Hygrocontrol GmbH

HYGROMESS TYPE 83 TRANSMITTER

MANUAL

Version 06 / 10

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1. Fundamental Features of Series 83 Transmitters

HYGROMESS Humidity and Temperature Meters detect relative Humidity and Temperature. For this purpose the probes are equipped with a capacity type humidity sensor of very small mass. The temperature detection is done by a Pt-1000 RTD , which is placed very close to the humidity sensor to avoid differences in temperature between the two sensors.
Incoming sensor signals are temperature compensated and transferred into linearised analogue or digital outputs by digital electronics. We use a microprocessor for the control of all internal functions.

The electronics for transmitting the temperature and humidity sensor signals are built into a IP-65 housing of 80 x 160 x 55 mm.
Two different operational modes may be chosen by the user which are:

"MEASURING" and "CALIBRATION"

"MEASURING" is the normal mode for picking up humidities and temperatures, compensating, linearising and transferring the values to the outputs.

"CALIBRATION" mode is used for recalibration of sensor characteristics by special prepared LiCl solutions.

2. Preparations before Operating

2.1 Unpacking and Checking

Every instrument has been examined before dispatch in respect to its electrical and mechanical functions. After receipt of instrument, please check its operation. In case of any malfunction or damage, return the instrument with a detailed description of faults.

2.2 Set-up for Operation

The instrument has to be connected to a power supply of 9 to 36 VDC. The correct voltage is marked on the type label you find on one side of the housing. Do not use voltages other than the marked one! Severe damage would be the result of applying the wrong voltage.
The cross section of your conductors should meet the dimensions of 0.5 up to 1.5 mm^2 (AWG 16 to AWG 20). You will have to connect the 2 wires to the terminals marked (+) and (-), the shield should be connected at the cable gland. Opening of the housing is done by turning the four screws (quick-release types) with a screwdriver to the left.

Please take care that cable diameter corresponds with the dimension of the gland and so will guarantee a dense screwing. **During operation the housing of the instrument should be closed.**

2.3 Instructions for Dispatch

If there any problems you are not able to correct, we ask you to contact our technical department or to return the instrument with a short description of the fault. When returning please do not forget to pack the instrument safely in a cardboard box and fill up holes with soft packing material to avoid damage.

3. Technical Data

3.1 Humidity

Humidity Range	0....100 % RH.
Resolution	0,1 % RH.
Humidity Sensor	SE - 02
Temperature Error of Humidity	± 0,01 % RH./ °C
Repeatability	< 0,5 % RH.
Hysteresis after 4 hour Cycle 10 % - 95 % - 10 % r. F.	< 0,5 % RH.
Linearity of Electronic / Humidity	< 1 % RH.

3.2 Temperature

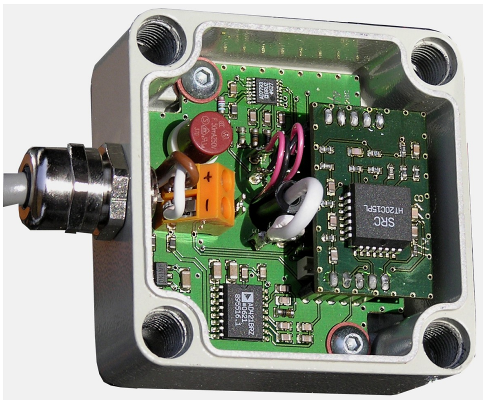
Range	-50.....+150 °C
Resolution	0,01 °C
Temperature Sensor	RTD: Pt-1000
System Accuracy for Temperature over the total Range	± 0,35 °C
Linearity of Electronic / Temperature	± 0,15 °C

3.4 Maximum environmental conditions during operation

Transmitter Electronics	-10...+ 50 °C
Probe Tube with Sensors	-50...+150 °C
Max. Humidity	95%RH

3.5 Connections

Screw Terminals
Marked with + and –



4. HART

Following universal commands are available:

0	Read unique identifier
1	Read primary variable
3	Read current and four variables
12	Read message
13	Read tag, description, date
14	Read primary variable sensor information
15	Read output information
16	Read finally assembly number
17	Write message
18	Write tag, description, date
19	Write finally assembly number
34	Write damping value
35	Write range values
44	Write primary variable units
49	Write primary variable sensor serial number
59	Write numbers of response preambles
109	Burst mode control

Sending following user messages will not cause their storage but result in starting the functions below:

%Hxxx	starts a humidity calibration with xxx * 0,1 %RH
%Txxxx	will do a temperature adjustment to xxxx * 0,01 °C
%Y	positive confirmation of humidity calibration
%N	negative confirmation of humidity calibration
%F	end of calibration and show of original users message

Command 3 results in the output of measurement values as follows:

primary variable	Humidity in %RH shown unit = %
secondary variable	Temperature in °C
tertiary variable	Humidity digits shown unit = none
quaternary variable	Reference digits shown unit = none

5. Operation

HYGROCONTROL Humidity and Temperature Meters detect relative Humidity and Temperature. For this purpose the probes are equipped with a capacity type humidity sensor of very small mass. The temperature detection is done by a Pt-1000 type RTD , which is placed very close to the humidity sensor to avoid differences in temperature between the two sensors.
Incoming sensor signals are temperature compensated and transferred into linearised analogue or digital outputs by digital

electronics. We use a microprocessor for the control of all internal functions.

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"MEASURING" and "CALIBRATION"

5.1 Operational Mode "Measuring"

After connecting the type 83 instrument to power, the transmitter is in its normal measurement mode. The actual values of relative humidity and temperature are taken, temperature compensated, linearised and fed to the analogue output (the temperature may only be read out by the HART protocol. Current taken by the transmitter (4...20mA) is directly proportional to the measured humidity (0...100%RH).

5.2 Operational Mode "Calibration"

5.2.1. General Notes about Calibration Standards

There is a lack of international standards for relative Humidity calibrations, therefore, different countries may have different methods of calibrations. Since the users of humidity meters need a simple method to check the accuracy of their instruments, we are supplying accessories for calibration or testing. As a standard method we have chosen unsaturated salt solutions to create rel. humidities of known amount - but saturated salt solutions may also be used, to check or qualify the instrument. We control the accuracy of our unsaturated solutions by comparison with a humidity generator with ÖKD certification.
HYGROCONTROL instruments are to be calibrated with relative humidity - since their sensors respond to relative, not to absolute, humidity values.

5.2.2. How often Calibrations should be done

Before dispatch, all probes have been calibrated at 0, 20, 35, 50, 65, 80 and 95%. Changes of sensor characteristic are hard to predict, as they depend on mechanical and chemical attack on the probe. If stresses are high (such as temperature, vibration, dust and aggressive media like acids, solvents and highly reactive gases), we recommend a test within 3 to 12 months. If deviations of more than 2% are found, a recalibration makes sense.

The solutions we supply for calibration create relative humidities from 0 to 95%. We are using the following:

0% - drying granulate

10% - mixed LiCl and $ZnCl_2$ solution

20, 35, 50, 65, 80, 95% - unsaturated LiCl solutions

The marked relative humidities relate to a temperature of 22°C and do have a temperature dependency. The accuracy of the solutions at 22°C is +/- 0.5%, they are not toxic and are not dangerous to the environment.

To assure the easiest handling and highest accuracy, the solutions are enclosed in glass ampoules, which should be opened only before usage. Opening is simplified by the weakened middle part of the ampoules. Once opened the solutions may catch humidity from or give humidity to their environment - so the time of usage is restricted and they should be used for one calibration only.

5.2.3. Calibration Chamber

The calibration chambers we are supplying under No. 1810 (or 4716 for 12 mm diameter probes) are hermetically sealed chambers which consist of three parts:

1) Main part with thread for coupling with probe tip
2) Removable bottom to put the solution in
3) O-ring to give tight connection between parts 1) and 2).

The chamber is made from Aluminium to achieve

a) Temperature equilibrium
b) easiest cleaning procedure.

Mechanical dimensions of the chamber are optimised to form a closed body without edges. By this form a quick and stable atmosphere of the desired relative humidity over the solution is guaranteed.

Due to the temperature dependency of rel. humidity over salt solutions, you should maintain a constant temperature of 22°C with deviations of not more than 1°C. This can be done by placing the probe in an area free from draughts, direct sunlight, radiators and any other factors that might cause temperature fluctuations. Place the instrument on an insulating base such as polystyrene and assure that the instrument, calibration chamber and solutions are at the same temperature before starting a calibration.

5.2.4. Mounting the Calibration Device

First remove the filter from the tip of the probe. The chamber may now be screwed to the thread of the probe. The bottom of the chamber is removable and it is here that the textile pad and the solution are to be placed. To avoid improper humidity values, always clean the bottom of the chamber thoroughly: use new pads, and new solutions.

Ensure that the calibration chamber faces downwards, to avoid direct contact of the solution with the sensor. Before inserting the bottom into the chamber, unscrew the chamber slightly, to help escaping air, when you close the chamber. Tighten the chamber again after closing!

To do a calibration, the transmitter has to be connected to a computer with a coupler type LPT (changes RS232/3V with galvanic isolation to USB). The computer should have a driver which installs a virtual COM-Port. Possible and necessary commands are shown in next chapter.

We recommend doing a calibration at 2 humidity points which are widely separated (for example 0%RH and 80%RH). With a calibration of these 2 points you will get a straight line characteristic which fits to the sensor characteristic better than +-2%RH between 0%RH and 80%RH and better than +-3%RH between 80%RH and 100%RH.

To achieve more accuracy for your instrument, now point calibrations at other fixed points may be done at values of 10, 20, 35, 50, 65 and 95 %RH which brings the characteristic line closer to the individual sensor characteristic and will result in accuracies of 0.5 %RH at the calibrated points. These calibrations are always done at our factory before the instruments are shipped to our customers.

If changes of more than 5%RH will occur at any point of the scale you are calibrating, you should finish the calibration and delete all values in the calibration memory and start with a new calibration as mentioned before. Only after this step new point calibrations may make sense. Never disconnect the power supply during a calibration.

We divided the scale of 0%RH to 100%RH into 10 segments which are 0...4%, 4,1...15%, 15,1...26%, 26,1...37%, 37,1...48%, 48,1...59%, 59,1...70%, 70,1...82%, 82,1...92% and 92,1...100%RH. Each new calibration in one of these segments will replace the old value in the segment by the new one.

If a new straight line characteristic is wanted, first the old values in the memory must be deleted by function %E. After this is done, the memory has only 2 values – this are the first so-called “initial” points calibrated at the factory at 0%RH and 80%RH. Now you should recalibrate 2 points in the segments 0...4% and 70,1...82%RH. Only by this procedure you will have done a new straight line characteristic.

5.2.5. Operation via BUS commands

To do a calibration, the transmitter has to be connected to a computer with a coupler type LPT (changes RS232/3V with galvanic isolation to USB). The computer should have a driver which installs a virtual COM-Port. Operation is possible with a terminal program. The virtual COM-Port must be adjusted to 9600-8N1. Possible and necessary commands are:

5.2.6. List of Commands:

First an "F" for FullPromt output must be sent.
Each command must be ended by <CR>.

Hxxx : HUMID.CAL – starts a calibration with the humidity described by xxx, where xxx="345" means 34,5% RH

D	:	DUMP - sends the values in the calibration memory
E	:	ERASE - deletes the calibration memory
F	:	FullPromt - switches over to "FullPromt" output
Txxxx	:	calibration of temperature with xxxx="2345" means 23,45°C
Y	:	YES - positive confirmation of request
N	:	NO - negative confirmation of request
S	:	ESC - cancellation before normal end of calibration

5.2.7. Output Examples:

Normal outputs of measured values:
R=43988 F=47447 Q=22709 H=5558 T=2740 DAC(h) = 8E48 ADC(h) = 987D

After the start of a calibration with „HUMID.CAL“:
CAL 0: R=43988 F=47456 Q=22962 H=5526 STOP? => S

If calibration was ended successfully:
CAL 0: R=43988 F=47457 Q=22962 H=5526 OK? Y/N

The answer to a command CALIB.TAB will be:

```
ADC calib val: 44793
Temp Offset  : -19
Error Profile  : 1
[ 0] Conc:=     0  Ratio:=19379
[ 1] Conc:=  100  Ratio:=20111
[ 2] Conc:=  200  Ratio:=20725
[ 3] Conc:=  350  Ratio:=21608
[ 4] Conc:=    -1  Ratio:=65535
[ 5] Conc:=  500  Ratio:=22408
[ 6] Conc:=  650  Ratio:=23217
[ 7] Conc:=  800  Ratio:=24071
[ 8] Conc:=    -1  Ratio:=65535
[ 9] Conc:=  950  Ratio:=24946
[10] Conc:=     0  Ratio:=19379
[11] Conc:=  800  Ratio:=24071
press  RET.
```

The last 2 values [10] and [11] are the so-called „initial“ calibration values done by Hygrocontrol, which cannot be deleted by customers.

Press RET will jump back to normal measurement mode..

ERASE: this command will delete the calibration values [0] to [9] if You confirm the request OK? [Y/N] by answering Y.

Tempcal:
Temperature Offset -20 is in the memory! (=correction by -0,2°C).

FullPromt:
R=43988 F=47456 Q=22962 H=5526 T=26570 DAC(h) = 8E48 ADC(h) = 987D

5.2.8 Used abbreviations are:

R:	Digits of Reference Oscillator
F:	Digits of Humidity Oscillator
Q:	Quotient Reference/Humidity
H:	Humidity in 1/100 %RH.
T:	Temperature in 1/100 °C
DAC(h):	Digital value of Analogue-Digital-Converter (hexadecimal)
DAC(h):	Digital value of Digital-Analogue-Converter (hexadecimal)
ADC calib val:	Digital value of Analogue-Digital-Converter at 70°C
Temp Offset:	Difference between measured and real Temperature in 1/100 °C
Error Profile:	x=1 output<4mA; x=2 hold output; x=3 output > 20mA
Conc:	Point of calibration in 1/10 °C
Ratio:	Quotient at calibration point

6. Practical Instructions and Limits

Besides the temperature limits specified for all our transmitters, probe heads and sensors, you should observe the following rules when using our instruments:

6.1 Direct Contact with Liquids

Avoid in any case direct contact between the humidity sensor and any liquid. The sensor may only detect the humidity in the atmosphere over the surface of a liquid or a solid material.
Even if the sensor will not be changed in his characteristic by direct contact with water and will measure correct values after being dried, you should avoid immersion or condensation. Some gases in the atmosphere could form acids and corrosion attack will cause damages of the sensor with time.

6.2 Filters

6.2.1 Protection against high Air Velocities

As our humidity sensor has a very tiny mass together with a great surface area, it is necessary to protect him against high gas velocities. Different filters are available which give protection according to the list below:

- Protection basket (SS-316):	Up to 1 m/sec
- Sinter filter (SS-316):	Up to 30 m/sec
- Teflon filter (sintered PTFE)	up to 50 m/sec
- Axial filter (SS-316 with PTFE Membrane):	Up to 30 m/sec (axial direction) Up to 50 m/sec (tangential)

6.2.2 Protection against Dust and Aerosols

Normally the Sinter filter (SS-316) - which has pores of approx. 18/1000 mm - will be used for protection against dust and particles. If quick response time of the sensor is needed, an axial filter is preferable, but then no particles of high speed should be able to hit the PTFE Membrane. As this membrane is only 65/1000 mm thick - with pores of 1/1000 mm only - it could be destroyed.
If humidity measurements are done in atmospheres containing Aerosols like solvents, oils or greases, a Teflon filter (pores are approx. 1/1000 mm) should be used for protection of the sensor. The smooth surface of the PTFE will not be contaminated so fast as other filters. High concentration of Aerosols will predict a cleaning of the Teflon filter from time to time. This may be done easily with an Ultrasonic Bath.

6.3 Resistance against Chemical Attack

Our sensors are well known for their resistance against most chemical attacks. To give the user some information over the additional errors which are arising from some chemicals, we listed our experiences over the last 10 years. (See the table at the end of this manual).
Be aware, that the given concentrations are valid for a single chemical in normal atmosphere (room temperature) only. As temperature has to be taken into consideration too, you cannot expect to get proper predictions out of the table - please contact our technical staff for more information.

6.4 Protection of Transmitter Electronics

To give highest protection against the surrounding atmosphere, our transmitter housings type "B" are according to IP 65. Avoid atmospheres of more than 80 %RH, as condensation could occur with rapid temperature changes.

6.5 Influence of Temperature on Humidity

To detect relative Humidity, the sensor has to be in equilibrium with the atmosphere - this cannot be done spontaneously! It is up to you, to choose a position of the sensor, where the equilibrium may be reached as quickly as possible. Take into consideration that also Temperature has a great influence on relative Humidity! At Room Temperature and 50 %RH, a temperature change of 1°C will cause a change of relative Humidity by 3%. This is the reason, why all instruments use a combination of Humidity and Temperature Sensors for detection of relative Humidity. Only if Temperature has stabilized, proper values of relative Humidity may be expected.
Different tube materials of sensors have an influence on temperature stabilization by their different thermal mass and conductivity. SS - 316 tubes predict higher times to achieve equilibrium of temperature as PTFE or PP tubes - be aware of this problem and choose a proper material.

Avoid errors by improper installation of the sensor as for example:

- Influence by Heat: direct Sun, Heaters, and unknown Air Streams etc.
- Influence by Water: Vapours, dropping or spraying Water etc.
- Influence by Pollution: Dust, Aerosols, Chemicals etc.

6.6 Humidity Measurements over Ice

Don't forget that our sensors are calibrated for conditions of vapour pressure over liquid water. If you are measuring relative Humidity over ice, you will get an error which is strictly dependent on the difference of saturation pressure of vapour over ice compared with the saturation pressure of vapour over chilled water. The following table shows the results of a measurement of saturated vapour over ice at different temperatures below zero.

Table 3: Display at 100% RH over Ice at different Temperatures

Temperature (°C)	PSF (mbar)	PSE (mbar)	M (%RH)
0	6,11	6,11	100,0
- 5	4,22	4,02	95,3
-10	2,87	2,60	90,6
-15	1,91	1,66	86,9
-20	1,26	1,03	81,7
-25	0,81	0,64	79,0
-30	0,49	0,37	75,5

PSF = Saturated Vapour Pressure over Chilled Water
PSE = Saturated Vapour Pressure over Ice
M = Relative Humidity displayed by HYGROMESS Instruments.

6.7 Measurements under Pressure or Vacuum

All probes can be used at pressures of 0,9 to 1,3 bar. Only special probes with a glass feed-through (which predicts SS - 316 tube material) may be used under pressures of 0,03 to 30 bar. As relative Humidity is directly proportional to the pressure (for example: increase of pressure by factor 2 also increases relative Humidity by factor 2, when temperature and content of water remain constant!) you should take care of a place with constant pressure values, when mounting the probe. Be aware that pressure may change, when diameters of tubes change - and air streams may be turbulent at these places.

Table 4: Gas Concentrations with Humidity Error < 2.5 %RH

Chemical	MAK-Concentration according to SUVA 1)		maximum Concentration at				Expl.-limit
			continuous load		50 % load		
	ppm	g/m^3	ppm	g/m^3	ppm	g/m^3	g/m^3
Ethanol (Alcohol)	1000	1,9	3500	6	7000	12	57
Isopropanol	400	0,98	4800	12	10000	25	67
Toluol + Xylol	100	0,38	1300	5	3000	12	53
Gasoline (pure)	300	1,1-1,4		150		200	51
Gasoline super (Automobile)				100		150	32
Ethylenglycol	100	0,26	1200	3	1200	3	80
Acetone	1000	2,4	3300	8	6500	16	56
Ethylacetat	400	1,4	4000	15	8000	30	79
Acetic Acid	10	0,03	800	2	1200	3	107
Ammoniumhydroxid	25	0,02	5500	4	11000	8	-
Chlorine Acid (HCl)	5	0,01	300	0,5	500	0,75	-
Sulfur hydrogen (H_2S)	10	0,01	350	0,5	700	1	-
Sulfurdioxid (SO_2)	5	0,01	5	0,01	5	0,01	-

1) MAK = max. concentration at work (at 1 bar and 20 °C)

2) ppm = g/m^3 x 24,04/MOL MOL = Molweight of Material