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NUMERICAL SYSTEM FOR TEMPERATURE MEASURING

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ABSTRACT:
Temperature should be supervised and/or regulated. Such processes happen in all industrial domains and the main purpose for that is to find out the most appropriate thermal flow during a technological process, to find the use of thermal energy, to evaluate and reduce any loss through the warmth transfer, to ensure and maintain some climate conditions during production, storage and transport stages, etc.
Temperature values that should be measures vary within some large limits: 0°C - 3500°C.This paper comes up with an original measuring method of the temperature 0…100°C. The preciseness of the measuring system is highly rated.
KEYWORDS: temperature, measuring, system, conversion

1. INTRODUCTION

Temperature represents one of the most frequently measured in very many domains, because most of the physical, chemical, biological, natural or artificial processes also contain some thermal phenomena.

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2. BLOCK SCHEME OF MEASURING SYSTEM. CIRCUIT CABLES. WORKING PROCESS

This paper work comes up with an original measuring method of the temperature 0…100°C. Figure1 represents the block scheme of the measuring system and figure 2 represents the circuit cables.

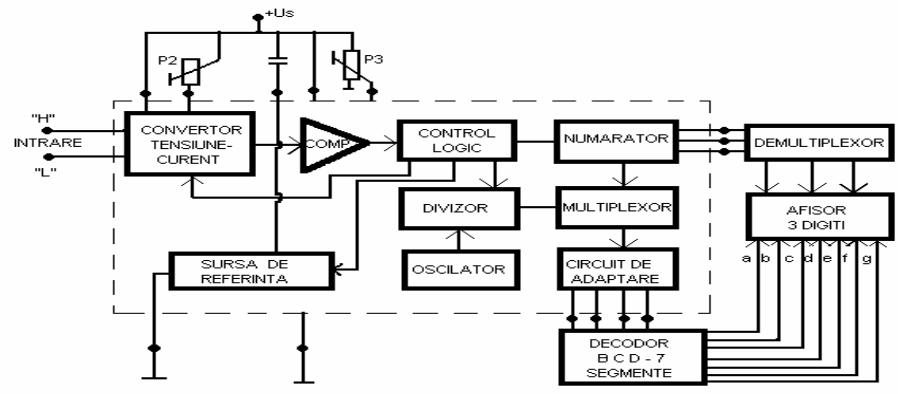

FIGURE 1. The block scheme

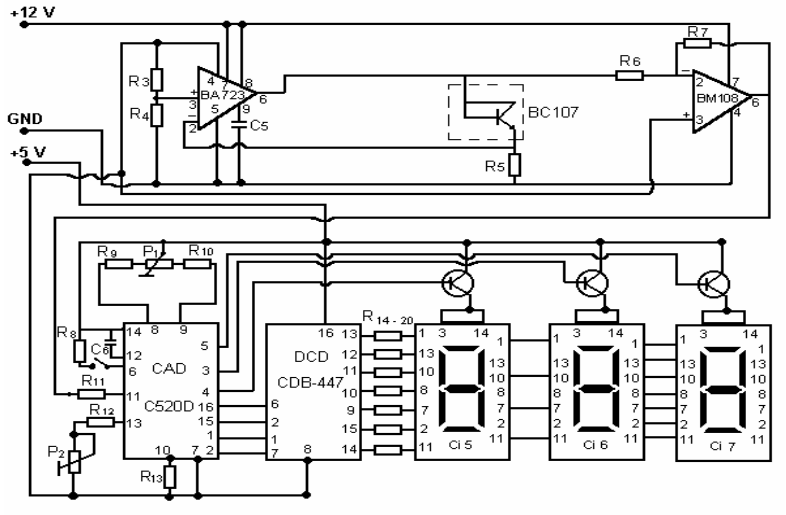

FIGURE 2. The circuit cables

Transistor T2 is the temperature sensor. We have used the famous property – tension – that stresses a half-conducting junction, and it varies along with the temperature (dV_{BE}/dT=-2,2mV/C). We used a transistor that produced a short circuit with the basic collector (we preferred a transistor inside a metal capsule, and the thermal constant value of the capsule was lower, in order to decrease the measuring inertness).

Integrator circuits that make up this block are fed with 12V. CI_1 is a type- βA723. This integrator ensures a constant value of the electric flow through T_2 , and low output impedance meant for performing the next stage.

We can see that the element T_2 (temperature sensor) is installed in between the output and the change-over switch input (pin 2). The non–reverser input (pin 3) is polarized to a constant potential (reference tension 7,15V from pin 4 divided with R_3-R_4). Reference tension (7,15V) is connected to the second source (of 5V).

Output tension of CI_1 - βA723 is applied, with the help of R_6, to the reverser input of the operational amplifier CI_2, installed into the reverser connection. CI_2 is a type- βA108A, the operational amplifier with a reduced thermal derivation. This AO is very precise and it has some polarizing electric flows and reduced offset tension in order to avoid offset compensation.

In the following, we shall refer to the measuring mechanism for the analogical thermometer: the more the temperature is increased, the lower the tension is – in case of T_2 junction, it decreases with 2,2mV, with each Celsius degree. So, the tension to the reversing input of the CI_2 decreases (pin 2) with the help of R_6, because of this tension on junction T_2 and of the low tension on R_5 (because it is constant, and the resistor is crossed by a constant electric flow).

The non-reversing input of CI_2 (pin 3) reaches a constant potential (potential $U_{REF.}$=7,15V who is common to the board of the second source).

In case of positive temperatures, the input tension CI_1 (pin 6) is always smaller than the tension of the non-reversing input of CI_2 (pin 3). So, the output CI_2 (pin 6), shall be positive: somewhere in between 0V at 0°C and 100mV at 10°C.

Due to a linearly functioning of the variation of the tension break on the half-conducting junction with the temperature, the calibration is made in case the temperature reaches in between 0°C and 100°C. It should obtain it to $CI_2$the output – pin 6 -, 0V at 0°C and 1000mV at 100°C, referring to the board of 5V source. The input signal (pin 11), through R_{11} reaches values between 0mV and 1000mV (corresponding to 0° and 100°C). In case of the output (pin 1, 2, 15, 16), we obtain it trough the signal – code BCD, used in case of CI_4, in case of input 1, 2, 6, 7. A CI_4 circuit is a decoding device BCD - 7 segments. We obtain a certain signal at output and we use it through the group R_{14}÷R_{20} , to the three boards - 7 segments.

The reduced multiplex circuit on the block-scheme is produced with the help of T_3, T_4 and T_5.

3. DESIGNING THE COMPONENT BLOCKS. CHOOSING THE NUMERICAL ANALOGIC CONVERTOR

The numerical analogical conversion is made with the help of the integrator circuit C520D. This has multiplex inputs of 3 digits (-90…000…999). It is compatible pin by pin with the integrator circuit CA3162 (E) and it has the following main features:

- Conversion A/D double slope;
- Internal reference tension source which is highly stable – type "band-gap";
- Differential input;
- Internal clock generator – it does not need an external "clock";

We can choose the type of conversion: SAMPLE with low speed (4Hz) or with high speed (96Hz) and HOLD, who keeps up the displayed information;

- High-efficiency multiplex operation;
- Highest allowed parameters:
- Highest feeding tension (between the terminals 7 and 14): +7V;
- Highest input tension (terminals 10 and 11 //la mass): = 15V.

Fig.3 represents the internal structure in the blocks of the integrator C520D (CA3161E).

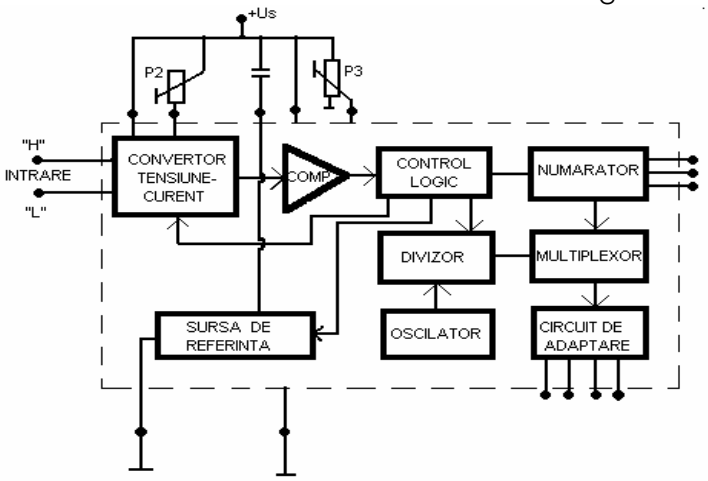

FIGURE 3. The internal structure of the integrator

We are able to see the following functioning blocks:

A precision converter tension-current at the input, who generates the current for charging the integrating condenser (external) connected to pin 12 at V_{cc}. The tension-current converter has a differential input: "INPUT HIGH" (pin 11) and "INPUT LOW" – therefore it is meant for coupling to sources of an analogical signal with differential output (for instance, temperature, pressure, humidity, gas, light – with a bridge structure). Usually, it is used the input "INPUT LOW" connected to the board; some of them are "INPUT HIGH" and its impedance of the input is up to 100M. This level has an external control circuit of the offset (a half-controllable precision device, situated between pin 8 and 9, and whose value is not critical).

A current reference generator device is meant for loading the integration condenser, and it is connected at the input to the internal precision reference source - type "band-gap" -, which is externally controlled, within some low limits, with the help of a half-controlling precision device, whose value is not critical - (2,5K…10K)-, connected to pin 13. Then, the next element is a limit detector, a concerting block, who sends some command impulses to the numerical block who controls the circuit. It also contains an internal oscillator with two dividing circuits and a driver block for multiplex board.

There is also an analogical block with controlled gates, who allow the control of the conversion module. When we use a tension between 0V and +5V on pin 6 (Sample/Hold), we

can obtain 3 working methods: Sample on 96Hz/Sample on 4Hz/ Hold (the change is stopped, but it keeps the same information on the board).

The configuration of the pins C520D is the one described in the figure 4. Pin 4 MSD is the most important digit, while pin 5 LSD is the less important digit.

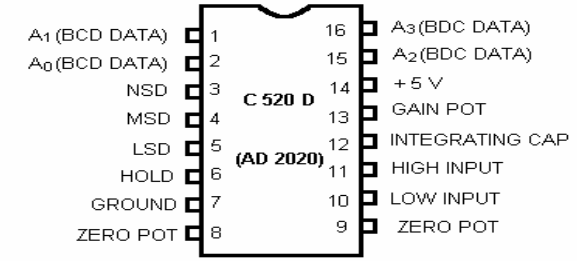

FIGURE 4. The configuration of the pins

4. CHOOSING THE 7 SEGMENTS-BOARD DRIVER

The digital board block is made up by the integrator MMC4511 and 3 digits where the tensions are displayed. The integrator MMC4511 is a digital circuit of general use meant for commanding a display LED-board (a digit –7 segments). It is made up by a mixed technique - CMOS (digital logics) and non bi-polar transistors (command outputs).

Functions:

- it ensures the command for activating the seven lit segments of a LED-display, according to the state of the inputs;
- it enables the command with the help of the commands received from the 7 inputs; 4 command-inputs (BCD inputs) and testing-inputs, to blank and validate the command.

Main parameters:

- exit/output current - max 25mA;
- input latches for memorising the BCD-codes;
- typical propagation time 210ns for U_a=10V;
- functioning temperature - 0..90°C.

Block scheme:

The internal structure of the integrated circuit has the block scheme presented in fig. 5:

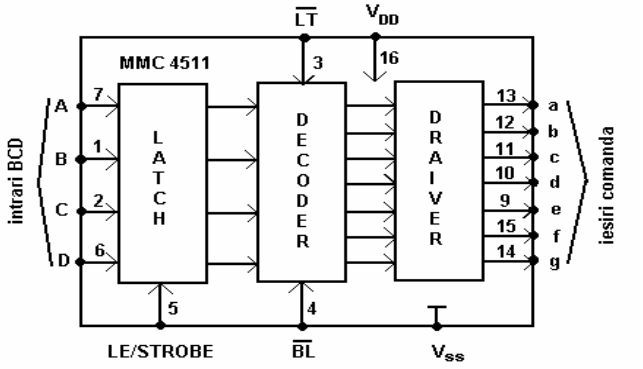

FIGURE 5. The block scheme of internal structure

The meaning of the terminals is:
- 1,2,6,7- BDC inputs (A,B,C,D);
- 3 – testing board input; LT-lamp test;
- 4 – out-input (blanking); BL-blanking;
- 5 – in/validation input; LE/STROBE - latch enable or strobe;
- 8 – general board;
- 9..15 – command outputs with corresponding LEDs: a/13, b/12, c/11, d/10, e/9, f/15, g/14;
- 16 – feeding input for continuous current (V_{dd}).

Capsule: The integrated circuit MMC4511 is inside the plastic capsule type - DIL16.

Table:

CONTROL			INPUTS				OUTOUTS							DISPLAY
LE	BL	LT	A	B	C	D	A	B	C	D	E	F	G	
*	*	1	*	*	*	*	1	1	1	1	1	1	1	8
*	1	0	*	*	*	*	0	0	0	0	0	0	0	Blanc
0	0	0	0	0	0	0	1	1	1	1	1	1	0	0
0	0	0	1	0	0	0	0	1	1	0	0	0	0	1
0	0	0	0	1	0	0	1	1	0	1	1	0	1	2
0	0	0	1	1	0	0	1	1	1	1	0	0	1	3
0	0	0	0	0	1	0	0	1	1	0	0	1	1	4
0	0	0	1	0	1	0	1	0	1	1	0	1	1	5
0	0	0	0	1	1	0	0	0	1	1	1	1	1	6
0	0	0	1	1	1	0	1	1	1	0	0	0	0	7
0	0	0	0	0	0	1	1	1	1	1	1	1	1	8
0	0	0	1	0	0	1	1	1	1	0	0	1	1	9
0	0	0	0	1	0	1	0	0	0	0	0	0	0	Blanc
0	0	0	1	1	0	1	0	0	0	0	0	0	0	Blanc
0	0	0	0	0	1	1	0	0	0	0	0	0	0	Blanc
0	0	0	1	0	1	1	0	0	0	0	0	0	0	Blanc
0	0	0	0	1	1	1	0	0	0	0	0	0	0	Blanc
0	0	0	1	1	1	1	0	0	0	0	0	0	0	Blanc
1	0	0	*	*	*	*	NON DETERMINATION							

Non-determination = the state of the output according to the last code used when LE=0.

The integrator MMC4511 could be fed to a continuous tension, whose values are situated between 5…15V. For it should be work as best as it can, 5 is connected to the first board, meanwhile pin 3 and 4 are connected to V_{dd}.

5. CONCLUSIONS

The system is a numerical system meant for measuring the temperature within the limits 0…100°C, and by using a specific measuring method. The preciseness of the measuring system is highly rated.

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