever possible use the original packaging materials.

# 4. SAFETY INSTRUCTIONS

**DANGER** **Danger to life and limb, risk of damage to equipment**

**Before starting to operate the device, please read the instructions carefully.**

**Please comply with all safety instructions !**

Such risks may occur in the following circumstances**:**

- Failure to heed the operating instructions and all the safety notes these contain
- Any form of unauthorized tampering or alteration inside the device
- Use of the device in environments or conditions for which it is not suited
- Use of the device with an unsuitable power supply and / or in conjunction with unsuitable peripheral equipment
- Use of the device for any purpose other than that for which it is intended
- Damage caused by electrostatic discharge or lightning.

**DANGER** **Risk of fatal injury through exposure to dangerously high voltage**

Such risks may occur in the following circumstances:

- Use of the device with an unsuitable power supply and / or in conjunction with unsuitable peripheral equipment
- Damage caused by electrostatic discharge or lightning
- Do not run sensor lines in the vicinity of high-voltage power cables.
- Before you touch any sensor lines, ensure that all static electricity has been discharged.

**DANGER** **Warning - explosive atmospheres or substances**


In the vicinity of various fuels or chemicals there is a risk of explosion.

Do not use the device in the vicinity of blasting work or filling stations.

## 4.1 Special notes on use

- If the device is brought into the work-room from a cold environment there is a risk that condensation might form on the electronics. You are advised therefore, before starting to use the device, to wait until it has adjusted to the ambient temperature.
- Before using the mains adapter make sure that the mains voltage is suitable.
- Be sure to observe the maximum load capacity of the sensor power supply.
- Sensors with their own integrated power supply are not electrically isolated from one another.

# 5. INTRODUCTION

## 5.1 Measuring instrument

Reference measuring instrument **ALMEMO® 8036-9** belongs to the new **X6 series** of high-precision devices providing the highest resolution and linearity available. It has nine electrically isolated measuring inputs for Pt100 sensors with a measuring range of -200 to +670 °C and a resolution of 0.001 K; this is without any linearization errors, because the temperature values are exactly calculated using the appropriate formulae. The volume of measured values (870,000 digits) is considerably larger than that provided by ALMEMO® V6 devices with a 16-bit structure (65000). This device cannot therefore support the standard functions usually provided (limit values, measured value correction, scaling, or analog output). As an alternative a multi-point adjustment option is offered as standard; this is via 24-bit control point interpolation or coefficients modification.

The ALMEMO® 8036-9 is thus ideally suitable as a high-precision reference device - not only for temperatures but also, with the psychrometer, for all the usual humidity variables.

The Pt100 psychrometer can be used to measure very accurately both dry temperature and wet temperature and thus exactly calculate all the usual humidity variables on the basis of formulae as per Dr. Sonntag and the enhancement factor as per W. Bögel (correction factor fw(t,p) for real mixed gas systems). These calculations must take account of atmospheric pressure; for this purpose the device incorporates as standard an atmospheric pressure sensor. The measuring range and accuracy of this device are thus much greater than with previous systems. The atmospheric pressure measured can also be shown as an additional climate variable.

## 5.2 Measuring humidity, basic principles

Humidity is always present in the atmosphere in the form of water vapor. The percentage of water vapor per volume of air varies. Saturation vapor pressure at any given air temperature is the maximum partial pressure of water vapor (its gas phase) over an even surface of water (its liquid phase). This is temperature-dependent; at each temperature there is a maximum quantity of water vapor that can be contained in a defined quantity of air. Atmospheric humidity can be specified either as **absolute humidity** or as **relative humidity**. In these operating instructions humidity variables will be given using first the new symbols defined in VDI/VDE 3514 and then in brackets the old abbreviations used in tables issued by the Deutscher Wetterdienst (German Meteorological Service).

**Absolute humidity $d_v$** (AH) is also referred to as water vapor content. This is the weight of water vapor contained in one m3 of a mixture of water vapor and air. Since 1 m3 will, depending on pressure and temperature, contain a different air mass, it is usually easier to refer to absolute humidity per 1 kg of dry air. This variable is known as the **mixture ratio r** (MH).

**Relative humidity $U_w$** (RH) is the ratio of the **water vapor's partial pressure e´** (VP) to the **saturation vapor pressure ew´** (SVP) in a mixture of water vapor and air at **air temperature t** (TT). The temperature at which saturation occurs (VP=SVP, RH=100%) is known as the **dewpoint temperature $t_d$** (DT). As soon as the air falls below this dewpoint temperature the water vapor (gas phase) condenses into droplets of water (liquid phase). Enthalpy h (En) is the thermal content in the mixture of water vapor and air.

## 5.3 Psychrometers

### Measuring principle

A psychrometer is a high-precision measuring instrument incorporating two highly accurate temperature sensors; it is used to determine all the usual humidity variables. One of these sensors is covered in a cotton sheath; this must be kept permanently moist with water from a reservoir and cooled by means of a current of air. When the power supply is connected and the integrated fan starts operating, the moistened temperature sensor will, depending on air temperature and humidity, cool down by a measurable amount. Based on this psychrometric temperature difference the water vapor's partial pressure e´ and thus all the variables associated with atmospheric humidity can be calculated.

## 5.4 Sensor programming

### Measuring quantities and ranges

For Pt100 sensors there are two high-resolution measuring ranges, -200.000 to +670.000 °C and -200.00 to 850.00 °C. The humidity variables, relative humidity and dewpoint, are calculated exact to two decimal places; there are also mixture ratio (MH, r [g/kg]), absolute humidity (AH, dv [g/m3]), vapor pressure (VP, e [mbar]), and enthalpy (En, h [kJ/kg]). Differential measurement and supply voltage monitoring are possible via further function channels.

### Measuring channel designation

Each sensor is identified by means of a 10-character alphanumeric name. These names are entered via the interface and will appear in the printout or on the computer display.

### Correction of measured values

Standard functions for measured value correction and scaling cannot be used because of the high volume of measuring ranges. However, it is possible to set the measured value of each measuring channel to zero. The sensors can also be adjusted at several points by means either of multi-point linearization (i.e. the error curve being stored in the connector) or modification of the Pt100 coefficients.

All programmed sensor parameters are saved in the connector and are automatically restored as and when a sensor is plugged in.

## 5.5 Measuring operation

For the nine temperature sensors there are altogether up to 36 measuring channels available; i.e. psychrometers can also be evaluated with three humidity variables . All activated measuring points are continuously scanned at a rate of 1.25 mops (measuring operations per second).

**Atmospheric pressure compensation**
Some humidity variables are heavily dependent on atmospheric pressure. To avoid errors of this nature the device incorporates its own atmospheric pressure sensor for automatically compensating its measured values.

**Measured value smoothing**
For all measuring channels measured values of an unstable, fluctuating nature can be smoothed by taking a sliding average over a number of values programmable between 2 and 99.

**Maximum and minimum values**
For each measuring operation the maximum value and minimum value are acquired and saved to memory. These values can then be displayed, output, or deleted from memory.

## Process control

To record the measured values from all connected sensors in digital form measuring point scanning must be performed continuously with measured value output according to a process scheduling system. This may be per output cycle or, if rapid results are required, at the measuring rate itself. The measuring operation can be started and stopped by means of a key, the interface, an external trigger signal, or the real-time clock.

**Date and time-of-day**
Each measuring operation can be accurately logged using the real-time clock in terms either of date and time-of-day or purely by actual measuring duration. For the purposes of starting / stopping a measuring operation the start / stop date and time-of-day and / or the actual measuring duration can be programmed.

**Cycle**
The cycle can be programmed to any value between 1 second and 24 hours. This function permits cyclic output of measured values to the interfaces or to the memory and provides cyclic calculation of the average value.

**Output**
All data logs, all saved measured values, and all programming parameters can be output to any peripheral equipment. Using the appropriate interface cable any of interfaces RS232, RS422, USB, or Ethernet can be used. Measured data can be output in list, column, or table format. Files in table format can be processed directly using any standard spreadsheet software. Recording can be accelerated if all measured values are stored to memory and / or output via the interface at the conversion rate. The print header can be programmed to

refer specifically to your company or to a specific application.

**Data logger**
The device can, by fitting an external memory connector with a micro-SD memory card, be upgraded to a high-capacity data logger. Using this external memory (available as an accessory) files can be read out very quickly via any standard card reader.

**Networking**
All ALMEMO® devices can be individually addressed and can be networked together by simply linking them up via network cable or, for longer distances, via RS422 network distributors.

**Software**
Each ALMEMO® Manual is accompanied by the ALMEMO®-Control software package, which can be used to configure the measuring instrument, to program the sensors, and to read out from the measured value memory. Using the integrated terminal, measuring operations can also be performed online. The WINDOWS® software package WIN-Control is provided for measured value acquisition from networked devices, for graphical presentation, and for more complex data processing.

# 6. PUTTING INTO SERVICE

**1. Sensor connection** Connect sensors to sockets **M0** to **M8.** (4) see 8.

**2. Power supply** Connect mains adapter to socket DC. see 7.1

**3. Switching ON** Press the **ON** key (2). see 7.3

**4. Device configuration by PC via the interface**
Connect the computer via interface cable to socket A1. (5) see Man. 5.2
Activate the software, e.g. the supplied ALMEMO®-Control.
Identify the device by means of <Search network>.
If the device is not found select <Setup interface>.
Set the correct COM port and the transmission rate to 9600 baud. see Man. 6.1.1 <Update list>
<Program device>
Enter 'Cycle' for automatic measuring point scan. see Manual 6.5.2
To save activate 'With saving to memory'.
(with memory connector only)
If so required 'Accept date and time-of-day from PC'. see Manual 6.2.8
Program the output format.
see Manual, Sections 6.5.5, 6.6.1
'Table' for MS-Excel; 'List' or 'Columns' for printer or text editor

**5. Measured data acquisition from PC without saving on device**
Select <File - terminal> see Manual, Section 6.1.3
Select <File> - <Terminal> - <Open log>, then enter file name, and 'Save'.

Start measuring operation by actuating the 'START' button or pressing the **START/ STOP** key. see Manual, Section 6.6
Stop measuring operation by actuating the 'STOP' button or pressing the **START/ STOP** key.
<Close file - terminal - log>
Select file e.g. from within MS-Excel and import using ';' as separator.
see Man. 6.1.4

**6. Saving measured values in the device** (with memory connector only)
Select <Devices - Measured value memory>.
If so required click on 'Clear memory' and 'Execute'. see Manual 6.9.3
For long-term recording (cycle > 2 minutes) Activate sleep mode see 10.2.3
Activate 'Start saving to memory' immediately. or
Start measuring operation on site by pressing the **START/ STOP** key.
or In <Program device> enter the measuring operation 'Start date', 'Start time', and 'End date', 'End time'. see Manual, Section 6.6.2
At the end of the measuring operation stop recording by pressing the **START/ STOP** key.

**Transferring data from memory to the computer**
If the memory connector is being used withdraw the micro-SD-card and using a USB reading device copy to the PC. see Manual 6.9.4.2 or
Reconnect the computer via interface cable to socket A1. (5) see above
In ALMEMO®-Control select <Devices - Measured value memory>.
Click on 'Read out whole memory'.
Read out, 'Execute', enter file name, 'Save'. see Manual, Section 6.9.3
Select file e.g. from within MS-Excel and import using ';' as separator.
see Man. 6.1.4

# 7. POWER SUPPLY

Power can be supplied to the measuring instrument in any of the following ways : Mains adapter 12 V / 2A ZB 1212-NA10
Power supply cable, electrically isolated
(10 to 30 VDC, 0.25 A) ZB 3090-UK
See product overview, Annex 13.2, and the following chapters.

## 7.1 Mains operation

To power these devices from the mains preferably use the mains adapter provided; connect it to the socket **DC** (7). Please ensure that the mains voltage is correct.

## 7.2 External DC voltage supply

The **DC** socket (7) can also be used to connect another DC voltage, 9 to 13 V (minimum 200 mA). For this connection use a cable with two banana plugs

(ZB 5090-EK). If, however, the power supply has to be electrically isolated from the transducers or if a larger input voltage range (10 to 30 V) is required, then an electrically isolated supply cable must be used (ZB 3090-UK). It will then be possible to use the measuring instrument in a 12-volt or 24-volt on-board supply system.

## 7.3 Switching ON / OFF

To switch the device ON press the **ON-OFF** key (2) briefly and release.

To switch the device OFF press the ON / OFF key and hold down for approx. 1 second. After the device is switched off the real-time clock continues to run and all saved values and settings are retained intact.

see Section 7.4

If interference (e.g. electrostatic or mains failure) causes the device to behave abnormally, you are advised first of all to try clearing the problem by simply re-initializing, i.e. switching off and then on again.

If this does not help then you are advised to restore all device programming to the factory default settings. The device can be **reset** by setting the code switch **G** (1), before switching on, to address 99. This has the effect of also resetting the baud rate setting on the data cable to 9600 baud. However, the programming of the sensors in the ALMEMO® plugs always remains unaffected and intact.

## 7.4 Data buffering

The sensor's programming is stored in the EEPROM on the sensor plug; the device's calibration and programmed parameters are stored in the EEPROM on the device itself; both are fail-safe. The memory data is also saved in non-volatile flash cards. Date and time-of-day are buffered by a dedicated lithium battery; this data is retained intact for years - even when the device is switched off and without batteries.

# 8. CONNECTING THE SENSORS

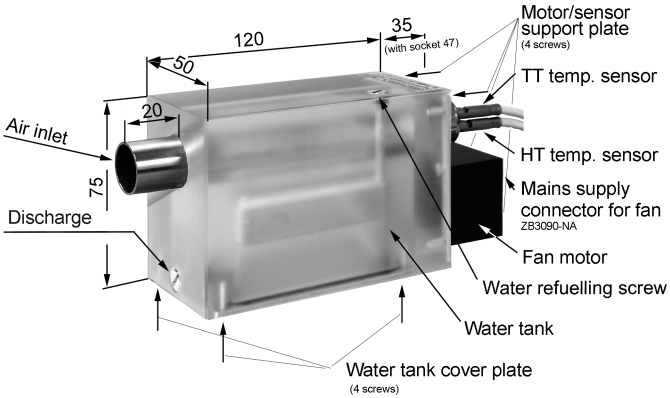
Measuring sockets M0 to M8 (4) on the X6 measuring instrument series can be use to connect high-precision X6 Pt100 sensors FPA923-L0250 with the P314 range (0.001 K) or X6 plug ZA9030-FS2P3 with the P214 range (0.01 K). Or, alternatively, stationary high-precision X6 psychrometer FPA836-3P3 can be used.

## 8.1 Pt100 sensors

All the afore-mentioned X6 sensors with an ALMEMO® plug have their range and units already programmed and can thus be connected to the measuring sockets of X6 Pt100 measuring instruments without any further adjustment. They cannot be used on standard ALMEMO® devices. A mechanical coding

system ensures that sensors and output modules can only be connected to the correct sockets. All ALMEMO® plugs incorporate two snap-lock levers; these snap into position as soon as the plug is inserted into the socket, thus preventing unintended disconnection if the cable is pulled accidentally. To withdraw the plug these two levers must first be pressed in at the sides.

## 8.2 Stationary high-precision psychrometer FPA 836-3P3




**Fill the water reservoir**

1. Undo the refill screw
2. Top up the reservoir with distilled water using the squeeze bottle supplied

The water in the reservoir may in certain circumstances become contaminated. The reservoir must be cleaned therefore about every 6 weeks. In the event of long periods of inactivity or for transport purposes the reservoir should be emptied completely.

**Changing the wick**

If the cotton wick becomes dirty or encrusted it will no longer absorb moisture properly; as a result measured values may be falsified. It should therefore be replaced at regular intervals (depending on how clean the air and water are).

1. Emptying the reservoir (see above)
2. Unscrew the water reservoir lid
3. Unscrew the motor / sensor retaining plate and withdraw the old wick from the humid temperature (HT) sensor
4. From the side of the reservoir insert the new wick into the psychrometer tube and pull over the HT sensor
5. Screw the motor / sensor retaining plate back again
6. From the side of the reservoir adjust the wick, screw the reservoir lid back in position, and refill the reservoir.

**Using the psychrometer**

To obtain reliable results it is very important that the psychrometer be operated properly. Please ensure therefore that you always comply with all the following

advisory notes:

1. After the fan starts up it will take approx. 20 to 30 seconds before the wet temperature sensor is sufficiently cooled. Only after this period will humidity values be stable.
2. Ensure that the humidity sensor is always sufficiently moistened. If you are unsure whether there is sufficient moisture carry out a visual inspection of both the cotton sheath and the wick itself. To moisten the wick use distilled water only. Ordinary water may leave calcified deposits on the wick.
3. If the wick no longer absorbs water properly (through dirt or dryness), replace its cotton sheath.
4. Air velocity at the air intake must be minimum 2 m/s. Ensure therefore that the air intake is always free and unobstructed.
5. Avoid inadvertently warming the probe head from external heat sources or your own body heat.

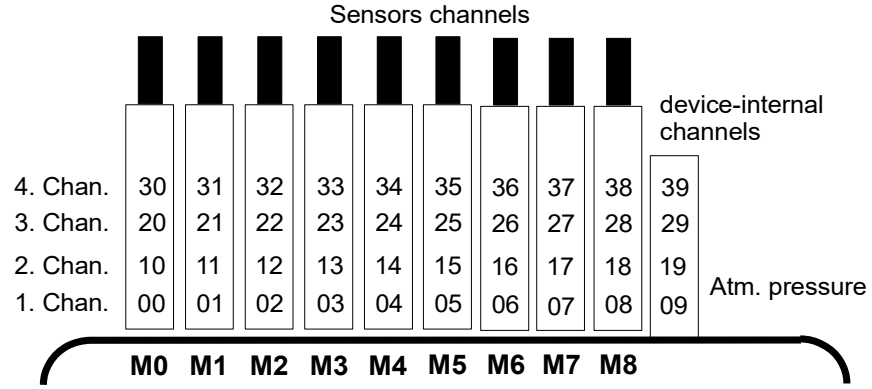
## 8.3 Measuring sockets and measuring channels

Measuring instrument ALMEMO® 8036-9 has nine measuring sockets M0 to M8 (4) and to each of these up to four measuring channels can be allocated. Each such psychrometer comprises two Pt100 sensors; that for wet temperature (TW) must be connected first at socket Mx and that for dry temperature (TD) with the humidity variables must be connected at the very next socket Mx+1.

**Device-internal channelse**

This device also provides four additional device-internal channels. These can be used to program not only the device-internal atmospheric pressure but also, if so required, the battery voltage or a function channel for differential.

**Channel assignment** on the 8036-9:



These psychrometers are supplied with the following quantities and ranges pre-programmed:

| | **Pt100 psychrometer FPA836-3P3** | | **Measuring instrument 8036-9** |
|---|---|---|---|
| 4. | | D r | |
| 3. | | P2td | |
| 2. | | P2Uw | |
| 1. | P314 HT | P314 TT | AP |
| | **Mx** | **Mx+1** | **M9** |

## 8.4 Potential separation

When organizing a properly functioning measuring setup it is very important to ensure that no equalizing current can flow between sensors, power supply, and peripherals. All points must therefore lie at the same potential and / or any unequal potentials that do exist must be electrically isolated.

The analog inputs are electrically isolated from one another by means of photovoltaic relays; the maximum potential difference permitted between them is 50 VDC or 60 VAC. The A/D converter is also electrically isolated from the CPU and the power supply. The power supply is isolated by the transformer in the mains adapter or by a DC/DC converter in connecting cable ZB3090-UK.

# 9. OPERATION AND CONFIGURATION

High-precision data acquisition module ALMEMO® 8036-9 has only a few operating controls; it is operated mainly via a PC.

## 9.1 Combination key

The first function of the one and only key ON/OFF - START/STOP (2) has already been described in Section 6.5.
To switch the device ON this key must be pressed just briefly; to switch the device OFF again this key must be pressed and held down.
If the device is on and a cycle has been programmed the same key can be used to start and stop a measuring operation.
The current operating status is clearly shown by the status LEDs.

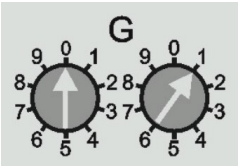
## 9.2 Status LEDs

The status LEDs (3) report the current device status as follows:

| | |
|---|---|
| **ON** | Device is switched ON |
| **ON** flashes briefly just once | Device is in sleep mode |
| **START** is lit continuously | Cyclic measuring has started |
| **COM** is lit continuously | Cyclic measured value transmission to the PC |
| **COM** flashes | Transmission to the PC at the conversion rate |
| **REC** is lit continuously | Cyclic data saving to the device memory<br>This also lights up during output from memory. |
| **REC** flashes | Data saving to the device memory |
| **START** flashes briefly just once | Once-only measuring point scan is initiated by the PC |
| **COM** flashes briefly just once | Once-only measuring point scan transmits data to the PC |
| **REC** flashes briefly just once | Once-only measuring point scan<br>saves data to device memory |
| **ALARM** | Sensor breakage |
| **ALARM** flashes | Supply voltage to device is too low |

## 9.3 Interface, device address, networking

For connecting to the various interfaces a selection of data cables is available (see Manual, Section 5.2); all of these are connected to socket A1 (5) - with the exception of network cable ZA 1999-NK (used for networking a further device) which should be connected to socket A2. Via the serial interface and using the supplied ALMEMO®-Control software the device can be fully configured and all measured data output to a PC (see Manual, Chapter 6).
The ALMEMO® 8036-9 measured data acquisition module too, like all ALMEMO® devices, can be networked. To communicate with networked devices it is absolutely essential that each device should have its own dedicated address; this is because only one device should respond per command. Before each network operation therefore all measuring instruments must be set, by means of their code switches (1), to different device numbers.




*Example:* Module address 01 0 1

☞ In network operation consecutive numbers between 01 and 99 should be used; this ensures that device 00 is not addressed unnecessarily in the event of interruption to the power supply.

## 9.4 Data communications

For data retrieval and programming we provide a comprehensive ALMEMO® protocol (described in the Manual, Chapter 6). Since this high-precision instrument exceeds the standard ±16-bit range limits (65000), certain sensor parameters (e.g. base value, factor, zero-point, gain, limit values, analog scaling) are not available. Measured value correction is performed therefore using a 24-bit multi-point correction system. Data retrieval should be performed using the table format; this is also supported by the Win-Control data acquisition program.

To display measured values in list format - together with channel, overflow indication, range, and comments text - a new command is provided in the table format.

```
f1 P35  (individual channels with Mxx P35)
 00;;20,044;°C;P314;HT
 01;;26,962;°C;P314;TT
 02;;942,6;mb;AP  ;Atmospheric pressure
 11;>;54,27;%H;P2Uw;r. Humidity
 21;;17,06;°C;P2td;Dewpoint
```

The command 'f1 P18' previously used for maximum / minimum / average values with date and time-of-day has been converted for use in the table format:

```
f1 P18  (individual channels with Mxx P18)
 MS;MEAS.VAL.;MAX VAL;MIN VAL;AVERAGE;NUMBER;MAX TIME;MAX DATE;MIN TIME;MIN DATE
 00;20,044;150,007;20,038;-;0;02:31;05.01;02:32;05.01
 01;26,961;27,017;26,952;-;0;02:33;05.01;02:45;05.01
 02;942,6;942,7;942,5;-;0;02:43;05.01;02:46;05.01
 11;54,28;54,32;53,99;-;0;02:45;05.01;02:33;05.01
 21;17,06;17,06;17,02;-;0;02:46;05.01;02:32;05.01
```

Certain measured value outputs in list format (commands p, P01..P03, P-04, Sx) are still available but are now output with an additional decimal place.

## 9.5 Programming

Since on ALMEMO® devices all sensor programming is stored in the ALMEMO® connector itself, the user will not normally need to reprogram each time. However, with humidity sensors it is necessary sometimes to program other humidity ranges than those provided as standard. Each channel can also be assigned a designation (see Manual, Section 6.3.6) or smoothing (see Manual, Section 6.7.4). Device configuration and process control are also as per standard V6 devices.

### 9.5.1 Measuring quantities and ranges

The following table lists the measuring ranges available for temperature sensors and psychrometers FPA8363P3. Humidity variables are each programmed in sensor TD; sensor TD must be connected at the very next socket after sensor TW. Atmospheric pressure, differential, or supply voltage can be accessed on device-internal channels M09 to M39 (see Section 8.3). Commands for entering this via an interface using a terminal are also listed.

| Measuring function | Measuring location | Measuring range | Units | Display | Command |
|---|---|---|---|---|---|
| Pt100-3 ITS90 0.001°C | FPA903L0250 | -200.000...+670.000 | °C | P314 | B96 |
| Pt100-3 ITS90 HT, tw | FPA8363P3 | -200.000...+670.000 | °C | P314 | B96 |
| Pt100-3 ITS90 TT, t | FPA8363P3 | -200.000...+670.000 | °C | P314 | B96 |
| Pt100-2 ITS90 0.01°C | ZA9030FS2P3 | -200.00...+850.00 | °C | P214 | B69 |
| Rel: atm: humidity 0.01 %H | FPA8363P3 | 0.00... 100.00 | %H | P2Uw | B-10 |
| Dewpoint temp: 0.01 °C | FPA8363P3 | -64.80... 100.00 | °C | P2td | B-11 |
| Mixture MH, r | FPA8363P3 | 0.0... 6500.0 | g/kg | D r | B-04 |
| Absolute humidity AH, dv | FPA8363P3 | 0.0... 596.3 | g/m³ | D dv | B-05 |
| Vapor pressure VP, e | FPA8363P3 | 300... 1100.0 | mbar | D e | B-06 |
| Enthalpy En, h | FPA8363P3 | 0.0... 6500.0 | kJ/kg | D h | B-07 |
| Atmosph: pressure AP int. | Device channel M9 | 300.0... 1100.0 | mbar | AP | B86 |
| Differential | Device channel M9 | | | Diff | B71 |
| Supply voltage | Device channel M9 | 0.0... 26.0 | V | Batt | B14 |

### 9.5.2 Multi-point adjustment

On these special devices the sensor parameters for measured value correction, as already mentioned, cannot be programmed. However, each Pt100 sensor can store a correction curve that will help optimize its measuring accuracy. Any deviations from the ideal setpoint that have been detected at various points in a calibration laboratory can be programmed by means of the ALMEMO®-Control software to the EEPROM in the ALMEMO® plug and then interpolated on a linear basis for subsequent measuring operation (see Manual, Section 6.3.13).

If a channel with a correction characteristic is deactivated or programmed with a different quantity, the characteristic can subsequently be reactivated by restoring the special quantity using command 'B99'.

Other information that can be entered in the connector includes the order num-

ber, the serial number, the date of the next calibration, and the calibration interval. In networked systems the calibration intervals can thus be monitored automatically.

### 9.5.3 Correction by modifying the Pt100 coefficients:

When calibrating a Pt100 sensor in a calibration laboratory any deviation detected can also be managed by adjusting the sensor on the basis of the four real coefficients in the Van Dusen equation. The easiest way is to use the ALMEMO®-Control software <measuring points><list><edit><coefficients>.
This provides the following terminal commands :
The four coefficients of a Pt100 sensor can be identified using command P27:

| | |
|---|---|
| Select the input channel | E00 |
| Identify the coefficients | P27 |
| | Pt100 COEFFICIENTS: |
| | 00: A = 3.90830E-3 |
| | 00: B = -5.77500E-7 |
| | 00: C = -4.18300E-12 |
| | 00: R0 = 100.01234 |

To enter coefficients A, B, C and resistance R0 (at 0 °C) in the Pt100 formula, first select the input channel and then specify the associated coefficients.

| | | |
|---|---|---|
| Select the input channel | E00 | |
| | | Input range |
| Enter coefficient A | f1 ax.xxxxx | 3.7 ... 4.1 |
| Enter coefficient B | f2 ax.xxxxx | 5.6 ... 6.0 |
| Enter coefficient C | f3 ax.xxxxx | 4.0 ... 4.4 |
| Enter resistance R0 | f2 exxx.xxxxx | 95.0 ... 105.0 |

The input format is one integer digit before the decimal point (three integer digits for R0) and up to five decimal places. If fewer decimal places are entered, the input must be completed by pressing ENTER. There is no need to enter the arithmetic sign or exponent - just the mantissa.

Measured value correction is denoted by '!' at the end of the comments text.

To delete all coefficients use C27; to delete individually enter '0'.

# 10. MEASURED DATA ACQUISITION

Measured data acquisition can be performed in basically two ways:

1. Perform measuring operation online; data is transferred to the PC immediately (no device-internal memory is required).
2. Perform measuring operation offline; data is first saved to an external memory connector with a micro SD card and then transferred to the PC later.

## 10.1 Online measurement with PC

For conveniently recording measured data directly on the PC our Win-Control measured value acquisition software is ideally suited. This software is unique in that it can scan one stand-alone or several internetworked measuring modules each at its own measuring cycle, then save the measured data on the PC, and output it online in a clearly understandable form as a line diagram, table, or list of individual measured values; thus for process control purposes you need simply program each measuring cycle in Win-Control. There are many other possibilities using formula channels, control and regulation functions, and alarm reports via SMS and e-mail, etc. but these are too numerous to be described here in detail.

## 10.2 Offline measurement

To perform offline measuring operations, i.e. data logging in the device itself, an external memory connector with an SD memory card must be used (accessory ZA 1904-SD) and the following parameters must be configured.

1. Date, time-of-day
2. Cycle with saving to memory activated
3. Sleep mode, possibly

The easiest way to do this is by means of our ALMEMO®-Control software, in menu <Program device> and <Measured value memory - Save to memory>.

### 10.2.1 Memory connector with SD memory card

Another convenient method for data recording is memory connector ZA 1904-SD with a conventional micro SD memory card. Measured data is written to the memory card via the plug-in memory connector; this data is saved in standard FAT16 table format. The memory connector works in a completely different way to the device-internal memory; this brings with it not only restrictions but also new advantages.

**Memory connector functions**

Virtually unlimited memory capacity
With each new connector configuration a new file is created.
No recording to ring memory
Sleep mode
Data can be evaluated using any reader on site or anywhere else.
Very fast data transfer via the reader
Data recording and output in table format only

On the ALMEMO® device itself only the last file can be read.
Selective data output according to date and time-of-day or by number code is not supported.

The memory connector with the memory card can be connected at socket A2; it will be recognized automatically. If at the start of any measuring operation an external memory has been connected, it will be used. In the course of a measuring operation the external memory must not be unplugged; this would cause all temporarily buffered measured values to be lost.

Before starting any measuring operation you can enter an 8-character file name (see Chapter 11). In the absence of a user-defined file name, the default 'ALMEMO.001' or the name most recently used will be suggested automatically. So long as the connector configuration is not altered, any number of measuring operations can be saved - either manually or cyclically, also with number codes, all in the same file.

If, however, the **connector configuration** has been **changed** since the last measuring operation, a new file will be created; and, if no new file name has been programmed, the index in the file name extension will automatically be incremented by 1, e.g. 'ALMEMO.002'. Similarly, if the file name now entered already exists, a new file will be created with the same file name prefix but with a new index.

## 10.2.2 Starting / stopping a measuring operation

To start / stop a measuring operation on site the following methods are available (see Manual, Section 6.6).

1. Press the START / STOP key (2) on the device.
2. Program the start date and time-of-day and then either the end date and time-of-day or the fixed measuring period (see Manual, Section 6.6.2).
3. Interface commands
4. Triggering in response to electrical signals (see Manual, Section 6.6.4).

The status of a measuring operation and of data recording can easily be tracked by watching the LEDs (see Section 9.2).

## 10.2.3 Sleep mode

For long-term monitoring involving long measuring cycles where power is supplied by rechargeable or normal battery the measuring instrument can also be operated in sleep mode. In energy-saving sleep mode the measuring instrument switches off after each measuring point scan and switches on again automatically after the cycle expires ready for the next measuring point scan. In this way, with just one battery recharge, it is possible to perform up to 30,000 measuring point scans; with a cycle lasting 5 minutes this represents a total runtime of over 100 days.

For data recording in sleep mode go to ALMEMO®-Control <Device programming> and take the following steps:

1. Enter a cycle lasting at least two minutes.
2. Activate saving to memory in this cycle.
3. Switch sleep mode on.
4. Start measuring operation as normal; the device should then switch off automatically; as a check the LED 'ON' (3) should flash rhythmically on and off.
6. In the specified cycle the device switches on automatically, performs one measuring point scan, and then switches off again.
7. To stop the measuring operation press key (2e) twice, function ´**ON**´ and ´**STOP**´.

In this way any number of measuring operations can be performed in sleep mode up until when sleep mode is deactivated again. With cycles shorter than two minutes measuring operations are performed automatically in normal mode.

### 10.2.4 Reading out measured data

To read out the measured data select ALMEMO® Control menu item <Devices - Measured value memory> (see Manual, Section 6.9.3). Here you can transfer the last file on the memory card to a file on the PC. Delete' will reformat the whole SD card, i.e. all files will be deleted.

However, via a card reader connected to the PC all files on the memory card can be individually read out or deleted, or the SD card can be formatted (see Manual, Section 6.9.4.2). This data can also be imported into MS-Excel or into Win-Control.

# 11. TROUBLE-SHOOTING

The ALMEMO® 8036-9 measured data acquisition module can be configured and programmed in many different ways. It is suitable for connecting a wide variety of different sensors, additional measuring instruments, and peripheral equipment. Given these numerous possibilities the device may in certain circumstances not behave quite as expected. The cause of such unexpected behavior is not usually a device defect; often the cause is incorrect operation by the user, an invalid setting, or unsuitable cabling. In such event try to pinpoint and clear the problem with the aid of the following tests.

**Error** No or all LEDs light up; keys do not react

**Remedy** Check the power supply, switch off and then on again. If necessary re-initialize. (see Point 7.3)

**Error** Measured values are incorrect

**Remedy** Check the channel programming very carefully, especially multi-point calibration

**Error** Measured values fluctuate unexpectedly or the system hangs in mid-operation

**Remedy** Check the cabling for any inadmissible electrical connections. Unplug any suspicious sensors. Connect a hand-held sensor in air or a phantom sensor (100 Ω for Pt100 sensors) and check. Connect the sensors again one at a time and check successively. If a fault persists for any one connection, check all wiring; if necessary, insulate the sensor and eliminate interference by using shielded or twisted wiring.

**Error** Data transmission via the interface does not function

**Remedy** Check the interface module, connections, and settings.

Ensure that both devices are set to the same baud rate and transmission mode. (see Manual, Section 6.10.12)

A reset with the interface module connected will set the baud rate to 9600 baud (see Section 7.3). Ensure that the correct COM port on the computer is being addressed. Test data transmission by means of a terminal (ALMEMO®-Control, Win-Control, WINDOWS Terminal). Address the device using its assigned device number 'Gxy' (see Manual, Section 6.2.1). Just in case the device is in the XOFF status, enter <ctrl Q> for XON. Check the programming by means of 'P15'. (see Manual Section 6.2.3). Test the transmit line only by entering the start command 'S2'; the LED START should light up. Test the receive line only by pressing the **START/STOP** key.

**Error** Data transmission in the network does not function

**Remedy** Check to ensure that all devices are assigned different addresses. Address all devices individually via the terminal using command 'Gxy'. Addressed device is OK if at least 'y CR LF' is returned as echo. If transmission is still not possible, unplug the networked de-

vices. Check all devices individually on the data cable to the computer (see above). Check the wiring for short-circuit or crossed wires. Ensure that all network distributors are supplied with power. Network the devices again one at a time and check successively (see above).

If, after performing the above-listed checks and remedial steps, a device still fails to behave as described in the operating instructions, it must be returned to our factory in Holzkirchen, accompanied by a brief explanatory note, error description, and if available test printouts. With the ALMEMO®-Control software you can print out screenshots showing the relevant programming details and save and / or print out a comprehensive 'function test' in the device list or terminal mode.

# 12. ELECTROMAGNETIC COMPATIBILITY

Ahlborn Mess- und Regelungstechnik GmbH declares herewith that measuring instrument ALMEMO® 8036-9 carries the CE label and complies in full with the requirements of EU directives relating to low voltage and to electromagnetic compatibility (EMC) (89/336/EWG).

In evaluating this product the following standards have been applied:

| | |
|---|---|
| Safety standards | EN 61010-1:2001 |
| Electromagnetic compatibility (EMC) | EN 61326-1:2013 |

CE

When operating the device the following advisory notes must be observed:

1. If the standard sensor is extended (1.5 meters) care must be taken to ensure that the measuring lines are not laid together with high-voltage power cables and that, if necessary, they are properly shielded so as to prevent spurious interference being induced in the system.
2. Using the device in strong electromagnetic fields may aggravate measuring errors. After exposure to such irradiation ceases, the device should resume operation within its technical specifications.

# 13. ANNEX

## 13.1 Technical data

| | |
|---|---|
| **Measuring inputs** | Nine ALMEMO® sockets for high-precision Pt100 sensors and Pt100 psychrometers FPA836-3P3 |
| Measuring channels | Nine primary channels, electrically isolated, maximum 31 additional channels for humidity variables and function channels |
| Electrical isolation | Semiconductor relay (50 V) |
| A/D converter | Delta - sigma 24 bit, 1.25 mops, amplification 5 |
| Measuring range Pt100 314 | -200.000 to +670.000 °C |
| Accuracy | ±0.010 K ±1 digit (in range -50 to +560 °C) |
| Measuring range Pt100 214 | -200.00 to +850.00 °C |
| Accuracy | ±0.05 K ±1 digit (in range -100 to +850 °C) |
| Measuring current | 1 mA |
| Nominal conditions | +23 °C ±2 K, 1013 mbar |
| Temperature drift | 2 ppm / K |
| **Atm. pressure sensor** | integrated in the device |
| Measuring range | 300 to 1100 mbar |
| Accuracy | ±2.5 mbar (700 to 1100 mbar, 0 to 65°C) |
| **Humidity variables** | Measuring ranges, calculated |
| Rel. atm. humidity RH, Uw | 0.00 to 100.00 %H |
| Dewpoint temp. DT, td | -64.80 to 100.00 °C |
| Mixture MH, r | 0.0 to 6500.0 g/kg |
| Absolute humidity AH, dv | 0.0 to 596.3 g/m3 |
| Vapor pressure VP, e | 300 to 1100.0 mbar |
| Enthalpy En, h | 0.0 to 6500.0 kJ/kg |
| **Outputs** | One ALMEMO® socket for data cable<br>One ALMEMO® socket for memory connector |
| Standard equipment | |
| Operation | One key |
| Date and time-of-day | Real-time clock, buffered by lithium battery |
| Power supply | external, 9 to 13 VDC |
| Mains adapter | ZB 1212-NA10 230 VAC to 12 VDC, 2A |
| Current consumption without | Input and output modules |
| active mode | approx. 35 mA |
| With saving to memory | approx. 45 mA |
| Sleep mode | approx. 0.05 mA |
| **Housing** | Polystyrene, 180 x 049 x 137 mm (LxWxH) |
| Weight | 490 g |
| **Operating conditions** | |
| Operating temperature | -10 to +50 °C (storage temperature -20 to +60 °C) |
| Ambient atmospheric humidity | 10 to 90 % RH (non-condensing) |

## 13.2 Product overview

| | Order no. |
|---|---|
| **High-precision X6 Pt100 measured data acquisition module ALMEMO® 8036-9 with atmospheric pressure sensor** | |
| Nine inputs, maximum 40 channels, two outputs, cascadable interface<br>One key, real-time clock, in eight-DU housing, mains unit 12 V, 1 A | MA 8036-9 |
| **Sensors** | |
| ALMEMO® X6 Pt100 temperature sensor range 314 | FPA923-L0250 |
| ALMEMO® X6 Pt100 psychrometer range 314 | FPA836-3P3 |
| ALMEMO® X6 Pt100 connector range 214 | ZA9030-FS2P3 |
| ALMEMO® X6 Pt100 connector range 314 | ZA9030-FS7P3 |
| **Accessories** | |
| Memory connector, including micro SD card, minimum 512 MB | ZA 1904-SD |
| DC power cable, 10 to 30 VDC, 12 V / 0.25A, electrically isolated | ZB 3090-UK |
| ALMEMO® data cable, USB interface, electrically isolated | ZA 1919-DKU |
| ALMEMO® data cable, V24 interface, electrically isolated | ZA 1909-DK5 |
| ALMEMO® network cable, electrically isolated | ZA 1999-NK5 |
| ALMEMO® data cable, Ethernet interface, electrically isolated | ZA 1945-DK |

## 13.3 Index

## 13.4 Your contact partners

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