ALGORITHMS FOR MANAGEMENT AND CONTROL OF SYSTEM FOR THERAPY BY „RANDOM" RUNNING LOW FREQUENCY MAGNETIC FIELD

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Abstract

It is well know thatcurrentsystems forphysical therapymost often arewith microprocessor control. The new systems for therapy by "running" low frequency magnetic field areno exception. The big advantageof themicroprocessoris thatitprovides arealization ofmultiplelogicblocks,without usingadditional-external components. Realization ofthe same number of-blocksbyusing discreteelementsincreases instability andfailuresin theoperation process of theapparatus.Also,the complexity, volume and price ofthe devicewould increasea lot.The articledeals with specificalgorithmsfor the management and-control ofoperating modes of themagnetsystemwithlow-frequency magneticfield.

1. Introduction

As control unit of system for magneto-therapy by a "running" low frequency magnetic field can be implemented microcomputer PIC18F452 connected to external passive components of the system. The basic task of the control unit is management of action mode of blocks connected to it, namely:

- Block external control Unit;
- Unit for output signal commutation;
- Unit for amplitude control;
- Generating unit

The main program is an endless cycle. Its purpose is to monitor whether there is an attempt to influence and change the status of the processor by the user. Block diagram of the initialization and main subprogram is shown Fig. 1. With each initial application of voltage to themicroprocessor following subroutines are called.

- 1. Resetthe timercountingdown thetime to generate aperiodicpulse train

- 2. Readinputs

- 3. Starting
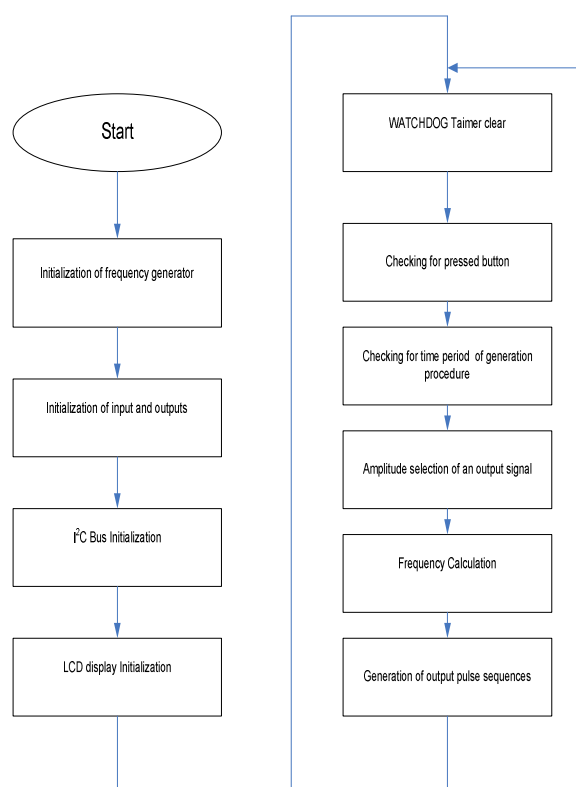
Fig. 1. Block diagram of the initialization and main subprogram

When supply voltage is applied to the microcomputer initialization function is proceed. The aim is to set the starting conditions to be taken into consideration in implementing the main subprogram. Proper operation of the device requires to define Input/Output ports in accordance with the principle scheme of the apparatus. To ensure control of the operation by the user are provided for 4 buttons. Their defining feature requires 4 pins in the microprocessor program as inputs.

2. Basic algorithms

On each cycle of the main subprogram four inputs of the microprocessor are checked. Logic program can be divided into 5 main units. External control unit consists of four irretentive buttons submitting input to four input terminals defined by the microprocessor. Each button has a defined function in execution of the main program.

Pressing a button means logical 0 for the processor and subprogram is called

Unit for commutation of the output consists of five outputs of the microprocessor.

Block switching voltage output consists of six outputs. They are used for determination of the amplitudes of output signals.

Fig. 2. Algorithm for button checking

Monitoring of output parameters of system and providing feedback from the user is done through visualization unit. It provides appropriate information, which is displayed on the LCD display as understandable text to the user.

The generation unit is implemented by configuring Taimer0 the micro-processor to generate a certain frequency at a specific point in time.

After successful initialization of the microcontroller LCD display shows a message to indicate that the microprocessor is in waiting mode. If button's state change has occurred a subprogram is called. Algorithm for button checking is shown in Figure 2. In order to eliminate mechanical noises buttons have to be rechecked after short period of time.

Button names depend from their functionality. Their names are:

(**Start, Enter**) -start the procedure for generation series of periodic impulses; confirmation of the choice of the parameters set by the user; continuation of the current procedure.

(**Stop, Set**) – call the program menu; checking the set of parameters of microprocessor; suspension procedure for generating pulse sequences; induce a pause in the procedure.

(**Up**) – increasing values of different signal when entering the program menu;switching from automatic to manual mode frequency change;increasing frequency in manual mode;preview imprint.

(**Down**) – reducing the values of various signal's parameters of entry to the program menu; switching from automatic to manual mode frequency change; reducing the frequency in manual mode; preview imprint.

The function of button (**Start/Enter**) in primary placing on the device can be described by the algorithm shown in Fig. 3. The button serves to start the subroutine for generating pulses at certain intervals. Pressing the button a message appears on the display, which shows the user that the application is accepted by the microprocessor and will execute the selected subprogram. It is called as soon as they found a change of state of the signal.

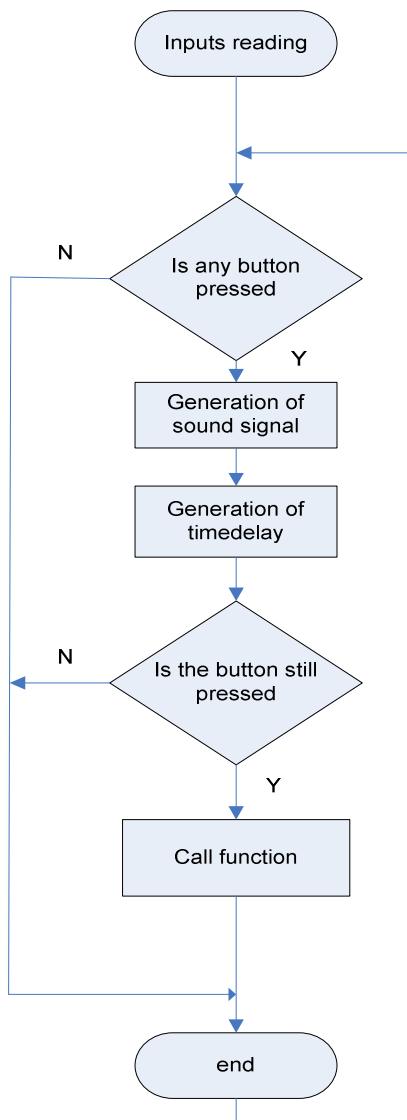This is done to avoid repeatedly calling the subroutine in the case when the user holds too long pressed a button.
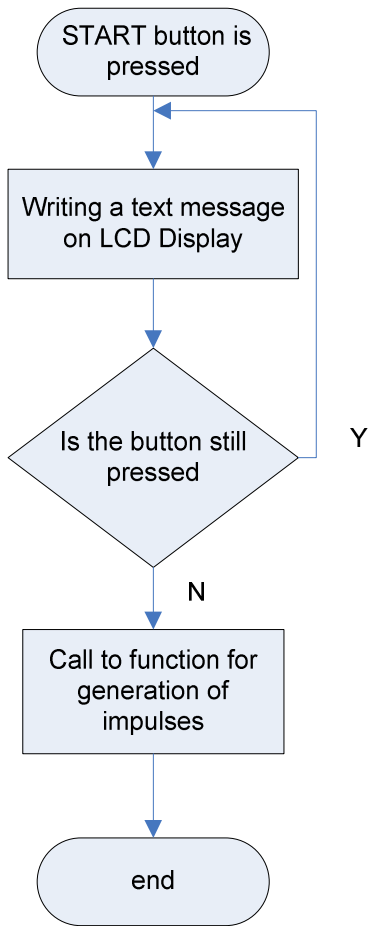
Fig. 3. Algorithm of work of the button Start / Enter

Button (Stop/Set) is set to enter the menu and to view parameters set of generated output signals of the microprocessor. Pressing it microprocessor go in a cycle that consistently reviewed and adjusted as necessary parameters of the generated signals and modes of the generator. Its function can be described by a functional algorithm shown in fig.4. Pressing the SET button first displays the current setting of a parameter of the output signal. In the case that the user wishes to change it can enter into a separate submenu and make the desired correction. To save changes it is necessary to press again the button SET.

Pressing the SET button will show the next value of the parameter signals and will give the possibility for changing. From the menu it is possible to go only when consistently review all the possible parameters for the output device signals. After first pressing of SET the first parameter of the output signals is called. This is the maximum operating frequency of the signals. At this point, the microprocessor monitors which button is selected by the user. Pressing the START button call a function for setting the operating maximal frequency.

If now the SET button pressed again is displayed information about the next parameter signals. This is the duty cycle of the generated pulses. The next parameter that has the potential to change duration set to generate periodic pulse train output of the device. The next parameter that has the potential to change duration set to generate periodic pulse sequence at the output of system. The last parameter determines amplitude and operation mode. The change of the amplitude of the output signal can be set thanks to service subprogram.
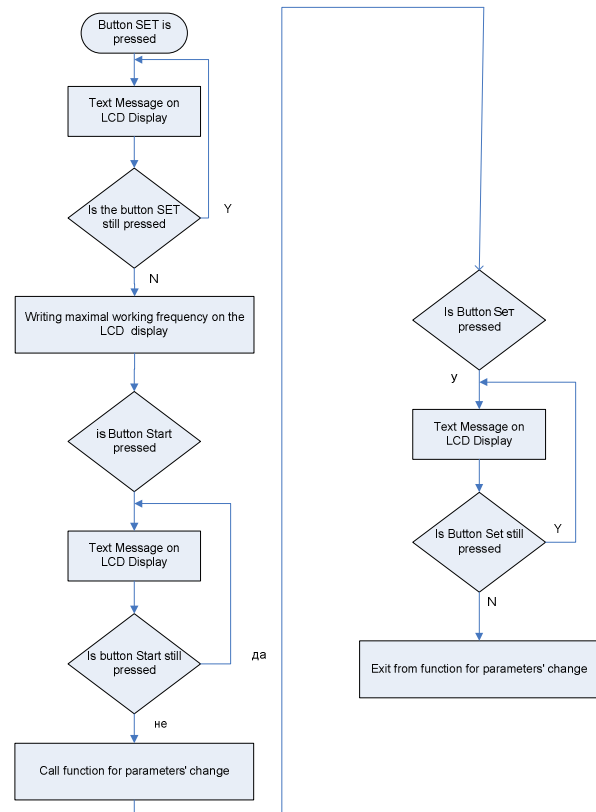

Fig. 4. Algorithm of the functions are a button Stop / Set

This amplitude can be changed automatically during the process of therapy or to be fixed precisely. The sequence of the crawl parameters in implementing software menu is shown in Fig. 5.
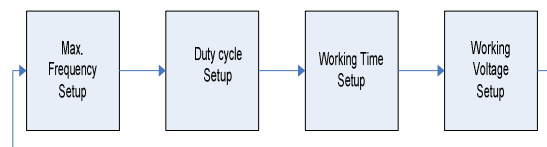

Fig. 5. Algorithm for sequence of parameters setup

Buttons up/down is used only to increase or decrease the values of selected parameter to change the camera output signals. Algorithm of the action buttons UP/Down is shown on Figure 6.
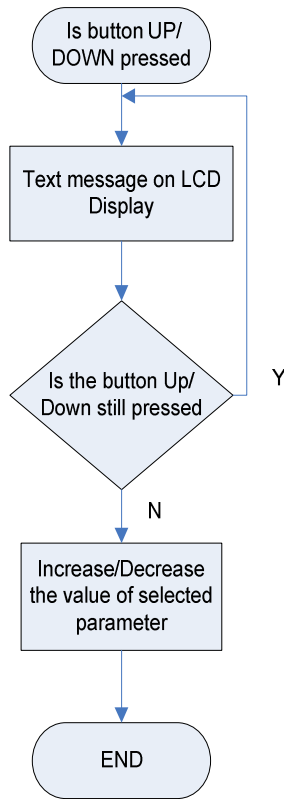
Fig. 6. Algorithm of the action buttons UP / Down

The main subroutine is divided into several sub-divided according to their purpose. By Sub Setup () is implemented for menu browsing and setup parameters of the output signals of the system.

Algorithm of work on the main subprogram is shown in Fig. 7. To achieve feedback from the user and easy monitoring of the operating mode of the microprocessor function is done using an infinite loop.

Therefore the microprocessor always waits intervention by the user before an operation. In primary set automatic mode switching for the amplitude of the output signals of each device to switch from maximum to minimum frequency is automatically switched the amplitude of the output.

Switching amplitude as a function of time is shown fig. 8. Manually change the frequency can be done by pressing the Up or Down buttons. The time remaining until the end of the procedure is kept in memory of the processor and then return back in the automatic mode continues to check the time remaining. In manual mode the user can increase the frequency of pulses generated by pressing Up, a Down button to reduce it. Switching back in the automatic mode is performed after pressing Start.

The procedure for generating pulses continues until the time specified by the user time to generate or not a button is pressed Stop.
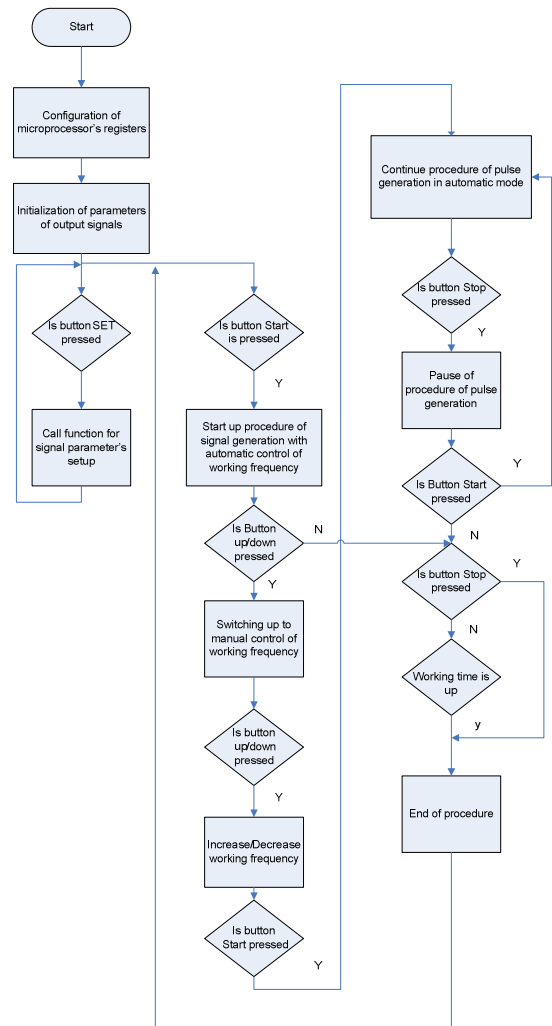

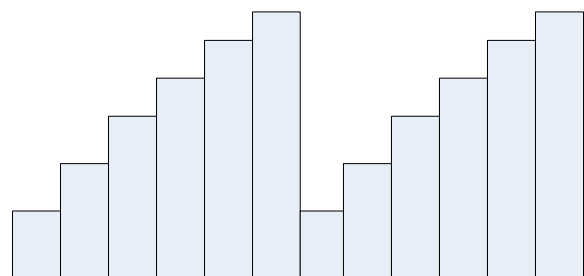**Fig. 7. Algorithm of work on the main subprogram**

Fig. 8. Switching amplitude as a function of time

Registering Stop button pressed puts the CPU in the Pause mode. This situation generates an audible signal and the microprocessor expected after pressing the start button or stop. The values of the current frequency modes remaining and time saved. Pressing the start button to continue the program execution the place where he stopped, and when pressing the procedure is terminated.

The process of generation of pulse sequences with automatic changing of frequency is shown fig. 9.
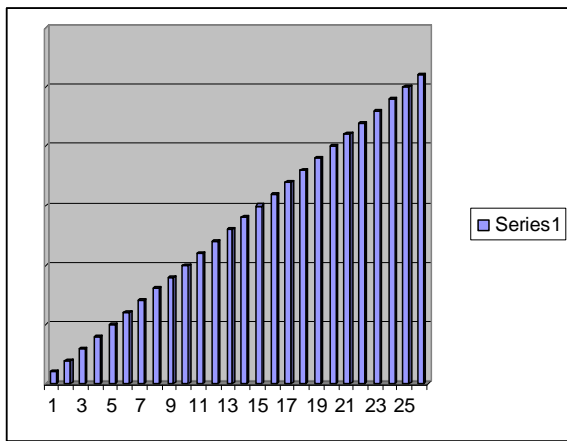
Fig. 9. Process of generation of pulse sequences with automatic changing of frequency

The display shows the raw data for signals that will start to generate. Write out information about the operating voltage, duty cycle of the output magnetic signals generated current frequency and timing of generation of pulse sequences.After initialization process starts the process of generating pulses from the microprocessor.When the highest frequency is reached, it is automatically switches back to the lowest. Any such transition is related to increased unit with a variable voltage to determine what is fed to the outputs of the device. After reaching the maximum frequency used for all terminals controlling the output voltage is reset. Termination of the procedure for generating pulses occurs when it detects a double interference by the user or if the time set for the procedure of generations has elapsed. To inform the user that the procedure generated pulses ended short message is displayed on the display. CPU returns to waiting mode output, which monitors the re-intervention by the user.

Algorithm on fig. 10 shows the process of generating a certain periodical time series of rectangular pulses automatically changing frequency and amplitude modulation of automatic.

3. Conclusion

The main goal of this paper is to present a basic algorithms for management and control of system for therapy by "running" low frequency magnetic field. These algorithms provided a high level of flexibility not only for above mentioned system for magneto-therapy, but for other different microprocessor systems for physiotherapy. The changing of different modes of therapy is very friendly. Nevertheless the system can provide many modes of
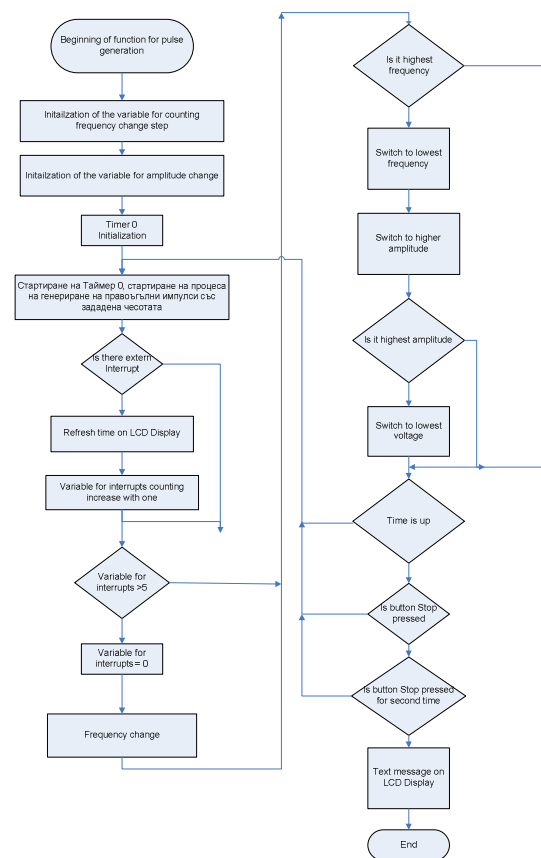
Fig. 10. Algorithm of process of generating a certain periodical time series of rectangular impulses

therapy. Some of them can be very complicated. In fact the number of modes of therapy provided by this kind of system is not limited. The assurance of described system, which is provided by algorithms for CPU is another very important advantage.

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