METHOD FOR DESIGN OF SYSTEM FOR THERAPY USING „RANDOM" RUNNING LOW FREQUENCY MAGNETIC FIELD

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Abstract

The systems for magnetotherapy, which use "running" low frequency magnetic field, are new generation of systems for magneto therapy. It is well known that familiarization of patients with parameters of external influence is a big disadvantage of systems for physiotherapy. This problem can be avoided with systems for low frequency magnetic field by moving the magnetic field around the human body. The possibility for simultaneously influence of "running" low frequency magnetic field on different part of the human body is one additional advantage of systems for magneto therapy. The basic requirements and method for design of above mentioned system for magneto therapy is described in the paper.

1. Introduction

The main component of the systems for magneto therapy using low frequency magnetic field is digital controlled generator for rectangular electrical impulses with special parameters.

The use of digital elements with programmable logic offers greater flexibility, economy and more functions in one system. The data which pass through various digital modules can be saved in memory, subject to various digital processing, and also can be displayed on digital display. In the design of pulse generators can be used and one-chip microcomputers, characterized by low consumption and a limited number of external components. Programmable logic of one-chip generators is a great advantage over the basic generators. Any functional change can be implemented easily without any hardware changes (making a new board, adding/replacing components).

2. Theoretical solution of the system for magneto therapy by therapy "running magnetic field"

The system for low frequency magneto therapy with the "running wave", the subject of this paper is achieved through a successful combination of analog and digital elements. Digital control of the system is implemented thanks programmable microcontroller.

The output impulses from the microcontroller are close to perfect rectangular signals with extremely short falling and rising edges. This allows easy and extremely precise control of analog components connected to the microcontroller, and accurate control of output signals for the system. The block diagram of the system for magneto therapy by a "running" low frequency magnetic field is shown in Figure 1.

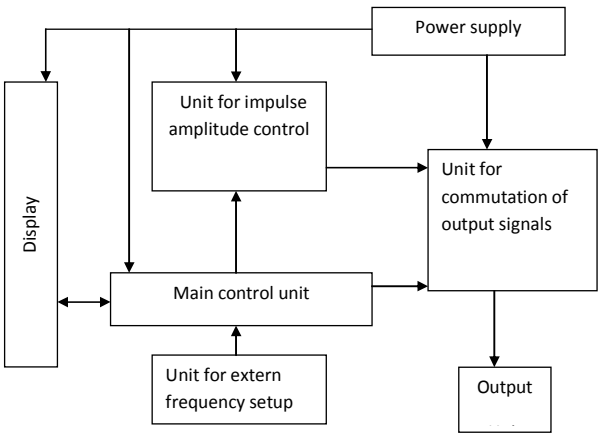

Fig. 1. Block-diagram of systems for magneto therapy with "running" magnetic field

There are seven functional blocks. Principle of operation of each of them will be discussed in details below. Working modes of therapy system can be described as follows: The output of the Main control

unit generates series of rectangular digital impulses to the Unit for commutation of the output signals. Amplitude of the output signals of the systems is determined by the Unit for amplitude control. External user control of the working frequency is possible thanks to Unit for external frequency control. There are also liquid crystal displays for visualization of the parameters of output pulses for the system in real time.

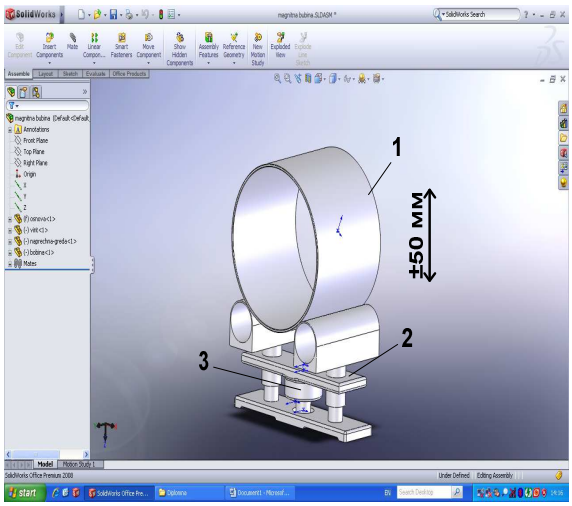

Fig. 2. Apparatus for magneto therapy with one girdle coil

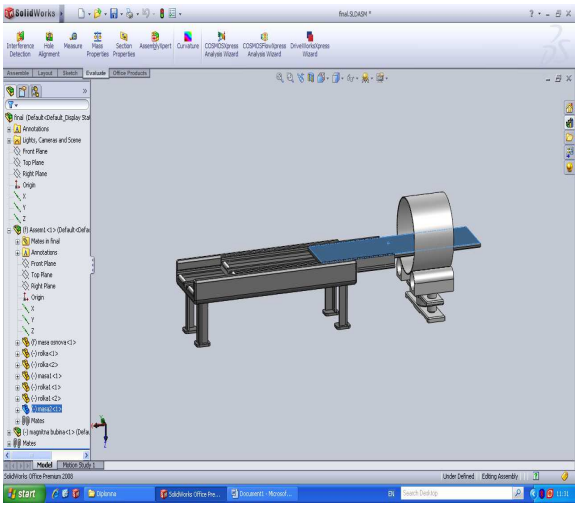

Fig. 3. Apparatus for magneto therapy with one girdle coil put on bed

This system can be build as apparatus for magneto therapy which outputs are connected with one girdle coil (Fig. 2). The girdle coil can be put on the bed for magneto therapy (Fig. 3)

3. Basic components of system for magneto therapy by "running magnetic field"

Main Control unit:

The main control unit is the most important part of the system and has to and control the working modes and to analyze signals form the "*Unit for amplitude control block*", "*Unit for commutation output signals*", "*Unit for extern frequency setup*". This block is responsible for: the time for generating periodic pulses, the maximum operating frequency, amplitude and rate of filling of the system output signals. The change the operating mode of this module is possible by detecting the signals coming from "Unit for external frequency setup".

The main control unit is based on programmable microprocessor, with uploaded suitable firmware on it.

Real-time monitoring of the status of the different working modes of the system is possible thanks to installed digital liquid crystal display.

Created software for the processor allows generation of different time delays, syntheses of impulses with different frequencies control and analyses of different input/output signals. Mainly system processor use one byte instructions performed by a single instruction cycle. Exceptions are cases where there is a condition for branching in the program or the changes of the program counter. In this situation, execution takes two instruction cycles, the second run by NOP /no operation/. Two-byte instructions are performed in two cycles; one cycle consists of four periods of the oscillator. Time for one command at frequency of 20MHz clock generator is equal to 0.2us. In case of branching in the program or when the program counter is changed as a result of the instructions, the time needed for implementation will be 0.4us. Therefore making delays of 1 ms is necessary to make 5000 cycles in the microprocessor. The frequency of pulses at the terminals of microcomputer specified and outputs can be easily changed by appropriate subroutine. Manually changing the frequency via external buttons is also possible.

Providing this type of user control requires constant monitoring of button status.

One algorithm for implementation of this functional is shown on fig. 4.

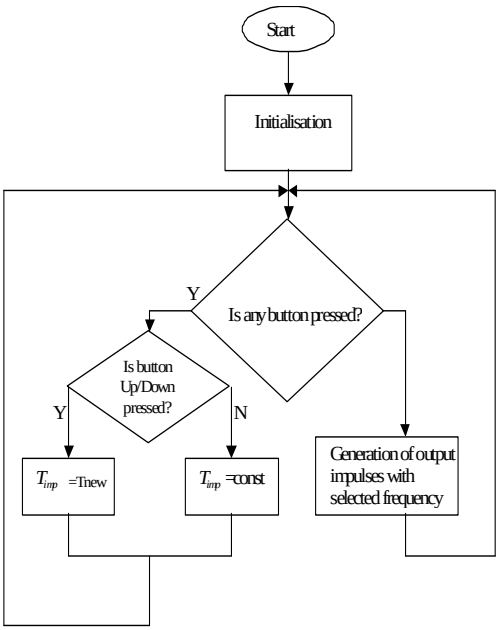

Fig. 4. Algorithm for button's monitoring

The unit generates series of impulses when upload certain values to internal timer and counts up the amount of timer's overflows. Time-delays that ocurs as a result of counting corresponds to the period of desirable pulse frequency. In the begging of instructions counting all outputs are cleared.

An example functional diagram of pulse generator realized with single-chip microcomputer is shown on Fig. 5.

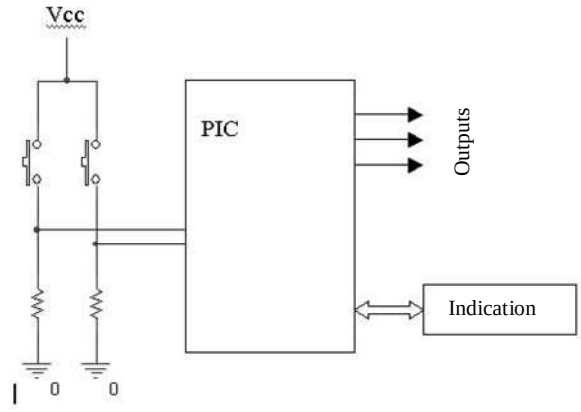

Fig. 5. An example functional diagram of pulse generator realized with single-chip

With two buttons, the user can adjust the working frequency of the device.

The outputs of the microcomputer are connected to the other functional units to provide control over the different working voltages and systems outputs.

This is necessary because the outputs of the circuit can not provide the required output power. Real time feedback to the user is possible thanks to liquid crystal (LCD) which is also connected to the microprocessor. Thus it is possible to monitor the current frequency and amplitude of the output device.

Unit for external frequency control

This block allows to the user to select appropriate working frequency. By pressing the buttons and text messages on the LCD display the frequency can be easily selected from the user.

Block switching output

This unit carried out and successively shift the generated impulse to one of the device's output. Switching signal as a "running wave" is done automatically using appropriate software solution. Principle of action can be explained by the fact that continuous time monitor which output is a logical unit. When an output is high level, all others are low. For the realization of a series of impulses running /"running wave"/ the duty cycle of pulses depends inversely on the number of outputs.

Unit for amplitude control

Thanks to this unit it is possible to perform manipulation of amplitude output signal of the device. The unit provides precise control of amplitude of output signal for the system.

Output unit

The unit represents the synthesized output interface system. It consists of appropriately selected connector box mounted to the apparatus. It provides smooth and reliable interface between the device and external to the system inductive load.

Liquid-crystal display

It allows monitoring of pulse parameters and system feedback. Visualization of the computer is deliberately avoided, because in this case functions will be limited in the absence of a computer connected to projection device. Seven segment displays is a good choice because of the need to use a large number of terminals to display a symbol. The ability to simultaneously monitor multiple parameters using a small number of connection wires and low power consumption makes LCD-display as the most appropriate choice for system parameters visualizations.

Power supply Unit

The power supply consists of a special transformer for medical equipment and a group of voltage straightening, maximum filtration and stabilization of

the interference with the mains voltage. The main task of the unit is to ensure proper working voltage to all electronic components of the system. Input/output signals used for communication between management and individual blocks are:

– Power supply should work with the input output voltage ~220V/50 Hz. Voltages of secondary windings usually must be 60, 80, 110 V AC.

– The output of power supply usually must be stable voltages +12 and +5 V.

After identification of the signals is done processing and software programming decision-making.

Field"

– Communication between the liquid crystal display and microcomputer is done by data bus. It consists of a 4-bit data channel signal and 2 service configuration.

4. A real system for magneto-therapy with "running magnetic field"

System therapy "running magnetic field" is synthesized by the successful combination of analog and digital components and appropriate software. The successful combination of analog power components with micro-electronic integrated circuits offers a modern and easy way to precisely control, monitor and generate low-frequency analog signals with high power. Main advantage of using such a combination consists of low power consumption and relatively simple hardware solution. Similar systems with traveling wave therapy in the manner described can be easily implemented in portable cases. That is makes the system convenient and easy to use.

A real system for magneto therapy for "running magnetic field" can be seen on Fig. 6. The outputs of apparatus for magneto therapy are connected with five independent coils.

The output impulses of the independents coils can be seen on Fig. 7.

5. Conclusion

1. A method and basic requirements for design of systems for magnetothearpy by running low frequency magnetic field are described in the paper.
2. A real system for magnetothearpy by running low frequency magnetic field is done, also.

Fig. 6. System for magneto-therapy with "running magnetic field"

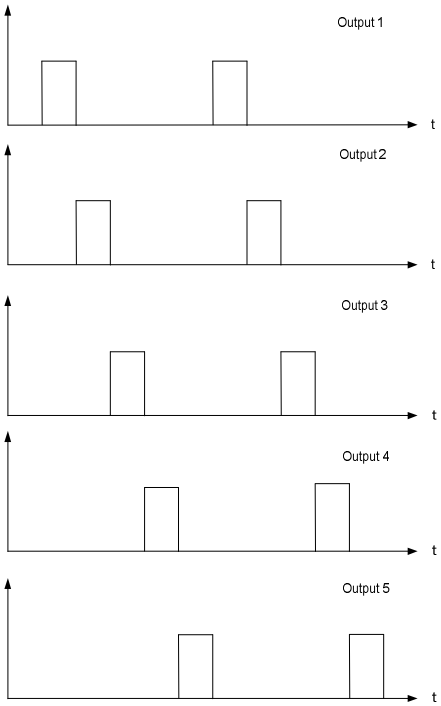

Fig. 7. Output impulses of the independents coils

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