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Wind speed & direction combined sensor with Modbus output

User manual

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1 Introduction

The DNA921 sensor includes, in a single apparatus, the transducers for measuring wind speed and direction; internally enclosed there is the electronics that allows an external data acquisition systems to connect to it using RS-485 serial line and Modbus communication protocol. Its use simplifies the installation and the plant design in respect of the systems with separate units plus giving some other advantages being smaller, lighter and cheaper.

The measurement system is made up of a sensor, the rotors DNA124 and DNA127 and the cable of DWA type.

1.1 Notes about this manual

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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 well-exposed spot for the instrument. The WMO (*World Meteorological Organization*) suggests that the instrument is assembled 10 m off the ground; in a place where the distance of the gauge from surrounding obstacles which might disturb the measurements, it is at least 10 times the height of those objects from the ground.

As such a position is difficult to find, the WMO suggests that the instrument is assembled in a spot which is reasonably uninfluenced by local obstructions; where the measurements taken will be as equal as possible to those taken from an ideal spot.

2.3 Mounting

Unscrew the nut and washer from the shaft thread.

Mount the DNA124 rotor on the combi sensor's body.

Tighten the screw of the rotor (indicated by the arrow).

Insert the DNA127 wind vane on the sensor's body. Keep the shank in a steady position and insert the vane until it goes to the nut adjustment.

Fix the top (indicated by the arrows) and tighten it.

Connect the cable to the sensor.

Mount the sensor on the mast and tighten the screw.

When fixing the sensor in its position on the pole, point the "red nose" to NORTH for orientation.

2.4 Electrical connection

Power the instrument according to the technical specifications. Particularly you will get the correct operation using the suitable earthling of the power lines 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 DISACC6095 for connection details; they are summed up through the following table:

Signal	***Wire colour***	***Name***	***Meaning***
1	Brown	Power In +	Sensor power, positive
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, negative
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 ESC 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 MSB 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*. s*top 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***
Wind speed	10
Wind direction	1

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 Address map

Following table shows the relation between the address of Modbus register and sampled (instantaneous) value.

Value Type	*Measurement*	*Address*	*Value*
Floating point, 2 x 16 bit	Wind speed	0	Instantaneous
	Wind direction	2	Instantaneous
Integer, 1 x 16 bit	Wind speed	1000	Instantaneous
	Wind direction	1001	Instantaneous

5 Specifications

Referenced norms: VDI 3786 Part 2 e ASTM D 5096-96.

5.1 Measuring specifications

- Measures:
  - Wind speed
  - Wind direction
- Wind speed section:
  - Principle: 32 step optoelectronic disc
  - Range: 0 ÷ 60 m/s
  - Accuracy:
    - 1.5 % (@ wind speed 0 ÷ 3 m/s)
    - 1 % (@ wind speed > 3 m/s)
    - 0.1 m/s + 1 % of readout
  - Resolution: 0.07 m/s
  - Integration time: 1 s
  - Threshold: 0.26 m/s
  - Delay distance:
    - 4.8 m (@ 10 m/s), according to VDI3786 and ASTM 5096-96
    - @ 5 m/s: 4.5 m
    - @ 10 m/s: 4.8 m
- Wind direction section:
  - Principle: Hall effect
  - Range: 0 ÷ 359 degrees
  - Threshold: 0.15 m/s
  - Accuracy: 1 %
  - Non linearity: < ±1.4 degrees
  - Resolution: 1 degree
  - Delay distance: 1.2 m (@ 10 m/s), according to VDI3786 and ASTM 5366-96
  - Responce time:
    - @ 0.5 m/s: 0.2 s
    - @ 10 m/s: 0.12 s
  - Damping coefficient: 0.21 (@ 10 m/s), according to VDI3786 and ASTM 5096-96
  - Temperature term drift: maximum ±0.9 degrees over the full operative conditions

5.2 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: with 7 pin IP65 watertight connector

5.3 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
    - TTY:
        - Programmable spontaneous measurement transmission (ASCII text format)
        - Functions menu for instrument configuration

5.4 Mechanical specifications

- Housing: anodized aluminum
- Rotor: PA6 plastic and fiberglass
- Vane: Aluminum
- Size: 425 mm (W), 353 mm (H), with rotor and vane mounted on sensor body
- Weight: 950 g
- Operating conditions:
    - Temperature range: -30 ÷ 0 °C (without ice)
    - Damage threshold: > 75 m/s
- Storage conditions:
    - Temperature range: -40 ÷ 80 °C
- Mounting: on mast ø 48 ÷ 50 mm

5.5 General specifications

- EMC compliant: Nemko test report no. 257775-3TRFEMC

6 Diagnostics

6.1 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 §2.4). 2. Power source conformance to the specifications (vedi §0). 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.

7 Maintenance

This sensor is a precision measurement apparatus. In order to maintain the specified measurement precision over the time, LSI LASTEM recommends checking periodically (at least twice a year) the followings:

- Rotor and flag are not in any way deformed.
- Conical pin on which the rotor rotates moves freely.
- The sensor is clean and in good conditions; attention to the space between the transducer and the rotor.

It is recommended to check the sensor calibration every two years.

8 Accessories / Spare parts

Code	*Description*
DNA124	Rotor with cups for speed section
DNA127	Weather vane rotor for directional section
DWA510	7-wire shielded cable L = 10 m with connector
DWA525	7-wire shielded cable L = 25 m with connector
DWA526	7-wire shielded cable L = 50 m with connector
DWA527	7-wire shielded cable L = 100 m with connector
MG2251	Trailing connector
MM2011+MM2020	Set of 2+2 spare bearings
ML659	Anemometric optoelectronic speed element

9 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.

10 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

11 CE conformity declaration

Product description: Wind speed & direction combined sensor with Modbus output

Models: DNA921

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