BUS BASED MULTIPROCESSOR SYSTEM FOR WIND SPEED REGISTRATION

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Wind speed and wind direction are the most important parameters used in the wind measurements. Their values are measured in different ways but the most commonly used device for it is the rotational anemometer. In the paper a bus based multiprocessor system has been proposed. The system has possibilities to register the wind speed (WS). The WS data is stored in an appropriate database. The results included in the database have been used for analysis. Based on of this analysis is possible to be taken a decision if the place (where has been received the concrete WS values) is suitable for building a wind power plant or not.

Keywords: Multiprocessor system, Wind speed, Registration

1. INTRODUCTION

Wind is a phenomenon caused by large moving masses of air molecules. These molecules comprise the gaseous atmosphere that surrounds our planet. Heat is the driving force behind the movement of air molecules in our atmosphere. Solar radiation heats the surface of the earth, which in turn heats the air closest to it [1].

This heated air begins to rise, forming convective air currents (i.e., vertical columns of rising warm air). As the heated air rises, it gradually loses its heat, falls away, and is replaced by the continually rising stream of warm air from the surface. Global circulation results when the intense sunlight striking the equator causes this convective upwelling of heated air molecules. These air molecules flow north and south toward the poles, cooling and sinking en route. Cooler air from the Polar Regions is in turn drawn into the solar powered furnace at the equator.

This natural flow creates a gradient of air pressure, with low-pressure areas near the equator increasing to high-pressure areas near the poles. Finally, the effects of the earth's rotation about its axis work to ensure that the effects of atmospheric circulation, and varied atmospheric pressure, are distributed over a wide geographical area. These factors contribute in large part to the continually changing weather patterns we experience every day. Moving air masses (wind) are most often quantified in terms of their relative direction and velocity.

Although wind is a vector quantity and may be measured and processed as such, it is common to measure and/or process the scalar components of the wind vector separately, i.e. wind speed (the magnitude of the wind vector) and wind direction (the orientation of the wind vector) [6]. Wind speed determines the amount of initial dilution experienced by a plume, and appears in the denominator of the steady-state Gaussian dispersion equation (in the non-steady state puff model, the wind speed determines the plume/puff transport). In addition, wind speed issued in the calculation of plume rise associated with point source releases, to estimate aerodynamic effects in downwash calculations and in conjunction with other variables, in the determination of atmospheric stability. Instruments used for in situ monitoring of wind speed are of two types: those which employ mechanical sensors (e.g., cup and propeller anemometers) and those which employ non-mechanical sensors (hot wire anemometers and sonic anemometers).

The rotational anemometer is the most common type used for meteorological measurements [1]. This anemometer consists of a windmill, propeller, or as is most often the case, three semi conical cups attached to a rotating horizontal shaft. This is shown on Fig. 1.

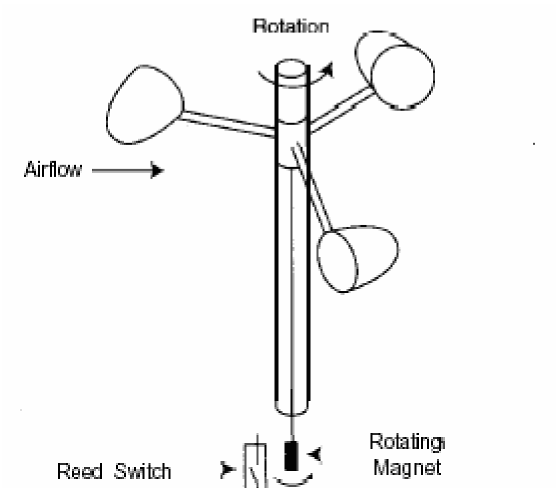

Fig. 1: Rotational anemometer

Moving air molecules striking this anemometer exert a force on the cups, causing the shaft to rotate about its axis. As air velocity increases, the anemometer shaft's rotational velocity increases proportionately. The shaft is often directly coupled to an electric generator, which measures shaft rotational speed and thus winds speed. In most generator-type rotating anemometers, the magnitude of the generator's AC voltage output increases with shaft frequency. A precision rectifier and filter can be used to convert the AC voltage generated by the rotating shaft into a more useful DC voltage.

This DC voltage is then directly displayed on a voltmeter calibrated to wind speed. More common today is a mechanical or electronic switch output. In these anemometers, there is at least one (and often more) switch closure(s) for each rotation of the anemometer shaft. The frequency at which switch closures occur is proportional to the wind speed. This frequency can be converted to an analog voltage for measurement, or a microcontroller or computer can measure wind speed directly.

2. PROPOSED BUS BASED MULTIPROCESSOR SYSTEM FOR WIND SPEED REGISTRATION

The simplified block diagram of the proposed bus based multiprocessor system is shown on the Fig. 2.

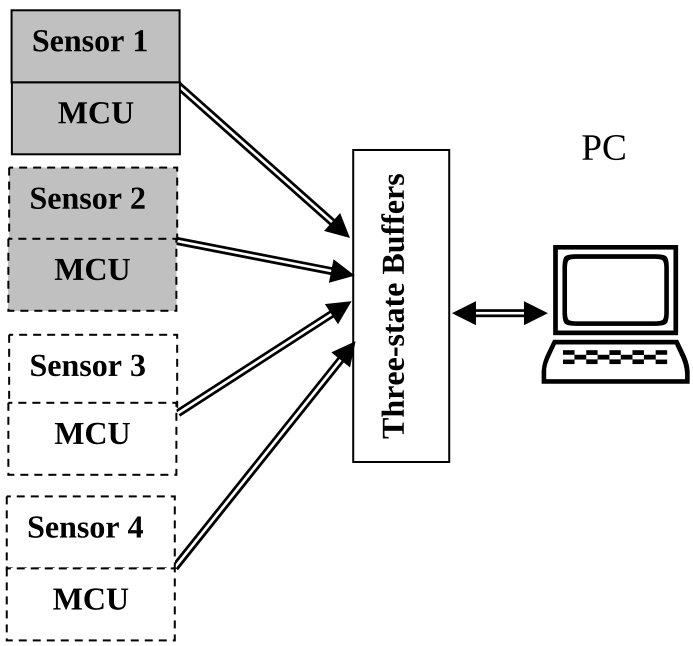

Fig. 2: Bus based multiprocessor system (BBMS)

The BBMS consist of different type of sensors – Sensor 1, Sensor 2, Sensor 3, Sensor 4, etc. Sensor 1 is used for wind speed measurements. Sensor 2 will be used for wind direction measurement. Sensors 2 and 3 are optional – they have not been connected to the systems. In the future enlargement of the BBMS they will be used as a source of information as example for ambient temperature as well as for relative humidity. In this way proposed BBMS will become small meteorological station.

Sensor 1 is the same as the sensor used in anemometer N188A produced by Meratronick. When the sensor work it produce the square pulses which frequency is proportional of the wind speed. An additional electronic circuit is connected between sensor and MCU in order to form square pulses with very steep edges suitable for digital circuits.

Sensor 2 which we plan to use in the near future is a 10-bit programmable magnetic rotary encoder of type AS5040 produced by Austria Microsystems [8]. One of possibilities is that AS5040 will send information about wind direction using PWM (Pulse width modulation).

The corresponding formula used in AS5040 documentation is:

(1)
$$Position = \frac{ton \times 1025}{(ton + toff)} - 1$$

Every one of the sensors is connected to the microcontroller unit (MCU). For simplicity MCUs are of the same type – PIC16F88. The role of the microcontroller is to interact with a sensor and after that to send 8 bit parallel data through three-state buffer to PC (Personal Computer). In case of 16 bit information sensor sends it two times by 8 bits.

Three-state buffers are used to for multiplexing by the time of received data of the couple sensor – MCU. The buffers are also used to avoid destroying the PC in case of short circuits from the side of sensor or MCU. They also have been controlled by PC. Parallel port of the computer is used as a bus on which is received information from the MCU. The algorithm of communication between MCUs and CPU (Central processor unit located in PC) included the next steps:

- When data is ready MCU send a signal CPU in order to inform it for the event;
- The master microprocessor (CPU) selects one of the microcontrollers in order to start communication. CPU enables the corresponding buffer and put the others in the third stage. After receiving information from Sensor 1 the master processor collected information from the Sensor 2, them from Sensor 3, etc.;

The parameter which will be put in the database is stored on the hard disk of the computer as an average value of 100 of received values of the same type. On every 10 minutes has been entered only one piece of data into the database.

After a year of collection of information the specialist will have enough information in order to take a decision or not for building a wind power plant on the place which has been carried out this monitoring [5].

The proposed electronic circuit is the first part of BBMS realization. It is shown on the Fig. 3 [4, 9]. There are two main tasks which have to be solved by BBMS. First of all is to measure wind speed. It is done using TMR0 module as a counter. For a given period of time counter is working and then number of pulses is send to PORTB of the microcontroller. As we mentioned before the pulses correspond to wind speed. The second main task which has to be solved by the microprocessor system is interaction with a main computer (PC).

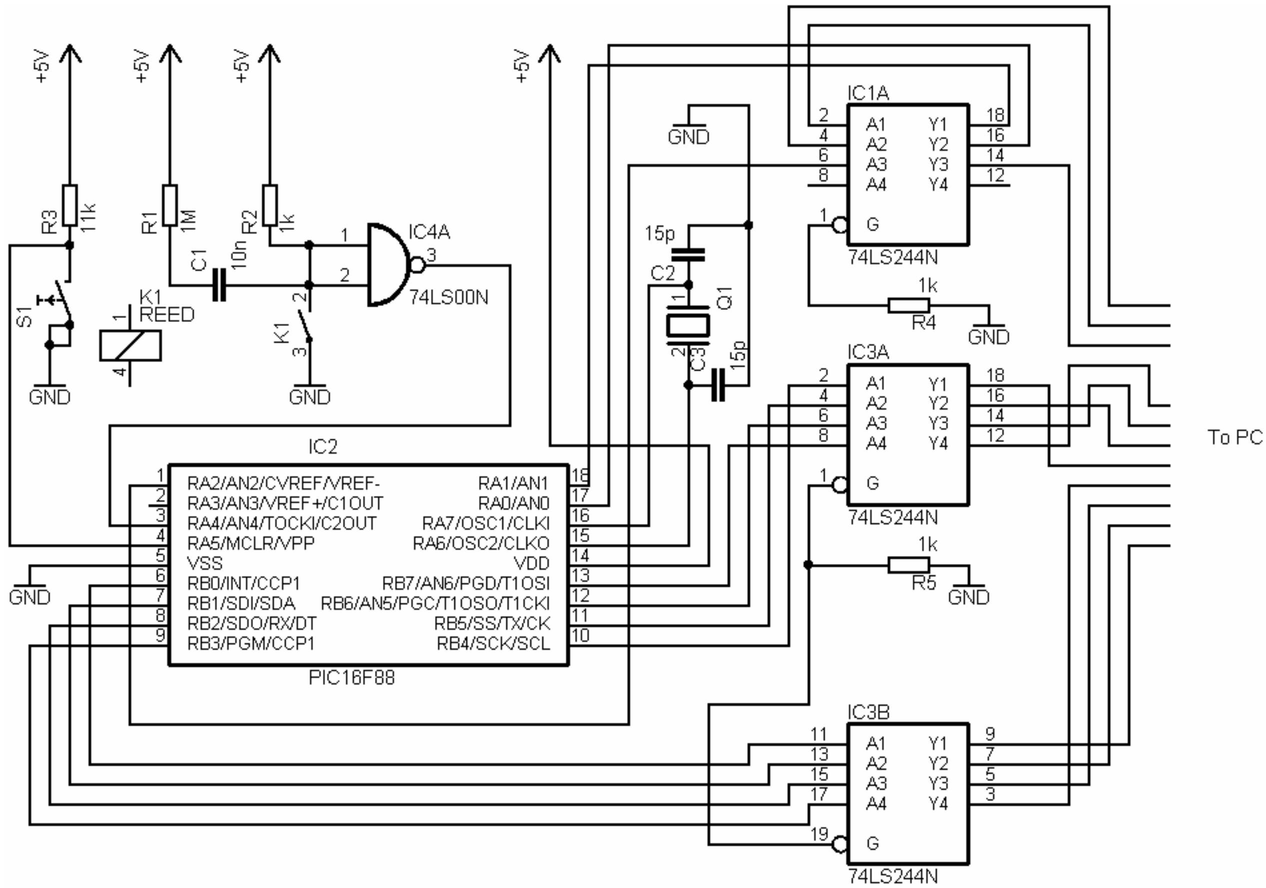

Fig. 3: Electronic circuit of the first part of BBMS

It has been chosen Bidirectional mode of parallel port of a PC. We have selected this mode from the Setup menu of the computer. In case of newer models of PC the above mentioned Bi-directional mode is possible to select with bits b7 – b5 located in ECR (Extended Control Register) register of PC parallel port working in ECP (Extended Capability Port) mode [3]. The diagram of interaction between PC and BBMS in order the last one to send byte information is shown on Fig. 4.

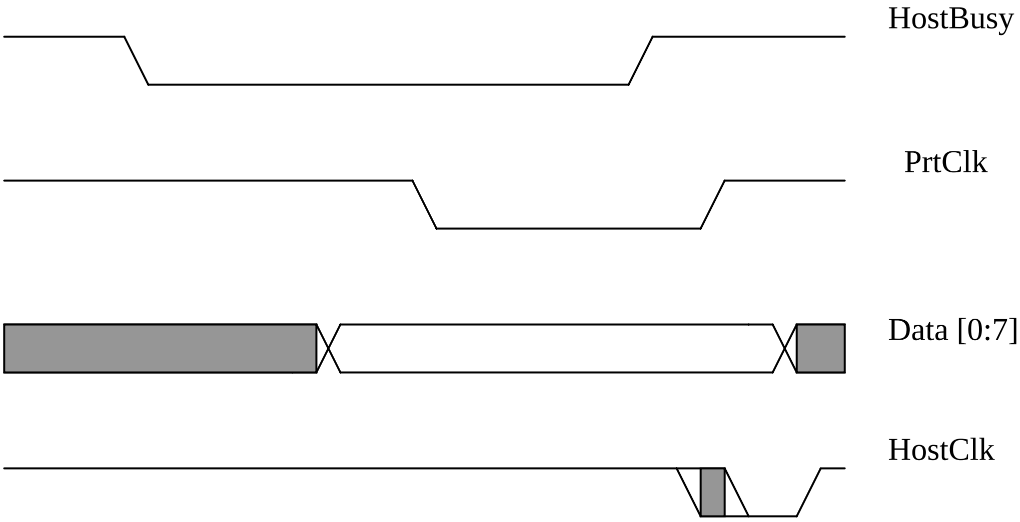

Fig. 3: Diagram showing receiving a byte from BBMS

3. CONCLUSIONS

The results received from proposed microprocessor system are obtained in laboratory environment. They are close to [2].

We are going to receive results from real environment (real meteorogical conditions). If we have possibility to buy a similar system produced by APRS World [7] we will compare results received from the two systems.

The next step of our project will be adding a wind direction sensor [8] and updating the software which will control two sensors and corresponding microprocessors.

4. REFERENCES

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