UDC 681.2.083

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Automated system of environment thermal and moisture state control

Research presents system that allow to measure temperature and humidity of controlled environment at the same time with single measuring system and sensing element using environments own thermal noise.

In the dampish environment always present electrical charge carriers (free electrons, ions, holes).In the process of environment heating movement speed of these charge carriers increases and electrical thermal noise appears. It's intensity increases with the increase of the temperature. Increase of environments humidity results in change of its electrical resistance that also effects the thermal noise intensity. According to this thermal noise can be used as the informative parameter for estimation of environments temperature and humidity [1].

On the base of existing devices [2, 3] was designed the new automated system of environment thermal and moisture state control shown in figure 1.
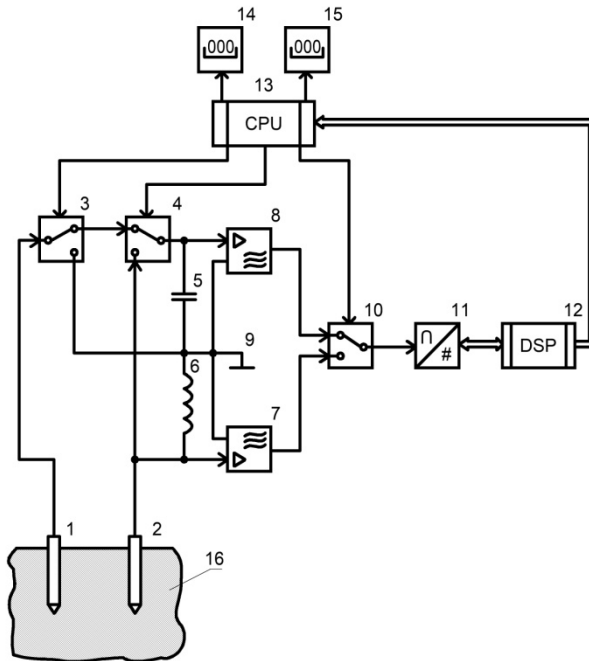

Fig. 1. Automated system of environment thermal and moisture state control

Electrodes 1 and 2 are placed directly into the environment. Output of automatic switch 3 connected with electrode 1. First output of automated switch connected with the input of automated switch 4 second output is connected with the junction between capacitor 5 and inductance coil 6 which form the oscillatory circuit. Second input of automated switch 4 is connected with electrode 2, end of inductance coil 6 and high potential input of wide band amplifier 7.Output of automatic switch 4 is connected with capacitor 5 and high potential input of wide band amplifier 8. Low potential inputs of wide band amplifiers 7 and 8 are connected with common ground 9. Outputs of these amplifiers are connected with inputs of automatic switch 10. The output of switch is connected to the input of digital signals processor (DSP) 12 via the analog to digital converter (ADC) 11. Output of DSP is connected to the input of microprocessor (CPU) 13.Logical outputs of the CPU are connected to the control inputs of automatic switches and the digital outputs are connected to digital indicators 14 and 15 where the values of measured temperature and humidity are displayed.

Position 16 marks the controlled environment.

Electrodes receive the electric thermal noise from controlled environment. These signals pass through the automatic switches to the oscillatory circuit. According to the program stored in the CPU at the first stage automatic switches 3 and 4 are switched to the upper position (see fig. 1). Electrodes gets connected to the serial oscillatory circuit. That operates in short circuit mode. In this mode thermal noise is determined only by the inner electrical resistance of the environment.

Voltages on the capacitor and inductance coil are determined only by the short circuit current.

Noise voltages from the output of oscillatory circuit are amplified by the wide band amplifiers and alternately transmitted to the input of ADC through the automatic switch and transformed into the digital signals. Own noises of the amplifiers are also amplified and converted to the digital form. These digital signals are transferred into the CPU where in accordance with the program are processed by the correlation algorithm. Thermal noise signals are correlated because they originate from the one source. At the same time amplifiers own noises are non-correlated so such processing allows to eliminate them from the resulting digital code. Frequency of automatic switch 10 operation is set 5 – 10 times less than the resonance frequency of the oscillatory circuit. Resulting code N_1 is stored in the CPU memory.

At the next stage automatic switches 3 and 4 are switched into the lower position and oscillatory circuit is transforms into the parallel configuration. Parallel oscillatory circuit has grater electrical resistance in comparison with the electrical resistance of controlled environment so the thermal noise source begins to operate in the idle mode and mean square voltage reaches the value of idle voltage.

Noise voltage after the similar conversions is stored in the memory of CPU as the digital code N_2.

The third stage is the processing of codes N_1 and N_2. First operation is the division of code N_2 on the code N_1 and taking the square root from it. Result is stored as N_3 code that is proportional to the value of environment electrical resistance R_x. Resistance R_x is corresponding with the humidity W by the logarithmic

law that is represented by the calibration curve stored in the CPU memory. Calculated value of humidity is displayed at digital indicator.

By taking the square root from the product of codes N_1 and N_2 we will get code N_4 that is equal to the measured value of temperature T_x that is displayed on the second digital indicator.

In order to exclude the influence of measuring scheme component parameters instability it is necessary to perform calibration in the environment with known temperature and humidity. Results of such calibration are stored in the CPU as calibration codes N_3'andN_4'.

Conclusions

Designed system allows to measure to parameters of controlled environment at the same time using only one sensitive element – pair of electrodes. Absence of probing current from external source through the environment excludes the inevitable local heating. Digital output allows to incorporate the system into bigger automatic systems as the information source.

Proposed system can also be useful to control of temperature and humidity of flammable and explosive materials because of absence of local heating and sparks. It can be used to control the temperature and humidity if medicines because it has no probing currents which can cause electrochemical dissociation.

References

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