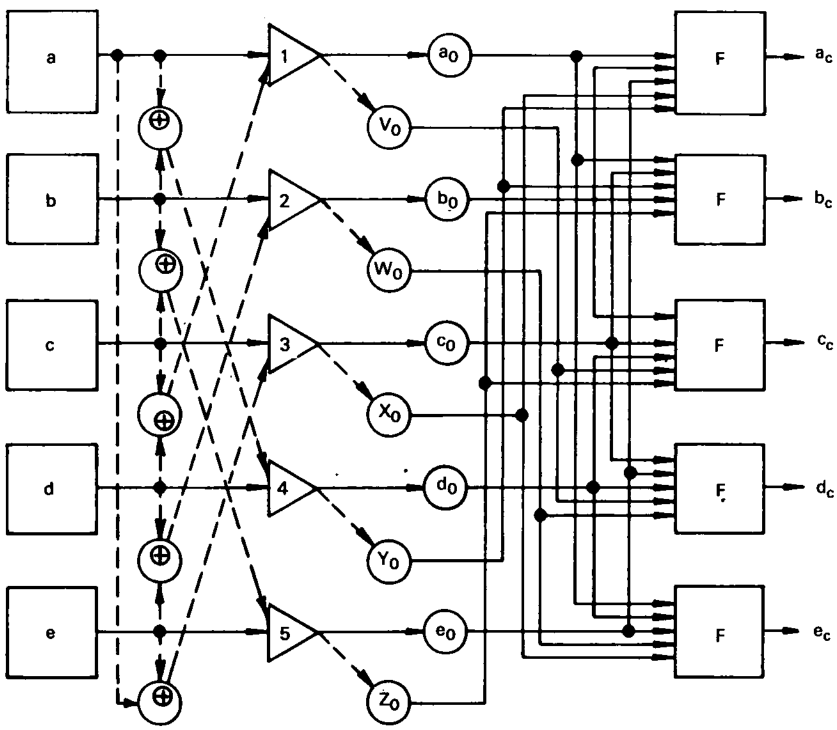
NASA TECH BRIEF

Simplified Circuit Corrects Faults in Parallel Binary Information Channels



The problem:

To prevent the appearance of erroneous output signals from the possible failure of any single channel element interconnected in parallel binary information channels, various redundant circuits have been used. Although these redundant circuits accomplish the desired result, they are unduly complex and costly.

The solution:

A circuit that corrects for any single temporary or permanent fault in one set of channels which serve several independent data sources, without using any redundant channels.

How it's done:

The system, illustrated for five independent binary signal sources, a, b, c, d, and e, includes signal channels through amplifiers 1, 2, 3, 4, and 5; temporary storage elements a_0, b_0, c_0, d_0, e_0, V_0, W_0, X_0, Y_0, and Z_0; and logic elements, F, for error corrections.

The signals a, b, c, d, and e are used for two transmissions. On the first transmission the signals are sent through amplifiers 1, 2, 3, 4, and 5 respectively, using the paths indicated by the solid lines entering and leaving the amplifiers, and the observed values are temporarily stored in elements a_0, b_0, c_0, d_0, and e_0. On the second transmission, pair-wise parity functions produced by exclusive *OR* logic gates are transmitted through the amplifiers, using the paths indicated by dashed lines. Thus the functions $a \oplus b$, $b \oplus c$, $c \oplus d$, $d \oplus e$, and $e \oplus a$ are transmitted through amplifiers 4, 5, 1, 2, and 3, respectively, and the observed values are temporarily stored in elements Y_0, Z_0, V_0, W_0, and X_0, respectively.

The signals a_c, b_c, c_c, d_c, and e_c are generated by the combinational logic-elements, F, according to the following rules:

$$a_c = \text{Majority}\ (a_0, Y_0 \oplus b_0, X_0 \oplus e_0)$$
$$b_c = \text{Majority}\ (b_0, Y_0 \oplus a_0, Z_0 \oplus c_0)$$
$$c_c = \text{Majority}\ (c_0, V_0 \oplus d_0, Z_0 \oplus b_0)$$
$$d_c = \text{Majority}\ (d_0, V_0 \oplus c_0, W_0 \oplus e_0)$$
$$e_c = \text{Majority}\ (e_0, X_0 \oplus a_0, W_0 \oplus d_0)$$

Each function is the majority of three versions of the same original variable. For example, since Y is obtained by transmitting $a \oplus b$, if there is no error, $Y_0 \oplus b_0 = (a \oplus b) \oplus b = a$; similarly, $X_0 \oplus e_0$ should be $(a \oplus e) \oplus e = a$. Since all the variables in the function are obtained from different amplifiers, an error in one amplifier can change only one value. Since at least two of the three terms in the majority function will be correct, the function still produces the true value of the original variable.

Note:

A related innovation is described in NASA Tech Brief B65-10025, February 1965. Inquiries may also be directed to:

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Reference: B66-10261

Patent status:

No patent action is contemplated by NASA.

Source: Jacob Goldberg
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