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Automatic System for the Wheat Grind Process

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Abstract - This paper intends to present a new constructive, modern and reliable variant, of an automatic system that controls the electrovalves of the filter with aspiration in the technological process of wheat grinding; this variant implies a low cost price and an easy upkeep.
Keywords: technological process, automatic system, lapses of time, electrovalves, microcontroller, program.

I. INTRODUCTION

The aspiration filter, figure 1, is a device placed in the final zone of the technological flux of wheat grinding and has the role of separates and eliminates the particles of dust from the flour. It is made up of a metallic cylinder (1) through which a powerful ventilator aspirates the air and a great number of filterable bags (2) closed at the lower part and open at the upper one. To ensure aerodynamicity and efficiency of the filter, the lower parts of the bags are conical and elastically coupled through springs (6) to the fastening bars (7). The surface between the walls of the cylinder and the open muzzles (3) of the filterable bags is completely obturated, so that the air absorbed by the ventilator cannot circulate through the cylinder (1) unless it crosses the walls of the bags.
The flour, imbued with the partials of dust resulted from the process of decortication of the wheat beans, is stored in the cylinder through the pipe (4) and evacuated through the pipe (5). While crossing the cylinder, the thin and light particles of dust from the flour are driven upwards by the filterable bags, these particles are evacuated outside, in the atmosphere. At the same time, the thinnest flour particles are also driven, and stocking on the outward walls of the bags, obturate them, rendering more difficult or even blocking the process of filtration.
The only way of clearing the aspiration filter without stopping the technological process, is the periodical and successive cleaning of the filterable bags by shaking them with the help of some powerful air jets, injected downwards from the top through the open muzzles of the bags, by some spouts assembled on the distribution pipes (8) connected to the electrovalves (9), coupled, in their turn, to a pressure pipe.

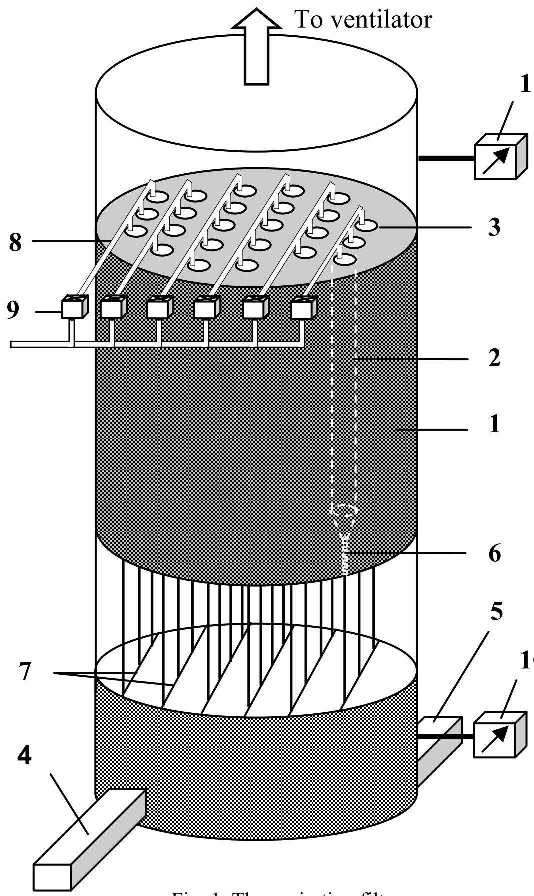

Fig. 1. The aspiration filter

The action of an electrovalve starts the process of cleaning the battery of filterable bags set under the spouts of the respective distribution pipe.
The electrovalves are controlled by an electronic device with microcontroller, according to the fitting cleaning cycle presented in the figure 2.
The adjustable lapses of time that should be considered are:
$t_i = (0,1 \div 1)$ sec. - the duration of action of an electrovalve is the same with the duration of the cleaning air jets of a battery of filterable bags;
$t_p = (6 \div 36)$ sec. – the duration of the pause between the moment of “fall” of an electrovalve and that of coupling of the next electrovalve is the same with the

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duration between the cleaning of two adjacent batteries of filterable bags;

t_c = (36 ÷ 360) sec. – the duration of pause between two successive cycles of action of electrovalves is the same with the duration between two successive cycles of cleaning.

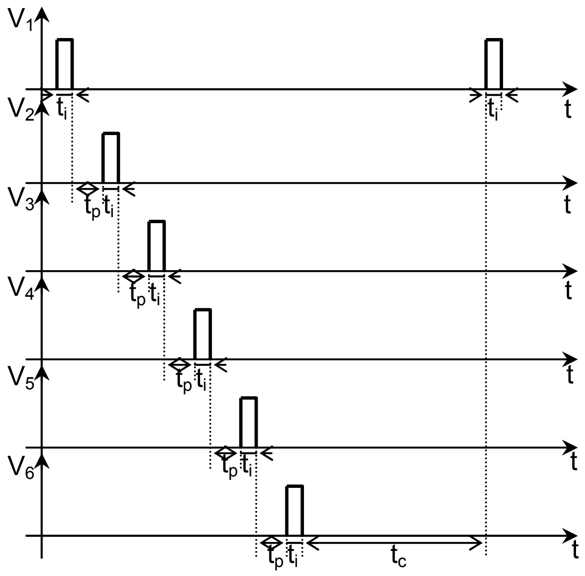

Fig. 2. The control of electrovalves

The adjustment of the three lapses of time is done depending on the flour amount and the differential pressure that has been measured between the entrance and the emergence of the filter by using pressure gauges (10) and (11). The differential pressure gives clear clues about the silting degree of the filterable bags from the aspiration filter, thus allowing the taking of the most propitious decisions regarding the 3 durations mentioned above.

The electrovalves (9) work at a tension of $220V_{DC}$ and consumes a power of 8W each

II. THE AUTOMATIC SYSTEM OF THE CONTROL OF ELECTROVALVES

The block scheme of the automatic system of the control of electrovalves is present in figure 3 and is made up of the following constitutive parts:

- The control block;
- The execution block;
- The display block;
- The supply block.

A. The control block

With a view to eliminating all the disadvantages of the similar existent systems, which use variants of analogical or digital control schemes less competitive from the point of view of accuracy, reliability and display systems, a simple control system was chosen, which is based on the microcontroller AT89C52, a component part which administrates both the control part of the electrovalves and the one of selection and display of the parameters of the working cycle of the electrovalves.

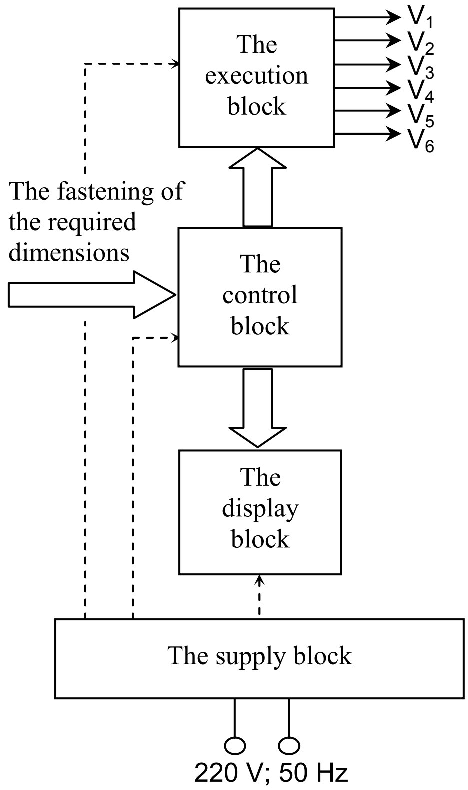

Fig. 3. The block scheme of the automatic system

More precisely, the microcontroller controls the span of the six electrovalves, considering the lapses of time presented in the diagram from the figure 2.

Thus, on initiation, the three lapses of time will be given the minimum values from the working areas (t_i = 0,1 s; t_p = 6 s; t_c = 36 s), following that depending on the development in the technological process, the values of the 3 lapses of time will be altered by the operator with the help of two keys SELection and INCrementation. These two keys represent for the system 2 external interruptions INT0 and INT1. Clap SEL performs the selection of one of the three lapses of time, and INC allows the increase of duration of the selected lapse of time.

The established values are saved into an EEPROM of type 24C02. The communication between microcontroller and EEPROM is made through the serial bus I^2C. The interface with the control unity is made through four special registers: S1CON (control register), S1STA (state register), S1DAT (data register), S1ADR (address register).

The control emergences of the electrovalves OUT1, …, OUT6, are directed by the port P0, port I/O bidirectional of eight bits, having the drainpipe emergences idly.

The microcontroller generates signals for the display block, to SEGM A, …, SEGM G and ANODE 1, …, ANODE 7, making a multiplexed display of seven digits. The signals ANODE 1, …, ANODE 7, select a digit with the common anode, and SEGM A, …, SEGM G, generate the figure on that digit.

The general electric scheme of the control block is presented in figure 4.

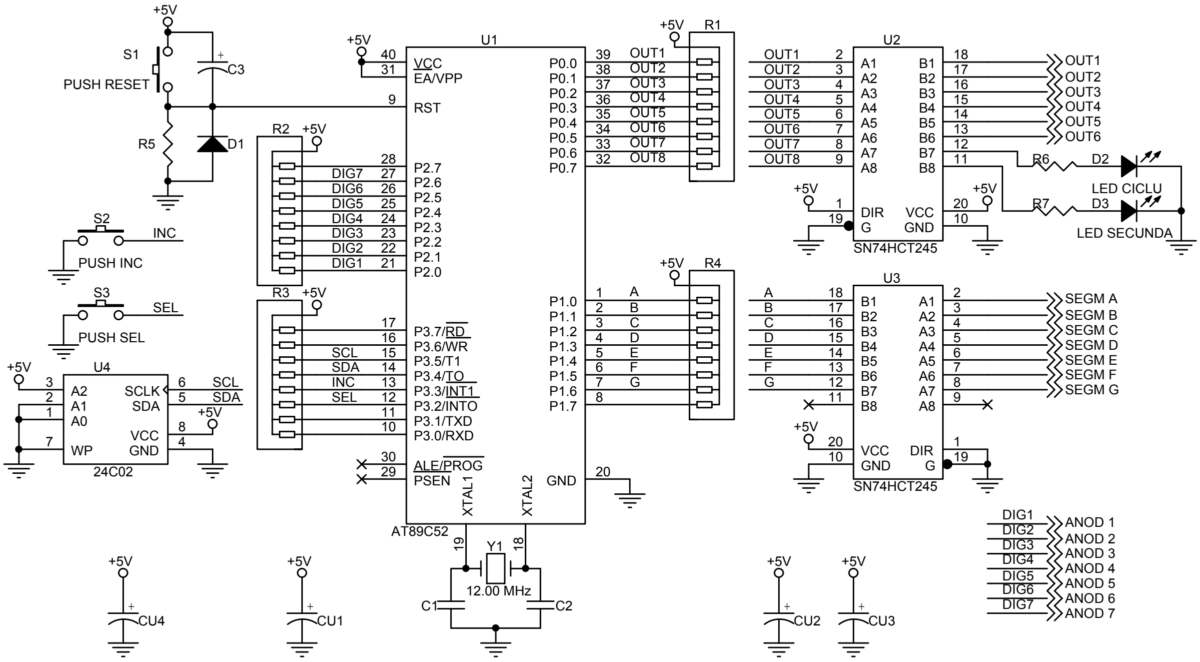

Fig. 4. The control block

B. The execution block

The execution block is formed of six identical sections, one for the action of each electrovalve. The electrical scheme of a section i, with i = 1, 2, …, 6 is presented in figure 5.

At the level of each section of the execution block a very good galvanic isolation is made between the control part and the power part through the optocoupler ISO1 – PC817, whose transistor has the collector polarized by the parametrical stabilizer DZ_i, R_{10i},.

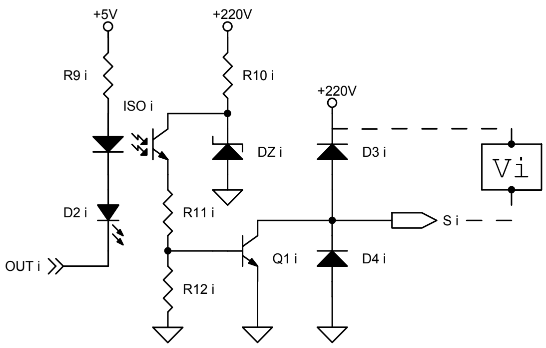

Fig. 5. The electric control scheme of one of the six sections of the execution block

For the entire duration of the control impulse, signalized by the LED D_{2i}, through the transistor of the optocoupler will circulate a current which will generate a tension fall on the resistor R_{12i} sufficient for the saturation of the transistor Q_{1i}. As a result, the electrovalve V_i will couple, allowing the transmission of a powerful air jet in the corresponding battery of filterable bags.

Transistor Q_{1i} is of the type BUT 11 AF, allows a collector-emitter tension of V_{CEmax} > 450V and a maximum collector current of Ic_{max} = 5A.

Diodes D_{3i} and D_{4i}, of the type 1N 4007, have the role of protecting the transistor Q_{1i} in the moment of shutting off.

C. The display block

The display block is formed of seven identical sections, one each seven-segment digit used. The electric scheme of a section i, with i = 1, 2, …, 7, is presented in figure 6.

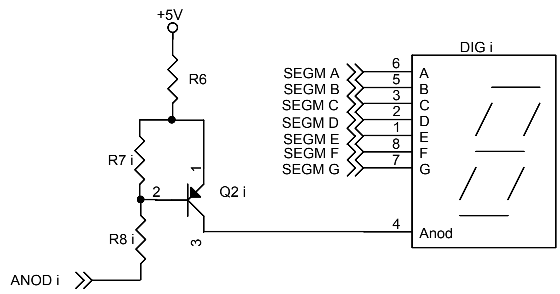

Fig.6. The electric control scheme of one of the seven sections of the display block

The use of seven display digits is justified by the total number of the figures used in the display of durations of the three lapses of time from the control cycle of the electrovalves, presented in figure 2.

Thus, the duration t_i of action of an electrovalve, may vary between 0,1 sec. and 1 sec., so it will need two display digits which will indicate the values 0.1, 0.2, …, 0.9, 1.0, the point being permanently activated, without control.
For displaying duration t_p = 6, ..., 36 sec. another two digits are necessary, and for t_c = 36, ..., 360 sec., another three digits are needed.
These seven digits are parallel connected, segment by segment, and successively activated by the emergences of the port P2 of the microcontroller. The activation of a digit coincides with the appearance at the emergence of the buffer SN74HCT245 of a logical combination corresponding to the figure that must be displayed on the respective digit.
Thus, a display cycle of the seven figures will be formed of seven steps; within each step the buffer releases just one logical combination, and the microcontroller activates only the digit that must display it.
The activation of a digit is done by transmitting a lower potential at the entrance of the scheme from figure 6, having as a result the saturation of the transistor Q_{2i} and the supply of the respective digit anode.
In conclusion, the display block works multiplexed, the frequency of work being chosen so that the figures periodically visualized on the seven digits persist on the retina, as if it were a continuous display, without flickers.

D. The supply block

The electrical scheme of the supply block, figure 7, contains a circuit for the supply of the execution part and one for the supply of the control part.
The supply circuit of the execution part, formed of the bridge rectifier P_1 and the filtering condenser C_1, generates a tension of 220 V_{DC} needed for the supply of the electrovalves.

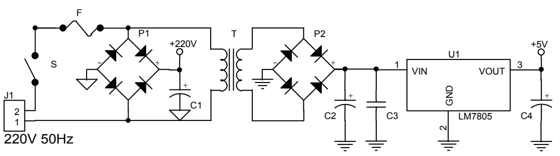

Fig. 7. The electrical scheme of the supply block

The supply circuit of the control part consists of a bridge rectifier P_2, a filtering circuit formed of the condensers C_2 and C_3 and a stabilizer U_1 of a type LM7805, which generates a tension of 5 V_{DC} needed for the supply of the control circuit.

III. THE PROGRAMMING OF THE MICROCONTROLLER

The programming of the microcontroller is achieved in assembly language as in C language.
The code source resulted from the compilation of the created program is taken down in microcontroller AT89C52 memory of program with the help of a specialized developer. The program was created after the algorithm presented in figure 8.
In order to control the electrovalve as in diagrams presented in figure 2, are necessary the many more step of associative programming.

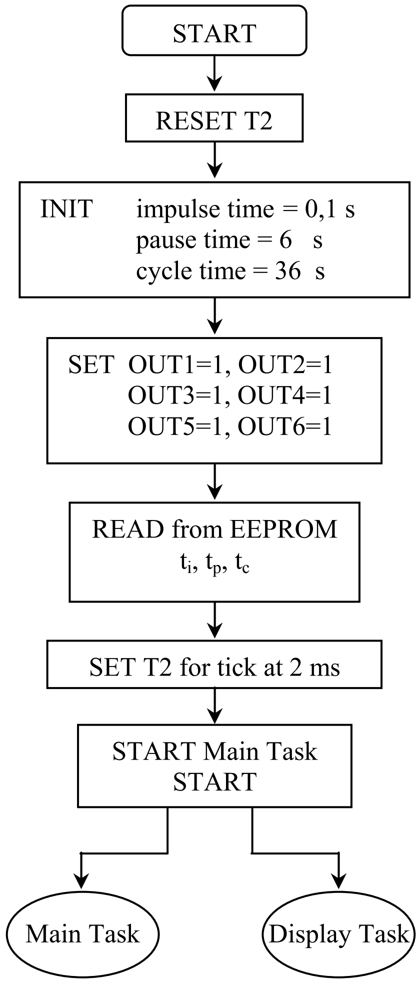

Fig. 8. The algorhythm of program

First, the T2 timer of microcontoller is reset, it is utilized for generating the tick of 2 ms used to establish times of command and for their multiplexed display these on the screen. The two registers T2H and T2L at the T2 timer are initialized with the value 0000h.
The three lapses of time are initialized to the minimum values (time_impuls = 0,1 sec., time_pauza = 6 sec., time_ciclu = 36 sec.) and the outs are set so that no valve could be commanded (OUT1 = … = OUT6 = 1), and so avoiding an abnormal function of the command system and of the filter with aspiration in the moment of coupling the supply power and of starting the process of production.

The microcontroller reads from EEPROM the values previously saved, for the three lapses of time.
Therefore, the bus serial I2C is activated between the microcontroller and EEPROM, the signal of the clock on bus, SCL is established and the saved dates, SDA are received.

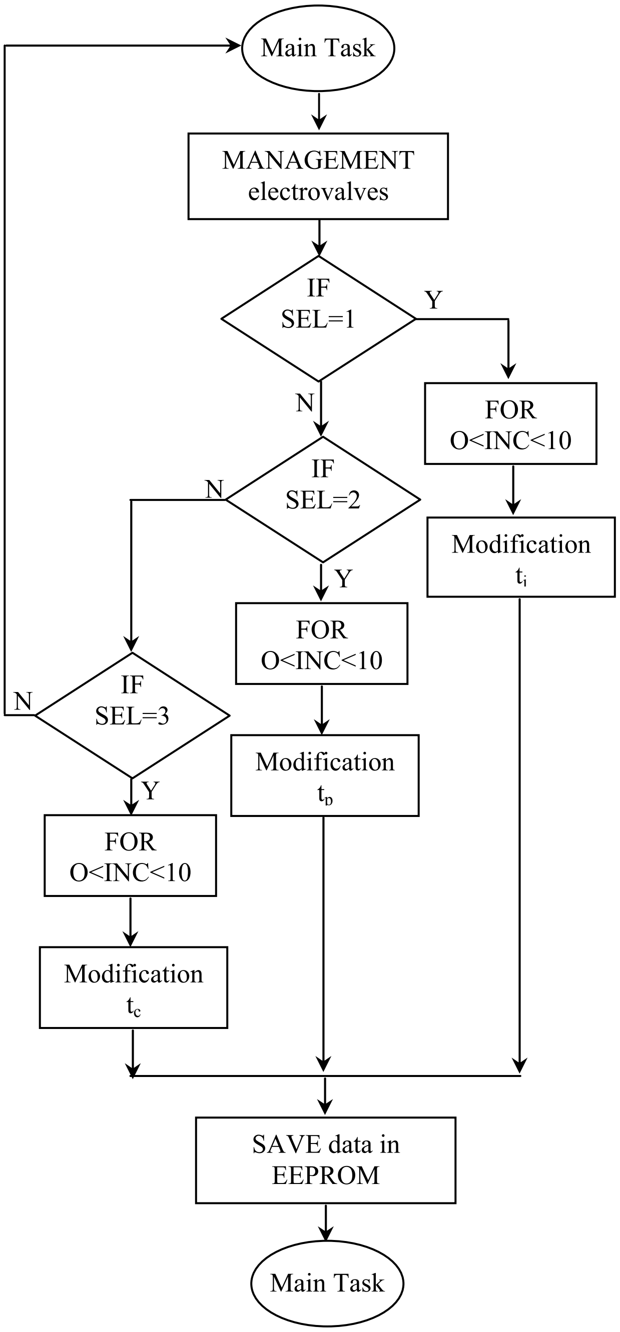

Fig. 9. The algorhythm for Main Task

The microcontroller allocates for the three lapses of time a number of seven bytes. For t_i are allocate two bytes, to addresses 0 and 1; for t_p, a number of two bytes to addresses 2 and 3; for t_c a number of three bytes to addresses 4, 5 and 6 from the data memory.

The T2 timer is set, by loading the two registers with the values T2H = 0F8H and T2L = 30H, to generate the tick of 2 ms, starting thus the T2 timer.

The two tasks of the program Main Task and Display Task are started.
In Main Task there are the order instructions for electrovalves, for examining the two external interruptions INT0 and INT1, if they were highlighted or not for modifying the intervals of time t_i, t_p and t_c, if the keyboard is acting (that is if one or both interruptions INT0, INT1 are activated) and the dates saved in EEPROM. The algorithm for Main Task is presented in figure 9.
The procedure for the control of electrovalves is described in the next sequence; and it is written in language C.

```
void management_electrovalve(void)
{  switch(status_cmd)
   { case 0x00:
        if(counter_command>=impulse time)
        { OUT1=1;   counter_command=0;
          status_cmd++; }
        else
        { OUT1=0;   counter_command++; }
        break;
     case 0x01:
        if(counter_command>=pause time)
        { OUT2=0;   counter_command=0;
          status_cmd++; }
        else
        { counter_command++; }
        break;
     case 0x02:
        if(counter_command>=impulse time)
        { OUT2=1;   counter_command=0;
          status_cmd++; }
        else
        { OUT2=0;   counter_command++; }
        break;
     case 0x03:
        if(counter_command>=pause time)
        { OUT3=0;   counter_command=0;
          status_cmd++; }
        else
        { counter_command++; }
        break;
     case 0x04:
        if(counter_command>=impulse time)
        { OUT3=1;   counter_command=0;
          status_cmd++; }
        else
        { OUT3=0;   counter_command++;  }
        break;
     case 0x05:
        if(counter_command>=pause time)
        { OUT4=0;   counter_command=0;
          status_cmd++; }
        else
        { counter_command++; }
        break;
     case 0x06:
        if(counter_command>=impulse time)
        { OUT4=1;   counter_command=0;
```

```
        status_cmd++; }
      else
      { OUT4=0;   counter_command++; }
      break;
    case 0x07:
      if(counter_command>=pause time)
      { OUT5=0;   counter_command=0;
        status_cmd++; }
      else
      { counter_command++; }
      break;
    case 0x08:
      if(counter_command>=impulse time)
      { OUT5=1;   counter_command=0;
        status_cmd++; }
      else
      { OUT5=0;   counter_command++; }
      break;
    case 0x09:
      if(counter_command>=pause time)
      { OUT6=0;   counter_command=0;
        status_cmd++; }
      else
      { counter_command++; }
      break;
    case 0x0A:
      if(counter_command>=impulse time)
      { OUT6=1;   counter_command=0;
        status_cmd++; }
      else
      { OUT6=0;   counter_command++; }
      break;
    case 0x0B:
      if(counter_command>=cycle time)
      { OUT1=0;   counter_command=0;
        status_cmd=0;
        set_led_cycle(); }
      else
      { reset_led_cycle();
        counter_command++;}
      break;
} }   }
```

The modification of the lapses of the command time is achieved as follows.

Once to 2 ms, the two external interruptions INT0 and INT1, connected to two keys SEL and INC are interrogated. The selection of the time lapses duration is done by pressing consecutively the keys SEL: SEL = 1 for t_i, SEL = 2 for t_p and SEL = 3 for t_c. The modification of the duration of the selected time lapse is done by pressing the key INC. Thus, for one pressure, the new time value will be: $t_i = t_i +$ time_impuls or $t_p = t_p +$ time_pauza or $t_c = t_c +$ time_ciclu.

If one of the three durations has touched the maximum value, then, at a new pressure of the keys INC, the duration will receive the initial value. The process is repeated in a curle till no key is pressed.

The dates thus modified are saved in EEPROM through bus I^2C.

In Display Task there are the activating instructions for the screen and for the multiplexed display of seven digits, with the value saved in each of the seven bytes of the addresses 0 to 6 from the data memory. The algorhythm for Display Task is presented in the figure 10.

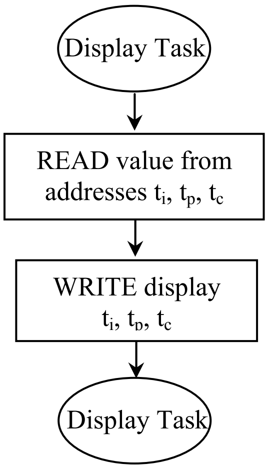

Fig. 10. The algorhythm of Display Task

IV. CONCLUSIONS

The utilization of the microcontroller in this present application represents a solution which substantially reduced the number of electronics component parts, and also the cost of projecting and developing the product. Nevertheless, however advanced the microcontroller were, some external component parts could not be excluded. These are the component parts of interface with the outside environment, which, in out case, are represented by optocouplers, transistors of power, display elements, etc.

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