International Journal of Applied Engineering Research ISSN 0973-4562 Volume 10, Number 23 (2015) pp 43831-43834

Study Algorithm Speed Signal Generating Feedbackfor Information-measuring System Control Active Vibration Protection Red

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Abstract
Methods of reducing vibration loads on the radioelectronic devices (RED) with the use of active vibration protection systems. Selected the most relevant of them, on the basis of which the structure of the algorithm for generating feedback signals for information-measuring system (IMS) control active vibration damping RED. It is proposed to implement the algorithm on the basis of the ATmega128 microcontroller, for which a theoretical analysis of its computational power. Experimental studies of the performance of the proposed algorithm in conjunction with a microcontroller ATmega128, which confirmed the possibility of their application for the protection of the RED from external vibration exposure at frequencies up to 1 kHz.

Keywords: Algorithm, Vibration Control, Active System, the Protection Electronic Device.

Introduction

Existing cushioning systems are active for reducing the amplitude of vibrations to the design of radioelectronic devices (RED) not only at the resonant frequencies, but on the whole desired frequency range. Their work is based on the introduction of additional compensating for the external vibration exposure. The signals are in opposite phase and equal in amplitude that provides a positive effect vibrostabilization RED.

This approach entails the complication of the structure of active shock absorbers by introducing additional means of measuring vibrations and increase their value, so the use of such remedies is justified only in exceptional cases, the responsibility of RED. Moreover, in many cases, sufficient vibration protection at the resonant frequencies as the rest of the range of influences on the RED is not much [1].
Therefore, further consider a new option to create a structurally simple means of active vibration protection RED implementing highly effective way to reduce vibration loads on the resonant frequencies [2].
The subject method consists in introducing the resonant frequencies of the phase error at the attachment points of the object vibration protection due to the amplitude of the forced oscillations RED sharply reduced and energy consumption is significantly less than in systems with full compensation.

The Structure of the Algorithm of Formation of Feedback Signals

To bring this method of reducing vibration loads to the practical implementation of the framework we have developed an algorithm signal generating feedback information-measuring system (IMS) management of the active vibration protection RED, which is presented in Figure 1.
The beginning of operation of this algorithm is a power-IMS control active vibration protection RED.
First, there is a loading object parameters of vibration protection in the memory of the microcontroller (Young's

modulus, Poisson's ratio, density of the material and the geometry of the object vibration protection, the distance between the attachment points of vibroshockabsorbers).

Further, during operation there is a constant monitoring and varying the input parameters of the external impact-amplitude and frequency. Tracking is carried out only one measurement channel.

On the basis of the data obtained it's essential to generate an additional signal, allowing in its resignation to the main signal of external action to implement the phase shift at the attachment points of the object vibration protection at a predetermined angle.

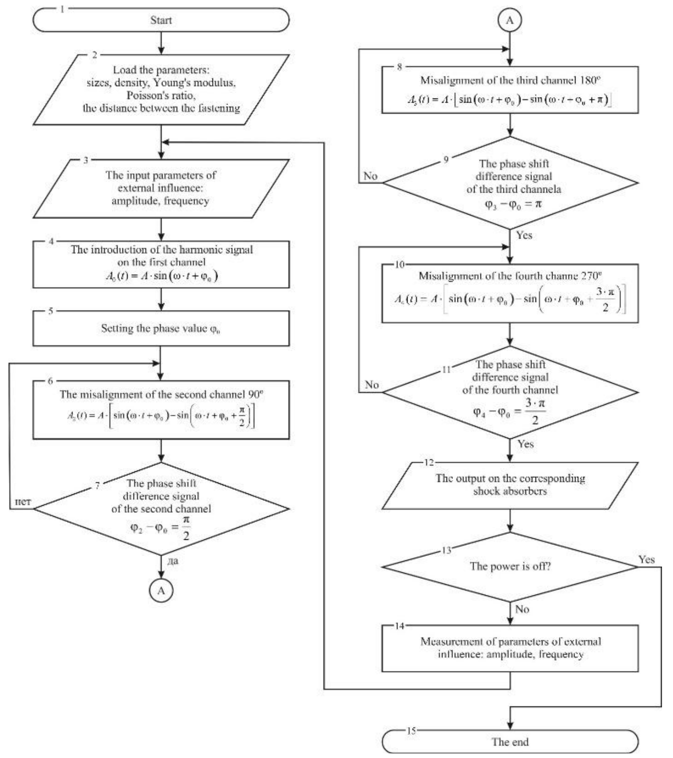

Fig. 1. The algorithm for generating feedback signals to the information-measuring system of active vibration protection RED

Since joining structureRED into resonance all its points move harmonically [3, 4], it's essential to generate the amplitude of the additional signal by the formula

$$A_D = A_0(t) \cdot \ \sin(\omega \cdot t + \varphi_0) - \sin(\omega \cdot t + \varphi_0 + \Delta\varphi) \ ,$$

where A_D-the amplitude of the additional signal; $A_0(t)$-the amplitude of the main signal; ω-frequency of the main signal; φ_0-the initial phase of the main signal; Δφ-the required phase shift.

Fulfilling all four conditions all mismatched channels are displayed on the respective shock absorbers. The condition of the output of the algorithm is the availability of supply on-chip microcontroller.

Analysis of the Performance of the Microcontroller ATmega128

To carry out the implementation of the algorithm is proposed on the base of on the widespread modern microcontroller ATmega128, having low power consumption and high speed. [5] To do this, we carry out an analysis of its computing power with regard to our problem. For this we present the following theoretical calculations.

With a maximum speed of microcontroller on a single measurement it is necessary

$$t_{\max} = n \cdot t_{\text{work. max}}, \tag{1}$$

where *n*-the number of measurements per period of the vibration; $t_{\text{work.max}}$-maximum speed microcontroller spent on digitization and processing of information.

It's necessary and sufficient to carry out eight measurements at a period. Knowing the range of values of work performance of the selected microcontroller (from 10 mcs to 260 mcs), ask $t_{\text{work.max}}$ = 10 mcs. Substituting the values of n and $t_{\text{work.max}}$ in the formula (1), we obtain

$$t_{\max} = 8 \cdot 10 = 80.$$

Thus, the maximum speed of microcontroller is 80 microseconds.

With a minimum speed of microcontroller on a single measurement time is necessary

$$t_{\min} = n \cdot t_{\text{work. min}} \tag{2}$$

where $t_{\text{work.min}}$-the minimum time performance microcontroller spent on digitization and processing of information.

From the range of values of work performance of the selected microcontroller (from 10 ms to 260 ms) ask $t_{\text{раб.min}}$ = 260 microseconds. Substituting the values of n and $t_{\text{раб.min}}$ in the formula (2), we obtain

$$t_{\min} = 8 \cdot 260 = 2008.$$

Thus, the minimum speed of the microcontroller is 2.08 ms.

The measuring range is wide, so pressing is the question of time spent on the processing of information by the algorithm, it is necessary to conduct empirical research, which revealed how much time you will need a microcontroller to process information according to the algorithm shown in Figure 1.

Scheme of Experimental Studies of the Algorithm 128

As the critical values of the boundary frequencies at which conducted the study in accordance with GOST 17516.1-90 (Electrotechnical products. General requirements regarding resistance to mechanical external factors) were selected frequency of 10 Hz and 1 kHz [6, 7]. ThestudydesignisshowninFigure 2.

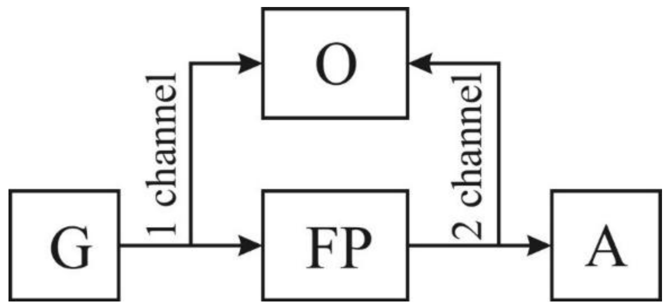

Fig. 2. Scheme of experimental research limitations of the algorithm

The generator (G) is designed to generate a sinusoidal signal with given parameters, which goes to the function generator (FP), which is the study microcontroller ATmega128, as the firmware used by software developed by the proposed algorithm. Load-active dampers (A) readings were taken with an oscilloscope (O).

For the study we used the following measuring equipment: generator GW INSTEK GFS-2104 (included in the State Register of measuring № 29967-05), Digital remembering oscilloscope GW INSTEK GDS-71022 (included in the State Register of measuring № 38084-08).

Experimental Study of the Performance of the Proposed Algorithm in Conjunction with a Microcontroller ATmega128

The first test took place at a frequency of 10 Hz, the theoretical value of time determined by the formula

$$T_f = \frac{1}{f}\varphi \qquad (3)$$

where f-frequency of the external vibration exposure; φ-phase shift angle.

We assume f is 10 Hz, phase shift equal to 90º (since the, phase shift occurs in the ¼ period), the $\varphi = \frac{1}{4}$ Substituting the values of a and in the formula (3), we obtain.

$$T_{10} = \frac{1}{10}\cdot\frac{1}{4} = 0.025 = 25 \text{ msec}.$$

During the tests at 10 Hz revealed that the actual time at 90º phase shift is T10E = 25.025 msec (Fig. 3).

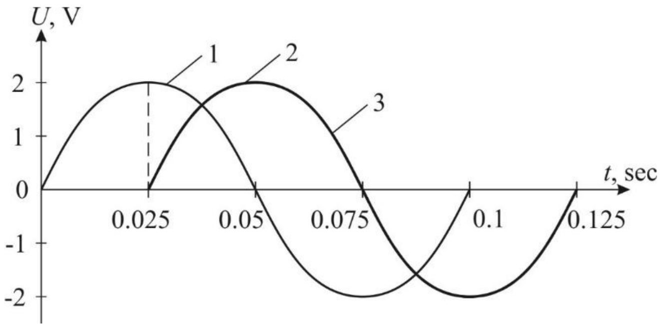

Fig. 3. The amplitude and temporal characteristics of the vibration at a frequency of 10 Hz: 1-the signal generated; 2-calculated signal shifted by 90º; 3-a pilot signal is shifted by 90º

The absolute error is calculated by the formula

$$\Delta T_f = T_{fE} - T_f .$$

Substituting the resulting values T_{fE} and T_f at 10Hz, we obtain

$$\Delta T_{10} = 25.025 - 25 = 0.025,$$

since the absolute error at 10 Hz is 25 microseconds.

We find the relative error of the formula

$$\delta_f = \frac{\Delta T_f}{T_{fE}}\cdot 100\%.$$

Substituting the resulting value ΔT_{10} and $T_{10\text{E}}$, and obtain

$$\delta_{10} = \frac{0,025}{25.025}\cdot 100\ \% = 0.1\ \%$$

since the relative error at the frequency of 10 Hz was 0.1%.

The second test took place at a frequency of 1000 Hz, so we take f = 1000 Hz. Substituting the values f in formula (3), we obtain

$$T_{1000} = \frac{1}{1000}\cdot\frac{1}{4} = 0.00025 = 0.25 \text{ ms}$$

During the test at a frequency of 1000 Hz was found that the actual time at 90º phase shift is T_{1000E} = 0.275 ms (Fig. 4).

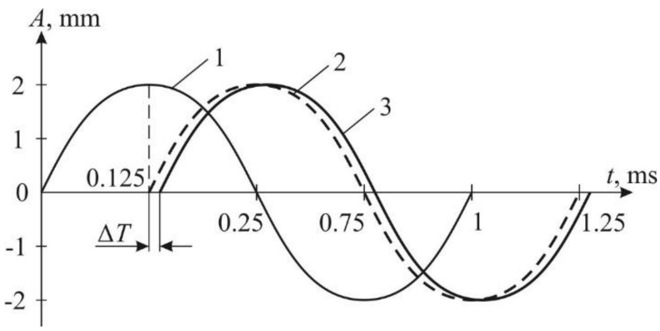

Fig. 4. The amplitude and temporal characteristics of the vibration at a frequency of 1000 Hz: 1-the signal

generated; 2-calculated signal shifted by 90º; 3-a pilot signal is shifted by 90º

For the absolute error at 1000 Hz and we substitute the resulting value T_{1000E} and T_{1000} and obtain

$$\Delta T_{1000} = 0.275 - 0.25 = 0.025,$$

that is, absolute error of 1000 Hz is 25 microseconds.
For the relative error at a frequency of 1000 Hz, let's substitute the resulting value ΔT_{1000} from (2.18) T_{500E}, we get

$$\delta_{1000} = \frac{0.025}{0.275} \cdot 100\ \% = 9.09\ \%.$$

Thus, the relative error on the frequency of 1000 Hz was 9.09%.

From these results it is clear that at all frequencies absolute error remains unchanged,it indicates its additive character. Since the absolute error remains unchanged, and the relative error increases with increasing frequency, we can say that both errors-systematic. This result is good, because the frequency range selected in accordance with GOST 17516.1-90 corresponds to 10 Hz and 1 kHz, depending on the category of performance RED.

Conclusions

Thus, the algorithm of the formation of the feedback signals for the control of IMS active vibration protection RG, wherein the transformation of measuring information through the use of phase mismatch model the external effects RG and engendering feedback signals for each channel and a phase to implement the principle of redistribution.

The criterion limitsof the application of this algorithm is the value of the relative error. The implementation of this algorithm on microcontroller ATmega128 can be used in the proposed IMS control active vibration protection at frequencies forcing up to 1 kHz.

The research has been realized at the expense of the grant of the Russian Science Foundation(the project № 15-19-10037 from May, 20th 2015г.)

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