ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 8, Issue 4 , April 2021

Construction of graph models of multiparameter optoelectronic converters of liquid turbidity

ShipulinYu.G., Ergashev O.M., Usmanov J.K., Jabbarov Z.R., To'ychiboyev A.E.

Professor, Department of Information Processing and Control Systems, Tashkent State Technical University, Tashkent, Uzbekistan
Assistant Professor, Department of Information technologies, Tashkent University of information technologies, Fergana, Uzbekistan
Deputy Head of the Department of the Chirchik Higher Tank Command Engineering School, Chirchik, Uzbekistan
Assistant Professor, Military Training Center, National University of Uzbekistan, Tashkent, Uzbekistan
Student, Department of Programming Engineering, Tashkent University of information technologies, Fergana, Uzbekistan

ABSTRACT: The article deals with the issues of constructive construction and graph models of multipara meter optoelectronic converters of concentration and turbidity of liquids. It is shown that the graph method of analysis makes it possible to visually display the structural property and inter-chain connections of optoelectronic converters.

I. INTRODUCTION

Optoelectronic primary converters are very effective for obtaining information about linear and angular displacements, liquid level, concentration and a number of other technological quantities [1, 2].

The designs of optoelectronic converters are very diverse. In the construction shown in fig. 1, a, the input value $X_{вх}$ — displacement of the liquid level 4 - causes a change in the distribution of the luminous flux Φ_o along with the fiber and the illumination E_o of the radiation receiver (PI) 3. In another design (see Fig . 1.6 $A_{вх}$ — change in the concentration of the liquid (or gas) 5 - also changes the distribution of the luminous flux Φ_o along with the fiber 2 and the illumination PI 3.

In these structures, one can distinguish circuits of various physical nature: electrical (power supply and measurement), optical (transformation), mechanical (input value), etc. In any of these circuits, generalized values of impact (voltage) $U_i$and reactions (current) I_i, as well as resistance parameters $R_i$and conductivity G_i.

II. METHODOLOGY

Based on the concepts of geometrical optics in relation to the distribution of the luminous flux along a hollow fiber, we use a formal analogy between the quantities of electrical and optical nature [1], according to which illumination is used as an analogue of the voltage in the optical circuit $U_0 = E_0$,as a current - luminous flux $I_o = \Phi_o$, resistance —

$$R=K_xL/S, \tag{1}$$

and conductivity —

$$G=1/R0=K_xL/S, \tag{2}$$

Where K_x — absorption coefficient; L, S — length and cross-sectional area of a hollow fiber; R, $R0$—resistance of the longitudinal and transverse sections of the conversion circuit.

The existing methods for analyzing optoelectronic converters are very complex and involve cumbersome calculations, which do not allow effective analysis of existing structures and the development of new ones.

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 8, Issue 4 , April 2021

In our opinion, the graph method of analysis is very promising, which clearly displays the structural properties of optoelectronic converters and allows resorting to machine methods of analysis and synthesis of structures and distributed circuits. The analysis of the principles of constructing converters in the language of graphs is reduced to the procedure for transforming an initial graph consisting of a single arc outgoing from a point $X_{\text{вх}}$ (vertices - source) and entering the point $U_{\text{эвых}}$ (the vertex is a sink) into the desired decision graph. The original two-vertex graph, by forming new vertices and arcs, is transformed into the sought-for solution graph of a set of paths corresponding to a set of construction principles.

The graph model shown in Fig. 1, v, contains the following subgraphs (paths): $U_{\text{э}1}\rightarrow I_{\text{э}1}$—Radiation source power circuit; $\Phi_0\rightarrow E_0$ — conversion chain;
$U_{\text{э}2}\rightarrow I_{\text{э}2}$—power supply circuit of the measuring circuit and $I_{\text{э}2}\rightarrow U_{\text{эвых}}$. The indicated paths refer to circuits of the same physical nature and are characterized by the product of the circuit function T_i per parameter Π_i. Second group of chains — interchain paths: $I_{\text{э}1}\rightarrow\Phi_{\text{э}}$, $E_0\rightarrow U_{\text{эвых}}$, the third - the ways of influence of the input quantity $X_{\text{вх}}\rightarrow\Phi_0$, $X_{\text{вх}}\rightarrow E_0 X_{\text{вх}} \rightarrow U_{\text{эвых}}$.

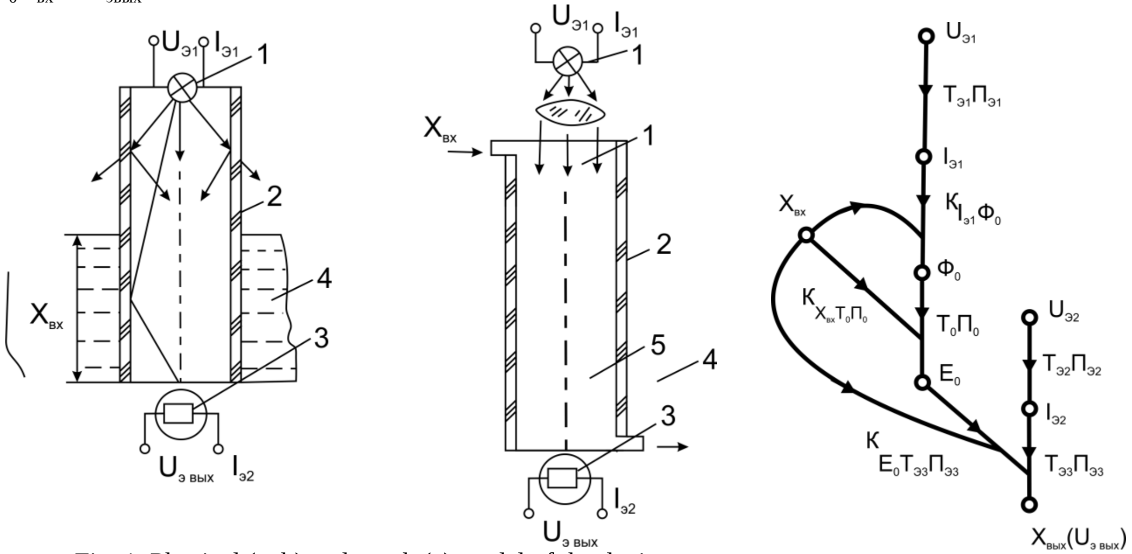

Fig. 1. Physical (a, b) and graph (c) model of the device:
1 — radiation source; 2 — light guide; 3 — radiation receiver; 4 — liquid; 5 — cavity of the light guide

Thus, this graph model allows us to identify the following construction principles:

1. $X_{\text{вх}}\rightarrow\Phi_0\rightarrow E_0\rightarrow X_{\text{вых}}$.This principle is associated with exposure to the input variable $X_{вх}$ on chain link function К $(I_{\text{э}1},\Phi_o)$, those. on the process of converting electric current into a luminous flux. The function transformed based on the graph model has the form

$$U_{\text{э вых}} = U_{\text{э}1}T_{\text{э}1}\Pi_{\text{э}1}К\big(X_{\text{вх}}, К(I_{\text{э}1},\Phi_0)\big)T_0\Pi_0 К(E_0 T_{\text{э}3}\Pi_{\text{э}3})T_{\text{э}2}\Pi_{\text{э}2}X_{\text{вх}}. \quad (3)$$

2. $X_{\text{вх}}\rightarrow E_0\rightarrow X_{\text{вых}}$.This principle of action is associated with exposure $X_{\text{вх}}$ on the transformation process $\Phi_0\rightarrow E_0$, what is displayed by the circuit function $T_0\Pi_0$. It is widespread and implemented by changing the absorption coefficients K_x and reflections p, violation of total internal reflection (TIR), moving the screen, and other methods. The transformation function is

$$U_{\text{э вых}} = U_{\text{э}1}T_{\text{э}1}\Pi_{\text{э}1}К(I_{\text{э}1},\Phi_0)К(X_{\text{хв}}, T_0\Pi_0)X_{\text{вх}}К\times(E_0, T_{\text{э}3}\Pi_{\text{э}3})U_{\text{э}2}\Pi_{\text{э}2}U_{\text{э}2}T_{\text{э}2}. \quad (4)$$

3. $X_{\text{вх}}\rightarrow U_{\text{вых}}$. This principle is characterized by the impact $X_{\text{вх}}$on the current conversion process $I_{\text{э}2}$в$U_{\text{эвых}}$ in the measuring chain, which is displayed by the inter-chain function $K(E_0, T_{\text{э}3},\Pi_{\text{э}3})$. The transformation function is

$$U_{\text{э вых}} = U_{\text{э}1}T_{\text{э}1}\Pi_{\text{э}1}К(I_{\text{э}1},\Phi_0)T_0\Pi_0К\big(X_{\text{вх}}К\,(E_0 T_{\text{э}3}\Pi_{\text{э}3})\big)T_{\text{э}2}\Pi_{\text{э}2}U_{\text{э}2}X_{\text{вх}}. \quad (5)$$

To analyze transformation functions (3) - (5), it is necessary to determine specific expressions for the communication functions $К\,(E_0 T_{\text{э}3}\Pi_{\text{э}3})\times К\,(I_{\text{э}1}\Phi_0)$ and $К(X_{\text{хв}}, T_0\Pi_0)$ circuit functions $T_{\text{э}1}$, $T_{\text{э}2}$, T_o and parameters $\Pi_{\text{э}1}$, $\Pi_{\text{э}2}$, Π_{01}, $T_{\text{э}3}$. Communication function К($I_{\text{э}1}$, I_0), and $T_{\text{э}1}$и$\Pi_{\text{э}1}$ are determined by the types of radiation source, which can be LEDs, lasers, incandescent lamps, etc. Circuit function $T_{\text{э}2}$ and parameter $\Pi_{\text{э}2}$ are determined by the types of power supply of the measuring circuit; for a simple concentrated electrical circuit, their values are: $T_{\text{э}2} = 1, \Pi_{\text{э}2} = G_2$.

The essential nodes of the considered converters are the influence circuits of the input quantity $X_{\text{вх}}$ and optical voltage E_o on the parameter of the sensitive element $T_{\text{э}3}\Pi_{\text{э}3}$, which are determined by communication functions $К(X_{\text{хв}}, T_0\Pi_0)$ and $К\,(E_0, T_{\text{э}3}, \Pi_{\text{э}3})$.

ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 8, Issue 4 , April 2021

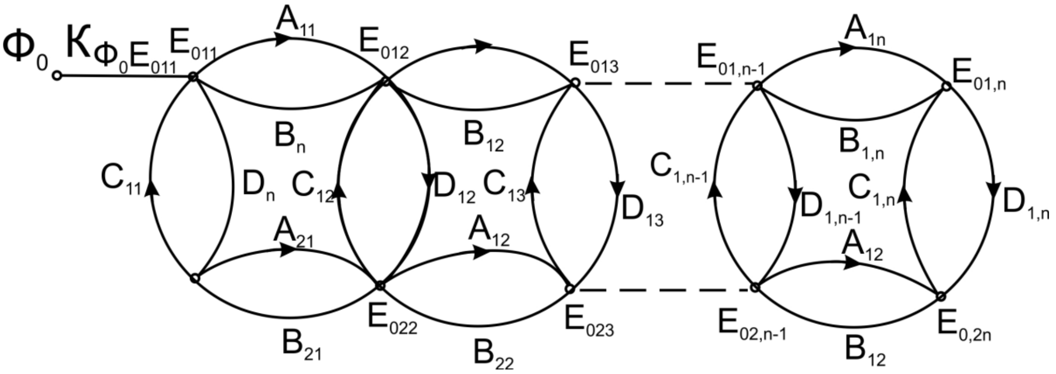

Fig. 2. Graph model of a distributed optical circuit.

III. CONCLUSION

In the considered converters, the transformation function can be determined if the nature of the distribution is known$\Phi_0(E_0)$ along the fiber chainThis problem is also effectively solved on the basis of the graph model of the distributed optical circuit of the converter (Fig. 2). The nodes of the model display the values of the illumination $E_{oij}$and the branches $A_{ij}B_{ij}C_{ij}$, $D_{ij}$are found from the expressions [3]

$$A_{ij} = \frac{1}{R_{ij}\left(\frac{1}{R_{ij}} + \frac{1}{R\emptyset_{ij}} + \frac{1}{R_{j,\ i-1}} + \frac{1}{R\emptyset_{j-1,\ i}}\right)},$$

$$B_{ij} = \frac{1}{R_{ij}\left(\frac{1}{R_{ij}} + \frac{1}{R\emptyset_{j,\ i+1}} + \frac{1}{R_{j,\ i+1}} + \frac{1}{R\emptyset_{j-1,i+1}}\right)},$$

$$C_{ij} = \frac{1}{R\emptyset_{j,\ i}\left(\frac{1}{R\emptyset_{j,\ i}} + \frac{1}{R_{j+1,\ i}} + \frac{1}{R_{j+1,\ i+1}} + \frac{1}{R\emptyset_{j+1,i}}\right)},$$

$$D_{ij} = \frac{1}{R\emptyset_{ij}\left(\frac{1}{R\emptyset_{ji}} + \frac{1}{R_{ij}} + \frac{1}{R_{j,\ i-1}} + \frac{1}{R\emptyset_{j-1,i}}\right)},$$

The distributions E_{0ij} are determined on the basis of the ASPRP program complex [3], developed on the basis of the graph model (see Fig. 2).

REFERENCES

[1] Azimov RK, Shipulin Yu. G. Optoelectronic converters of large displacements based on hollow fibers. Moscow: Energoatomizdat, 1987.56 p.
[2] Yakushenkov. SOUTH. Theory and calculation of optoelectronic devices. Moscow: Logos, 2004 .-- 472 p.
[3] Torshina I.P. Computer modeling of optoelectronic systems for primary information processing. Moscow: Logos, 2009 .-- 448 p.
[4] Tarasov V.V., YakushenkovYu.G. Two- and multi-band optoelectronic systems with matrix radiation detectors. Moscow: Logos, 2007.
[5] Sood A.K., Egerton E.J., Bhadra S.K. et.al. Design end development of high performance radiation hardened anti-reflection coatings for LWIR HgCdTe focal plane arrays. SPIE Proc. 2004. Vol. 5564. P. 15-26
[6] Chen J.Y., Reed I.S. A detection algorithm for optical targets in clutter // IEEE Trans, on Electron Systems. 1987. Vol. AES-23. P. 46-59.
[7] Sato M., Takagi N., Jamala F. Potentiometer using the photoconductive thin film. "Fujitsu" (Set. And Teshn. Y.) 1978, 14, no. 2 p 111-122.
[8] Photoelectric converters of information. Edited by prof. Presnukhina L.I. M .: Mashinostroenie, 1974 .-- 376 p.