REGARDING THE QUESTIONS OF DIGITAL OSCILLOGRAPH CHARACTERISTICS IMPROVEMENT

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Annotation

In the article it is suggested to improve the characteristics of digital oscillograph. It was offered to introduce a function of digital multimeter that allowed creating a universal combined measuring device which would satisfy the needs of the modern engineering.

Key words: portable oscillograph, sinusoidal form, meander, sawtooth form, multiplexer, register, microcontroller.

1. Introduction

At present digital devices develop rapidly. Due to better characteristics analog devices are ousted by digital. The same happened to measuring devices, namely to oscillographs. As any controlling and measuring device, oscillograph got through many stages of development and improvement of various functions and capabilities, such as a signal processing, improvement of synchronization, high resolution, functions of control and capabilities of the received signal form storage in the device memory and subsequent work with results that remained in memory.

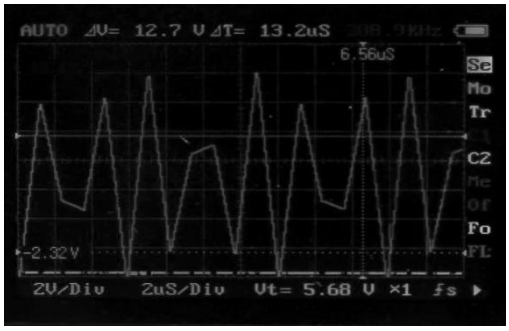
In our time there is a great number of producers which specialize in the development and production of digital oscillographs that satisfy the needs of the modern engineering. A wide range of devices has been developed, from simple, inexpensive stationary units to complex, expensive portable multichannel devices with numerous auxiliary functions and capabilities. However, it’s not always efficient to use expensive, bulky stationary devices for everyday use and during repair and adjusting of industrial equipment, while there exists a possibility to use portable analogue which contains almost all necessary functions and possibilities.But there appears another problem: portable device is considerably more expensive if compared to its stationary analogue. To use such device on everyday basis is not expedient, as in the process of repair and

adjusting in portable conditions there exists a probability of mechanical damage of the device. Device which is used must be inexpensive and reliable. Inexpensive models which fully satisfy the requirements of the modern engineering appear from time to time at the market of digital oscillographs. One of such devices is the pocket oscillograph NAN0201 produced by DSO. It is distinguished among competitors by the least size, a size of modern mobile telephone, and by the price. Basic characteristics declared by the producer: frequency band 1 Mhz, sampling rate – 1000 samples per second. It is possible to conduct a compliance test of sample unit by connecting a signal generator to oscillograph input. We will choose frequency of 200 kHz and will get oscillograph signals of sinusoidal, meander and sawtooth formshown on a display.

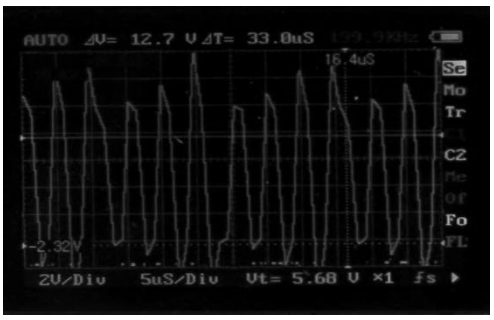
As showed by the received characteristics, there is a substantial distortion of form on all types of in-coming signal (picture 1, picture 2, picture 3). There are several different versions of weaving for a microcontroller in Internet. Replacement of software versions did not give substantial results, the location of auxiliary elements on the screen and architecture of menu changed only.That is, errors, which appear in a device are not of software, but of hardware origin as they arise because of low-quality circuits and principle of device operation.

II. Problem statement.

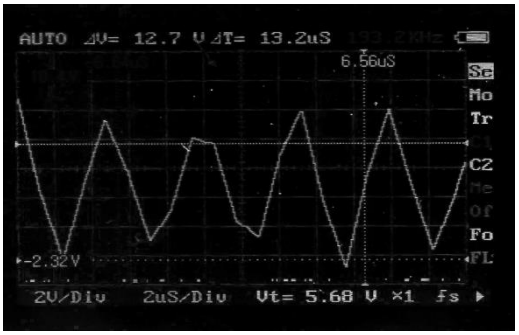
It is suggested to improve device characteristic. It was offered to introduce a function of digital multimeter that allowed creating a universal combined measuring device which would satisfy a wide range of users.



Picture 1. Signal of sinusoidal form, frequency of 200 kHz.



Picture 2. Signal of meander form, frequency of 200 kHz



Picture 3. Signal of sawtooth form, frequency of 200 kHz

As the developed oscillograph will be portable, it is necessary to foresee all nuances of this circuit, namely power supply from a storage battery during not less than four hours, comfortable and ergonomics corps, display light for work in premises with insufficient illumination, possibility of the automatic measurements, rapid calibration with minimum interferenceinto the device circuit.

III. Results.

In course of development a decision has been taken to use an inexpensive element base available in Ukraine. As known, an analog signal should be weakened or strengthened before digitizing depending on amplitude and the amount of Volts-per-Division (Volts/Div.) chosen by the user.It is important that voltage in the analog input of analog-digital converter (ADC) doesn’t exceed maximum allowed values after conversions. For this purpose attenuators, amplifiers and voltage dividers are set up at the input. In order to make the automatic measurements possible it is necessary to enable a microprocessor to automatically manage the level of in-coming signal, and such possibility can be provided only by the use of digital switchboards – multiplexers. An external specialized eight-bit analog-digital converter with the external triggering signal and internal source of reference voltage is used in the device. Analog-digital

converter AD9280 produced by Analog Devices fits such parameters. Information about a signal after digitizing by ADC should be quickly saved in memory, so that its sampling rate would be saved. In order to fulfill this condition the access time in memory (Tacc) must coincide with an ADC sampling period (Ts).

In our case:

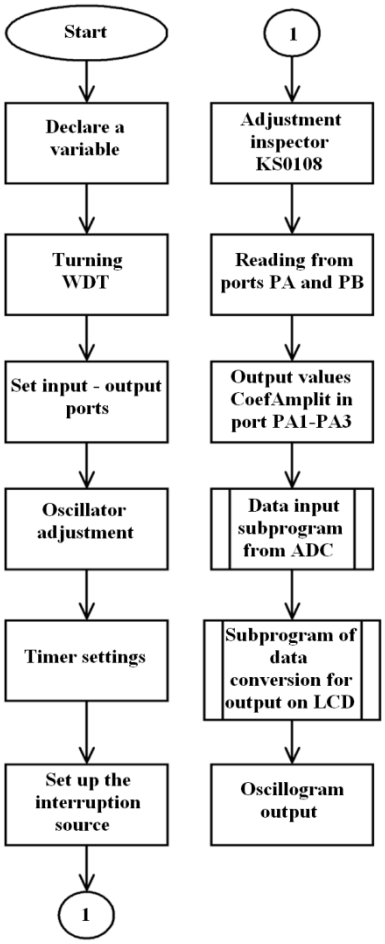
$$T_s = T_{acc} = 50 \text{ ns}$$

or 5000 samples persecond.

Microprocessor should receive and processin-coming data, save them into memory, conduct mathematical actions for converting data array into a parallel code, clear for a built-in processor of a liquid-crystal display. Only a speed controller which executes the majority of operations per one machine cycle will be able to manage such operations. Series of microcontrollers AT mega 32 produced by AVR can satisfy such requirements as high productivity is achieved due to the use of developed RISC architecture, that enabled most commands to be executed during one machine cycle. The controller achieves 1 MIPS productivity on 1 Mhz operation frequency, that allows a developer to effectively optimize energy consumption due to selection of optimum productivity. AVR kernel combines an extended set of commands with 32 general-purpose operation registers. All 32 registers are connected to arithmetically – logical device (ALD) which provides access to two independent registers for time of command execution perone machinecycle. Due to the chosen architecture the fastest code speed and accordingly high productivity has been achieved, which 10 times exceeds the speed of proper CISC of microcontroller. A keyboard will be constructed as a separate block according to the scheme of resistor divider, but with the permanent variable division ratio in order not to load a processor with super fluousin coming signals. For the correct reflection of information it is most expedient to use a liquid-crystal display not less than 128 x 64 points in size. The most wide spread models on territory of Ukraine are liquid-crystal displays of Taiwan company WINSTAR. Graphic displays of this company are the modules with their own processor, matrix power-supply circuit and display light. They are built in as a separate block and operate with central processing into the universal data bus. From all of the components presented by the suppliers we choose the

display of model of WG12864a–YGH–TN, as it has satisfactory characteristics, light-emitting-diode illuminating from beneath, which enables to use it in premises with insufficient illumination.

On the basis of the considered MC features of AVR series, namely the models ATmega32 – 16AU the algorithm of oscillograph the program implementation has been developed developed. A flow chart for MC program algorithm is shown on picture 4.

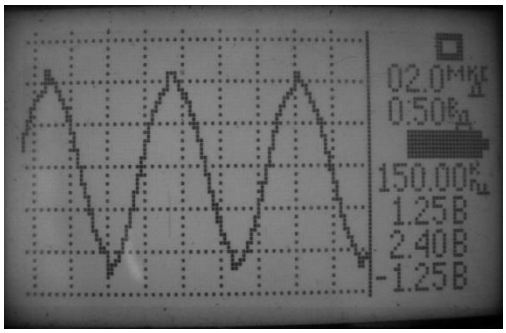


Picture 4. Offered flow chart of program algorithm for a microcontroller

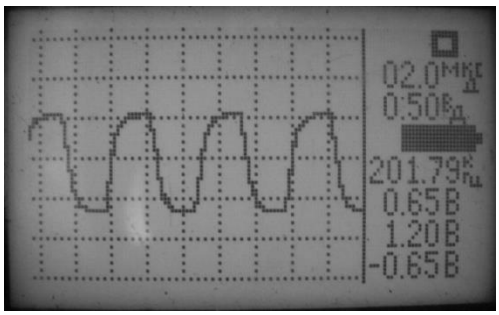
As the device is portable, it is necessary to provide a stable and trouble-free power-supply during four hours. Such requirements will be satisfied by DC-DC converter which will provide a stable outgoing voltage regardless of incoming subsidence of storage batteries.

The device is mounted on a bilateral printed circuit board made by actinic method, to which a liquid-crystal display and button keyboard are connected with a loop. Mounted, adjusted and calibrated oscillograph is assembled into a plastic corps which due to its ergonomic characteristics allows using this measuring device comfortably. If

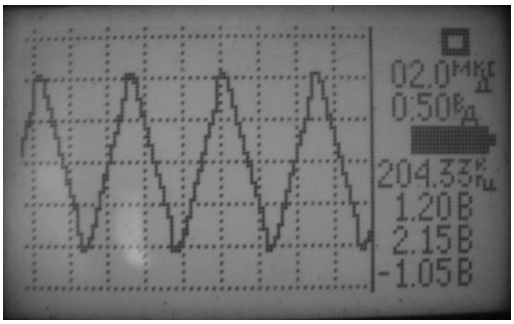
to connect signal generator to developed digital oscillograph, it is possible to read the following signals characteristics on frequency of 200 kHz.



Picture 5. Signal of sinusoidal form, frequency of 200 kHz.



Picture 6. Signal of meander form, frequency of 200 kHz



Picture 7. Signal of sawtooth form, frequency of 200 kHz

IV. Conclusions.

The developed sample exceeds the indexes of industrially produced oscillograph DSO NANO201. This goal is achieved due to the use of external analog-digital converter and fast-acting processor which processes received data. In an industrial prototype the result from in-coming cascades is moved to a built-in ADC of processor, which does not own such speed as external ADC, thus it results in distortion of signal form, as the declared key-in value and the amount of samples per second do not correspond the reality.

A digital oscillograph allows to observe on LCD the signals of any form and polarity on frequency up to 15 MHz. It is also possible to explore the signals stored in the device memory. Upon desire this device can be used as add-into the personal computer with the purpose of data collection, processing and storage.

Complete device management is carried out with help of a built-in keyboard. Oscillograph has functions of both automatic and manual selection of level of vertical and horizontal involute. Also there are functions of automatic measuring of in-coming signal frequency, general, positive and negative amplitude followed by displaying on LCD.

Also the developed device can be used as multimeter that extends the area of its use in industry or in laboratories, i.e. it is a universal measuring device. During work as multimeter it has a capability of measurment and report on the display frequency, capacity, resistance, current, voltage and inductance. Also function of software calibration is implemented which simplifies procedure of device calibration and its testing in Center of Standardization and Metrology (CSM).

In the process of oscillograph use the index of storage battery level of charge was added on a display, the function of automatic shutdown was implemented for the purpose of battery saving if there were no changes of signal during five minutes on oscillograph input. But this function is switch-controlled, i.e. upon desire of user this function can be turned off, however such action reduces operation time of storage-battery in autonomous mode.

For comfortable use of the device illuminating from beneath with adjustable brightness for liquid-crystal display is made. Illuminating is controlled by a button the button, depending on the conditions of use.