

Memorandum M-2195

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Digital Computer Laboratory
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SUBJECT: FURTHER WORK ON NONDESTRUCTIVE READ SYSTEM

To: Dudley A. Buck

From: Werner J. Frank

Date: May 27, 1953

Abstract: The Nondestructive Read System was used on relatively low power levels. Good discrimination between ONE and ZERO could be achieved with β field currents as low as 20 ma and readable signals were obtained with 7 ma.

One of the main objections to the Quadrature field type nondestructive read system has been the need for relatively high power levels for its operation. The earlier results were obtained with quadrature field (β field) currents of several hundred milliamperes and back voltages of several volts. When proposing to use such a system in a 64×64 core memory plane, for instance, provisions would have to be made to overcome several hundred volts of cumulative back voltage, making it impractical for most applications. It was necessary, therefore, to try to obtain results with lower β field currents and correspondingly lower back voltages.

In previous experiments it had been found that

- (a) metallic ribbon type cores were much more efficient, i.e. produced larger outputs for a given β field current than ferrite cores,
- (b) for any given β field current the ratio of output to back voltage improved as we reduced the number of wraps of magnetic material making up the core.

Based on these premises tests were made with 2, 4, and 8 wrap cores, and the 4 wrap core was found to be most advantageous: it had better output to back voltage ratio than the 8 wrap core and, although not quite as good as the 2 wrap core, its ZERO to ONE discrimination was better than in the latter.

1 Previous work reported in Engineering note E-454-1 by Dudley A. Buck and Werner J. Frank, "Nondestructive Sensing of Magnetic Cores."

The measurements below were therefore taken with Mo-Permalloy 216 cores, 4 wraps 1/4 mil thick and 1/8 inch wide metal tape on slotted ceramic bobbins, inside diameter 3/16 inch, with β field leads attached to either end, and a 20 turn output winding.

At these low levels of operation considerable difficulty was encountered in that the ringing caused by the relatively fast rise time of .1 μ second tended to "drown out" the desired signal and poor ZERO to ONE discrimination resulted. Better discrimination, although accompanied by somewhat smaller output signals, was obtained when rise time was increased to .15 μ second. The maximum back voltage, too, was greatly reduced by slowing up the rise time of the β field current pulse.

It was found that the maximum output was no longer obtained with the narrowest possible pulse as had been the case for the previous high power level experiments. Instead, as the β field current was reduced, wider pulses were required for optimum output. Fig. 1 gives a graphical illustration of the relationship between maximum obtainable output, width and amplitude of quadrature field current pulses.

Unfortunately the figures presented here vary a good deal with the individual core setups. Also the nature of the equipment used in these measurements did not permit better than about 20% accuracy. Furthermore, at very low power levels, such things as "balanced" input and, to some extent, even the position of the leads become quite important when trying to duplicate a result previously obtained.

Since the change in flux created by the quadrature field is proportional to $(1-\cos\theta)$, where θ is the angle of rotation of the remanant flux vector under the influence of the quadrature field, it was expected that this $d\Phi$ would rapidly diminish as the quadrature field current is reduced. This was found to be so as indicated by the rapid falling off of the output voltage. Typically, when I_β is reduced from 0.3 ampere to 0.1 the output drops from 1.1 to 0.08 volts. Fig. 2 shows the output voltage and the back voltage as a function of I_β .

Although reductions in back voltage are almost directly proportional to quadrature field reductions while output falls off more rapidly, the results are encouraging: with only 20 ma of I_β we will get excellent ZERO to ONE discrimination and back voltage remains below .1 volt. The relatively small output signal is hardly objectionable since in any case the output would have to be amplified before it could be gated.

One possible way to use the nondestructive read scheme in a two dimensional matrix is shown in Fig. 3. For simplicity's sake only the leads involved in the actual readout operation are shown. The cores used here would be of the metallic ribbon type mounted on slotted bobbins, with one end of the core material brought out through the slot on the inside of the bobbin. A lead connects the inside end of each core to the outside end of the next core such that all the cores in one row are linked together. A sensing winding (output winding) passes through all the cores lying in the same column.

Now if, for instance, a β field current pulse were sent through row X_2 , all of the sensing windings would pick up an output from their respective X_2 cores. However, since only the Y_3 line is gated, as indicated by the closed switch, the only output transmitted would be that of core (X_2, Y_3)

Disadvantages of this system would include:

- 1) Necessity for a number of amplifiers equal to the number of columns in order to be able to gate the output signals of each column.
- 2) Since signals may be positive or negative, 2 gate tubes may be needed, unless something-to-nothing discrimination should be used rather than the more dependable positive-negative discrimination.
- 3) The usual write-ONE and write-ZERO lines would still be needed.

However, the method is nondestructive and considerably faster than methods used at present.

Signed Werner J. Frank
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Drawings attached: A55126
A55127
A55128

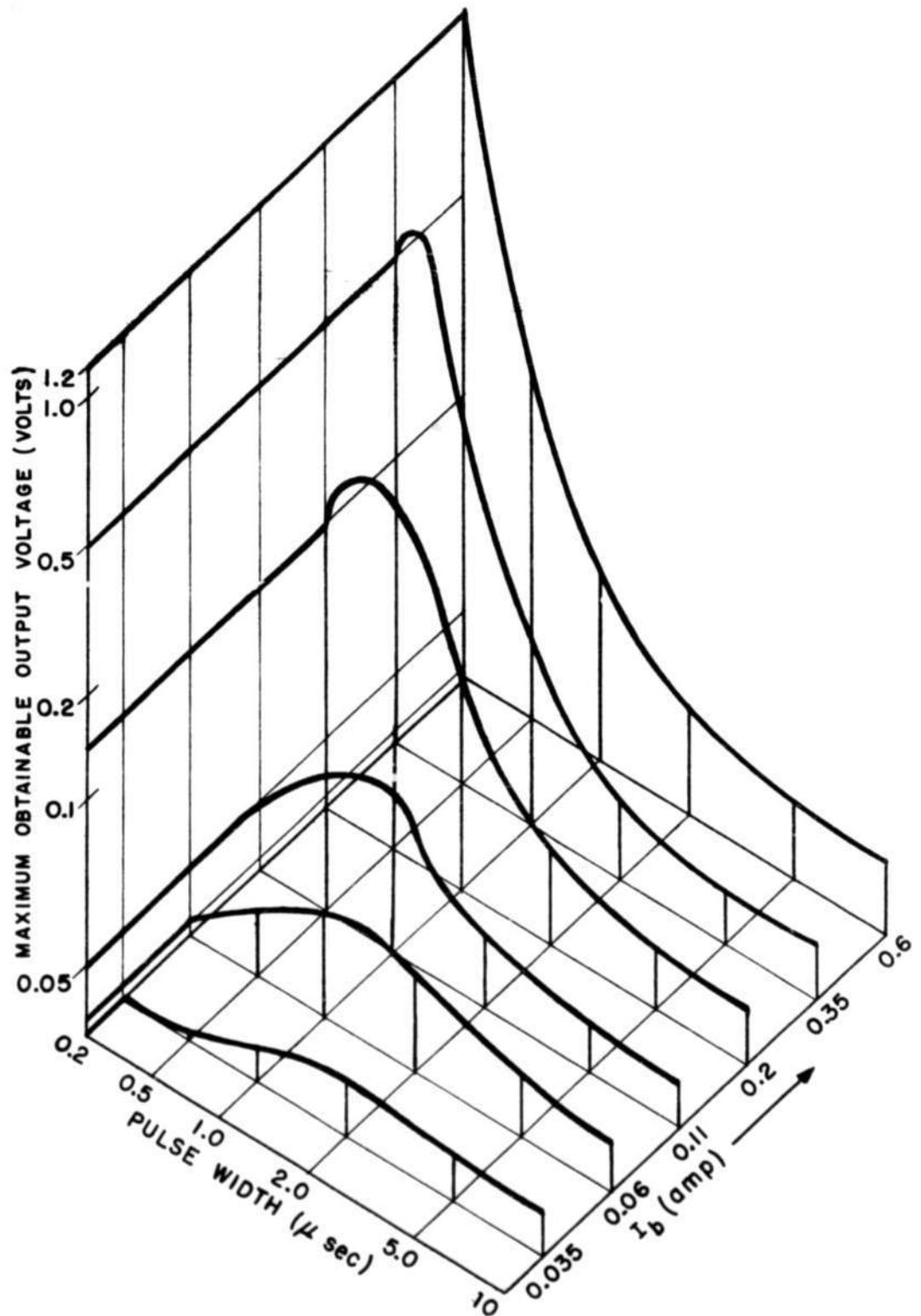


FIG. 1
RELATIONSHIP BETWEEN MAXIMUM OUTPUT VOLTAGE,
 β FIELD PULSE WIDTH AND PULSE AMPLITUDE

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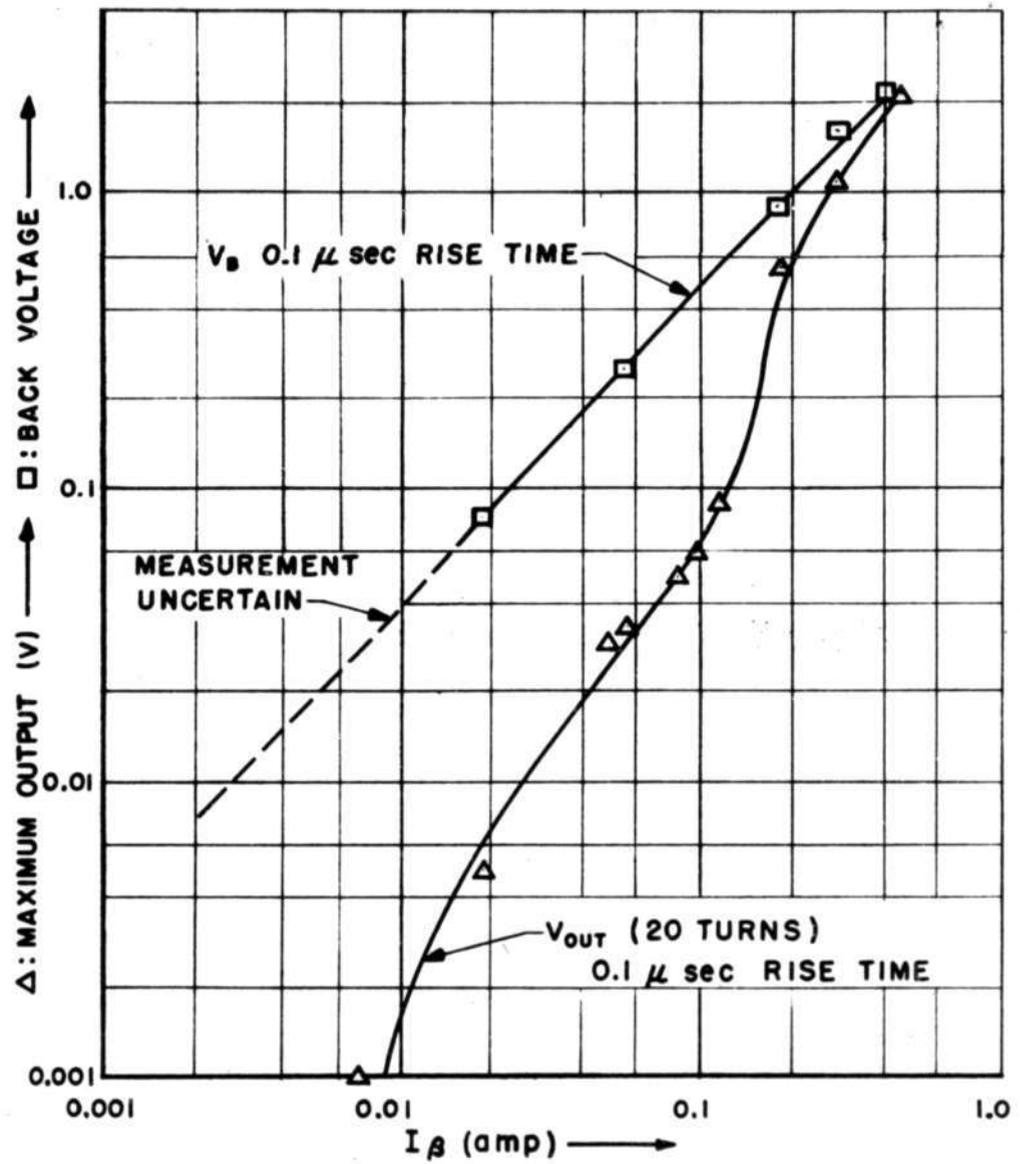


FIG. 2
OUTPUT VOLTAGE AND BACK VOLTAGE AS A
FUNCTION OF β FIELD CURRENT.

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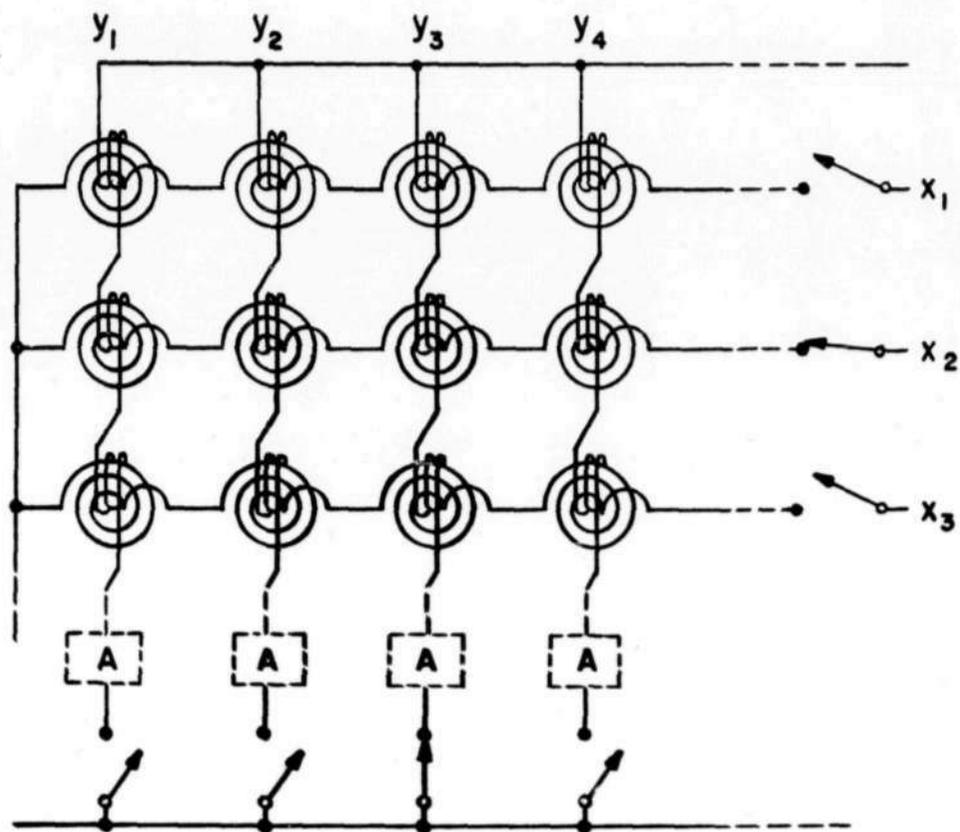


FIG. 3
SELECTION SCHEME FOR
NON-DESTRUCTIVE READ

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