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HUMIDITY MEASUREMENT IN THE SATURATED STEAM STERILIZATION SPACES

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***Abstract* – This paper presents one solution concerning the modality for humidity measurement in the saturated steam sterilization spaces, where the level of temperature is very high.**

Keywords: *measurement, humidity, microcontroller, sensor, saturated steam.*

1. INTRODUCTION

The start point of this application is a production hall for Pleurotus mushrooms production. It has been proposed automation for production process by watching and rigorously controlling environment's parameters. To obtain a functional food, the Pleurotus mushroom production environment must be permanently controlled. One of the parameters which can be monitorised is humidity and temperature in the sterilisation zone. The thermal disinfecting of nutritious celluloshic blend is reducing or destruction the number of pathogen agents (rival mushrooms, moulds), harmful fauna (spiders, blowfly, larva, etc.) witch can be found frequently in celluloshic material.
In sterilisation zone, in first stage from a work cycle must be assured the limits of temperature of 80-90 degrees Celsius and humidity of 84-90% for six to eight hours witch is followed by suddenly cool down to 20 degrees Celsius of celluloshic material
The measurement of the humidity in the saturated steam sterilization areas involves many problems related to this humidity level as well as the high temperature.
In this way it was appeared the necessity to achieve a humidity measurement system closely connected to the temperature. For this purpose it has been used an humidity sensor SMTHS10 made by SMARTEC
The most important features of this sensor are: it is linear between 0 and 100 % RH, long term stability, very low cost.
The typical applications where this sensor can be used are: Air conditioning units, Climate control for green houses, Storage and warehouses, Meteorological applications, food processing, room comfort control, medical applications and many more. In many applications 100 % RH and condensation may occur. This condensation has no effect on the performance of the Smartec humidity sensor.

2. PRESENTATION OF SYSTEM FOR HUMIDITY MEASUREMENT

The system of humidity measurement consists of a humidity sensor SMTHS10, a temperature sensor Dallas 18B20, a timer TLC555, a processor ATMEGA8 and an interfacing circuit with the standard communication bus 232 (see figure 1).

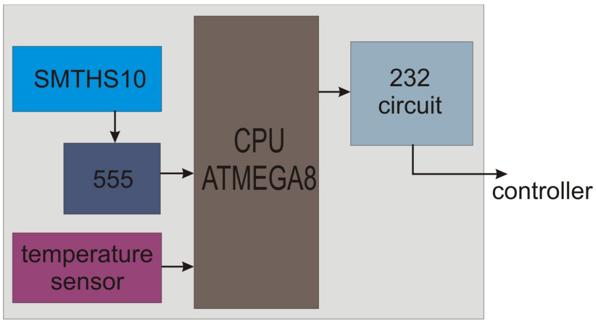

Figure 1: The system measurement diagram

2.1. Humidity sensor

2.1.1 Description and working of sensor

The Smartec humidity sensors have linear capacitance change from 0 % to 100% RH within a band of 2%. Due to this and the production technology on silicon substrate we can offer now a humidity sensor at a price level that will allow measurement of humidity where the traditional humidity sensors are to expensive or to unreliable. Due to its robust construction the response time is slower as it should be. Therefore it is not recommended the use of the sensor for applications where a very high speed of response is required.
The Smartec humidity sensor is a two terminal capacitor which increase in value as water molecules are absorbed into its active polymer dielectric. The capacitor plates consist of a base plate and a water permeable platinum top plate. The sensor will be

delivered with gold-plated lead wires attached. Besides the active dielectric, polymers give protection to the base plate, prevent polarization and pinholing and generally ruggedise the sensor so that it can be used in a wide range of hostile environments.
With this sensor that we have developed an electronic circuit that read the value of humidity and transmit it serial to a controller.

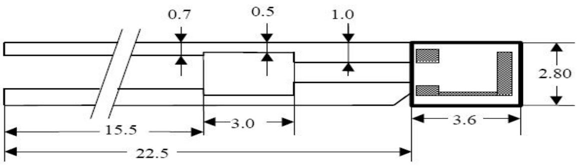

Figure 2: Humidity sensor ″SMTHS10″

Characteristics of sensor:
Humidity range: 0 - 100 %RH
Temperature operating: -40 – 120 ºC
Value of capacity: @ 25 ºC, 60 %RH, 100 KC 240 pF ±15 %
Capacity range: 0-100 % RH 40 pF ±10 %
Relationship of temperature -0.15% RH/ºC
Response time: 60 s.
Linearity: ± 2% RH
Stability in the time (during a 12 mounts): ± 3 % RH
Maximal supply voltage: 5 V AC

2.1.2 Signal conditioner of humidity sensor

For use of this sensor is necessary a montage for signal processing. The electrical scheme of sensor is presented in figure 3.

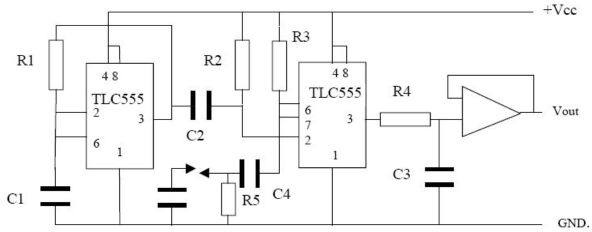

Figure 3: Electrical scheme of ″SMTHS10″ humidity sensor

The elements R3 and C1 are used for to prevent the limit of supplied voltage for sensor. Vout varied between 0.5 Vcc and Gnd, but is influenced by R3 and C1.

2.2. Temperature sensor

The "DS18B20" temperature sensor is manufactured by Dallas Semiconductors public house, but is not necersary other components for signal processing and may measured temperature within between -55 °C and +125° with ± 0.5% accuracy, in 10°C … + 85°C temperature domain.

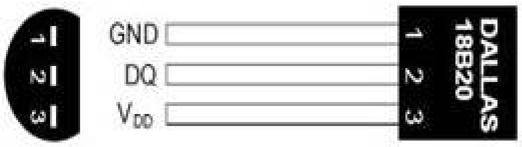

Figure 4: The ″DS18B20″ temperature sensor

The resolution of sensor is screening between 9 and 12 bits. The temperature conversion is realising in maximum 750 ms.
The bloc scheme of sensor is presented in figure 5.

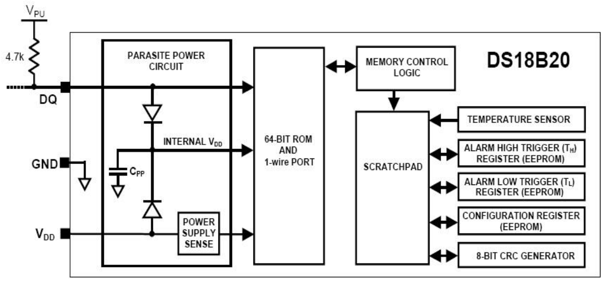

Figure 5: The bloc scheme of ″DS18B20″ temperature sensor

The sensor contain two registers of 8 bits for stocking minimal and maximal levels of the (T_H şi T_L) alarms, and a configuration register by who the programmer may constituted the temperature conversion in 9, 10, 11 or 12 bits in digital format. This thing constituted the incremental step of the 0.5, 0.25, 0.125 and 0.0625°C. measured values.
The implied resolution is of 12 bits.
T_H and T_L values are stocking in a non-volatile EEPROM memory so they can be used even if the sensor supplied it was cut.
The communication with the sensor is made by an only pin with 3 logical states; the communication protocol is based to a code of 64 bits. A singularity of this sensor is represented by the thing that it can work with no extern supplied power source. The supplied can be made through a single pull-up resistor how can be seen in the figure 5.
The sensor memory is SRAM type, but some in formations aren't lost of cutting supplied on account of a EEPROM memory where are stocked the trigger of temperature values for alarm and the configuration octet. The write of this is always made in EEPROM memory and are loaded automat in the RAM memory at supplied.

2.2. ″ATMEGA 8″ processor

The ATmega8 is a low-power CMOS 8-bit microcontroller based on the AVR RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega8 achieves throughputs approaching 1 MIPS per MHz, allowing the system designer to optimize power consumption versus processing speed.
The pin configurations are shown in figure 6.

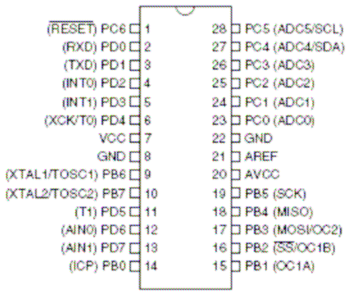

Figure 6: The pin configurations of ″ATmega8″microcontroller

The AVR core combines a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in one single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers.
The ATmega8 provides the following features: 8K bytes of In-System Programmable Flash with Read-While-Write capabilities, 512 bytes of EEPROM, 1K byte of SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible Timer/Counters with compare modes, internal and external interrupts, a serial programmable USART, a byte oriented Two-wire Serial Interface, a 6-channel ADC (eight channels in TQFP and MLF packages) where four (six) channels have 10-bit accuracy and two channels have 8-bit accuracy, a programmable Watchdog Timer with Internal Oscillator, an SPI serial port, and five software selectable power saving modes. The Idle mode stops the CPU while allowing the SRAM, Timer/Counters, SPI port, and interrupt system to continue functioning. The Power-down mode saves the register contents but freezes the Oscillator, disabling all other chip functions until the next Interrupt or Hardware Reset. In Power-save mode, the asynchronous timer continues to run, allowing the user to maintain a timer base while the rest of the device is sleeping. The ADC Noise Reduction mode stops the CPU and all I/O modules except asynchronous timer and ADC, to minimize switching noise during ADC conversions. In Standby mode, the crystal/resonator Oscillator is running while the rest of the device is sleeping. This allows very fast start-up combined with low-power consumption.

3. OPERATION OF SYSTEM

The operating principle is based upon measurement of the time of a pulse generated by an electronic mounting and initiated even by the microcontroller. The microcontroller initiates this signal on the falling front. Immediately after generation, a timer starts and it stops in the moment when the pulse progresses from 1 in 0 logic.
The timer is stopped by means of an external switch. This timer was optimal because it has a resolution of 16 bytes.
If the switch doesn't appear and the timer reaches 0xffff, then the measurement is considered to be wrong and a breakdown signal.
The humidity measurement is correlated with the temperature variation
The header emitted by the transducer is identical with the received one. In this way it is ruled out the possibility that the transducer answers to the request received by another type of package and the element which receives the data doesn't detect this
1. If the request sent to the transducer has the shape <0xD0, 0x00> then the transducer answers with the humidity value 0xAA, humidity, /humidit, CRC.
2. If the request sent to the transducer has the shape <0xD6, 0x00>, then the transducer answer with the pulse length. In this case the package has 7bytes from the octet L, 6 bytes from the octet H and in position 6 from the octet H it is the byte 7 from the octet L.
3. If the request sent to the transducer has the shape <0xAD, 0x00>, then the transducer locks the acquisitions until a new request of humidity and it answers with the humidity above calculated value
4. If the request sent to the transducer has the shape <0xAE, 0x00> then the transducer answers with the memorised calibration coefficient.
5. If the request sent to the transducer has the shape <0xAF, 0x00> then the transducer answers with the scanning temperature value.
The locking control is given then when it desires to acquire the humidity information, pulses length emitted by EEPROM memory with the goal to check and calibrate the transducer. In order to avoid the locking in normal operation, it must be cancelled immediately when it is requested a humidity information.
If the transducer has "problems" then it answers at all kind of call outside the range, so:
111 – advance- breakdown to the electronics
112 – it has received a request which is not recognized

113 – the error generated in EEPROM memory
114 – the sensor wrong calibration–the found value is out of the range 0-100%.
115 – the temperature sensor is broken down.
116 – the slave has received a wrong package from the transducer.
The code 110 is sent to the master if the slave finds that the humidity transducer doesn't answer.
The main board of measurement system is shown in figure 8.

Figure 7: The main board of measurement system

It was also achieved the software package for the adaptor processor between the humidity sensor and the programmable device and a calibration and configuration application.

4. CALIBRATION OF "SMTHS10" HUMIDITY SENSOR

It was applied WIN 32 for calibration of sensors by means of which it can interact with real devices of the automation system. This application can be deployed on a Microsoft Windows provided computer.
Starting of the execution of this application leads to the display of a splash-screen followed by the program main window (see figure 8).

Figure 8: Main window of the application

The software is made in Visual Basic 6 high level langage, who is paricularity to the industrial application and is easy to used and efficient.
The firs part of the program will allow the PC conected with the numerical equipement, will chek always the corect functionary of all system, testing to receiver informations for warning the user at the tchnical problem or any other problem. The informations will be memored in RAM of PC, beeing in this way availabe for the second part of the program.
For humidity sensor calibration are used a portable equipement wich has an etalon sensor having the first class of precission.
For much better calibration are testing for extreme humidity values (see figure 9).

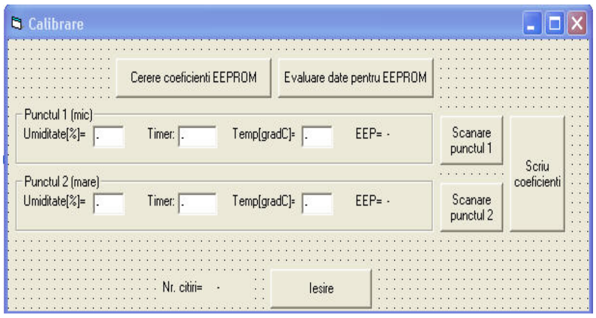

Figure 9: Main window of the application

In the aplication are realised the elimination of temperature sensors erors, the activation and the work with watchdog and also the low voltage equipement reset.

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