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Design Project

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Purpose:

This project is used in the first term of the logic design course for electrical and computer engineering students. It is taken in the middle of their 2nd year. Variations of the project have been done for about 10 years at PCC. The student must complete the project and it must work correctly to pass the course. A PC is used to confirm correct operation. A program has been written to output the 64 codes and to check the circuit's response. It is written in 8086 assembler and uses the parallel printer port. The character codes are changed each year.

Equipment:

- PC
- 2-, 3-, 4-, and 8-input nand gates
- 2 ea. 7493 counters
- Logic Analyzer, such as HP 54645D, HP 1664A
- Special Test Program for PC

Problem Description:

In digital computers, letters of the alphabet and the ten decimal numerals can be coded in the form of unique combinations of five or six bits. One of these codes is the 6-bit Flexowriter code, which is used for some punched paper tape. This code is given below in terms of HEX equivalents.

CHARACTER CODES

A= 08	B= 1C	C= 2E	D= 32	E= 00	F= 36
G= 14	H= 02	I= 2C	J= 3A	K= 3E	L= 12
M= 18	N= 26	O= 04	P= 0A	Q= 3C	R =2A
S= 34	T=28	U= 0C	V= 06	W= 38	X= 16
Y= 1A	Z= 10	0= 01	1= 0E	2= 07	3= 27
4= 13	5= 11	6= 15	7= 1E	8= 05	9= 03

Your job is to design a circuit which detects whether a code on six data lines represents a number, a letter, or an illegal code. The circuit produces three output signals, A, N, and E, as shown below.

A	N	E	E
1	0	0	Alphabetic character sensed
0	1	0	Numeric character sensed
X	X	1	Illegal character sensed (X = don't care)

Outputs:

The **A** output is high when an alphabetic character is sensed, low when a numeric character is sensed, and either high or low for any other character.

The **N** output is low for an alphabetic character, high for a numeric character, and high or low for any other character.

The **E** output is low for both alphabetic and numeric characters, and high for any other characters.

Examples:

When a code (example: input pattern for the letter B is 1C HEX) assigned to an alphabetic character is sensed, the A output is high, the N output is low, and the E output is low.

When the input pattern is neither alphabetic or numeric (20 HEX), the E output is high, and A and N outputs can be either high or low.

Design Constraints:

The circuits which implement the three outputs can use only 2, 3, 4, and 8-input NAND gates and inverters. A maximum of 6 IC packages. A bonus of 5 points will be given if you use 5 packages and 15 points if you use 4 packages.

Design Log:

AS YOU WORK you are to keep a log which discusses the steps you take and the results of each. A part of the grade will depend on how thoroughly and clearly you document your work. This log MUST be done as you do your design and not be recreated after the design is completed. It is to show all your work, both correct and incorrect. DO NOT USE SCRATCH PAPER AT ANY TIME.

The LOG is to use one or more of the BLUE Examination Books (8.375 by 6.75 inches) available in the PCC bookstore. No other type of logbook is acceptable. More than one may be needed. If you need to include a computer output, then fold and fasten it to the log book.

You are to time and date each entry into the book. The final report must be supported by the entries in the logbook. The first page of the LOG is to contain a table used to track your progress. It is to have the following columns:

Date	Start Time	End Time	Elapsed Time	Work Category	Description of Work

Work categories: D-design, C-construction, DB-debug/test
At the end, make a summary of the time spent in each phase and the total time.

Procedure:

1. Make a truth table for the design.

2. Make three 6-variable Karnaugh maps and get the minimal SOP expression for each output.

3. Study the symmetry of the outputs and decide how to best implement the circuits within the design constraints stated previously. This will probably not be the SOP form you found from the maps but a variant of that form.

4. Draw a schematic diagram for the design. You may either hand draw using a logic template or use a schematic capture program such as PSPICE.

5. Build the circuit and test its operation. Use two 7493 counters to give the input signals and the logic analyzer to make the measurements.

6. After you are sure the circuit works correctly, and it is your best design using the minimal number of IC packages, have the instructor test the circuit at the PC based test station. It is expected that every circuit will pass the computer based test on the first attempt. Five points will be subtracted for each incorrect try.

Report:

1. Your logbook(s) which show all your design steps and thinking process. Again these are to be done as you proceed with the project, not at the end of the project.

2. A fully labeled and correctly drawn schematic diagram of your circuit as it was tested. The instructor will sign-off the schematic when the circuit passes the computer based testing.

3. A one to two page report done on a word processor. The report is to summarize the problem being solved, the major design decisions you made in solving the problem, and the problems you encountered and how they were resolved in completing the design. It is expected that the report will be of a professional quality.

4. The signed intellectual property statement:

I do hereby affirm that I did the work on this circuit by myself.

Signed _____ Dated_____

Computer Test Interface:

A PC will be connected to your circuit for the final test. The computer will supply the input signals to your circuit and will read the three outputs. The outputs will be compared to a look-up table to determine your circuit functions correctly.

To make the test work correctly you are to remove the two 7493 counters from your board so their outputs do not interfere with the computer test. The wiring for the counters should be left in place in case you need to retest your circuit using the logic analyzer. A place on your circuit board needs to be wired with wires which will supply your circuit with the test signals, and make your circuit outputs available to the computer. A plug which looks like a 16 pin IC will connect your board to the computer. The wiring of the interface socket on your board is shown below. It is essential this diagram be followed exactly.

U-Z are the input signals. Note: Z is the LSB (Qa of the first counter)
1-16 are the pin numbers of the interface socket.

Z-1	V-2	X-3	W-4
V-5	U-6	NC-7	NC-8
16-A	15-N	14-E	13-NC
12-NC	11-NC	10-NC	9-GROUND

Grading:
Logbook   30%
Formal report and schematic   30%
Design & operation   40%