# Microcontroller-based system for the greenhouse

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***Abstract*—The microcontroller-based system for the greenhouse microclimate monitoring is presented. The Texas Instruments MSP-430 family microcontroller and temperature sensors TMP100 are used as the basic components. The system also includes power managing system, solar power supply battery and computer as the data processing unit. Wireless SimpliciTI transmission protocol is used for data communication between the greenhouse and computer. An alarm signal is generated and transmitted while the real microclimate parameters exceed predefined limits.**

***Key words: microcontroller; sensors; greenhouse***

## I. INTRODUCTION

Greenhouse is one of essential factors for crop growth and has been widely used all of world. In recent years, the study of crop growth plays an important role in guiding greenhouse cultivation. Most of all, modern and intelligent control technology greatly facilitate high-yield greenhouse. Intelligent control with computer for greenhouse environment is the new fashion compared to controls in engineering such as greenhouse structure, thermal moisture control and so on. [1]

The idea of microclimate monitoring and digital control of the greenhouse using wireless transmission technology was implemented in several solutions [1, 2, 3].

## II. MICROCLIMATE PARAMETERS

The plants are very sensitive to the changes of temperature and humidity. So temperature and humidity are the major controlled parameters of microclimate.

The soil, water and solar energy are important as well in cultivating any plant. Energy for the growing of plants came from the sun [4]. Solar radiation measurements are planned in the further improvements of the discussed system.

## III. SYSTEM ARCHITECTURE AND IMPLEMENTATION

The UML diagrams were used for the system modeling. There are two parts of the greenhouse system. The hardware in the greenhouse communicates with the computer that can be stayed on some distance from greenhouse.

To implement hardware part we have to connect next elements.

- Computer with the first board eZ430-RF2500T. This is the easiest part because we have development tool eZ430-RF2500 with USB connecter.
- The second board eZ430-RF2500T with TPS5423, temperature sensors and power system.

The one board is used as an access point and the second as an end device according to SimpliciTI wireless protocol. The sensors and managing power system must be implemented on the second board.

For the first stage “System design” was designed system architecture presented on the fig. 1.

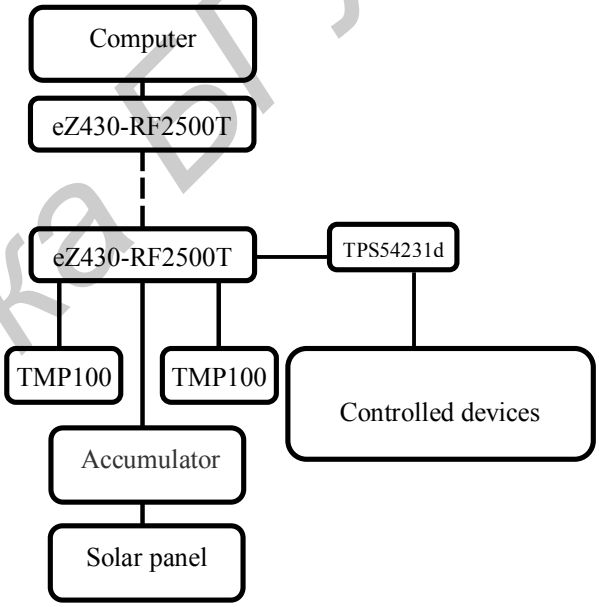


Fig. 1 System components

There are different sensors are in the discussed system. The basic system includes temperature sensors. Humidity is calculated from the readings of dry and wet temperature sensors. In the enhanced system solar radiation sensor will be provided. MSP430 allows to process the data both from digit and analog sensors. In the current project only digit sensors are used.

## IV. SENSORS

The sensors used are LM92 and TMP100. Both of them are digital sensors. The difference is in the LM92 is active and the TMP100 is passive. This means that LM92 can control temperature itself. In the current solution we decide to abandon the LM92 sensors and to use more simple passive sensors TMP100.

The TMP100 (fig. 2) is a passive digital sensor with i2C bus, SOT-23-6 package, that suitable for soldering.

For the humidity measurement two temperature sensors are used.

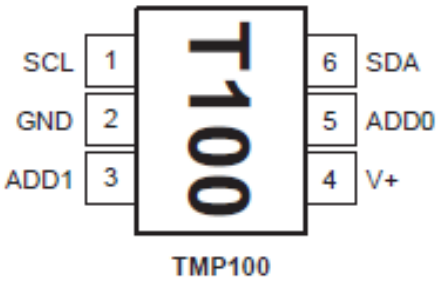


Fig. 2 . Temperature sensor TMP100

The first sensor is in real greenhouse environment and the second is in the humid environment in greenhouse. It can be reached if the second sensor is mounted on a container with water steam. There are psychometric charts based on the difference in temperature measurements. This functional is convenient to realize in the monitoring software on PC.

## V. The eZ430-RF2500 Wireless Development Kit

This development kit allows developers to create high functionality system. The kit contains two eZ430-RF2500T boards, which can communicate together (fig. 3). As a base for program implementation we have used the demo source for eZ430-RF2500 development kit. We have tried to adapt this program to work with sensors. We have also used the MSP430-TMP100 demo for it.

The eZ430-RF2500T uses the MSP430F2274 which combines 16-MIPS performance with a 200-ksps 10-bit ADC and two op-amps and is paired with the CC2500 2.4 GHz multi-channel RF transceiver designed for low-power wireless applications.


Fig. 3. eZ430-RF2500 development kit

The current solution with the eZ430-RF2500T, wireless target board suggests that all data from sensors would be process with software on PC. There are the following actions: getting parameters from sensors, calculating humidity, control parameters for outing of range. Also the user receives information about current processes.

## VI. Testing

The described architecture planning was completed and the system was implemented in hardware. The base equipment hardware includes solar or/and battery power system, TMP100 sensors and the eZ430-RF2500 development kit. After manufacturing the temperature sensors boards the entire system was tested with edited TMP100-MSP430 source example cod. Note that the temperature range accuracy +-3% is not significantly for this project. So we can measure temperature and calculate humidity using the data from the second temperature sensor.

The discussed system allows transmitting the data from sensors to computer, then computer processes given information, calculate humidity using psychometric charts and then provides to operator temperature and humidity values. It alerts the operator if these values exceed predefined limits.

## VII. Conclusion

The Texas Instrument components allow developing a mobile monitoring greenhouse system, that helps to create greatly facilitate high-yield greenhouse on low-cost components.

The basic system includes two temperature sensors TMP100 connected to the first MSP430. The data from dry and wet temperature sensors are transmitted to the second MSP430 and processed in order to calculate humidity. The alarm signal is generated in case of exceeding the installed limits. The current system is flexible and extensible.

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