DAVIS ANEMOMETER MODBUS INTERFACE MODULE

DA485

Manual

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The purpose of this Manual is to get the users familiarized with the technology and operation principle of the Davis Anemometer 6410 interface module DA485 (hereinafter converter). An anemometer is a wind speed measuring device. Davis 6410 has included a wind direction vane but still refers to the entire instrument as an anemometer. Davis 6410 is shown in Figure 1.

Figure 1

1 Description and Operation of the Product

1.1 Product Designation

1.1.1 The converter is designed to measure electrical signals that are proportional to air flow (wind) direction and speed. A computer with the software via the RS485 converter can be used to display the measured information.

1.1.2 The principle of the converter operation is based on measuring the voltage proportional to the wind direction and the frequancy proportional to the wind speed. The converter provides conversion of signals to physical parameters (wind speed and direction) by means of individual calibration factors.

1.1.3 The RS485 interface that provides access to the data using the Modbus-RTU protocol is implemented in the converter.

1.2 Technical Specifications

1.2.1 The converter provides automatic measurement of electrical parameters under the operating conditions of application within the ranges indicated in Table 1.

Table 1

Characteristics			**Values**
Frequency measurement range, Hz			From 0 to 60
Voltage measurement range, V			From 0 to 1,2
Digital interface RS485			A, B
Power supply voltage, V			Ftom 7 to 24
Useful current, mA			30
Operating conditions:			
- ambient temperature, °C			From minus 40 to 50
- relative humidity at the temperature of 25°C, %			Up to 98
Average life time, years			8
Length, mm	Width, mm	Height, mm	Mass, kg
95	50	25	0.053

1.3 Technology and Operation

1.3.1 The operation principle of the Davis 6410 anemometer is based on the relationship between the air flow speed and the number of wind cups rotations, as well as between the speed vector direction and the position of the freely turning wind vane. The anemometer and vane is a passive analog device. It is not powered. It responds to a brief direction excitation pulse from the DA485.

1.3.2 Refer to the schematic diagram in Figure 2 for the description. The flat (not twisted) cable has 4 conductors.

— yellow - direction excitation. This is an excitation pulse sent from the converter to the anemometer and is applied to the high end terminal of the potentiometer (CW).

— green - direction. This is the direction signal from the anemometer to the converter. This wire is connected to the potentiometer slider terminal of the potentiometer (S). The slider returns a portion of the excitation pulse depending on the angular position of the vane.

— red - common or analog ground. This wire is connected to the wind speed and the wind direction circuits. This is low end terminal of the potentiometer (CCW).

— black - wind speed signal. This wire provides the wind speed pulses from the magnetic reed switch to the converter.

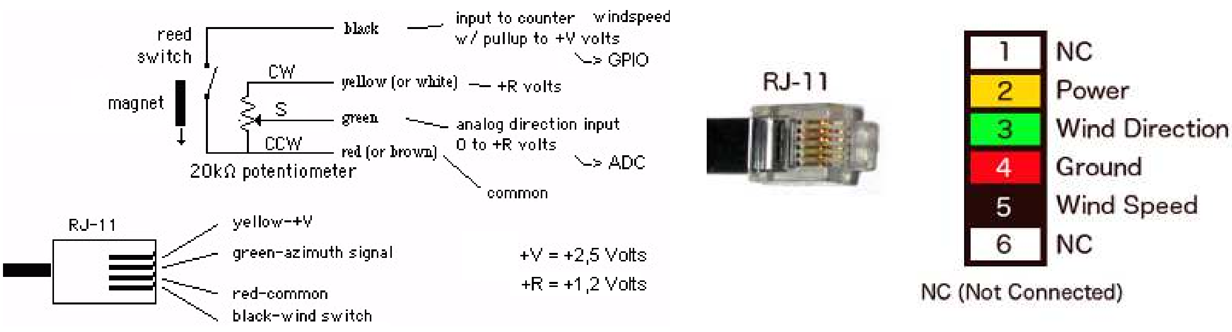

Figure 2

The wind speed and wind direction functions have separate circuits but the red wire is common to both. The three-cup type impeller spinning induces switchover of the sensor digital output at each rotation, thus resulting in the generation of a sequence of pulses with a frequency proportional to the spin rate. The pulse sequence period is converted into the wind speed using the formula: **$v = a/\tau^2 + b/\tau + c$**,

where:

— v – wind speed;

— τ - pulse sequence period ($\tau = 1/f$ – the value reciprocal of frequency);

— a, b, c - conversion factors obtained in the course of calibration.

The freely spinning wind vane of the anemometer is set on the potentiometer shaft. As the wind direction changes, the vane follows and changes the resistance at the slider terminal of the potentiometer. The potentiometer is a linear resistance type that is free to rotate 360º with no mechanical stop. Rotation of the wind vane axis pin induces variation of electrical voltage that is proportionl to the wind vane direction as shown in Figure 3.

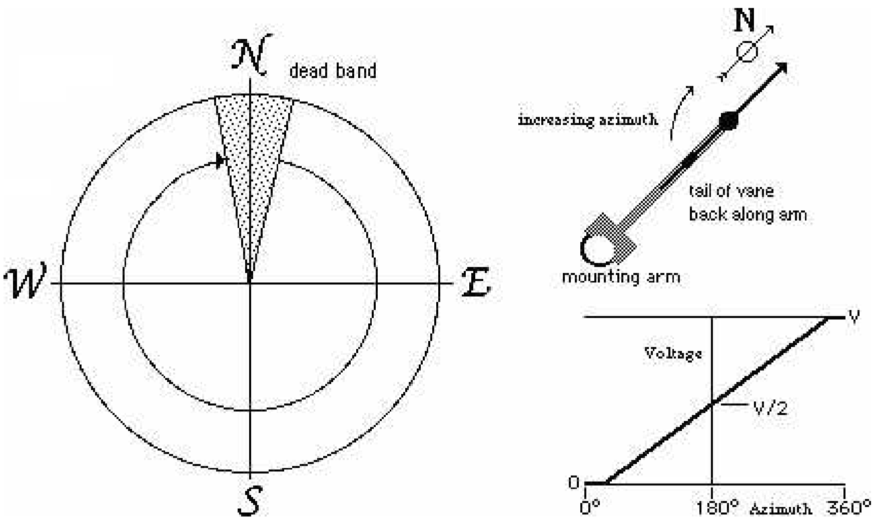

Figure 3

The wind direction circuit uses a linear 20K Ohm potentiometer to sense the position of the vane. A voltage pulse is sent from the converter to the pot through the yellow wire. This voltage is applied to one end of the pot. The mechanical slider in the pot picks a portion of that voltage depending on the angular position of the vane/slider. The voltage level of this pulse is determined by the vane/pot slider position.

The voltage level is converted into the wind direction by the formula:

$\boldsymbol{\alpha = 360 \cdot u / U}$,

where:

- α – wind vane direction in degrees;
- u – the voltage of the slider;
- U – an excitation pulse (supply voltage).

1.3.3 DA485 converts the measured values into physical values by the formulas described above, with the coefficients from the non-volatile memory. The formula for conversion of resistance into direction describes an ideal anemometer with a linear characteristic. In order to adapt the real anemometer Davis 6410, write the direction values in degrees at four directions of the wind vane - 0, 90, 180 and 270 degrees, to the converter non-volatile memory.

1.3.4 The external view of the converter is shown in Figure 4.

Figure 4

1.3.5 The data from the converter are visualized in the user's data acquisition center. The converter is connected to the computer via the RS485-USB (RS485-Ethernet) converter. The exchange protocol is given in Appendix A.

1.3.6 The program provides for a special mode to setup the converter. In this mode the wind speed is determined independently of the wind direction. To switch to this mode, either set the parameter ***max*** to 0 in the setup file, or programmatically give the switch command as described in Appendix A.

1.3.7 Before turning on power, check the converter for external damage, then:

- connect the cable to the computer through the RS485 converter;
- connect the power adapter;

— activate the console application “Anemometer service” from the supply package, as shown in Figure 5. The software and description of its operation are on the CD.

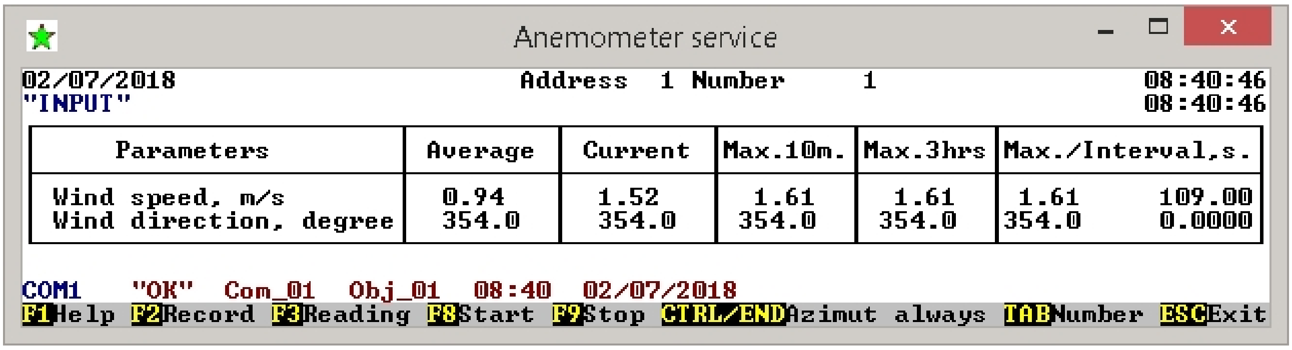

Figure 5

1.3.8 Digital values that qualitatively characterize the ambient conditions of the room should appear on the display in the program window:

— wind speed - zero;

— wind direction - zero.

The converter performance is tested by rotating the wind cups and changing the wind vane position.

2 Supply Package

Table 2

No	Component designation	Identifier	Quantity, pcs.
1	Converter	DA485	1
2	Manual	-	1
3	Compact disk	CD	

Table 3 describes the configuration of the converter supplied.

Table 3

Designation	Address
Communications port RS485 (19200, 8, 1, no parity)	

Appendix A

Computer Communication Protocol DA485

A.1 Data structure for wind processing

The Modbus-RTU protocol is used for data exchange in DA485. Functions 3 and 4 are used for data reading, and functions 5 and 16 - for recording.

The data structure used for setting up is provided below. The console application “Anemometer service” is used to display data from the Davis Anemometer 6410 via DA485. All the structure parameters are readable and writeable by means of the Modbus protocol functions. The console application uses the setup file to upload the data.

```
typedef struct {
        _U8    object;        // Modbus address
        _U8    max;           // Maximum determination time (from 30 minutes to 24 hours)
                              // max >100, max-100 minutes,  max>200 max-200 hours, if        //
                              max<30min or max>24 hours, then - 1 hour;
                              // max=0 for setting up: direction is always displayed
                              // irrespective of the wind speed.
        _U16   id;            //identifier (serial number)
//*****************************************************
        _F32   ac[4];         // the values at the wind vane directions of 0, 90, 180 and 270 degrees
        _F32   mc[3];         // speed correction factors
//*****************************************************
        _F32   fVal[19];      // the values of wind speed and direction
} eepromData;
```

The last 76 bytes of the data structure, 19 floating-point numbers [nineteen], are read-only. Each pair of data structure bytes corresponds to the Modbus protocol register with a shift of 10 registers (20 bytes), if the data are read with function 3. If function 4 is used for reading, the measurement results can be read, starting with the zero register. More details on the cross-reference between the data structure contents and the Modbus protocol registers will be described below in Tables 4, 5.

Before using the numbers obtained, check their applicability for processing. Four-byte floating point numbers, where all the bits of all the four bytes are equal to 1, are considered unprocessable (no data, measurement errors, etc..). For verification, it is sufficient to compare the numbers in both registers that are part of the value under verification, with the number 65535 (0xFFFF hexadecimal) or all the 4 bytes with the number 255 (0xFF hexadecimal)).

A.2 Converter setup registers

Table 4

Register Number	Byte Number	Structure	Description
0	0	max	Interval to determine maximum (0 at calibration)
	1	object	Modbus Address of the converter
1	2	id	Identifier of the converter (serial number)
	3		
2	4	ac[0]	Converter reading at the wind vane direction of 0 degrees
	5		
3	6		
	7		
4	8	ac[1]	Converter reading at the wind vane direction of 90 degrees
	9		
5	10		
	11		
6	12	ac[2]	Converter reading at the wind vane direction of 180 degrees
	13		
7	14		
	15		
8	16	ac[3]	Converter reading at the wind vane direction of 270 degrees
	17		
9	18		
	19		
10	20	mc[0]	Quadratic polynomial coefficients to correct the wind speed module using the formula: $\mathbf{v = mc[2]/\tau^2 + mc[1]/\tau + mc[0]}$ (п.1.3.1)
	21		
11	22		
	23		
12	24	mc[1]	
	25		
13	26		
	27		
14	28	mc[2]	
	29		
15	30		
	31		

A.3 Operation control

To reset the maxima, use register 22, into which the number 0 should be written by means of function 6, or register 0, into which the number 0 should be written by means of function 5. To switch to the set-up mode and back by means of function 5, write the number 0 to register 3, and to show the ADC code instead of direction, write 0 to register 2.

A.4 Results registers (Modbus map)

Table 5

Register Number	Byte Number	Structure	Parameter
10	20, 21	fVal[0]	Current wind speed
11	22, 23		
12	24, 25	fVal[1]	Current wind direction
13	26, 27		
14	28, 29	fVal[2]	Wind speed averaged over 10 minutes
15	30, 31		
16	32, 33	fVal[3]	Wind direction averaged over 10 minutes
17	34, 35		
18	36, 37	fVal[4]	Maximum wind speed during 3 hours
19	38, 39		
20	40, 41	fVal[5]	Maximum direction during 3 hours
21	42, 43		
22	44, 45	fVal[6]	Maximum wind speed during 10 minutes
23	46, 47		
24	48, 49	fVal[7]	Maximum direction during 10 minutes
25	50, 51		
26	52, 53	fVal[8]	Wind speed averaged over 2 minutes
27	54, 55		
28	56, 57	fVal[9]	Wind direction averaged over 2 minutes
29	58, 59		
30	60, 61	fVal[10]	Maximum wind speed during the last 2 minutes
31	62, 63		
32	64, 65	fVal[11]	Maximum direction during 2 minutes
33	66, 67		
34	68, 69	fVal[12]	Wind speed averaged over 1 minute
35	70, 71		
36	72, 73	fVal[13]	Wind direction averaged over 1 minute
37	74, 75		
38	76, 77	fVal[14]	Maximum wind speed during the last minute
39	78, 79		
40	80, 81	fVal[15]	Maximum direction during a minute
41	82, 83		
42	84, 85	fVal[16]	Maximum wind speed since the reset moment
43	86, 87		
44	88, 89	fVal[17]	Maximum direction since the reset moment
45	90, 91		
46	92, 93	fVal[18]	Time in seconds from the 3-hour maximum to the current moment
47	94, 95		