Thermo-hygrometer and barometer

cod. DMA975 – DMA980

User manual

Revisions list

Issue	*Date*	*Description of changes*
Origine	01/03/2016	
1	04/03/2024	Changed layout; added harmful pollutants
2	02/08/2024	Change energy consumption and modpoll example

About this manual

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LSI LASTEM reserves the right to carry out changes to this product without timely updating of this document.

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1 Introduzione

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 efficiency natural ventilation radiant screen.

DMA980 model measures temperature, relative humidity and barometric pressure.

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

2 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.
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.

For safety regulations please refer to manual INSTUM_05290.

2.2 How to choose the survey site

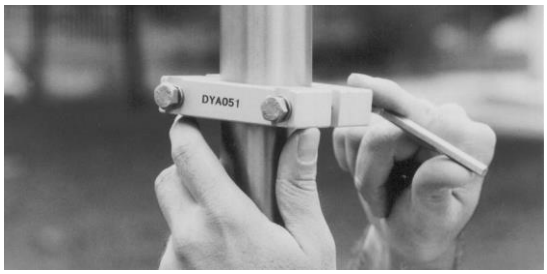
Select a site with conditions representative of the environment being examined.

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

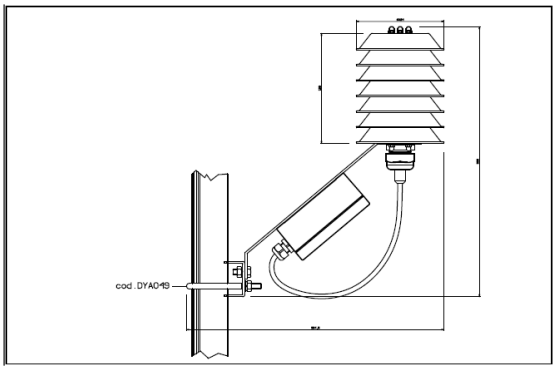
Fit the DYA049 or DYA051 supporting collar to the pole at the desired height, usually at 1.5 - 2 m, and tighten the screws using an allen key n. 6.



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 sensors 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 §2.5). The terminal program has to be programmed as follow:

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

At power-on the device starts operating with Modbus protocol on the serial line thus allowing data communication with external devices. When the configuration operations are needed, the device let to switch to the TTY protocol when a special *escape sequence* is transmitted to it. The protocol switch procedure can be done in this way:

1. Disconnect the sensor RS-485 line from the operating bus where the Modbus master device operates.
2. Connect the PC to the sensor RS-485 line using a proper media converter.
3. On the PC terminal program press slowly three or more times the '#' character.
4. The sensor should propose its main menu. If nothing happens, check the PC terminal configuration against the sensor/Modbus master serial communication configuration, and retry.

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 by 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 waits 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 Function 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 restart 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 (vedi §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 §3). 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	Mltiplication 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.exe -t 3:float -a 1 -r 1 -c 3 -p even -b 9600 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.exe –m enc –a 1 –r 1 –c 3 –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

Tab. 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

Tab. 2 – DMA980 Modbus addresses map.

5 Diagnostics

5.1 On board LEDs

La scheda dello strumento utilizza alcuni led per indicarne il funzionamento. In particolare:

- 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

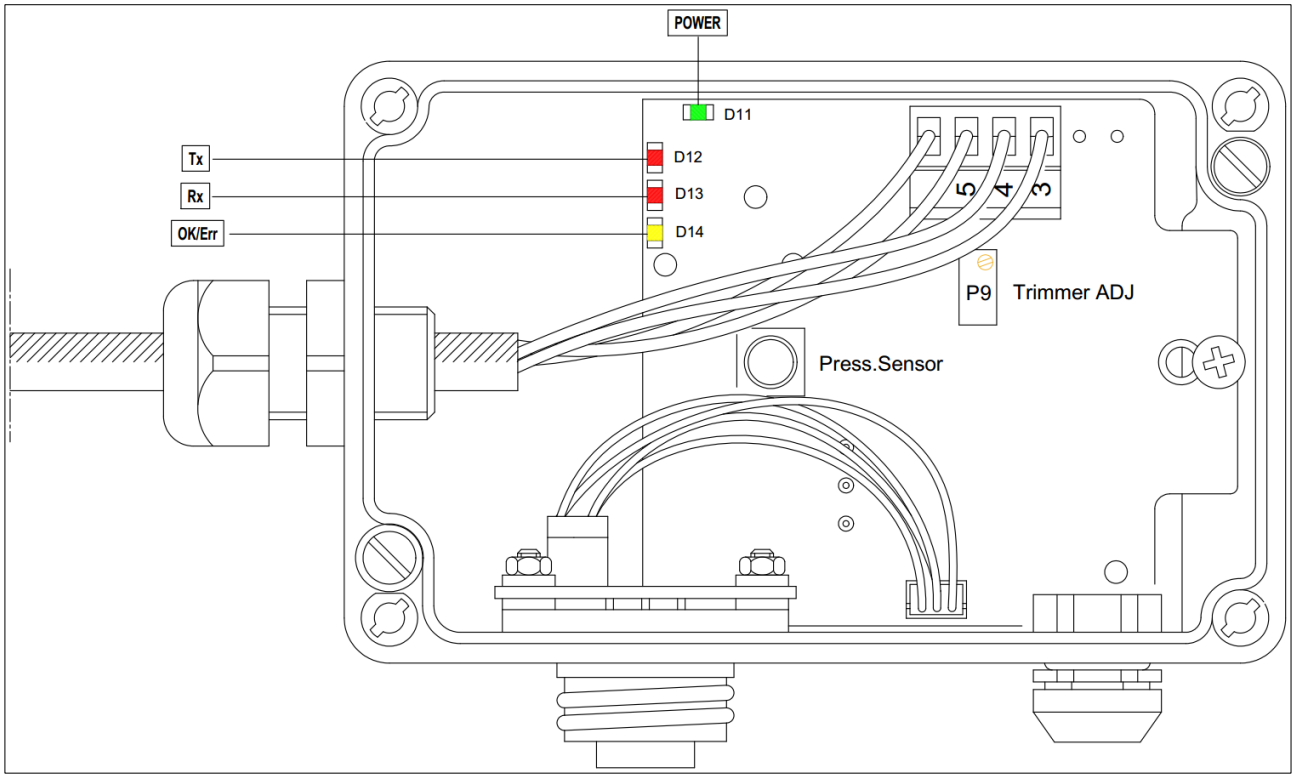


Fig. 1 – Sensor case, inside view.

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: 1. Electrical connection of the sensor against the drawing scheme (see §**Errore. L'origine riferimento non è stata trovata.**). 2. Power source conformance to the specifications (vedi §**Errore. L'origine riferimento non è stata trovata.**). 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 §**Errore. L'origine riferimento non è stata trovata.**); in case of floating point format try to invert the content of two registers through the proper function (see §**Errore. L'origine riferimento non è stata trovata.**); 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*.

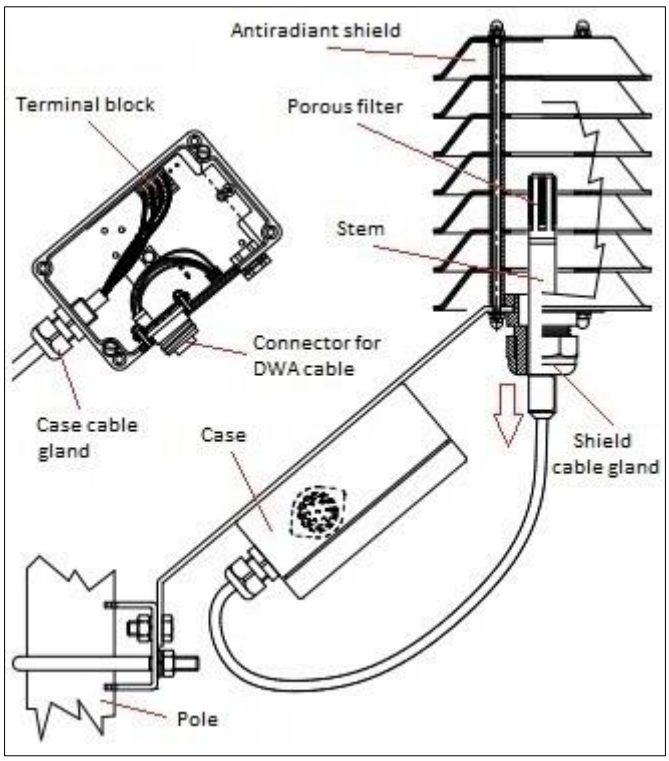


Fig. 2 – DMA975-DMA980 sensor.

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 Handling

Avoid electrostatic discharge (ESD). The product, or part of it, is fragile, avoid mechanical shocks, abrasions or scratches on the surface.

9 Storage, packaging, preservation, delivery

For storage, respect the humidity (0÷100% non-condensing) and temperature (-40÷80 °C) limits. Avoid direct sun exposure.
For delivery and storage, use the packaging supplied with the product.
For preservation, it is recommended to respect the environmental limits of humidity (0÷100% non-condensing) and temperature (-40÷80 °C).
Upon receipt of the material, visually check the package for signs of crushing or perforation; in the presence of these signs, check the integrity of the product inside.

10 Disposal

This product is a device with high electronic content. In accordance with the standards of environmental protection and collection, LSI LASTEM recommends handling the 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.

Recycle or dispose of the packaging material according to local regulations.

11 How to contact LSI LASTEM

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

For further information refer to addresses and numbers below:

- Phone number +39 02 95.414.1 (switchboard)
- Address: Via ex S.P. 161 – Dosso n. 9 - 20049 Settala (Milano)
- Web site: www.lsi-lastem.com
- Commercial service: info@lsi-lastem.com
- After-sales service: support@lsi-lastem.com, Repairs: riparazioni@lsi-lastem.com

12 Specifications

Measuring specification

Absolute pressure	Principle	Piezoresistive silicon sensor
	Range	10 ÷ 1100 hPa
	Accuracy	±0.5 hPa (@ Ta=25 °C, p=750 ÷ 1100 hPa), after offset adjustment at one
	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	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	Principle	Pt100 thermoresistance
	Range	-40 ÷ 80 °C
	Accuracy	±0.2 K @ 23 °C
	Resolution	0.01 °C
Humidity	Principle	Hygro-capacitive
	Range	0 ÷ 100 %rh
	Accuracy	±1.5 %rh @ 23 °C
	Resolution	0.1 %rh
Dew point	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)

The values given may differ depending on environmental conditions and the presence of the pollutant. Allowed fault caused from the pollutant: ±2 %RH (10 ÷ 90 %RH).

Pollutant	Formula	Max. Workplace Concentration		Allowed Concentration Continuous Operation	
		(ppm)	(mg/m^3)	(ppm)	(mg/m^3)
Acetic acid	CH_3COOH	10	25	800	2000
Acetone	CH_3COCH_3	1000	2400	3300	8000
Ammonia	NH_3	25	18	5500	4000
2-Butanone (MEK)	$C_2H_5COCH_3$	200	590	3300	8000
Chlorine	Cl_2	0.5	1.5	0.7	2
Ethanol	C_2H_5OH	1000	1900	3500	6000
Ethyl acetate	$CH_3COOC_2H_5$	400	1400	4000	15000
Ethylene glycol	$HOCH_2CH_2OH$	100	260	1200	3000
Formaldehyde	HCHO	1	1.2	2400	3000
Hydrocloric acid	HCl	5	7	300	500
Hydrogen sulfide	H_2S	10	15	350	500
Isopropanol	$(CH_3)_2CHOH$	400	980	4800	12000
Methanol	CH_3OH	200	260	3500	6000
Nitrogen oxides	NOx	5	9	5	9
Ozone	O_3	0.1	0.2	0.5	1
Petrol		300	1200		150000
Sulfure dioxide	SO_2	5	13	5	13
Toluene	$C_6H_5CH_3$	100	380	1300	5000
Xylene	$C_6H_5(CH_3)_2$	100	440	1300	5000

Electrical specifications

Power supply	10 ÷ 30 V AC/DC
Power consumption	< 1.3 W
Signal output	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

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 protocol	• 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

Mechanical specifications

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

General specifications

EMC compliant	Report 2014/05/28, doc. TR_01436_en

13 CE conformity declaration

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

Models: DMA980

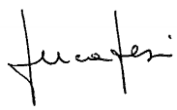
Issuer: LSI LASTEM Srl

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