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Procedia Engineering 168 (2016) 1024 – 1027

Procedia Engineering

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30th Eurosensors Conference, EUROSENSORS 2016

A Low Cost Fully Integrable in a Standard CMOS Technology Portable System for the Assessment of Wind Conditions

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Abstract

Nowadays, the environmental meteorological monitoring is becoming a primary need in many fields of human activity. Continuous and accurate measurements are often required also in absence of local and fixed stations. This scenario leads to the development of low cost portable systems and to the design of innovative architectures, thanks to the availability of new technologies and sensors. The full system here proposed - easily integrable on a CMOS technology - is based on a hot wire anemometer, provided by *Telecontrolli SME,* and a suitable heater feedback that achieves, thanks to a dedicated algorithm, a novel portable solution with a robust design, without moving parts and small dimensions. It is suitable to operate up to 50°C and provides accurate wind speed and direction measurement.

Peer-review under responsibility of the organizing committee of the 30th Eurosensors Conference

Keywords: Differential capacitance sensors; bridge-based circuits; analog circuits; Wheatstone bridge; electronic interface.

1. Introduction

Wind-monitoring systems are essential in several situations: from itinerant activities like sports (e.g. sail and ski), to critical environments like bridges or urban buildings. Currently, different types of wind meters exist. In this scenario, a well-known solution is certainly the electromechanical sensor, typically used in fixed stations. Alternatives are usually based on the pressure measurement or on the heat exchange with the air flow [1-6]. Such solutions are preferable for portable applications and installations in severe conditions. The application here proposed takes advantage of the heat exchange principle in hot wire sensors to obtain an accurate evaluation of both

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Peer-review under responsibility of the organizing committee of the 30th Eurosensors Conference
doi:10.1016/j.proeng.2016.11.331

wind speed and direction. In addition, being the design without moving parts, it has a better robustness and the further advantage of requiring a reduced maintenance. The basic element is a hybrid flow sensor, *FLW1* provided by *Telecontrolli*, which embeds a thermal resistor (*Heater*) and a thermistor showing a negative thermal coefficient (*NTC*) on a ceramic substrate.

2. The proposed interface

The *NTC* resistor is included in a self-regulating Wheatstone Bridge that allows an automatic and continuous detection and quantification of the sensor resistance as shown in Fig. 1.

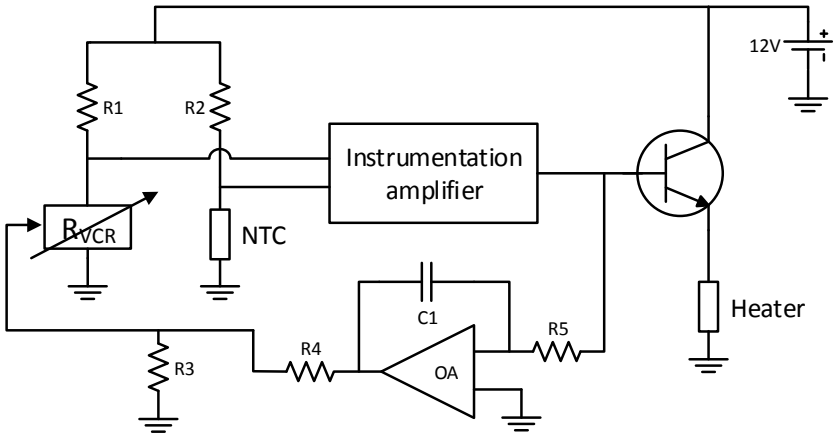

Fig. 1. Proposed interface for the standalone FLW1.

The output voltage of the amplifier is used to determine the current flow through the heater, setting the correct working temperature of the system. The discrete prototype can be seen in Fig 2.

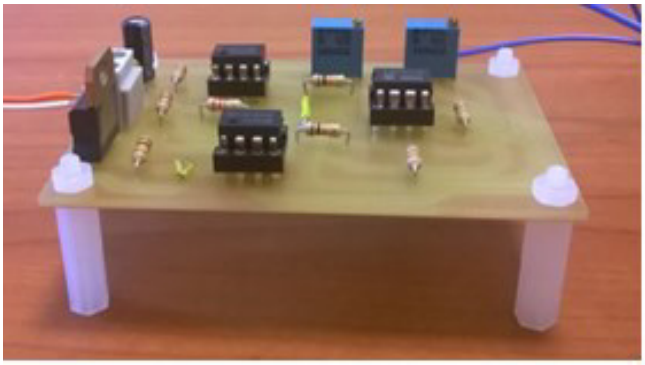

Fig. 2. Prototype board of the single sensor interface.

3. Results

The system has designed with a pattern of sensors (Fig. 3), so determining also the wind direction and to overcome limitations in term of accuracy, due to not orthogonal flows. In this way, analyzing the signal provided by each sensor, the wind conditions are evaluated by means of differential measurements. At each time step, data received from the sensors are read by a microcontroller (Fig. 4), an Arduino board in this first prototype. Once the maximum value has been found, the relative sensor is identified, then this data is compared with the values provided by neighbors sensors and the exact direction and magnitude are obtained by triangulation algorithm. The output voltage of the sensor interface as a function of the wind speed is shown in Fig. 5.
The proposed architecture has also the advantage to be fully integrated in a standard CMOS technology especially by taking advantage of the current mode approach and low voltage low power techniques [7-13].

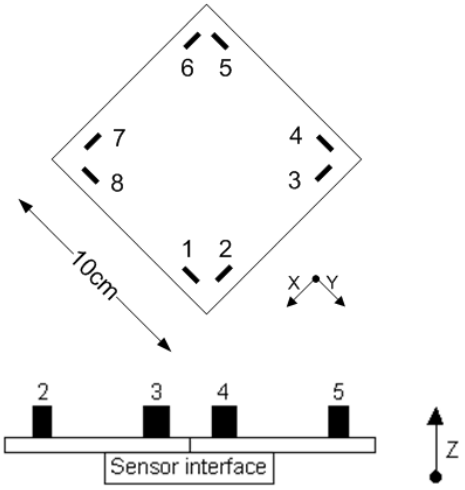

Fig. 3. The flow sensors pattern Output.

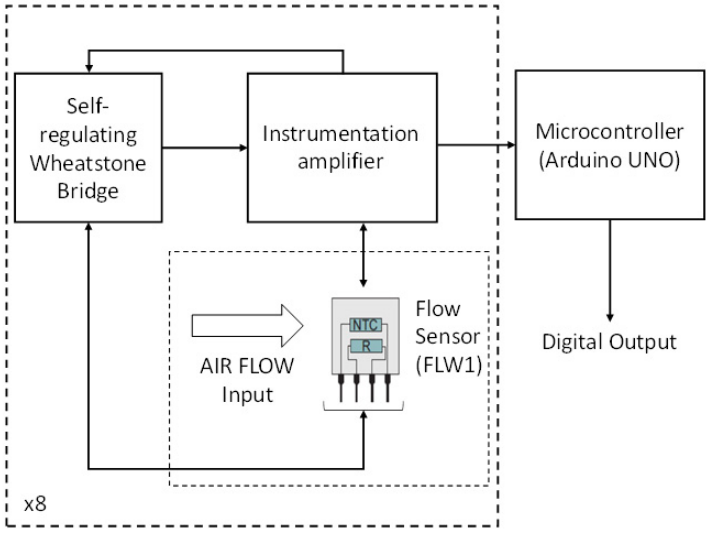

Fig. 4. Block scheme of the complete sensing system

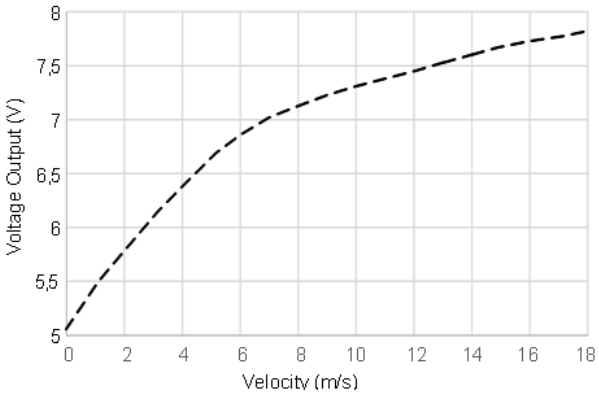

Fig. 5. Output voltage versus wind speed.

4. Conclusions

We have presented an easily integrable on a CMOS technology hot wire anemometer based wind detection system. It shows good performances and is suitable to operate up to 50°C, providing accurate wind speed and direction measurement.

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