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Dispersive-Frequency Companding of Low-Frequency Finite Signals for Objects Remote Control

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Abstract—There are noted specificities of known methods of frequency companding of radio signal by high frequency (HF) dispersive delay lines (DDL). It is proposed a principle of dispersive-frequency companding of low-frequency (LF) finite signals for remote control of physical objects and its realization system. It is shown that LF DDL of definite order can be both frequency compressor and frequency expander. The system of this principle realization at transmitting side contains LF DDL—frequency compressor and low-pass filter, and at transmitting side it contains LF DDL of the same order—frequency expander.

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INTRODUCTION

Among analysis of the signals spectrum [1] there is a possibility of application of band dispersive delay lines (DDL) for frequency compression of finite signals in case of decrease of operation frequency band of group delay time (GDT) of line. Principle of frequency compression of spectrum of functions $f(t)$ is based on Fourier transformation $F(\omega)$ of scale change, which is following [2]:

$$f(kt) \leftrightarrow \frac{1}{|k|} F\left(\frac{\omega}{k}\right), \quad (1)$$

where k is coefficient of scale change.

Dependently on required analytical expression of realization of principle (1) there are used different specificities of high-frequency (HF) lines. As shown in [3], the response of band HF DDL with transfer function

$$K(\mathrm{j}\omega) = \exp \mathrm{j}(\omega - \omega_0)^2 / \pm 4k$$

on HF influence voltage $\underline{U}_1(t) = u_1(t) \exp \mathrm{j}(\omega_0 t \pm kt^2)$ is complex HF voltage in form of

$$\underline{U}_2(t) = \sqrt{\frac{k}{\pi}}\, u_1(\pm 2kt) \exp \mathrm{j}(\omega_0 t \pm kt^2 \pm \pi / 4),$$

where function envelope $\sqrt{k/\pi}\, u_1(\pm 2kt)$ is characterized by not only scaling factor $2k$, but also level modification coefficient $\sqrt{k/\pi}$ of the envelope.

Analogously, in [4, 5] there are obtained envelope functions, which have more complex expression for scaling factor and level modification coefficients, therefore it is necessary to realize more complex devices, where two HF DDLs are used.

Principles of frequency companding of finite signals by means of DDL can be used not only in radar systems [3]. Development of measuring systems of automated control of physical objects leads to growth of