Applying the Frequency-Symbolic Method to Optimization of Double-Circuit Parametric Amplifier

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Abstract – **It deals with possibility of applying the frequency-symbolic method for solving of double-circuit parametric amplifier optimization problems.**

Keywords – **symbolic analysis, double-circuit parametric amplifier, frequency-symbolic method.**

I. Introduction

The frequency-symbolic method [1,2] make possible to obtain approximation of transfer function $W(s,t)$ (s-complex variable, t-time) of a linear parametric circuits in the form of Fourier series:

$$\hat{W}(s,t) = W_0(s) + \sum_{i=1}^{n}[W_{-i}(s)\cdot\exp(-j\cdot i\cdot\Omega\cdot t) + $$
$$+ W_{+i}(s)\cdot\exp(j\cdot i\cdot\Omega\cdot t)],$$

where $W_0(s)$, $W_{-i}(s)$, $W_{+i}(s)$ - independent on time t fractionally rational functions of complex variable s, n-the number of harmonics in series. Necessary parameters of linear parametric circuit may be leaved in symbols. Consequently we obtain symbolic expression, which is the base for optimization problems solving using any suitable method.

II. Double-circuit parametric amplifier optimization

The circuit of double-circuit parametric amplifier model is shown on Fig.1.

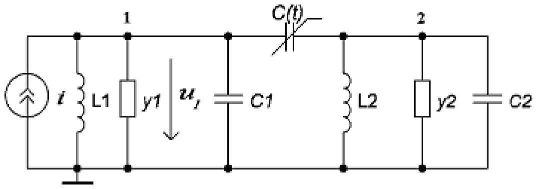

Fig.1. Double-circuit parametric amplifier model.

$i(t) = \text{Im}\cdot\cos(w\cdot t + j))$; $j = 45^{0}$; $\text{Im} = 0{,}1mA$;

$w = 2\cdot p\cdot 10^{8}$ rad/s ;; $y1 = y2 = 10^{-4}\,Sm$;

$C1 = C2 = 68\,pF$; $L1 = 37{,}70795$ nH;

$L2 = 9{,}312609$ nH; $C(t) = C0\cdot(1 + m\cdot\cos(\Omega\cdot t))$;

$m = 0{,}1$.

Using frequency-symbolic method an approximation of transfer function $W(s,t) = u_1 / i$ obtained with pump frequency Ω and parameter $C0$ in symbols. In article consider to find values of Ω and $C0$, which provides the maximum of transfer function absolute value. Dependence of absolute value of transfer function by pump frequency Ω and $C0$ shown on Fig.2. On the Fig.2 we can see only one local extremum in accepted ranges of parameters values changes. On the base of transfer function symbolic expression, using the MATLAB optimization functions, we obtained the next values of parameters: $\Omega_{opt} = 298{,}565$ MHz and $C0_{opt} = 1{,}0086$ pF.

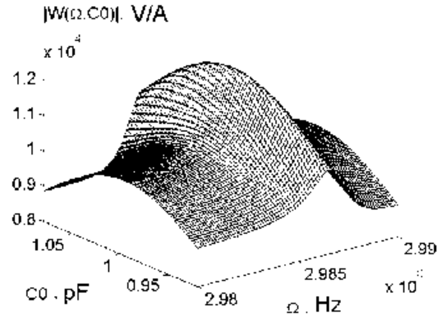

Fig.2 Dependence of transfer function absolute value by pump frequency Ω and $C0$.

In the Table 1 shows the amplitude values of output voltage obtained by MicroCap, obtained in small deviations of Ω and $C0$ values by their optimal values.

TABLE 1
COMARISON WITH MICROCAP

Output voltage amplitude, V					
			Ω,MHz		
			Ωopt − 0,005%	Ωopt	Ωopt + 0,005%
			298,550	298,565	298,580
C0, pF	C0opt − −0,7%	1,0015	**1,239**	**1,250**	**1,249**
	C0opt	1,0086	**1,247**	**1,252**	**1,247**
	C0opt + + 0,7%	1,0157	**1,249**	**1,250**	**1,239**

III. Conclusion

Analogically the frequency-symbolic method may be used to solve optimization problems for any other parameters of double-circuit parametric amplifier.

References

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