**LSI LASTEM S.r.l.**
Via Ex S.P. 161 Dosso, n.9 - 20090 Settala Premenugo (MI) - Italia
**Tel.:** (+39) 02 95 41 41
**Fax:** (+39) 02 95 77 05 94
**e-mail:** info@lsi-lastem.it
**WEB:** http://www.lsi-lastem.it
**CF./P. Iva:** (VAT) IT-04407090150
**REA:** 1009921 **Reg.Imprese:** 04407090150

# Thermo-hygrometer sensor and barometer with Modbus output cod. DMA975 – DMA980

# User manual

# Index

# 1 Introduction

Thermo-hygrometer DMA975 is an instrument to measure environmental temperature, relative humidity and dew point. Dew point is calculated in accordance with ISO 7726.
The sensitive element is located inside a high efficency natural ventilation radiant screen.
air temperature readings.

DMA980 model measures temperature, relative humidity and barometric pressure.

Both models have RS-485 output for communication with other devices through Modbus protocol.

## 1.1 Notes about this manual

Document: INSTUM_01372_en - Update on 2 Mar. 2016.

# 2 Product installation

## 2.1 General safety rules

Please read the following general safety rules in order to avoid injuries to people and prevent damages to the product or to possible other products connected with it. In order to avoid any damages, use this product exclusively according to the instructions herein contained.

The installation and maintenance procedures must be carried-out only by authorized and skilled service personnel.

Power the instrument in a suitable manner. Pay attention and observe the power supplies like indicated for the model in your possession.

Carry-out all connections in a suitable manner. Pay strict attention to the connection diagrams supplied with the instrument.

Do not use the product in case of suspected malfunctions. In case of suspected malfunction, do not power the instrument and contact authorized technical support immediately.

Do not set working the product in an explosive atmosphere.

Before you carry-out any operation on electrical connections, power supply system, sensors and communication apparatus:

- Disconnect the power supply.
- Discharge the accumulated electrostatic discharges touching an earthed conductor or apparatus.

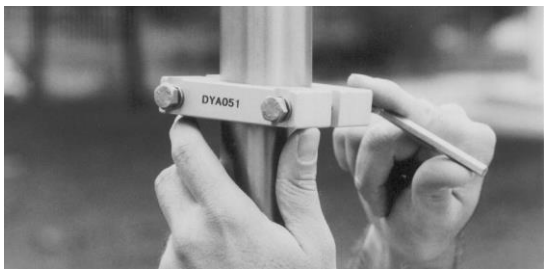
## 2.2 How to choose the survey site

Select a site with conditions representative of the environment being examined. Thermo-hygrometers must be assembled in sites where the morphological conditions of the earth, the urban structures and the environmental conditions in general make them particularly representative of the general conditions in which the measurement is to be performed.

It is important that there are no structures in the nearby areas which might radiate heat, such as cement floors, asphalt, walls, etc. The thermo-hygrometers should be installed at 1.5 - 2 m from the ground (see WMO n° 8 part 2).

## 2.3 Mechanical mounting

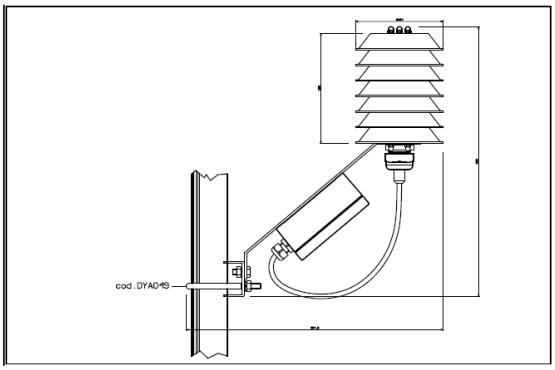
Fit the DYA049 or DYA051 supporting collar to the pole at the desired height, usually at 1,5 - 2 m, and tighten the screws using an allen key n. 6.



Fix the sensor to the supporting collar by tightening the two bolts indicated with arrows in the picture.
Connect the DWA cable to the sensor and to the data acquisition system according to drawing DISACC6101.
When a forced ventilation radiation shield is in use, feed the fan engine with a suitable power supply.

## 2.4 Antiradiant shield

DMA975 and DMA980 are equipped with a high efficency natural ventilation radiant screen, characterized by a special black paint on the lower surface of the plates, for a greater protection of the sensing element from sun rays and a more accurate air temperature measurement.



## 2.5 Electrical connection

Power the instrument according to the technical specifications. For optimal operation, ensure proper earthling of the power and communication lines.

Use cables mod. DWA510/525/526/527 for electrical wiring of the RS-485 communication line and sensors. See the main product-drawing sheet DISACC6101 for connection details; they are summed up through the following table:

| ***Pin*** | ***Wire colour*** | ***Signal*** | ***Meaning*** |
|---|---|---|---|
| 1 | Brown | Power In + | Sensor power (+ 10/30 V) |
| 2 | Black | RS-485 D+ | Serial line - positive RS-485 (non-inverting signal) |
| 3 | Blue | N.C. | Not connected |
| 4 | Red | RS-485 D- | Serial line - negative RS-485 (inverting signal) |
| 5 | Shield | Gnd | Shield/Earthling |
| 6 | White | Power In - | Sensor power (0 V) |
| 7 | Yellow | N.C. | Not connected |

# 3 System programming and management

The sensor is equipped with several functions that can be programmed easily through a terminal emulation program (for example *Windows HyperTerminal* or any other commercial or free program that can be downloaded from Internet).

The programming of the apparatus is carried-out connecting the PC serial line (through USB/ RS-232 and RS-232/RS-485 adapters) to the sensor serial line (see §**Errore. L'origine riferimento non è stata trovata.**). The terminal program has to be programmed as follow:

- Bit rate: default 9600 bps;
- Parity: even;
- Terminal Mode: ANSI;
- Echo: disabled;
- Flow control: none.

The sensor supplies the access to its functions through an easy menu interface. You can access to the main menu pressing '#' three times or more until the terminal program will show the following instructions:

```
Main Menu:
 1: About this device...
 2: Communication parameters
 3: Save configuration
 4: Restart system
 5: Data Tx
```

When the menu appears on the terminal window, the Modbus protocol is suspended until the next sensor restart, caused by a power cycle (off/on) or by the available reset command menu. Anyway, before the reset is done, make sure to save any configuration parameter changed with the menu.

The main menu is made up of several items. You can access to the different functions pressing, on terminal, the numeric keypad corresponding to the desired item. The next function may be a new menu or the request to change the selected parameter; in this case it is shown the current value of parameter and the system awaits for the input of a new value; press *Enter* to confirm the new inputted value, or press *Esc* to return to previous menu without changing the selected parameter; the *Esc* key also performs the move to previous menu.

Note: when you need to express decimal values use the dot as decimal separator for numbers input.

## 3.1 Default settings

Configuration parameters that can be changed with the programming menu have default values, set by LSI LASTEM, as reported in the following table:

| *Section* | *Sub-section* | *Parameter* | *Default value* |
|---|---|---|---|
| Communication parameters | Serial line | Bit rate | 9600 bps |
| | | Stop bits | 1 |
| | | Parity | Even |
| | | Network address | 1 |
| | Modbus parameters | Swap floating point values | False |
| | | Floating point error value | -999999 |
| | | Integer error value | -9999 |
| Data Tx | | Tx rate | 0 s (disabled) |

## 3.2 Functions available from menu

The programming menu of MSB offers following functions:

- *About this device…*: to display the registry data of the instrument: branding, instrument modem and program version.
- *Communication parameters*: it allows to program some parameters useful for communication between the sensor and the external apparatus (PC, PLC, etc.), particularly:
  - *Bit* rate, *Parity* and *Stop bits*: it allows to modify the serial communication parameters for each of two serial lines. Note that *Stop bit*=2 is allowed only when *Parity* is set to *none*.
  - *Network address*: the network address of the instrument. It is especially necessary for Modbus protocol, in order to detect (in univocal way) the instrument respect to the others connected on the same RS-485 communication line.
  - *Modbus parameters*: it offers the possibility to modify some parameters that are typical of Modbus protocol, particularly:
    - *Swap floating point values*: it is useful in case the host system requires the inversion of two 16 bit registers, which represent the floating point value.
    - *Floating point error value*: it shows the value used when the sensor has to specify an error datum in the registers that collect the floating point data.
    - *Integer error value*: it shows the value used when the sensor has to specify an error datum in the registers that collect the integer format data.
- *Save configuration*: after request to confirm the operation, it runs the final storage of all changes to parameters previous modified; please note that the sensor changes its operation immediately from the first variation of each parameter (excepted the serial bit rates, that need the instrument re-start necessarily), in order to allow the immediate evaluation of the executed modification; re-starting the instrument without the execution of final storage of the parameters, it is produced the operation of the sensor corresponding to the situation preceding the modification of parameters.
- *Restart system*: after request to confirm the operation, it runs the restart of the system; warning: this operation cancels the variation of any parameters that have been modified but not definitively stored.

- *Data Tx*: this menu allows the execution of a fast diagnostic check of the sampled data and processed by the sensor; directly from the terminal emulation program, it is possible evaluate the right signals acquisition by the instrument:
    - *Tx rate*: it shows the transmission rate of data to terminal.
    - *Start Tx*: it starts the transmission according to the specified rate; it is proposed the measures sampled by means of the sensor (the display sequence is from input 1 to input 4), updating the display automatically; press *Esc* to stop the transmission of data to terminal.

## 3.3 Minimal configuration

In order to operate the sensor with its Modbus system correctly, you have to set at least as follow:

- *Network address*: the default set value is 1;
- *Bit rate*: the default set value is 9600 bps;
- *Parity*: default value is *Even*.
- *Nr. stop bit*: default value is set to 1.

After changing the parameters remember to store them definitively through Save configuration command and re-start the system in order to make them effective (reset button, switch off/switch on or Restart system command). It is possible to check if the instrument works in the right way using the Data Tx function, available on the configuration menu.

## 3.4 Restart the instrument

The sensor can be restarted through menu (see §3.2) or acting a power cycle (off/on). In both cases the configuration changes, made through menu and not saved, will be completely cancelled.

# 4 Modbus protocol

The sensor implements the Modbus protocol in slave RTU mode. The commands *Read holding registers* (0x03) and *Read input registers* (0x04) are supported for access to acquired data by the device; both commands supply the same result.

Information available in the Modbus registers regard the instantaneous values of the sampled data every second.

The instantaneous and processed data are available in two different formats: floating point and integer. In the first case the datum is included in two consecutive registers of 16 bit and it is expressed in 32 bit IEEE754 format; the storage sequence in two registers (*big endian* or *little endian*) is programmable (see §0). In the second case each datum is included in a single 16 bit register; its value, without floating point, is multiplied by a factor fixed according to the type of measurement it represents and therefore it has to be divided by the same factor in order to obtain the primary factor (expressed with right decimals); the table below shows the multiplication factor for each measurement:

| ***Measurement*** | ***Multiplication factor*** |
|---|---|
| Absolute barometric pressure (only DMA980) | 10 |
| Pressure cell temperature (only DMA980) | 10 |
| Temperature | 100 |
| Relative humidity | 10 |
| Dew point | 100 |

It is possible use the *Modpoll* program in order to check the connectivity through Modbus in an easy and fast way: it is a free program that can be downloaded from site www.modbusdriver.com/modpoll.html.

You can use Modpoll by command line of Windows or Linux prompt. For example, for Windows version you can execute the command:

```
Modpoll –a 1 –r 1 –c 2 –t 3:float –b 9600 –p none com1
```

Replace *com1* with port really used by PC and, if necessary, the other communication parameters, in case they have been modified in comparison with the default parameters set in the sensor. Responding to command the program executes the second query of the sensor and displays the results on video display unit. Through –r and –c parameters it is possible fix the measures and their processings that the sensor requires. For further information about the commands use –h parameter.

Wanting to use an Ethernet/ RS-232/ RS-485 converter, Modbus requests can be encapsulated inside TCP/IP using this command (for example considering the Ethernet converter available on port 7001 and IP address 192.168.0.10):

```
Modpoll –m enc –a 1 –r 1 –c 2 –t 3:float –p 7001 192.168.0.10
```

## 4.1 Addresses map

Following tables show the relation between the addresses of Modbus register and sampled value.

| *Value Type* | *Measurement* | *Address* | *Value* |
|---|---|---|---|
| Floating point, 2 x 16 bit | Temperature | 0 | Instantaneous |
| | Relative humidity | 2 | Instantaneous |
| | Dew point | 4 | Instantaneous |
| Integer, 1 x 16 bit | Temperature | 1000 | Instantaneous |
| | Relative humidity | 1001 | Instantaneous |
| | Dew point | 1002 | Instantaneous |

**Table 1 – DMA975 Modbus addresses map**

| *Value Type* | *Measurement* | *Address* | *Value* |
|---|---|---|---|
| Floating point, 2 x 16 bit | Absolute barometric pressure | 0 | Instantaneous |
| | Pressure cell temperature | 2 | Instantaneous |
| | Temperature | 4 | Instantaneous |
| | Relative humidity | 6 | Instantaneous |
| | Dew point | 8 | Instantaneous |
| Integer, 1 x 16 bit | Absolute barometric pressure | 1000 | Instantaneous |
| | Pressure cell temperature | 1001 | Instantaneous |
| | Temperature | 1002 | Instantaneous |
| | Relative humidity | 1003 | Instantaneous |
| | Dew point | 1004 | Instantaneous |

**Table 2 – DMA980 Modbus addresses map**

# 5 Diagnostics

## 5.1 On board LEDs

Through the lighting of LED mounted on electronic card, the instrument card shows the following information:

- Green LED (Power): it lights to signal the presence of power supply;
- Red LEDs (Rx/Tx): they signal the communication with host;
- Yellow LED (Ok/Err): it shows the operation of the instrument; the flashing type of this led signals possible operation errors, as you can see in the table below:

| ***Flashing type*** | ***Meaning*** |
|---|---|
| Single fast flashing with pause of three seconds | Standard operation, no errors |
| Single flashing lasting one second with pause of three seconds | Found not-critical problem that does not compromise the operation of the instrument |
| Triple flashing lasting 1/3 of a second and then pause of three seconds | Found critical problem, contact LSI Lastem Support |

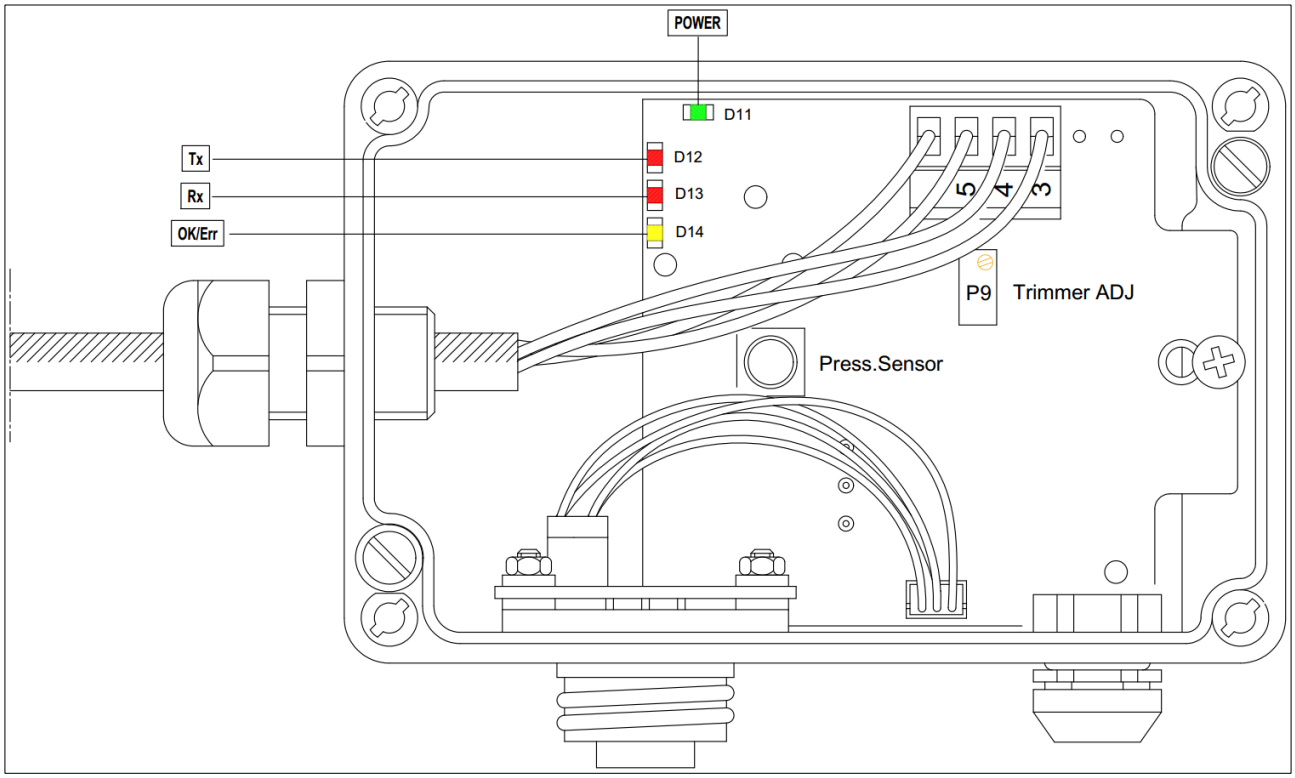



**Fig. 1 – Sensor case, inside view.**

## 5.2 Trouble shooting

The table below shows the causes of some problems detected by the system and the pertinent remedies that it can be adopted.

| ***Error*** | ***Cause*** | ***Remedy*** |
|---|---|---|
| The sensor does not communicate | Possible mistake on electrical connection, sensor power, serial line setup | Check in this order:<br>1. Electrical connection of the sensor against the drawing scheme (see §2.5).<br>2. Power source conformance to the specifications (vedi §0).<br>3. Communication parameters must match between the sensor and the Modbus master device. |
| Modbus reports wrong or non-consistent instantaneous values | The problem can be caused by an internal sensor fault or by an erroneous data interpretation of the system connected | Verify the correct access to the information through Modbus: use the corresponding register according to the kind of format (floating point or whole) considered by the system (look it up in §3.2); in case of floating point format try to invert the content of two registers through the proper function (see §3.2); in case of whole format divide the read value by a factor depending on the type of measurement. |

# 6 Maintenance

This sensor is a precision measurement apparatus. In order to maintain the specified measurement precision over the time, LSI LASTEM recommends check it periodically (at least twice a year); it is moreover suggested the replacement of the measure element according to the place of installation (in persistent conditions of high humidity, pollution, dust and chemical substances presence, the sensitive element deteriorate faster than the one placed in a location with less adverse conditions). It is, anyway, a good rule to replace the sensitive element at least once every two years.

Please, remind that the sensitive element ML3015, when used, is no under guarantee.

## 6.1 Cleaning of the antiradiant shield and porous filter

Referring to Fig. 2, proceed as follow:

1. Power off the sensor, disconnecting the *DWA* cable from the *connector*.
2. Unscrew *shield cable gland* and pull down the sensing element *stem*.
3. Clean the stem using a wet rag.
4. Clean the extern side of the *antiradiant shield* with the aid of a small brush or a wet rag.
5. Unscrew the *porous filter*.
6. Clean the filter with a cold air jet.

After cleaning mount the sensor following the operations described above in reverse order.

## 6.2 Sensing element replacement

For sensing element replacement, proceed as follows:

1. Power off the sensor, disconnecting the *DWA* cable from the *connector*.
2. Remove the *case* cover.
3. Unscrew wires from *terminal block*.
4. Unscrew *case cable gland*.
5. Unscrew *shield cable gland* and pull down the sensing element *stem*.
6. Insert the new sensing element in the *shield cable gland* until reaching the reference rim; tighten *shield cable gland*.
7. Insert the stem cable on *case cable gland* and connect wires on the *terminal block* as reported on the drawing DISACC6101.
8. Tighten *case cable gland*.
9. Mount the case cover and connect DWA cable to *connector for DWA cable*.

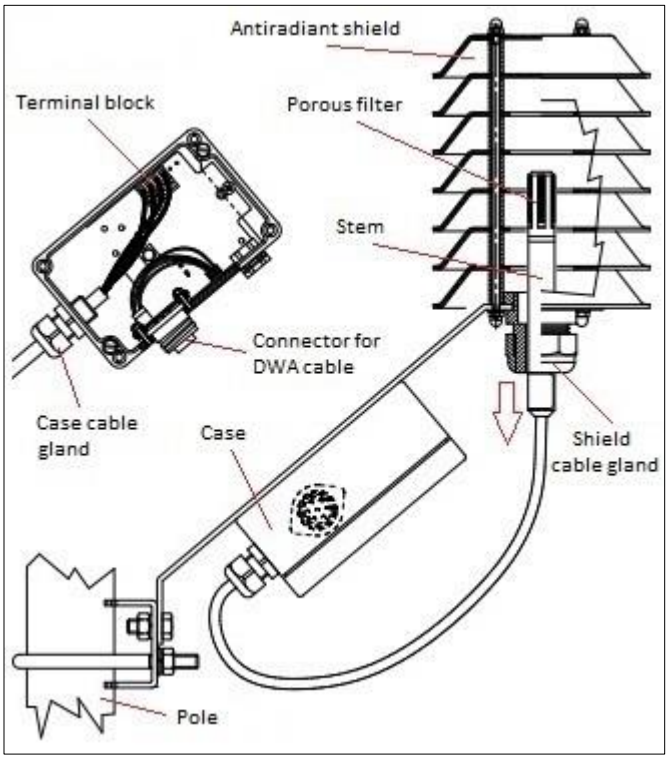



**Fig. 2 – DMA975-DMA980 sensor.**

# 7 Accessories / Spare parts

| ***Code*** | ***Description*** |
|---|---|
| DYA049 | Mast-mounting device for Ø46÷65 mm pipe |
| DWA510 | Cable L = 10 m |
| DWA525 | Cable L = 25 m |
| DWA526 | Cable L = 50 m |
| DWA527 | Cable L = 100 m |
| MG2251 | 7 pin free female connector |
| ML3015 | Sensitive element (spare part) |
| DZC301.S | Calibration certificate |

# 8 Disposal

This product is a device with high electronic content. In accordance with the standards of environmental protection and collection, LSI LASTEM recommends to handle this product as waste of electrical and electronic equipment (RAEE). For this reason, at the end of its life, the instrument must be kept apart from other wastes.

LSI LASTEM is liable for the compliance of the production, sales and disposal lines of this product, safeguarding the rights of the consumer. Unauthorized disposal of this product will be punished by the law.

# 9 How to contact LSI LASTEM

In case of problem contact the technical support of LSI LASTEM sending an e-mail to support@lsi-lastem.it, or compiling the technical support request module at www.lsi-lastem.it.

For further information, refer to addresses and numbers below:

- Phone number: +39 02 95.414.1 (exchange)
- Address: via ex S.P. 161 – Dosso n. 9 - 20090 Settala Premenugo, Milano
- Web site: www.lsi-lastem.it
- Commercial service: info@lsi-lastem.it
- After-sales service: support@lsi-lastem.it, riparazioni@lsi-lastem.it

# 10 Specifications

## 10.1 Measuring specifications

- Measures:
  - Absolute pressure [hPa]
  - Pressure cell temperature [°C]
  - Ambient temperature [°C]
  - Ambient relative humidity [%]
  - Ambient dew point [°C]
- Absolute pressure section:
  - Principle: piezoresistive silicon sensor
  - Range: 10 ÷ 1100 hPa
  - Accuracy: ±0.5 hPa (@ Ta=25 °C, p=750 ÷ 1100 hPa), after offset adjustment at one pressure point
  - Resolution: 0.1 hPa
  - Thermal drift: ±2.0 hPa (@ Ta=-40 ÷ 80 °C, p=300 ÷ 1000 hPa)
  - Long term drift: -1 hPa/yr (typ)
- Pressure cell temperature section:
  - Principle: silicon sensor
  - Range: -40 ÷ 80 °C
  - Accuracy:
    - ±0.8 °C (@ T=20 °C)
    - ±2.0 °C (@ T=-40 ÷ 80 °C)
  - Resolution: 0.1 °C (typ)
- Ambient temperature section:
  - Principle: Pt100 thermoresistance
  - Range: -40 ÷ 80 °C
  - Accuracy: ±0.2 K @ 23 °C
  - Resolution 0.01 °C
- Humidity section:
  - Principle: hygro-capacitive
  - Range: 0 ÷ 100 %rh
  - Accuracy ±1.5 %rh @ 23 °C
  - Resolution 0.1 %rh
- Dew point section:
  - Measurement calculated conforming to ISO 7726 formulas
- Common characteristics:
  - Sample rate: 5 ÷ 240 s, configurable; default 30 s
  - Warm-up time : 9 s (min. time, with sample rate = 5 s), 34 s (with default sample rate = 30 s)

## 10.2 Electrical specifications

- Power supply: 10 ÷ 30 Vdc/Vac
- Power consumption: < 0.5 W
- Signal outputs:
  - Output type: RS-485 opto-isolated
- Protections:
  - Reversal power polarity

    - Electrical discharge on power, sensor and RS-485 lines. Max dissipable power: 600 W (10/1000 µs)
    - Galvanic insulation on RS-485 (3 kV, UL1577)
- Connections:
    - IP65 7 pin connector for:
        - Power line
        - Communication line
    - Ambient probe:
        - Line cable to terminal block on the board: 4 poles
        - Cable: type PUR (polyurethane), length 3 m

## 10.3 Functional specifications

- Serial interface
    - Speed: 1200 ÷ 115200 bps, configurable; default 9600 bps
    - Data Bits: 8
    - Parity: none, odd, even, configurable; default even
    - Stop Bits: 1 ÷ 2, configurable; default 1
- Communication protocols:
    - Modbus:
        - Mode: RTU
        - Supported commands: *Read holding registers* (cmd 3), *Read input registers* (cmd 4), both giving last sampled values
        - Data format: 16 bit integer values (need scaling operation from the reading system), 32 bit floating point (IEEE754); big/little endian mode support
        - Error values: -9999 for 16 bit integer format; -99999 for 32 bit floating point; these values are programmable.
    - TTY:
        - Programmable spontaneous measurement transmission (ASCII text format)
        - Functions menu for instrument configuration

## 10.4 Mechanical specifications

- Environmental protection class: IP65
- Operating conditions:
    - Temperature range: -40 ÷ 80 °C
    - Umidity range: 0 ÷ 100 %rh
- Storage conditions:
    - Temperature range: -40 ÷ 80 °C
    - Umidity range: 0 ÷ 100 %rh
- Mounting: on wall/on pole

## 10.5 General specifications

EMC compliant: report 2014/05/28, doc. TR_01436_en.

# 11 CE conformity declaration

***Product description***: Thermo-hygrometer and barometer sensor with Modbus output**.**

***Models***: DMA980

***Issuer***: LSI LASTEM Srl

LSI Lastem Srl declare under sole responsibility the above products are made under European directives 2004/108/EC and, specifically to the electromagnetic conformity, with the relevant provision of the following harmonized standards:

- EN 61326-1 (2006): Electrical equipment for measurement, control and laboratory use — EMC requirements — Part 1: General requirements.
- EN 61000-3-2 (2006): Electromagnetic compatibility (EMC) — Part 3-2: Limits — Limits for harmonic current emissions (equipment input current ≤ 16 A per phase).
- EN 61000-3-3 (2008): Electromagnetic compatibility (EMC) -- Part 3-3: Limits — Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection.

The main standard(s) above contains references to other standards, which are listed below.

- EN 55011 (2009) + A1 (2010): Limits and methods of measurement of radio interference characteristics of industrial, scientific and medical (ISM) devices.
- EN 61000-3-2 (2006): Electromagnetic compatibility (EMC) — Part 3-2: Limits — Limits for harmonic current emissions (equipment input current ≤ 16 A per phase).
- EN 61000-3-3 (1995) + A1 (2001): Electromagnetic compatibility (EMC) -- Part 3-3: Limits — Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection.
- EN 61000-4-2 (1995) + A1 (1998) + A2 (2001): Electromagnetic compatibility (EMC) -- Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test.
- EN 61000-4-3 (2002): Electromagnetic compatibility (EMC) -- Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test.
- EN 61000-4-4 (2004): Electromagnetic compatibility (EMC) -- Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test.
- EN 61000-4-5 (1995) + A1 (2001): Electromagnetic compatibility (EMC) -- Part 4-5: Testing and measurement techniques - Surge immunity test.
- EN 61000-4-6 (2003): Electromagnetic compatibility (EMC) -- Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields.
- EN 61000-4-8 (1993) + A1 (2001): Electromagnetic compatibility (EMC) -- Part 4-8: Testing and measurement techniques - Power frequency magnetic field immunity test.
- EN 61000-4-11 (2004): Electromagnetic compatibility (EMC) -- Part 4-11: Testing and measurement techniques - Voltage dips, short interruptions and voltage variations immunity tests.

Settala, May 28, 2014 Luca Lesi