DIGITAL SENSORS AND TRANSDUCERS.OVERVIEW ON PRESENT TRENDS IN DEVELOPMENT OF THESE

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***Abstract* – The necessity of sensors and transducers with digital output has increased with the expansion of treating the process with processing computers. This paper presents a condensed review of nowadays sensors and transducers technology, problems implicated and some modern tendencies. One can find a digital output sensor practically any type of variable - temperature, flow, pressure, speed, humidity, level etc. - with their digital output signal represented in multiple formats. Smart materials are the focusing point of the future of material sciences, the foundation of technology and engineering of the next century. Smart sensors - enable users and systems integrators to automatically configure their measurement automation systems for analog sensors.**

Keywords: *tendency, sensors and transducers, measurement system, smart sensors.*

1. PRESENT BACKGROUND

The approaches about the achievement of the modern measurement systems become more and more numerous in the field of sensors and transducers. At the transducers with analogical output size we carry out the analogue-digital conversion. They are analogue signals which can be easily processed without the achievement of the analogue-digital conversion operation. Unlike the signals, using the digital signals is far too easy. I notice that in the environment there are not many phenomena that allow us to find out the result of the digital measurement. The digital transducers are few. The sensors and transducers are specific element of the automation systems. They are also used in the research, lab-analysis. They are included in complex measurement chains that are automatically controlled. One can find a digital output sensor practically any type of variable- temperature, flow, pressure, speed, etc. - with their digital output signal represented in multiple formats. Modern computers combined with recent development of Internet give the possibility to realize systems that can be accessed from remote location providing interactivity and animation, offering a flexible, faster and friendlier learning, [1, 2].An example of this kind of system is a remote data-logging on 1-Wire Addressable Digital Instruments (ADI) that can be remotely accessed by Internet. The system is realized using four temperature sensors: three DS18B20 temperature sensors and one DS1822 sensor type. The main characteristic features of these sensors are: each sensor has a unique 64 bit address; temperature measurement resolution is programmable within the range of 9-12bits; 1-Wire interface compatible; user-definable alarm settings using an EEPROM memory.

The MAX 6576/6577 low-cost, low-current temperature sensors are ideal for interfacing with microcontrollers or microprocessors. Both sensors feature a single-wire output that minimizes the number of pins necessary to interface with a microprocessor. In order to obtain best accuracy over the whole temperature range, it is recommended to compensate for the non-linearity of the output of the temperature sensor. This can be achieved by correcting the calculated temperature and pressure by a second order correction factor. Communication between the MS5534A (RoHS*) and the widely available microcontroller is realized over an easy to use 3-Wire serial interface.

Manufacturers have lately introduced a new generation of humidity and integrated temperature digitally and calibrated sensors. The SHTxx is a single chip relative humidity and temperature multi sensor module comprising a calibrated digital output. The 2-Wire serial interface and internal voltage regulation allows easy and fast integration. Its tiny size and low power consumption makes in the ultimate choice for even the most demanding applications. The SHT11 digital humidity and temperature sensor is fully calibrated and offers excellent long term stability and ease of use at very low cost. It is use in applications: data logging, transmitter, automation and process control, test and measurement, medical, automotive, humidifiers/ dehumidifiers. The advantage of combining of a pressure sensor with a directly adapted integrated circuit is to save other external components and to achieve very low power consumption. The main application field for this system includes portable devices with battery supply, but its high accuracy and resolution make it also suited for industrial and automotive applications.

Another example is the concept of smart dust transducers that incorporate the measurement, micro processing and communication in one capsule with dimension below 5 mm. An experimental technology is in progress that could offer computer networks million of small dimension sensors. Essential for these wireless monitoring systems are the miniaturizing sensor, type smart dust. Smart materials are the focusing point of the future of material sciences, the foundation of technology and engineering of the next century. The rare earth giant magnetostrictive material is one of the smart materials. Smart sensors- enable users and systems integrators to automatically configure their measurement automation systems for analog sensors. These rule out the necessity of other circuits or devices in the system. Working in plug-and-play system becomes practical. Sensors plug-and-play is revolutionizing measurement and automation. As the technology for interoperable plug-and-play sensors becomes available, more users are experiencing the benefits of plug-and-play measurement systems. Magneto elastic sensors can be remotely interrogated by magnetic, acoustic or optical means.

2. OUR INVOLVEMENT IN FURTHER TECHNICAL IMPLEMENTATION

This paper focused on technological improvements involved by the digital development in digital sensors and transducers domain. There are many classifications of sensors and transducers: depending on the output size- analogue or digital; depending on the input size-absolute or incremental; with or without contact, etc.
I made a classification of digital output sensor based on:

- Characteristic of the signal driving the sensor's output;
- Sinking vs. sourcing outputs;
- 2-Wire and 3-Wire sensors;
- Electronic component used to implement the sensor's output.

Nowadays, we find sensors that produce trains of transition between the On and Off state. With these types of sensors the frequency characteristic or even the shape of the pulse trains conveys the sensor's measurement, making it possible to implement continuous measurement. 2-Wire sensors: they are connected in series with the device that is acquiring the data. 3-Wire sensors: derive their power from an excitation terminal and not directly through the digital output line. Ideally, a transducer should measure the natural phenomenon and produce a parallel binary or binary coded decimal output.
I made a classification of the temperature transducers depending of the type output and the command mode: analogical; with numerical input and output; with numerical output also for the monitoring of the process. The transducers with computational out provide different types of computational output on a single line. If is embed in these transducers lines of delay, than, output data will be provides as a frequency or as a period a logical signal. At the transducers with computational input and output, the computational data representing the temperature are transmitted towards a computer. The transmission is made usually through a serial bus.
The quartz has very well elastically and mechanical properties. From this reason it is fit for making of vibratory elements. The sensors obtained with micro processing are used for measurements of vibrations, force and pressure, obtaining very high accuracy. There are not many pure digital transducers except the quartz crystal. In practice are accuracy of 0.0001ºC is possible over the range -40 ºC to 230ºC. The MAX6576 and MAX6577 low-cost, low-current (140µA) temperature sensors are ideal for interfacing with microcontrollers or micro processing, figure 1, [3]. The MAX6576 temperature sensors convert temperature sensor convert temperature to period and the MAX6577 to frequency.

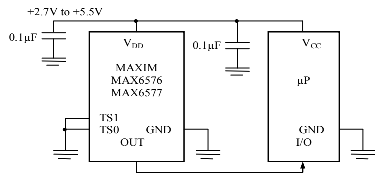


Figure 1: Typical operating circuit

They are use in: critical microprocessor and microcontroller temperature monitoring; portable battery- powered equipment; cell phones; networking and telecom equipment; medical equipment; automotive. The MAX6576 offers accuracy of ±3ºC at +25 ºC, ±4.5ºC at +85 ºC, and ±5ºC at +125 ºC. The MAX6577 offers accuracy of ±3ºC at +25 ºC, ±3.5ºC at +85 ºC, and ±4.5ºC at +125 ºC. The accuracy of the MAX6576/6577 is susceptible to noise generated both internally and externally. The effects of external noise can be minimized by placing a 0.1µF ceramic bypass capacitor close to the supply pin of the devices.
The MS5534A (RoHS*) barometer module is a SMD-hybrid device including a piezoresistive pressure sensor and Analog Digital Converter (ADC) – Inter Integrated Circuit (IIC). It provides a 16bit data from a pressure and temperature dependent voltage, [4]. As the output voltage of a pressure sensor is strongly dependent on temperature and process tolerances, it is necessary to compensate for these effects. This compensation procedure must be performed by software using and external microcontroller. A 3-Wire interface is used for all

communications with a microcontroller. For both pressure and temperature measurement the same ADC is used (sigma delta converter).The MS5534A (RoHS*) are uses in: mobile altimeter/barometer systems; weather control systems; GPS receivers. It can withstand a pressure of 11 bars in salt water or 100m water respectively. The advantage of combining of pressure sensor with a directly adapted integrated circuit is to save other external components and to achieve very low power consumption. The main application field for this system includes portable devices with battery supply, but its high accuracy and resolution make it also suited for industrial and automotive applications. The possibility to compensate the sensor with software allows the user to adapt it to his particular application.

3. HOT POITS OF THE DEVELOPMENT

DS18B20 and DS1822 digital thermometers provide 9- to 12-bits centigrade temperature measurements. The difference between the two sensor types is that the last one has an accuracy of ±2ºC for temperature measurement in comparison with the first type which has an accuracy of ±0.5ºC. The DS18B20 and DS1822 have an operating temperature range of -55 ºC to +125 ºC over the range of -10 ºC to +85 ºC, [5, 6]. An example of this kind of system is a remote temperature data-logger based on 1-Wire Addressable Digital Instruments (ADI) that can be remotely accessed by Internet. The system using four temperature sensors of which three DS18B20 sensors and one is a DS1822 sensor. The sensors are connected to a serial bus using the 1-Wire interface for communicating with a microcontroller. A large number of devices are now compatible with the 1-Wire interface: sensors for temperature, humidity, pressure, wind speed and direction, etc.; analog digital converters (ADC); digital analog converters (DAC); memories, etc. the system is used to measure and monitor the temperature in different places inside a computer. The measurement system can be operated locally or remotely. The system can be extended to use any number of sensors and can be used to monitor the temperature in other applications. Applications include thermostatic controls, industrial systems, consumer products, thermometers, or any thermally sensitive system. They are several methods available for interfacing 1-Wire devices such as the DS18B20, DS18S20 or DS 1822 to a microcontroller. The block diagram in figure 2 illustrates the simplicity of the hardware configuration when using multiple 1-Wire temperature sensors. A single-wire bus provides both communication access and power to all devices.

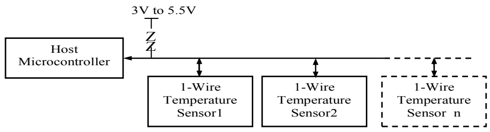
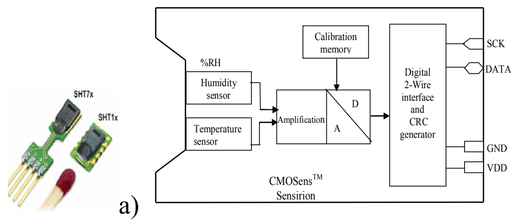


Figure 2: Host microcontroller interface

An almost unlimited number of 1-Wire devices can be connected to the bus because each device has a unique 64 bit ROM code identifier.

Manufacturers have lately introduced a new generation of humidity and integrated temperature digital and calibrated sensors. SHT11, the new product, is a “chip” for simultaneous measurement of relative humidity and of temperature, in a multi-sensor modulus with a digitally calibrated output that allows a simple and high-speed integration in the system. The SHT11 digital humidity and temperature sensor is fully calibrated and offers excellent long term stability and ease of use at very low cost, [7]. Is use in applications like: data logging, automation and process control, test and measurement, transmitters, comfort index. In order to measure the temperature, relative humidity and dew point the SHT11 product has been adapted. The SHT11 is made with the technology of CMOS, [8], figure 3.The devices SHT11 of very small size, only 5.08x7.62mm, that can be set either to a surface, or with the help of the pines, includes beside the temperature and relative humidity sensor of analogical type based on polymer as a dielectric, and Analog Digital Converter, a calibration memory and a digital 2-Wire interface and CRC generator, having four terminals: GND, VDD, DATA and SCK.



a) b)

Figure 3: a) SHTxx sensor; b) block diagram

In order to acquire and transmit data at the distance, from the three planned measurement points have been incorporated three SHT11 sensors types, figure 4. The sensors use two integrated circuits each SN75179BP that forming the transducer1, 2 and 3, [9]. This way a full duplex data communications and commands between sensors and a point of data acquisition, materialized by the module HIT-03 was achieved.

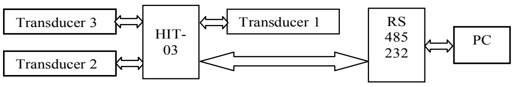


Figure 4: The communicate structure

From the HIT-03 data are transmitted trough serial interface RS485/422 to a conversion module RS485/422-RS232 in order to connect it to a computer. The SHT75 is a single chip relative humidity and temperature multi sensor module comprising a calibrated digital output. The device includes two calibrated micro sensors for relative humidity and temperature, which are seamlessly coupled to a 14bit analog to digital converter and a serial interface circuit on the same chip, [7]. This results in superior signal quality, a faster response time and insensitivity to external disturbances at a very competitive price.

The SHTxx are features: relative humidity and temperature sensors; fully calibrated; digital output; excellent long-term stability; dew point, no external components required; ultra low power consumption, surface mountable or 4-pin fully interchangeable; small size; automatic power down, [8].

Many developments in the area of magnetic measurement technology are initialized by the availability of new magnetic materials. These magnetic materials can be used to monitor a variety of environmental parameters such as: stress, pressure, torque, temperature, flow velocity, magnetic field and mass boarding. Magneto elastic sensors can be remotely interrogated by magnetic, acoustic or optical means.

Another example is the concept of smart dust transducers that incorporate the measurement, micro processing and communication in one capsule with dimension below 5mm.An experimental technology is in progress that could offer computer networks million of small dimension sensors. Essential for these wireless monitoring systems are the miniaturizing sensors, type smart dust. What makes difference between these sensors from the standard ones in their ability to chain one another in smart clusters, to process and convey the information. Any sensor can become a wireless sensor if a mote is added. Mote contains a bit of memory and a low power radio transmitter. EmbedSense is a tiny wireless sensor and data acquisition system that is small enough to be embedded in a product, enabling the creation of smart structures, smart materials and smart machines. EmbedSense was designed for battery-less sensor applications on rotating machines, smart structures, and medical devices. It has been, successfully deployed in turbine engine testing applications with operating temperature up to 150ºC and centrifugal forces to 60,000g.Wireless sensing networks are made of low cost, low-power, multifunctional magneto elastic sensor nodes that are small in size and communicate unthread in short distances, [10]. They can eliminate costs by easing installation and eliminating connectors. The ideal wireless sensor is networked and scaleable , consumes very little power, is smart and software programmable, capable of fast data acquisition, reliable and accurate over the long term, costs little to purchase and install, and requires no real maintenance.

4. CONCLUSIONS

This paper presents a condensed review of nowadays sensors and transducers technology, problems implicated and some modern tendencies. This paper focused on technological improvements involved by the digital development in digital sensors and transducers. The utilization of such up-to-date essential elements in any technical system is compulsory and followed by technical advantages and a better management.

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