Construction Of The Quick-Acting Integrated Circuits Basic Elements Of Telecommunication Means

Volodymyr Shulha
National Aviation University
Kyiv, Ukraine

Ivan Basiuk
National Aviation University
Kyiv, Ukraine

Denys Nevinskyi
Lviv Polytechnic National University
Lviv, Ukraine
nevinskiy90@gmail.com

***Abstract* — The research shows the exclusion possibility of periodic frequency characteristics at predetermined frequency range areas based on volume integrated circuits of super-high-frequency radiation, the possibility appears to suppress signals which interfere and provide favorable conditions for functioning of both integrated circuits, as well as information and communication equipment in general.**

Keywords — frequency, volume integrated circuit, super-high-frequency radiation.

I. Introduction

Multilayer (volume) integrated circuits (VIC) of super-high-frequency radiation (SHF-radiation) are widely used in electronic equipment for various purposes [1-6]. Considerable part of the VIC is constructed from segments of homogeneous lines [3,4]. This limits their use in cases when it is necessary to exclude the periodicity or frequency characteristics or provide a barrier at the predetermined frequency range areas [5].

II. Main Part

To eliminate frequency of characteristics and providing of the set transfer nulls it is advisable to design VIC based on heterogeneous lines with fixed poles and shifted nulls of input impedance [8]. Matrix of resistance $[Z'] = [Z'_{11}, Z'_{12}, Z'_{22}]$ of this line becomes in the result of the element transformation Z_{11} of some starting line. Let us denote through Z_{11}, Z_{12}, Z_{22} elements of matrix of source line resistance. To ensure transmission set nulls we transform the input impedance of the source line as follows:

$$Z'_{11}(P) = Z_{11}(P) * \left(1 + \frac{p^2}{\gamma^2}\right) / \left(1 + \frac{p^2}{\Omega_1^2}\right) \quad (1)$$

where p – complex frequency variable.

If $Z_{11}(j\Omega_1) = 0$ then transformation (1) corresponds to the element null shift Z_{11} from the position $j\Omega_1$ to the position $j\gamma_1$. Clearly, that the re-use of conversion (1) to the element Z_{11} results in heterogeneous line which provides two preset nulls of transmission. Using the procedure (1) M once, we will receive line with nulls $p_k = j\gamma_k \; k = 1, 2, 3 \ldots M$.

If as the source line to take homogeneous segment with wave-making resistance W and time of delay τ, then correspondingly the results can be written:

$$Z'_{11} = \mathrm{W} * \mathrm{cth}(\mathrm{p\tau}) * \frac{\left(1 + \frac{p^2}{\gamma_1^2}\right)}{\left(1 + \frac{p^2}{\Omega_1^2}\right)}$$

$$Z'_{12} = \mathrm{W}/\mathrm{sh}(\mathrm{p\tau})$$

$$\mathrm{Z}'_{22} = \phi(\mathrm{p}) - 2\mathrm{p} * \mathrm{res}[\phi(\mathrm{p})]/(\mathrm{p}^2 + \gamma_1^2) \quad (2)$$

$$\phi(p) = \mathrm{W} * \mathrm{cth}(\mathrm{p\tau}) * \frac{\left(1 + \frac{p^2}{\Omega_1^2}\right)}{\left(1 + \frac{p^2}{\gamma_1^2}\right)}$$

$$\mathrm{res}[\phi(\mathrm{p})] = \mathrm{W} * \mathrm{cth}(\mathrm{j\gamma\tau}) * \left[\gamma_1 * \frac{\Omega_1^2 - \gamma_1^2}{2j\Omega_1^2}\right]$$

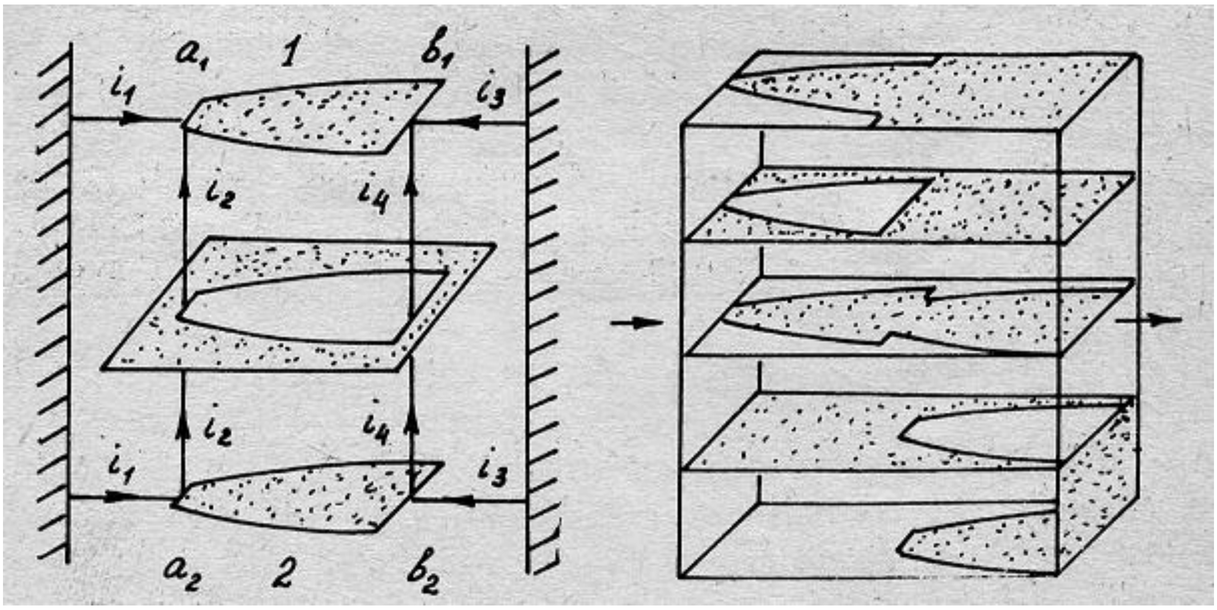
where $p = j\gamma_1$.

Wave-making resistance of line, resistance matrix elements which are determined from the ratio (2), change according to the following rule:

$$W_1(\tau) = \mathrm{W} * \frac{\Omega_1^2 \left(1 + \frac{K\gamma_1}{\Omega_1}\right)}{\gamma_1^2 \left(1 + \frac{K\Omega_i}{\gamma_i}\right)} \quad (3)$$

where $K = tg(\gamma_1 \tau) * tg(\Omega_1 \tau)$.

Let us make from a couple of heterogeneous lines the structure in which through the profiled diaphragm a balanced connection is implemented (fig. 1). To describe the model, we introduce fictitious currents i_1, i_2, i_3, i_4. We consider the properties of the formed structures from ends a_1, a_2.



a) b)

Figure 1. a) – balanced connection, which is implemented through the field diagram; b) – cascade connection of basic elements arranged in different layers of the multilayer package

Under the influence of currents i_2, i_4 in the lines 1, 2 there is an odd kind of fluctuations with voltage:

$$u_1^{(2)} = -u_2^{(2)} = z_{22}^{(0)}\, i_2$$
$$u_1^{(4)} = -u_2^{(4)} = z_{12}^{(0)}\, i_4 \qquad (4)$$

where $z_{22}^{(0)}$, $z_{12}^{(0)}$ – matrix components [z'] at odd form of vibrations. Currents i_1, i_3 cause in the lines 1, 2 pair type of fluctuations with voltage:

$$u_1^{(1)} = u_2^{(2)} = z_{11}^{(l)}\, i_1$$
$$u_1^{(3)} = u_2^{(3)} = z_{12}^{(l)}\, i_3 \qquad (5)$$

where $z_{11}^{(l)}$, $z_{12}^{(l)}$ – matrix components [z'] at the pair type of fluctuations.

As the positive we will assume current, coming to the line, and as the negative - the one that comes out of it. Then the total currents at the ends a_1, a_2, b_1, b_2 are written in the following way:

$$\mathrm{I}_{1a} = i_1 + i_2$$
$$\mathrm{I}_{2a} = i_1 - i_2$$
$$\mathrm{I}_{1b} = i_3 + i_4 \qquad (6)$$
$$\mathrm{I}_{2b} = i_3 - i_4$$

From the condition (6) we define:

$$\mathrm{i}_1 = (\mathrm{I}_{1a} + \mathrm{I}_{2a})/2$$
$$\mathrm{i}_2 = (\mathrm{I}_{1a} - \mathrm{I}_{2a})/2$$
$$\mathrm{i}_3 = (\mathrm{I}_{1b} + \mathrm{I}_{2b})/2 \qquad (7)$$
$$\mathrm{i}_4 = (\mathrm{I}_{1b} - \mathrm{I}_{2b})/2$$

Voltages, created at the ends a_1, a_2 of the lines 1, 2 are the sum of voltages of the separate fluctuations types:

$$\mathrm{U}_{1a} = u_1^{(1)} + u_1^{(2)} + u_1^{(3)} + u_1^{(4)}$$
$$\mathrm{U}_{2a} = u_2^{(1)} + u_2^{(2)} + u_2^{(3)} + u_2^{(4)} \qquad (8)$$

Based on correlations (4), (5), (7), (8) we receive:

$$\mathrm{U}_{1a} = \rho_{11}^{(1)}\mathrm{I}_{1a} + \rho_{12}^{(1)}\mathrm{I}_{2a} + \rho_{11}^{(2)}\mathrm{I}_{1b} + + \rho_{12}^{(2)}\mathrm{I}_{2b}$$
$$\mathrm{U}_{2a} = \rho_{12}^{(1)}\mathrm{I}_{1a} + \rho_{11}^{(1)}\mathrm{I}_{2a} + \rho_{12}^{(2)}\mathrm{I}_{1b} + + \rho_{11}^{(2)}\mathrm{I}_{2b} \qquad (9)$$

where

$$\rho_{11}^{(1)} = (z_{11}^{(l)} + z_{11}^{(0)})/2$$
$$\rho_{12}^{(1)} = (z_{11}^{(l)} - z_{11}^{(0)})/2$$
$$\rho_{11}^{(2)} = (z_{12}^{(l)} + z_{12}^{(0)})/2$$
$$\rho_{12}^{(2)} = (z_{12}^{(l)} - z_{12}^{(0)})/2$$

Let us consider the structure properties of the ends b_1, b_2. Currents i_2, i_4 cause odd fluctuations:

$$u_1^{(2)} = -u_2^{(2)} = z_{12}^{(0)}\, i_2$$
$$u_1^{(4)} = -u_2^{(4)} = z_{22}^{(0)}\, i_4 \qquad (10)$$

where $z_{22}^{(0)}$ – matrix element [z'] at odd form of fluctuations.

Currents i_1, i_3 cause in the lines 1, 2 pair form of fluctuations with voltage:

$$u_1^{(1)} = u_2^{(1)} = z_{12}^{(l)}\, i_1$$
$$u_1^{(3)} = u_2^{(3)} = z_{22}^{(l)}\, i_3 \qquad (11)$$

where $z_{22}^{(l)}$ – matrix element [z'] at pair form of fluctuations.

Voltages, created at the ends b_1, b_2 of the lines 1, 2, are determined by amount of voltage of fluctuations certain types:

$$\mathrm{U}_{1b} = u_1^{(1)} + u_1^{(2)} + u_1^{(3)} + u_1^{(4)}$$
$$\mathrm{U}_{2b} = u_2^{(1)} + u_2^{(2)} + u_2^{(3)} + u_2^{(4)} \qquad (12)$$

Based on correlations (7), (10) - (12) we receive:

$$\mathrm{U}_{1b} = \rho_{11}^{(2)}\mathrm{I}_{1a} + \rho_{12}^{(2)}\mathrm{I}_{2a} + \rho_{11}^{(3)}\mathrm{I}_{1b} + + \rho_{12}^{(3)}\mathrm{I}_{2b}$$
$$\mathrm{U}_{2b} = \rho_{12}^{(2)}\mathrm{I}_{1a} + \rho_{11}^{(2)}\mathrm{I}_{2a} + \rho_{12}^{(3)}\mathrm{I}_{1b} + + \rho_{11}^{(3)}\mathrm{I}_{2b} \qquad (13)$$

where

$$\rho_{11}^{(3)} = (z_{22}^{(l)} + z_{22}^{(0)})/2$$
$$\rho_{12}^{(3)} = (z_{22}^{(l)} - z_{22}^{(0)})/2$$

Based on dependences (9), (13) we define the matrix equation of the structure from two related heterogeneous lines:

$$\begin{bmatrix}\mathrm{U}_{1a}\\ \mathrm{U}_{2a}\\ \mathrm{U}_{1b}\\ \mathrm{U}_{2b}\end{bmatrix} = \begin{bmatrix}[\rho]_1 & [\rho]_2\\ [\rho]_2 & [\rho]_3\end{bmatrix}\begin{bmatrix}\mathrm{I}_{1a}\\ \mathrm{I}_{2a}\\ \mathrm{I}_{1b}\\ \mathrm{I}_{2b}\end{bmatrix} \qquad (14)$$

where the matrices-blocks have the form:

$$[\rho]_1 = \begin{bmatrix}\rho_{11}^{(1)} & \rho_{12}^{(1)}\\ \rho_{12}^{(1)} & \rho_{11}^{(1)}\end{bmatrix}$$

Basic elements (canonical links) are formed from the structure shown in Fig. 1, after the introduction of appropriate boundary conditions (idling or short circuit) for certain ends of heterogeneous lines. An integrated circuit with preset transmission nulls is constructed at the cascade connection of basic elements arranged in different layers of the multilayer package (Fig. 1b).

III. CONCLUSIONS

The received results allow to construct VIC of SHF-radiation that provide nulls of transfer at predetermined areas of frequency range. Consequently, the possibility appears to suppress signals which interfere and provide favorable conditions for the functioning of both VIC as well as apparatus in general.

REFERENCES

[1] Hvozdev V. I., Nefedov E. I. Obyomnyie integralnyie skhemy SVCh. – M.: Nauka, 1985.

[2] Kozlovskyi V. V., Soshnykov V. I. Ustroystva na neodnorodnykh liniyakh.– Kyiev: Tekhnika, 1987.

[3] Kozlowski, V.V., Mishchenko, A.V., Sakhybay, T. Method of simulation of UAV facilities numerical state. IEEE 3rd International Conference Actual Problems of Unmanned Aerial Vehicles Developments, APUAVD 2015 – Proceedings

[4] Kulyk, M., Khoma, V., Kozlovskyi, V., (...), Janisz, K., Falat, P. Using of fuzzy cognitive modeling in information security systems constructing. Proceedings of the 2015 IEEE 8th International Conference on Intelligent Data Acquisition and Advanced Computing Systems: Technology and Applications, IDAACS 2015

[5] Kozlovskyy, V., Parkhomey, I., Odarchenko, R., Gnatyuk, S., Zhmurko, T. Method for UAV trajectory parameters estimation using additional radar data. IEEE 4th International Conference Methods and Systems of Navigation and Motion Control, MSNMC 2016 – Proceedings

[6] Mishchenko A., Kozlovskiy V., Khlaponin Yu. Typical «effect-costs» dependence function for information security. Ukrainian Scientific Journal of Information Security, 2015, vol. 21, issue 1, p. 75-78.

[7] Pavlysh V., Surface Plasmons Polaritons based Four- Channel Multiplexer for Communication Systems / V. Pavlysh, M. Klymash, D. Nevinsky, L. Zakalyk, S. Lebid // Smart Computing Review. - 2016. - vol. 5, N. 4. - P. 34-43.

[8] Kozlovskiy V. Matrix 2D microstrip support many different shapes pole. Ukrainian Scientific Journal of Information Security, 2004, vol. 21, issue 4, P. 81-89.