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DEVELOPING FLEXIBLE AUTOMATION SYSTEMS BASED ON MICROCONTROLLERS OF MSP430 SERIES FOR A DWELLING HOUSE

Summary: In this article the construction of devices for automation dwelling house based on TI MSP430 microcontrollers has been suggested. This device can control the state of the gas boiler via wire and get information via wireless channel. The control program was written in ENERGIA.

Keywords: dwelling house, microcontrollers, automation

WIELOFUNKCYJNE AUTOMATYCZNE SYSTEMY DLA INTELIGENTNYCH BUDYNKÓW Z UŻYCIEM MIKROKONTROLERÓW MSP430

Streszczenie: W artykule opisano budowę urządzań do automatycznego zarządzania inteligentnym budynkiem mieszkalnym. Urządzenie zbudowano stosując mikrokontrolery typu TI MSP430. Takie urządzenie może sterować stanem np. bojlera gazowego poprzez połączenie przewodowe, a także zbierać informacje poprzez kanał transmisji bezprzewodowej. Program sterujący zastał napisany przy użyciu oprogramowania ENERGIA.

Słowa kluczowe: inteligentny budynek, mikrokontroler, automatyka

1. Introduction

Today's digital technologies are distributed into all spheres of human activity. The so-called "smart house» is the most effective and popular system. This system can save

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energy, increase the degree of comfort for the residents and ensure the safety of their homes. The market sells already finished technical solutions in the name of many well-known and lesser-known companies, such as Apple [1] and Samsung [2]. To install such systems one should consult with a representative of the company as to the possibility of installation and maintenance of a particular "smart house" system which complies with the tasks of the customer.
This raises a number of difficulties for the customer, especially if it is related to the adaptation of the existing classical system of providing heat to the house or the need for a simple and reliable security system of the house from outside penetration [3]. Therefore, the authors of the project have proposed the implementing of a small system of smart clothes according to individual requirements of the customer. The main terms of this project are the usage of the available component base, simplicity of the system and its low cost.

2. Implementation

Of course, the basis of the project is a microcontroller. The authors used the processor of Texas Instruments company, based on the launchpad modules. Such a solution allows one to test relatively new developments of TI company [4] which are today the alternative for better-known microcontrollers of ATMEGA and MICROCHIP companies and which compete with them in price policy. Besides, TI microcontrollers are characterized by extremely low energy consumption (more precisely - a flexible balance between productivity and energy consumption) and the ability to generate the code for a microcontroller in an accessible ENERGIA [5] environment. This environment is a complete analog to a known ARDUINO environment with the support of most standard libraries for sensors and data transmission systems.

In this project, the system of remote control of the thermal heating boiler and the protection system of the house were chosen as the automation objects.
In the first part of the project, the authors faced with the task of remote control of the gas boiler, as the boiler is located in the distant place (a basement). The manual mode of its switching-on is inconvenient, especially in the summer mode of its functioning when you need to switch on the boiler to heat the water heater for relatively a short period (about 10 minutes). Exceeding this time limit leads to overheating of the water volume in the boiler and as a result - you have an excessive use of precious energy. The reduction of the time limit leads to insufficient heating of water in the boiler. Besides, sometimes there are cases when due to insufficient gas pressure in the supply system the boiler protection halts its functioning. In this case, the user should press the button RESET on the boiler. The user who is at some distance from the boiler may not know at once when this situation has taken place but can find out about it only when there is no hot water in the tap. This causes the emergence of a number of inconveniences in using the hot-water system in the house.

3. Experimental data

The proposed automation device consists of the following parts: a control module, which is located in a convenient place for the user, wired connection and on / off submodule located near the boiler. In the control module there is a microcontroller itself with a system of operation indicators - sound and LED light, the start button of mode activation and the operating mechanism - relay. The program code for the TI MSP430G2553 [6] microcontroller is created in ENERGIA environment. Testing of the whole device operation was conducted on the original TI prototype board. In the final variant, in order to save space in the casing, the microcontroller is located directly on a single circuit board. The power supply is 12V, it is external.

The device should switch on the relay for a fixed period, with sound indication of the start and end of the process, and the blinking LED that indicates the active state of the boiler functioning. The active state is characterized by turning on of 12V to the wire line via relay contacts. This solution increases the safety of use, because no high voltage on the working elements and wired connection of the device is present. On the submodule, this voltage of 12 V from a wired connection is directly supplied to the coils of the power relay whose contacts directly switch on the voltage of the boiler. This provides control of the gas boiler operation. If you need to go back to the manual mode of operation, the button - switch is proposed which duplicates the relay contacts on the submodule.

The operating circuit is shown in Fig. 1.

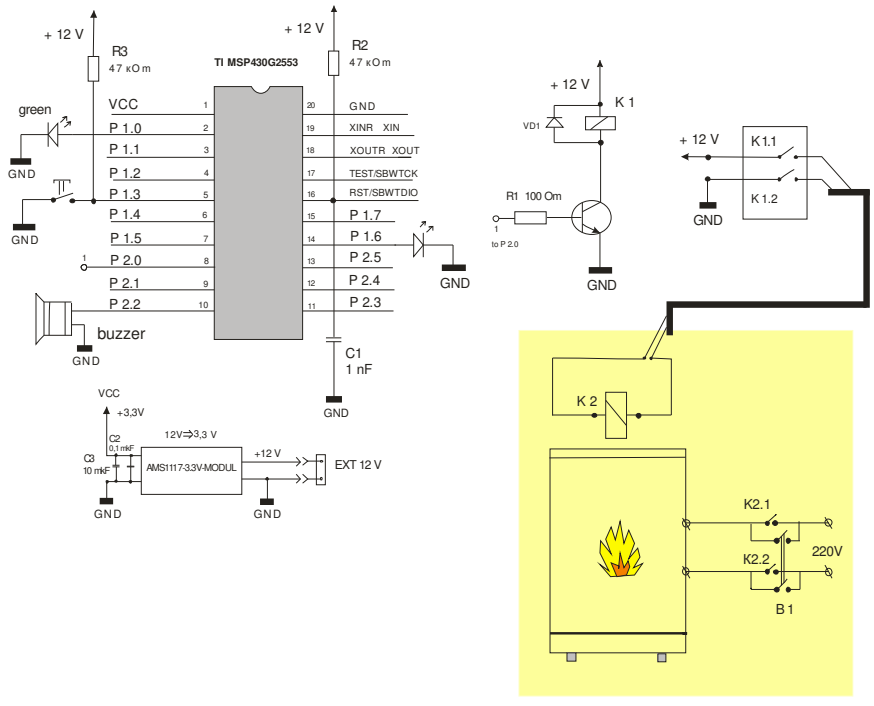

Figure 1. The diagram of device

A picture of the control module with the casing is shown in Fig. 2.

Figure 2. The picture of device in case

The program code for the microcontroller is presented below.

```
const int buttonPin = PUSH2;
const int ledPin = GREEN_LED;
const int led = RED_LED;
int stat=0;
int i=0;
int k=0;
int buttonState = 1; // variable for reading the pushbutton
status
void setup() {
 // initialize the LED pin as an output:
pinMode(ledPin, OUTPUT);
pinMode(led, OUTPUT);
 // initialize the pushbutton pin as an input:
pinMode(buttonPin, INPUT_PULLUP);
digitalWrite(led, LOW);
digitalWrite(ledPin, HIGH);
pinMode(P2_2, OUTPUT);
digitalWrite(P2_2, LOW);
pinMode(P2_0, OUTPUT);
digitalWrite(P2_0, LOW);}
void loop(){
 buttonState = digitalRead(buttonPin);
 if (stat==1) {i=i+1; digitalWrite(led, HIGH); k=1;};
 delay(200);
 if     (i==1)     {digitalWrite(P2_2,     HIGH);delay(400);
digitalWrite(P2_2, LOW);};// start sound
```

```
 if (stat==1 && k==1) {digitalWrite(led, LOW);k=0;};
 if (stat==1) {digitalWrite(P2_0,HIGH );}
 else
 {digitalWrite(P2_0, LOW);};
 delay(200);
 if (stat==1 && k==0) {digitalWrite(led, HIGH);k=1;};
 if (i==3100) {digitalWrite(ledPin, HIGH);digitalWrite(led,
LOW);stat=0;  i=0;  digitalWrite(P2_2,  HIGH);delay(1400);
digitalWrite(P2_2, LOW);};//stop sound
 if (buttonState == LOW) {
 stat=1;
 digitalWrite(ledPin, LOW);
 }
}
```

To control the state of the boiler failure the authors have proposed to use the wireless technology [7]. As this system is indicative, the use of wireless technology is appropriate. For this purpose popular standard NFS2214 modules are used, which allow one to provide a connection up to 50 m under the construction specifications of the house, which is a sufficient condition for this project. Through optocouplers the information about the boiler states is read out from its active light indicators (not presented in this article). This provides the galvanic isolation of input and output circuits of the circuit. After this the high level of signaling (the state indication - boiler failure) is supplied to the input port of the microcontroller, where this state is fixed by the microcontroller program and wirelessly transmitted to the receiving module of the system. The receiving unit, which is built on the same scheme, reflects this state with a luminous and sound signal.

4. Conclusion

So, this development can reliably and efficiently realize the function of remote control of the heating system of the house. In the future, it is planned to carry out the data transmission about the water's temperature in the boiler and present it on the graphic displays of the receiving unit, and also connect the signaling sensor of gas contamination of the premise.

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