Amplitude-Phase Conversion Signal and Feature of its use in Practical Application

By

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Objective

Search methods for creating Two-frequency optical generator and development on the basis of their differential analysis techniques.

The main objective of the research:

1. Development and analysis of the properties of the amplitude-frequency conversion of coherent radiation.
2. Impact of two-frequency oscillations at the resonant system.
3. The implementation of the measuring system and the evaluation of its parameters.

Analysis of internal structure two-frequency oscillations

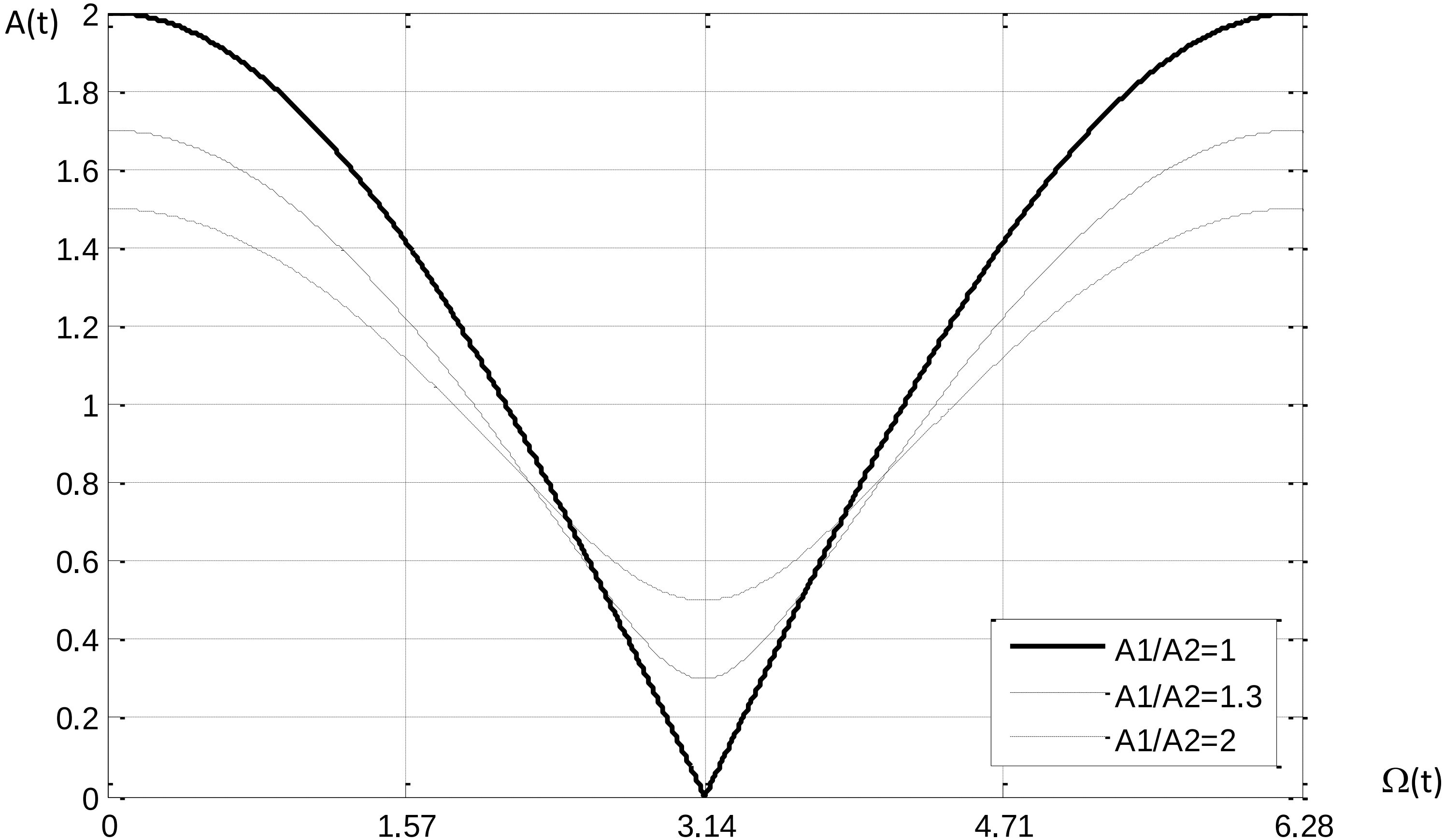
In general, the Two-frequency signal can be represented as:

$U(t) = A_1 \cos(\omega_{01} t + \theta_1) + A_2 \cos(\omega_{02} t + \theta_2)$

1- Investigation of the behavior of two-frequency signal instantaneous amplitude.

the value of the envelope of the two-frequency signal can be represented as:

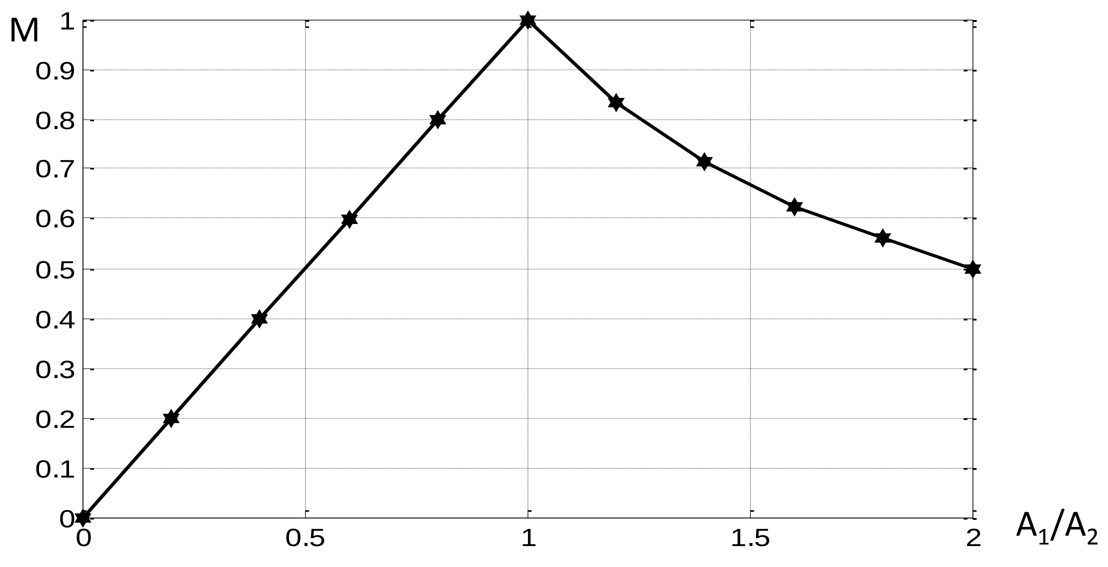
$$A(t) = \sqrt{A_1^{\,2} + A_2^{\,2} + 2 A_1 A_2 Cos(\Omega t)}$$



The A (t) for different values of A1 / A2.

$$M = 2(A_{max} - A_{min}) / 2(A_{max} + A_{min})$$

The results of calculations based m (A1 / A2), we present in Fig.



Dependence of M (A1 / A2).

2-Investigation of the behavior of the instantaneous phase Two-frequency signals

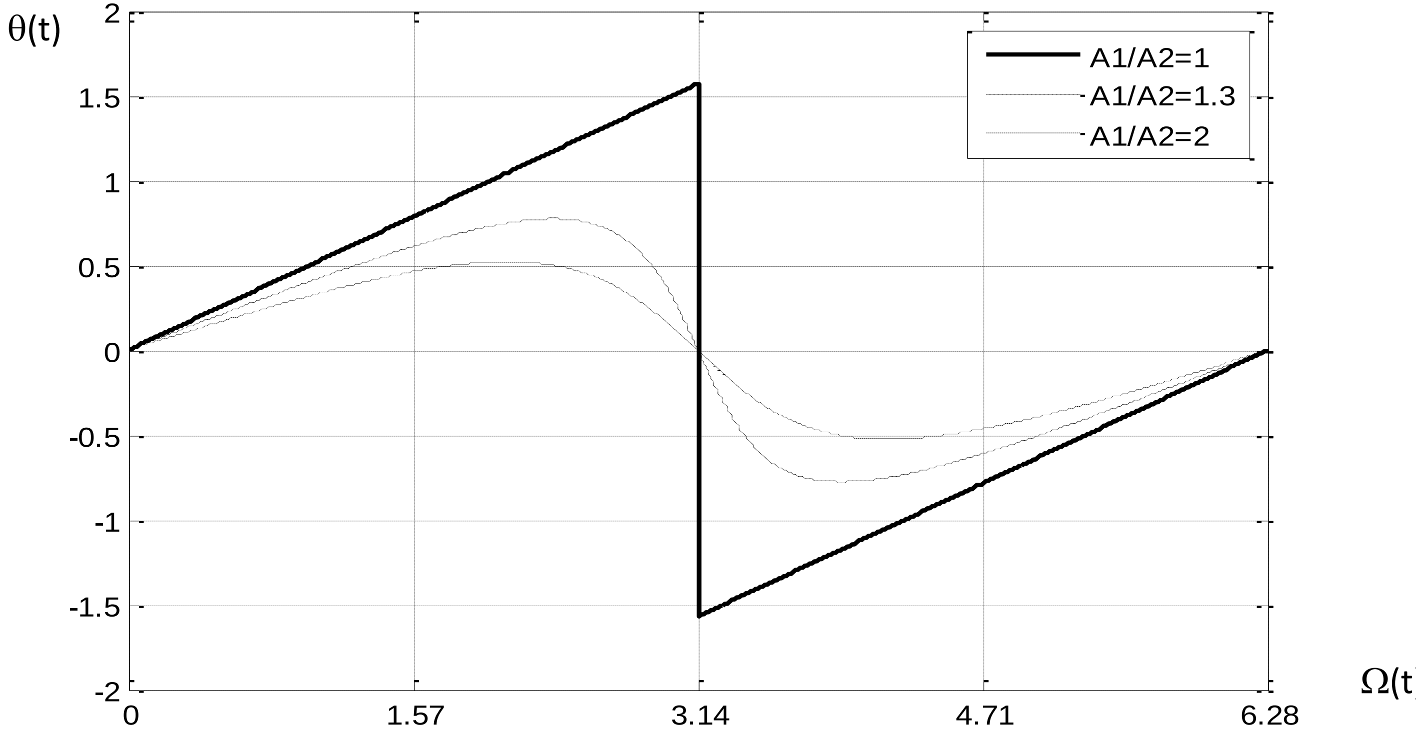
The instantaneous phase of the two-frequency signal when $\omega_{02} < \omega_{01}$, can be represented as:

$$\theta(t) = arctg\,\frac{\sin(\Omega t)}{A1/A2 + \cos(\Omega t)}$$

The instantaneous phase of the two-frequency signal when $\omega_{02} > \omega_{01}$, can be represented as:

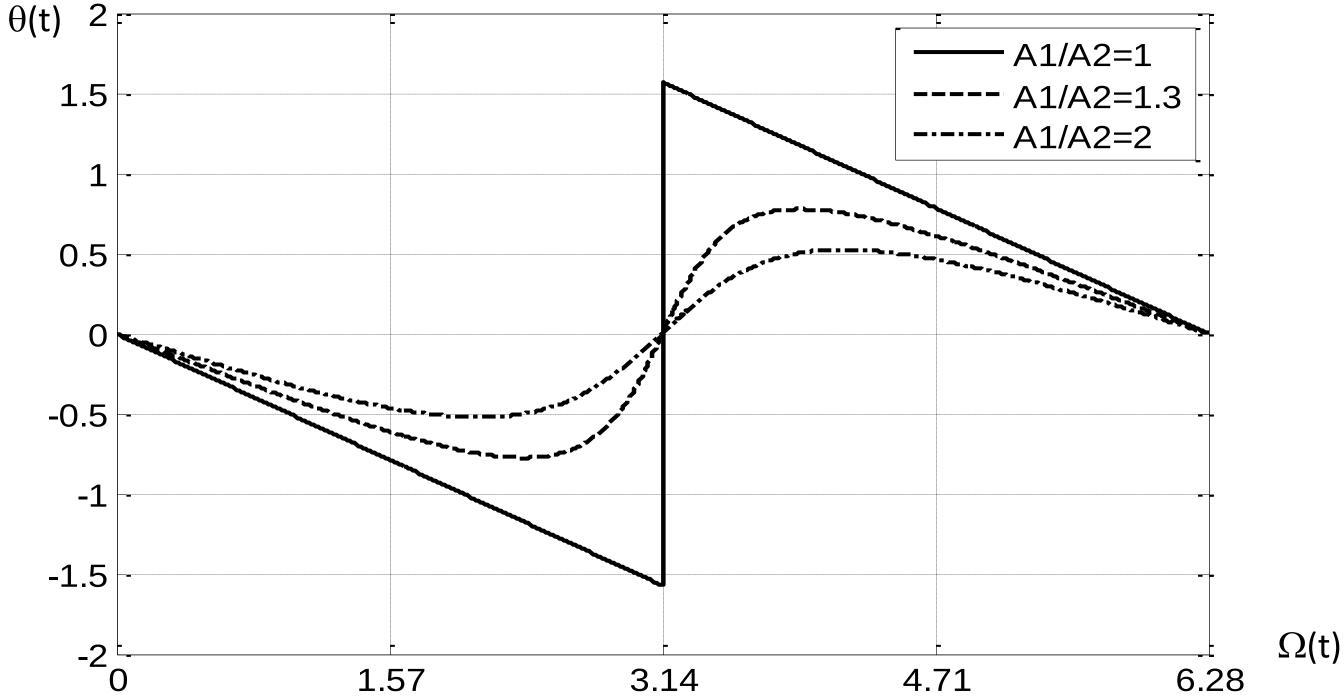
$$\theta(t) = -arctg\,\frac{\sin(\Omega t)}{A1/A2 + \cos(\Omega t)}$$

The results of calculations based $\theta(t)$ for the case: $\omega_{01} > \omega_{02}$, shown in Fig.



Dependence $\theta(t)$ for the case $\omega_{01} > \omega_{02}$.

The results of calculations based θ(t) for the case: $\omega_{01} < \omega_{02}$, shown in Fig.



Dependence θ (t) for the case $\omega_{01} < \omega_{02}$.

3-Investigation of the behavior of the instantaneous frequency Two-frequency signal

the expression for the instantaneous frequency of the two-frequency signal ω(t), when $\omega_{01} > \omega_{02}$

$$\omega_1(t) = \omega_{01}t - \left\{ \frac{\left[\dfrac{\cos(\Omega t)}{A1/A2+\cos(\Omega t)} + \dfrac{\sin(\Omega t)^2}{(A1/A2+\cos(\Omega t))^2} \right]}{\left[1 + \dfrac{\sin(\Omega t)^2}{(A1/A2+\cos(\Omega t))^2} \right]} \right\}$$

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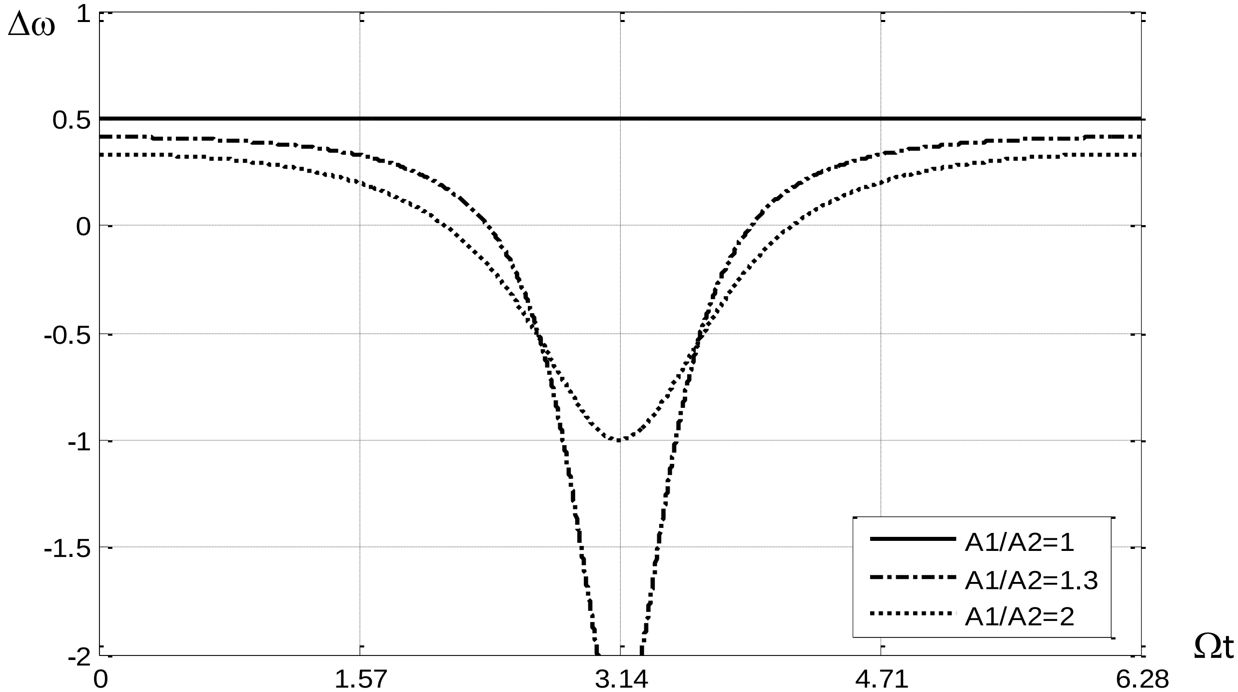
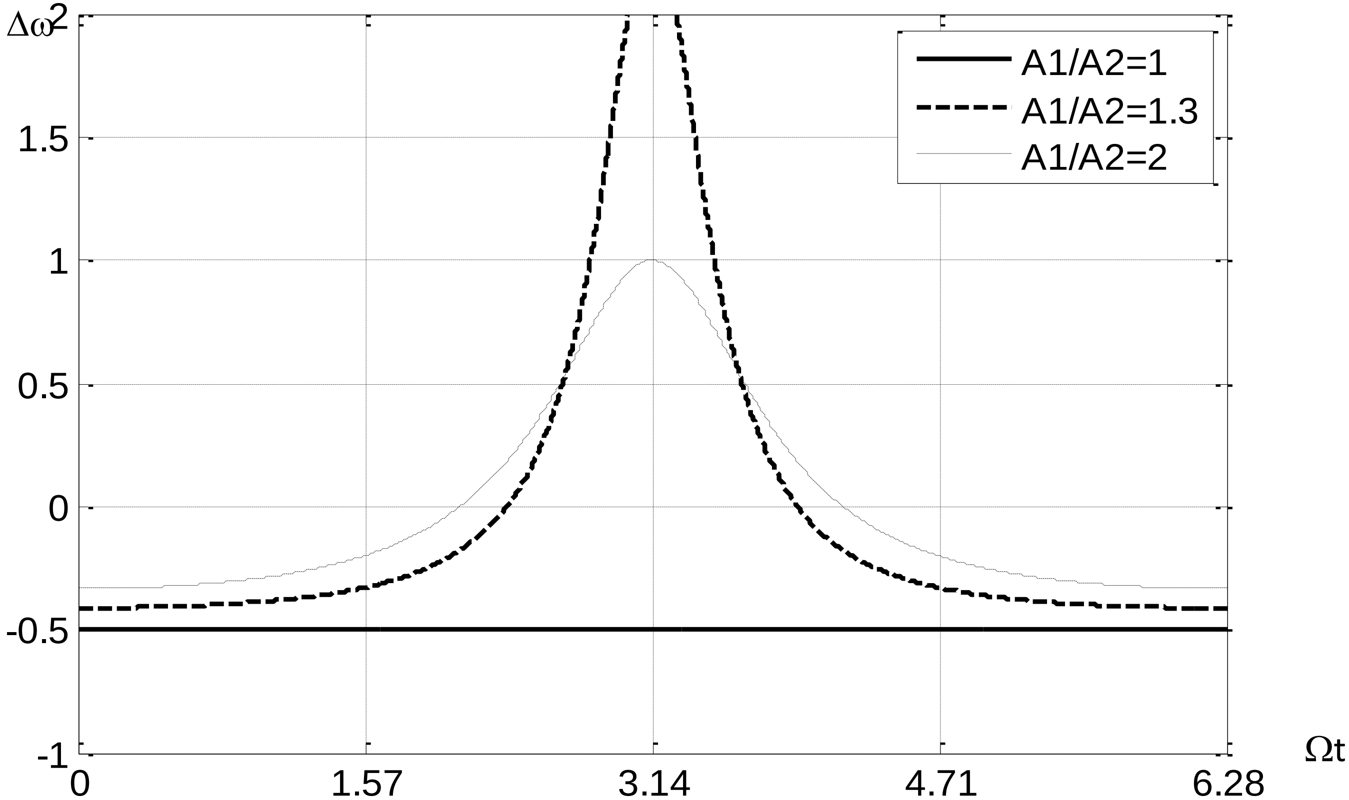
The results of calculations based $\Delta\omega(t)$ at $\omega_{01} > \omega_{02}$, shown in Fig.



Dependence $\mathbf{\Delta\omega\ (t\ )}$ at $\boldsymbol{\omega_{01} > \omega_{02}}$.

The results of calculations based $\Delta\omega(t)$ at $\omega_{02} > \omega_{01}$, shown in Fig.



Dependence $\Delta\omega(t)$ at $\omega_{02} > \omega_{01}$.

The total expression for the two-frequency signal, When $(A_1 / A_2) \geq 1$, $\omega_{01} > \omega_{02}$

$$U(t) = \sqrt{A_1^{\,2} + A_2^{\,2} + 2A_1A_2Cos(\Omega t)}$$

$$\times \cos\left\{ \omega_{01} - \left[\frac{\left[\dfrac{\cos(\Omega t)}{A_1 / A_2} + \dfrac{\sin(\Omega t)^2}{(A_1 / A_2 + \cos(\Omega t))^2} \right]}{\left[1 + \dfrac{\sin(\Omega t)^2}{(A_1 / A_2 + \cos(\Omega t))^2} \right]} \right] + arctg\, \frac{\sin(\Omega t)}{A_1 / A_2 + \cos(\Omega t)} \right\}$$

Impact two-frequency oscillations at the resonant system

Generalized amplitude-frequency characteristic of the oscillatory circuit whose input is fed a two-frequency signal can be determined from the following expression

$$\boldsymbol{Y}_{(\varepsilon)} = \frac{1}{\sqrt{1+\varepsilon^{2}{}_{0k}}}$$

where $\varepsilon_{0к} = Q(\omega/\omega_0 - \omega_0/\omega)$ - generalized detuning of the oscillating circuit generalized detuning of the first component of the output signal

$\varepsilon_{01} = \varepsilon_0 + \Delta\varepsilon/2$

$$A_{1out}(\varepsilon_{01}) = \frac{1}{\sqrt{1+(\varepsilon_0+\Delta\varepsilon/2)^2}}$$

generalized detuning of the second component of the output signal

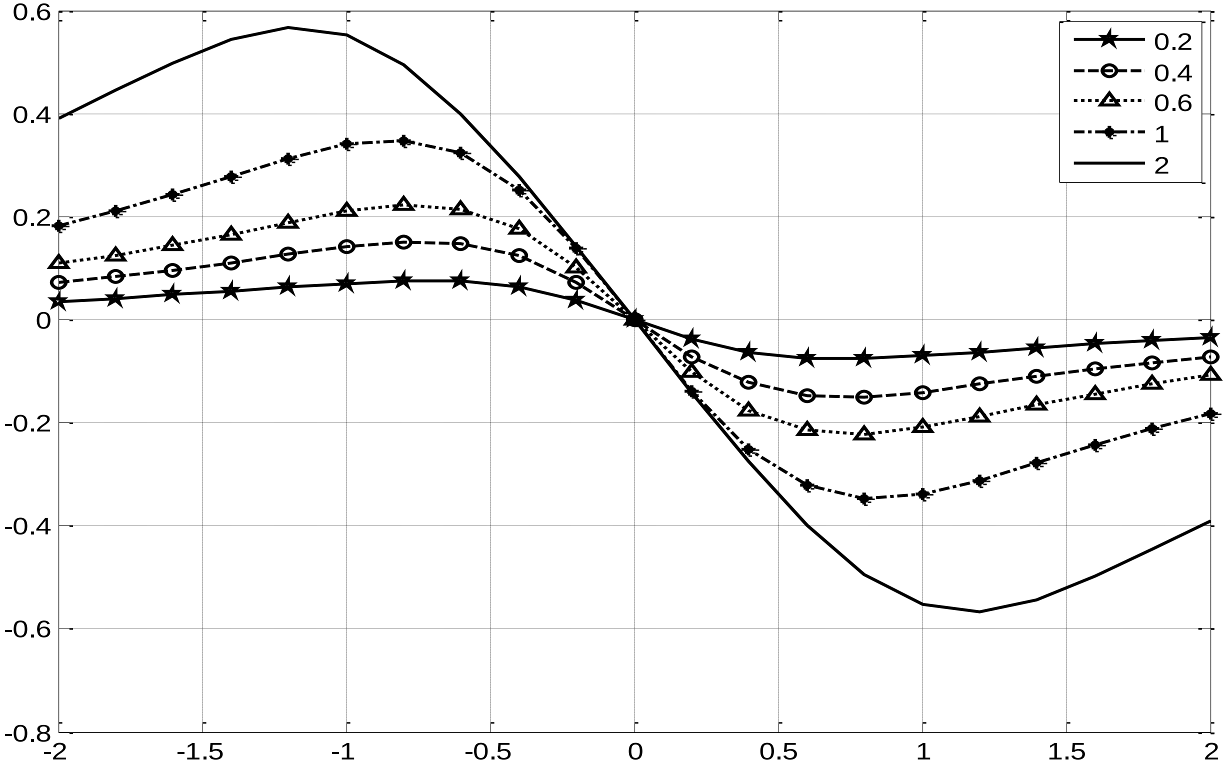
$\varepsilon_{02} = \varepsilon_0 - \Delta\varepsilon/2$

$$A_{2out}(\varepsilon_{02}) = \frac{1}{\sqrt{1+(\varepsilon_0-\Delta\varepsilon/2)^2}}$$

the difference between the amplitudes of the first and second components of the two-frequency output signal ΔA_{out} is given by type

$$\Delta A_{out} = \frac{1}{\sqrt{1+(\varepsilon_0+\Delta\varepsilon/2)^2}} - \frac{1}{\sqrt{1+(\varepsilon_0-\Delta\varepsilon/2)^2}}$$

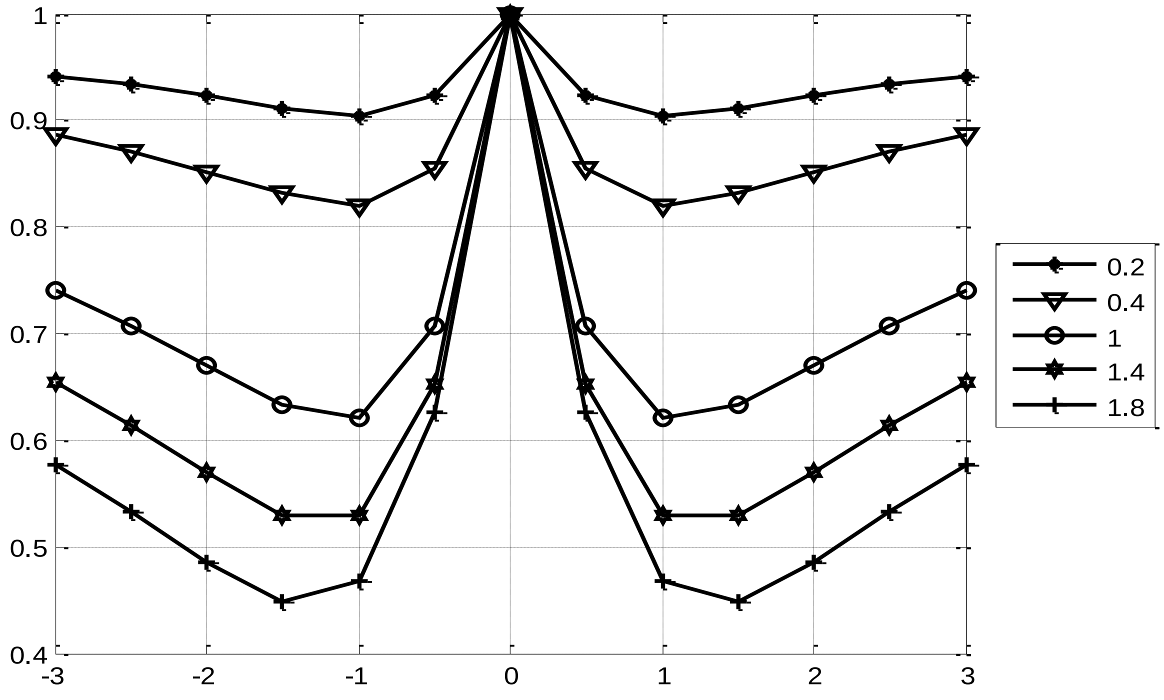
The results of calculations based ΔA_{out} (ε_0) for different values $\Delta\varepsilon$ [0.1; 0.2; 0.4; 1; 2]



Dependence ΔA_{out} (ε_0) for different values $\Delta\varepsilon$.

modulation index envelope of the two-frequency output signal is the ratio of the amplitudes of its components

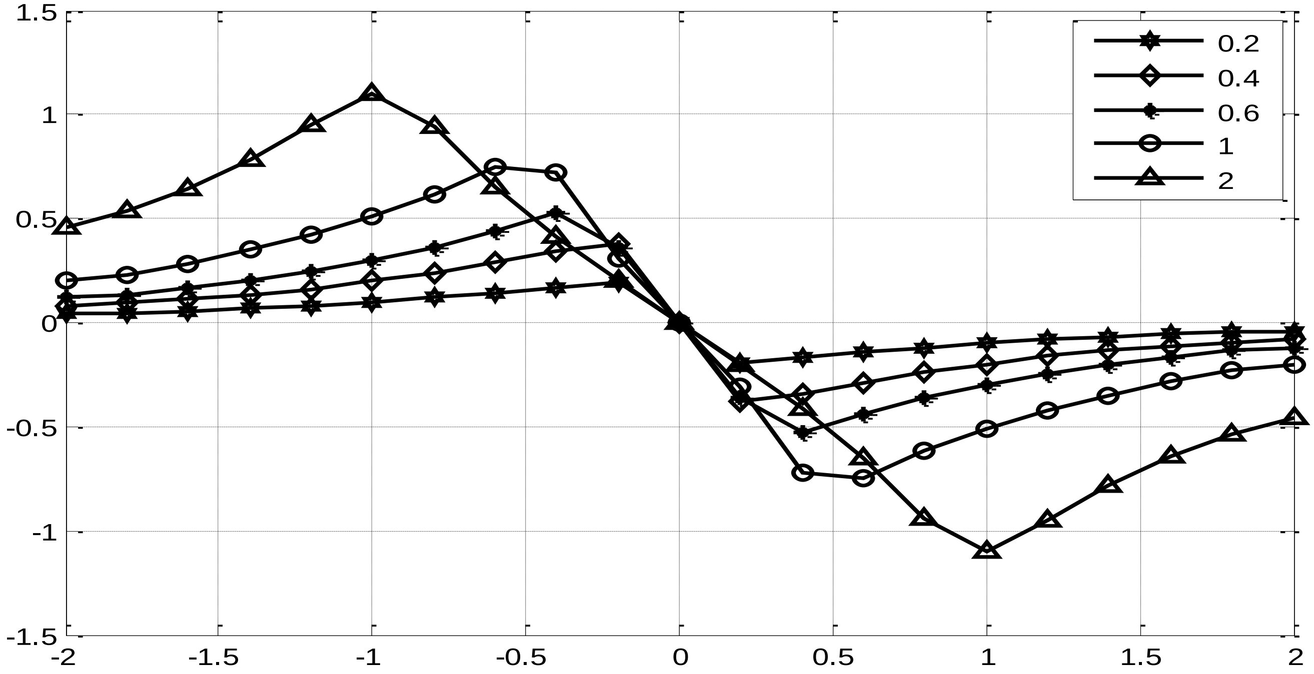
$$M = \frac{\sqrt{1 + (\varepsilon_0 + \Delta\varepsilon/2)^2}}{\sqrt{1 + (\varepsilon_0 - \Delta\varepsilon/2)^2}}$$



The dependence of m **(ε_0)** at different values **$\Delta\varepsilon$**

Result to the phase difference components (φ_{2out}-φ_{1out}), phase shift occurs envelope

$$\Delta\varphi\,(\varepsilon_0) = [-arctg\,(\varepsilon_0 - \Delta\varepsilon/2\,)] - [\,-arctg\,(\varepsilon_0 + \Delta\varepsilon/2\,)]$$



Dependence **$\Delta\varphi$ (ε_0)** for different values **$\Delta\varepsilon$**.

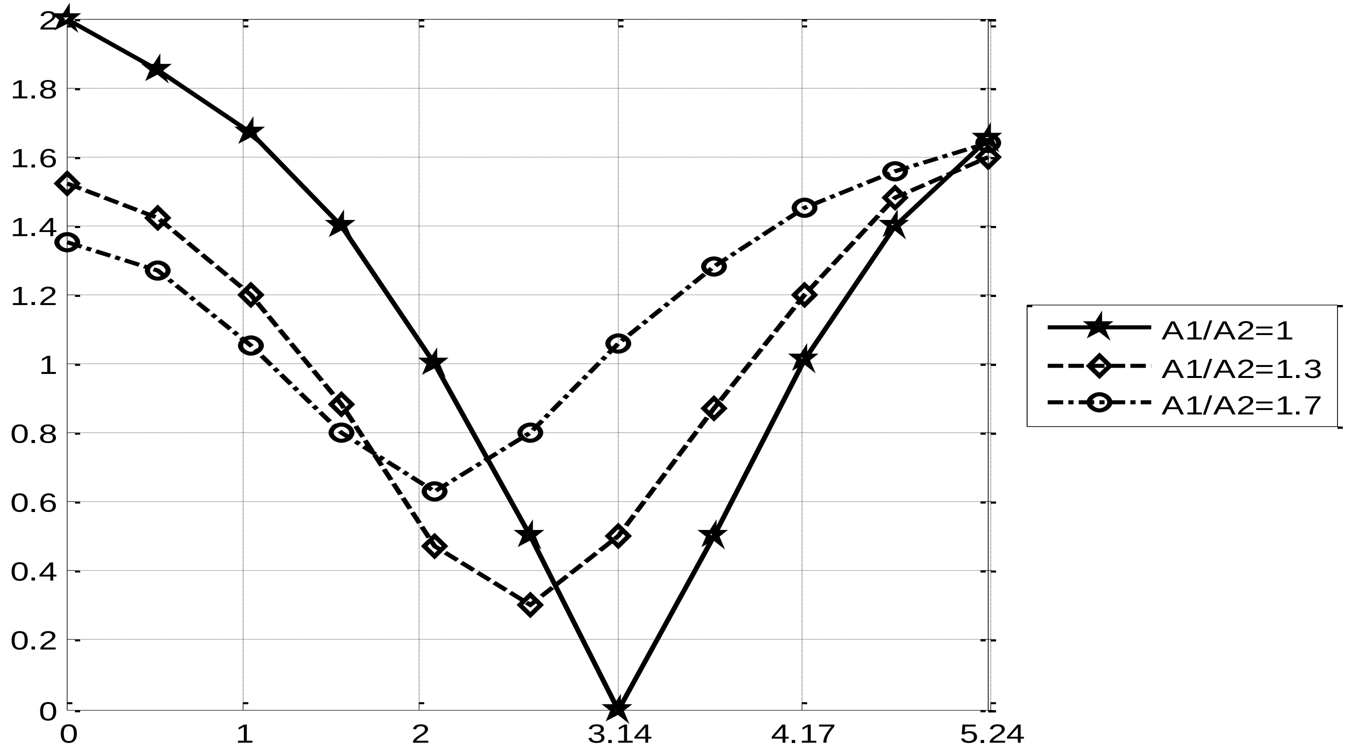
The total expression for the two-frequency output signal with the series resonant circuit

$- \infty < \varepsilon_0 < -\varepsilon_0/2: \varepsilon_{01} > \varepsilon_{02}, \quad A_1/A_2 > 1$

$$U_{вых}(t) = \sqrt{A_1{}^2{}_{вых} + A_2{}^2{}_{вых} + 2A_{1вых}A_{2вых} \cos\left[\left(\varphi_{2вых} - \varphi_{1вых}\right) + \Omega(t)\right]} \times$$

$$\times \cos\left(\omega_M(t) + \left\{\varphi_1 + arctg\left[\frac{\mathrm{Sin}\left[(\varphi_{2вых} - \varphi_{1вых}) + \Omega(t)\right]}{A_{1вых}/A_{2вых} + \cos\left[(\varphi_{2вых} - \varphi_{1вых}) + \Omega(t)\right]}\right]\right\}\right)$$

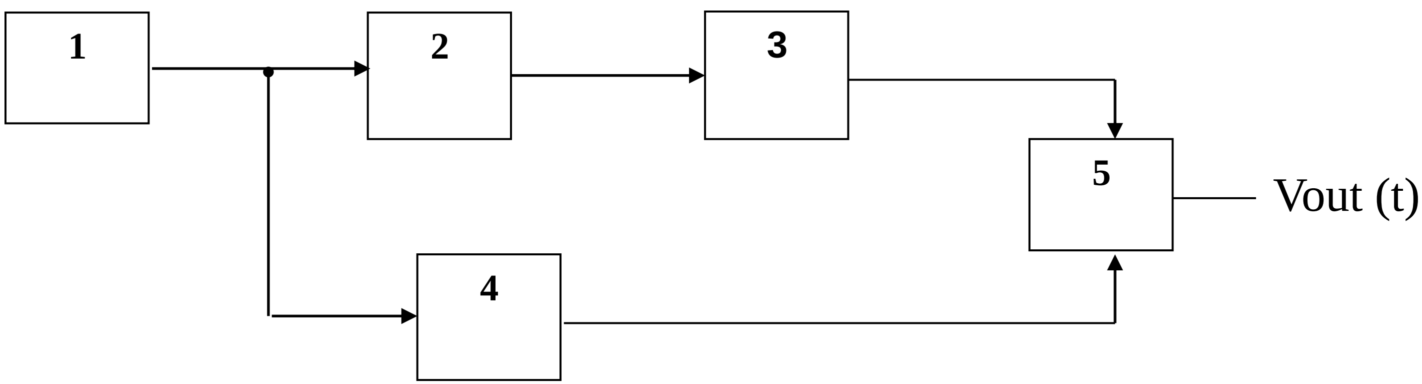
The results of calculations of the envelope of the output signal show



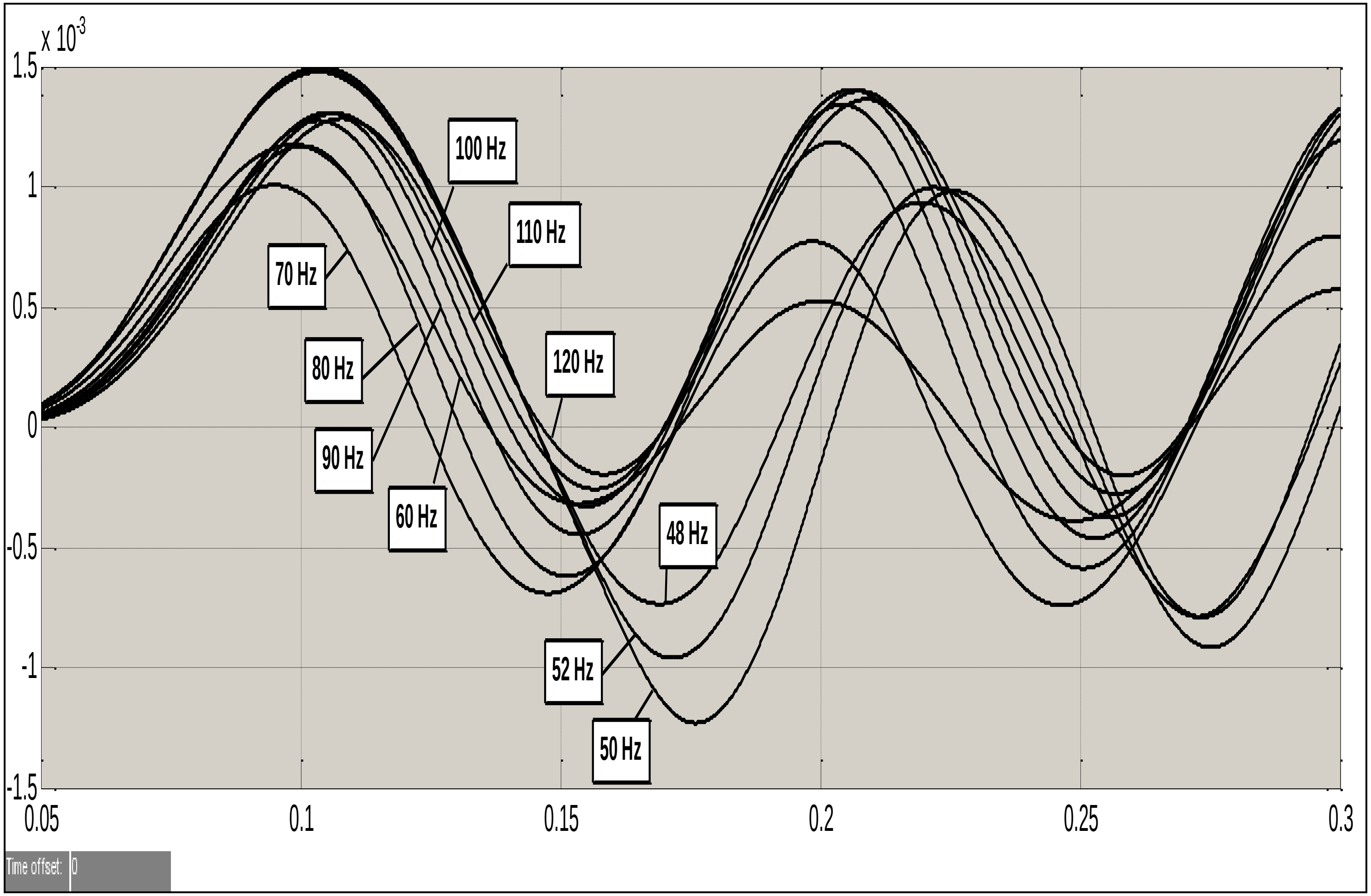
The envelope of the two-frequency output signal Vout (t) in the series resonant circuit **when** $-\infty < \varepsilon_0 < -\varepsilon_0/2$**:** $\varepsilon_{01} > \varepsilon_{02}$**,** $A_1/A_2 > 1$**.**

Technical measuring systems on resonant two-frequency signals

Two-frequency tuning method of resonant systems in the one-sided approach to the resonance



1- Two-frequency signal generator , 2 - resonance system , 3&4 - amplitude detector 5 - phase detector



The result of the scheme for the simulation of different signals after the phase detector

Thank you