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ESTIMATION OF THE LOGICAL EFFICIENCY OF INTEGRATED MICROCIRCUITRY

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The article proposes a new criterion for estimating the logical efficiency of combination logic elements, such that it is possible to determine the relationship between the logical efficiency of the elements employed and the number of them that is needed to realize an arbitrary formula or system of formulas. Examples of the application of this criterion to commercially mass-produced digital microcircuits are given.

In designing digital and logical microelectronic devices, we frequently encounter the problem of realistically estimating the efficiency of the element logic employed on the basis of criteria that are directly or indirectly related to hardware expenditures.

The criteria in question should allow for a simple physical interpretation, and should aid in correctly choosing and employing the element logic.

In what follows we offer some findings regarding the estimation of the logical efficiency of commercially manufactured digital integrated microcircuitry (combination-type circuits). These estimates can also be employed in developing new logic elements.

Logic elements that are currently being manufactured of the combination-circuit type (e.g., those that form part of the 133 and 134 series) have a structure that can be described by nonrepeating formulas.

A nonrepeating formula is one in which each variable appears only once. In such formulas the number n of variables and the number h of letters coincide.

In this paper, we will consider nonrepeating formulas specified in $(\&, \vee, \bar{\ })$ element logic.

Any logic element with m independent inputs can be regarded as multifunctional, since after setting signals equal to constant 0 and 1 or to information variables are fed to m - k inputs, it can be described by various formulas of k letters.

The number of information inputs of such an element is k, while the number of setting (or alignment) inputs is m - k.

For example, the 133LR1 element, which can be described by a four-letter formula of the form $y = \overline{x_1x_2 \vee x_3x_4}$, when set to $x_3 = 0$ realizes the formula $y = \overline{x_1x_2}$, while when set to $x_4 = x_3$ it realizes the formula $y = \overline{x_1x_2 \vee x_3}$, and so forth.

Usually, we consider setting of an element to different representatives of types of formulas rather than to different formulas, since each such representative can yield groups of formulas by renumbering or inversion of variables.

An element which, by being set, can realize at least one representative of each type of k-letter nonrepeating formula is universal in the class of arbitrary k-letter formulas, since, by identification of inputs with one another, it can realize any repeating formula that contains the same number of letters. For example, an element that realizes the nonrepeating formula $y = (x_1 \vee x_2)x_3 \vee x_4x_5$, can also realize the repeating formula $y = (z_1 \vee z_2)z_3 \vee z_1z_2$ for $x_1 = z_1$, $x_2 = z_2$, $x_3 = z_3$, $x_4 = z_1$, $x_5 = z_2$.

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