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Static Characteristics of Magnetomodulation DC Converters with Negative Feedback

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ABSTRACT: In this article, the negative inverse connection system of magnetomodulation DC converters has been developed. The negative inverse connection construction gives opportunity to increase accuracy rate of controlling system.

KEY WORDS: magnetomodulation, current, converters, transmission, amplifier, resistors, winding, conductivity, circuit.

I. INTRODUCTION

In this article, the negative feedback of magnetic-modulating DC converters is developed, static characteristics, block diagrams and equations of magnetic-modulating DC converters with negative feedback are considered. An experimental test of direct current magnetomodulation converters with negative feedback and without feedback was also carried out.

II.ENERGY EFFICIENCY

To calculate the static characteristics of magnetomodulation direct current converters (DCM) with negative feedback (NF) (Fig. 1), we present its structural diagram in the form shown in Fig. 2. Here K_t – is the static transmission coefficient of the DCM with an open NF; K_1– gain of amplifier $A1$; R_{nf} – the total value of the resistance of the R'_{nf}resistorsиR''_{nf} ; W_{nf} – number of turns of the feedback winding.

When all links of the structural circuit are linear, the output voltage of the DCM is determined by the following expression:

$$U_{out} = I_c \frac{K_t K_1}{1 + K_t K_1 \frac{W_{nf}}{R_{nf}}}. \qquad (2)$$

The transmission coefficient of the DCM with open feedback is equal to:

$$K_t = \frac{1}{I_c} E \frac{T_1 - T_2}{T_1 + T_2}. \qquad (3)$$

Expression (2) is convenient to use in the range of converted currents at which K_t is constant with a certain degree of accuracy. Since the values of T_1иT_2 nonlinearly depend on the converted current I_c, in the general case K_t is a nonlinear function of this current. Therefore, it will be more convenient to calculate the dependence $U_{out} = f(I_c)$ for DCM with NF in the following sequence. First, the dependence $U_{out} = f(I_\Sigma)$ is found. In this case, the current I_Σ is set in the same way as the current I_c was previously set. This dependence coincides with the static characteristic of the DCM with open NF at $I_c = I_\Sigma$. Then the value of the current I_c is found, corresponding to the given value of the voltage U_{out}:

$$I_c = I_\Sigma + \frac{U_{out} K_1 W_{nf}}{R_{nf}}. \qquad (4)$$

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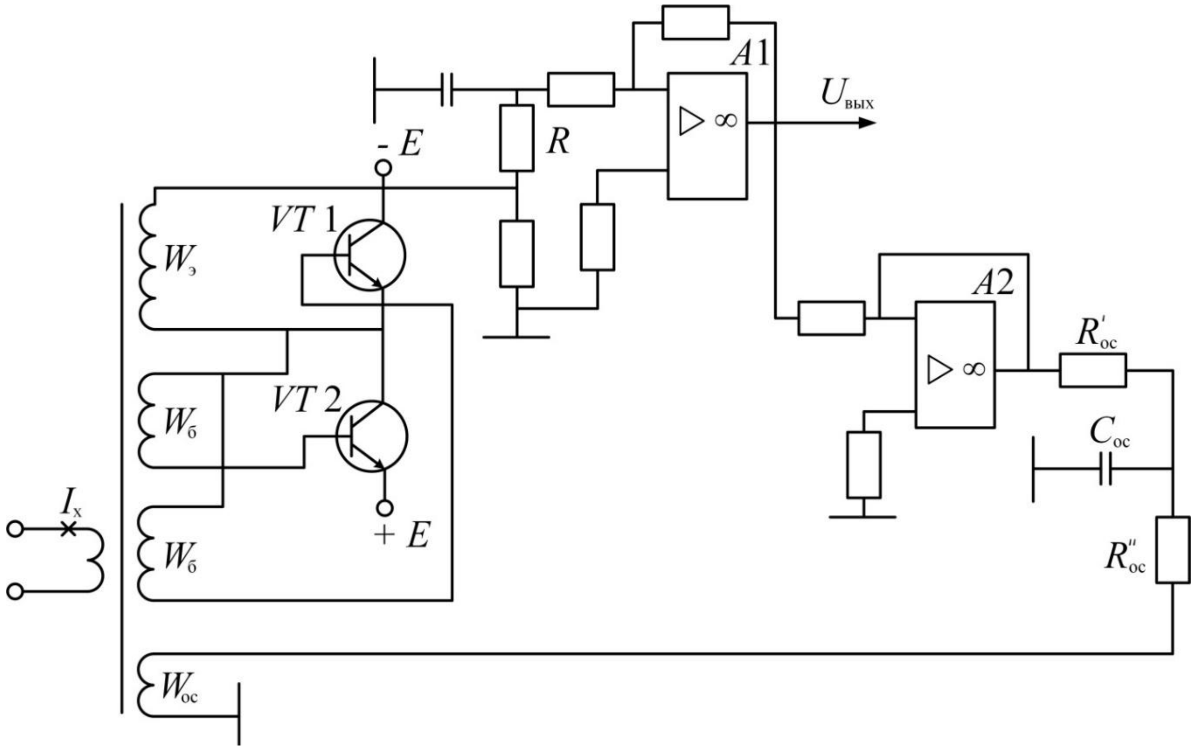

Fig. 1. DCM on transistors of different conductivity with negative feedback.

For the considered structural scheme, the following equations are valid:

$$\begin{cases} U_{out} = I_{\Sigma} K_t K_1 , \\ I_{\Sigma} = I_c - I_{nf} \\ I_{nf} = U_{out} K_1 \frac{W_{nf}}{R_{nf}} . \end{cases} \quad (1)$$

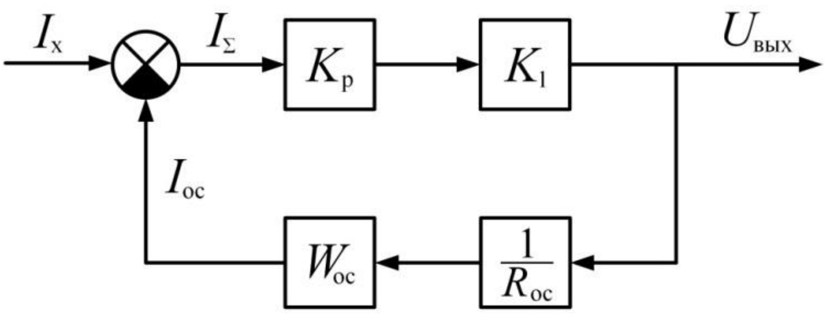

Fig. 2. Block diagram of DCM with negative feedback

Further, all currents on the curve $U_{out} = f(I_c)$. are calculated. The dependence $U_{out}(I_c)$ for the DCM with NF, assembled according to the scheme in Fig. 1, with open and closed NF, are shown in Fig. 3. DCM parameters: core $M2000HMI$ K20x12x6. W_e =150; $W_b = 75$; $W_{nf} = 400$; $E = \pm 12\ V$; $R = 180\ ohms$; $R_b = 300\ ohms$; $R_{nf} = 300\ ohms$.

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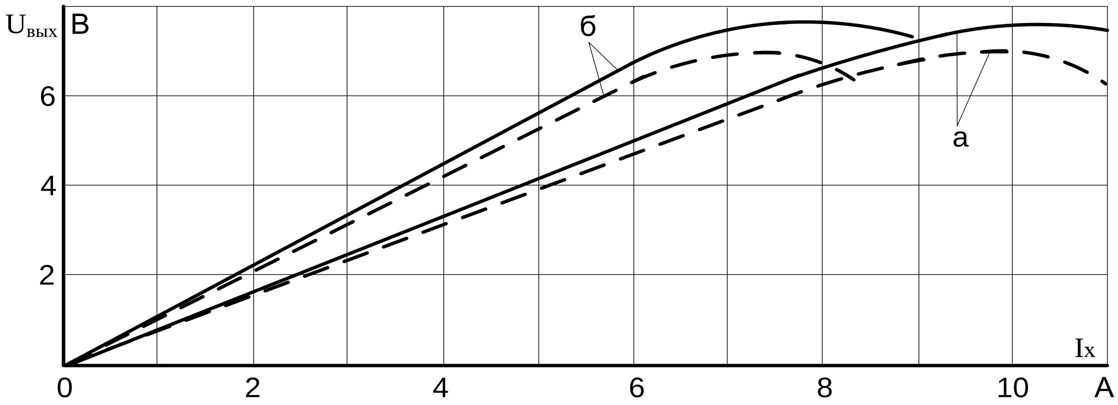

Fig. 3. Static characteristics of DCM with NF (a) and without NF (b): solid - calculated; dotted – experimental.

III.RESULTS AND DISCUSSION

Thus, when using NF in DCM on MTM with PWM, its sensitivity, as expression (2) shows, decreases by a factor of $1+K_tK_1\frac{W_{nf}}{R_{nf}}$ times, and the length of the linear section of the characteristic, as can be seen from the expression (4), increases by the amount $\frac{U_{out}K_1W_{nf}}{R_{nf}}$, which corresponds to the value of the feedback current I_{nf}. These statements are in good agreement with the experimental results.

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