



Date: November 29, 1967  
From (location): Advanced Computing Systems  
U.S. mail address: Menlo Park, California  
Dept. & Bldg.: 988/031  
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Subject: Cover Letter for Preliminary Distribution of Logical Design Memorandum

Reference:

To: Mr. S. F. Anderson                      Mr. R. J. Robelen  
Mr. B. O. Beebe                              Dr. H. Schorr  
Dr. C. V. Freiman                            Dr. E. H. Sussenguth  
Mr. M. E. Homan                            Mr. W. P. Wissick  
Mr. B. J. Mooney

A memorandum describing basic ACS logical design conventions is enclosed.

On joining ACS engineering, I found that there was no single convenient source of this information. Some of the information was not documented in any available references.

Since most of the designers use different notations and conventions, it proved to be a surprisingly time consuming and confusing process to learn the precise details of this very simple basic material. Many of the designers related to me that they had had similar initial experiences.

At that time I made some notes for my own personal use. I have since formed these into a memorandum in the hope that it might prove useful to other newcomers to ACS engineering. It might also be useful to members of other ACS departments.

If you have any comments, criticisms, or discover any errors needing correction, please contact me about them. I will then be able to get the memorandum into shape so that it might be useful during the coming expansion of Dept. 988.

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November 29, 1967  
Advanced Computing Systems  
Menlo Park, California  
988/031

Subject: ACS Logical Design Conventions: A Guide for the Novice

- References:
1. ACS Circuit Manual, February 23, 1967.
  2. ACS Packaging Manual, July, 1967.
  3. DRKS User's Manual, R. T. Blosk, December 5, 1966.
  4. McCluskey and Bartee, A Survey of Switching Circuit Theory, McGraw-Hill, 1962.

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Introduction:

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This memorandum describes the various rules and conventions for ACS logical design. The material presented is elementary in nature, but is basic to all ACS logical design.

A description is given of the logical functions of the ACS circuits available to the designer and of the various rules governing the use of these circuits in logical design. A number of different notations are in current use for writing the logical equations for these circuits and for drawing the diagrams of logical circuitry. Some of these different notations are illustrated and explained. Elementary logical design--the transformation from equations to circuits--is briefly described.

If we were designing in AND-OR logic with few restrictions, this memorandum would be unnecessary. However, we are usually designing with NOR-NOR or NOR-OR logic. The physical properties of the circuits force a number of restrictions in addition to simple fan-in and fan-out rules. The fact that designs eventually input a Design Record Keeping System (DRKS) has produced additional conventions and design notation.

These factors have led different designers to use different conventions for writing logical equations and drawing logic circuit diagrams, and to use different logical design techniques. It is true that at the time designs are input into DRKS, they all will be described in the same formal system. However, up to that time most designs will exist in the form of equations and diagrams in the "shorthand" of the originating designer. The newcomer may therefore become confused when attempting to decipher the designs of different engineers until he fully understands the fundamentals from which their different "shorthand" techniques originated.

These fundamentals are presented in this memorandum in the hope that they may assist the newcomer to ACS engineering in his first design efforts and serve as a reference for those outside of engineering who may wish to study some particular logical design in detail.

The newcomer should also study the listed references before undertaking any serious design. This memorandum was formulated from these references, but does not attempt to cover many important topics contained in them. Of particular importance is the information on circuit delays in the ACS Circuit Manual and information on wiring rules in both the ACS Circuit Manual and the ACS Packaging Manual. The DRKS User's Manual specifies the final form in which designs are to be placed.

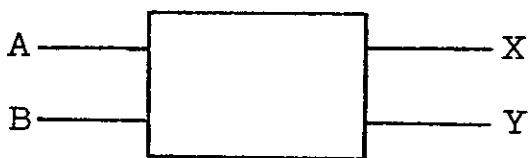
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This section describes the logical functions of the circuits and connections available to the ACS logical designer. Truth tables and equations are given describing the logical functions. The various conventions, restrictions, and limitations of each circuit are listed.

The truth tables use 0 and 1 as symbols, and these are related to the actual physical voltages in the circuits as follows: 1 symbolizes positive (or ground), and 0 symbolizes negative voltages.

The Current Switch:



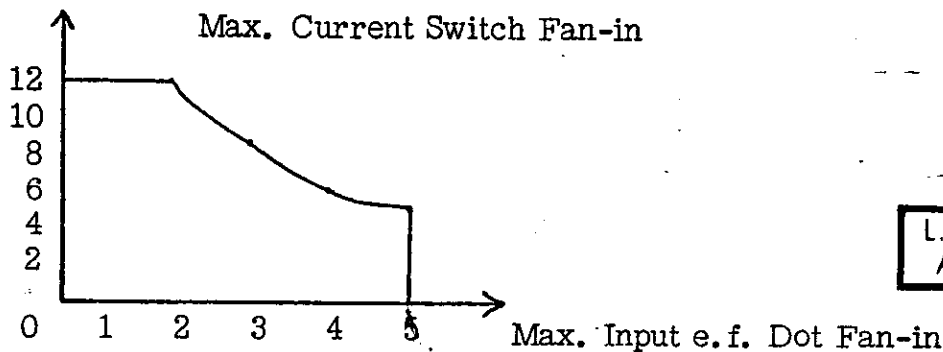
A	B	X	Y
0	0	1	0
0	1	0	1
1	0	0	1
1	1	0	1

$$X = \bar{A} \cdot \bar{B}$$

$$Y = A + B$$

Note the significance of the positions in the circuit symbol of the outputs X and Y. The top output X is the NOR of the inputs, and is often called the "out of phase" output. The bottom output Y is the OR of the inputs and is often called the "in phase" output. Note that  $Y = \bar{X}$ .

Fan-in: Current switch inputs are outputs of emitter followers or emitter follower dot circuits (see description of e. f. dot later in this section). The maximum number of inputs for a given current switch is a function of the maximum fan-in of those e. f. dot circuits forming the inputs. This function is as follows:



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