PC Programs for Engineers

Lawrence P. Huelsman, Editor

Welcome to the PCPE (PC Programs for Engineers) column. In this issue we describe the programs HAZ and HAZARD. These programs generate logic hazard covers for logic hazardous equations specified in a minimum SOP (sum of products) form. They were written by Dr. R. S. Sandige and Dr. B. M. Wilamowski of the University of Wyoming. Regular readers of this column will remember Dr. Wilamowski as the contributor who gave us the two excellent filter design programs FILTER (for active filters) and LADDER (for passive filters).

Program: HAZ and HAZARD - Logic Hazard Cover Generators

Purpose: Generate logic hazard covers for logic hazardous equations specified in a minimum SOP (sum of products) form for either the on-set, that is, the ones of the function, or the off-set, that is, the zeros of the function.

Information: Dr. R. S. Sandige and Dr. B. M. Wilamowski, Department of Electrical Engineering, University of Wyoming, Laramie, WY 82071

Description: The programs were written by Dr. Wilamowski and Dr. Sandige. The program HAZ is a user friendly program for generating logic hazard cover of signal names that are identified by a single letter for a simplified representation. The program HAZARD is a user friendly program for generating logic hazard covers of signal names that are identified by multiple symbols and numbers (up to ten). This program can also read the output documentation file of PLDesigner-XL, the commercial synthesis design package by Minc Inc., as its input, and generate the required logic hazard covers. Both programs:

- are menu driven and each contains a help file (press F1) to assist the user
- support up to 128 variables (signal names), 400 product terms, and 50 variables in each product term
- display up to 72 files in the current directory corresponding to commercial models.

Technical Data: Both HAZ and HAZARD were written in Turbo Pascal 7.0 and are distributed as an EXE file that runs on an IBMTM (or Compatible) personal computer using EGA, VGA or Hercules graphics.

Licensing: The program is copyrighted. They may be freely used by individuals as long as no charge is made. All other rights are reserved. Commercial use is prohibited.

Cost: The programs are available from Dr. L. P. Huelsman, Department of Electrical and Computer Engineering, University of Arizona, Tucson, Arizona 85721 on a 5-1/4 inch, 360k disk for a shipping and handling charge of four dollars ($4.00) U.S. funds in the continental U.S.A. Outside the U.S.A., the charge is six dollars ($6.00), U.S. funds, drawn on a U.S. bank or a bank with a U.S. correspondent. Checks should be made payable to "The University of Arizona."

As an example of the use of the program HAZ, consider the following logic function F1:

F1(A,B,C,D) = m(0,1,4,5,6,9,12,14,15) + d(10,13)

From a graphical point of view, the Karnaugh map in Fig. 1 shows that the function F1 contains two logic hazards. To use the program HAZ.EXE, first use PLDesigner-XL, ABEL, CUPL, PLDshell Plus, PALASM, ORCAD PLD, or any other reduction program to obtain a minimum SOP form for equation F1.

A minimum SOP form for equation F1 is represented as follows:

F1 = A*D + /A*/C + B*/D

The input source file supplied to the program HAZ.EXE is stored using the format ame.LI1. For example, the input source file for equation F1 contains the following information:

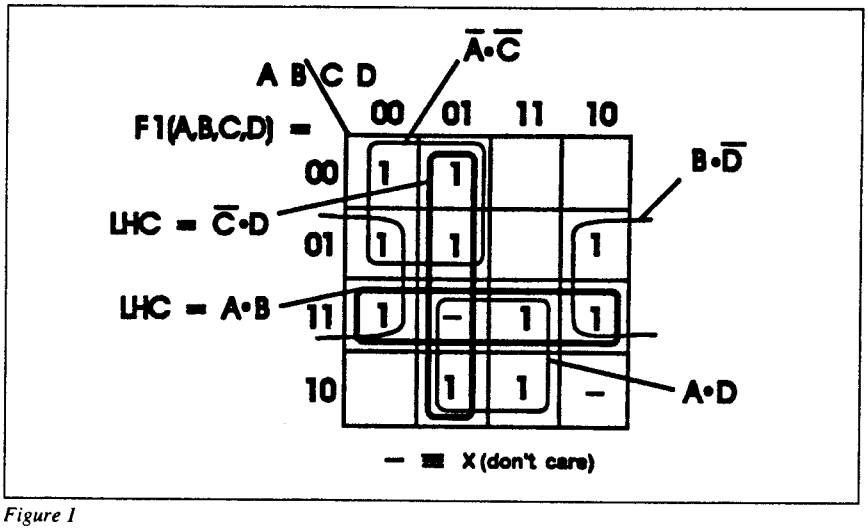

Figure 1

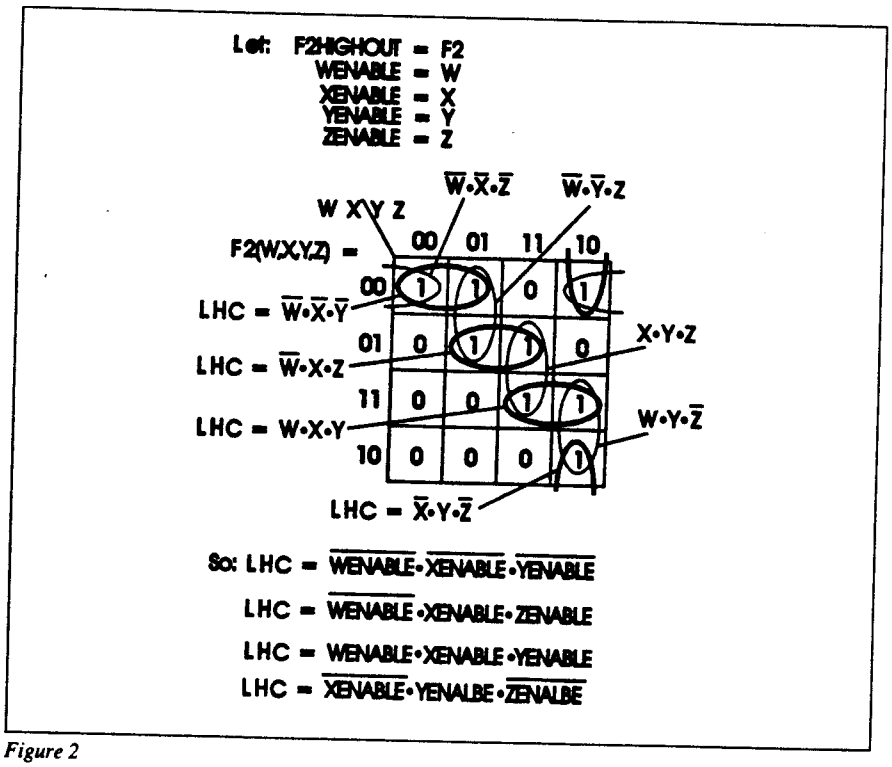

Figure 2

AD
/A/C
B/D

The output file produced by the program HAZ.EXE is stored using the format a-me.OUT. For our example, the output file produced by the program HAZ.EXE contains the following information for equation F1:

* input data:
AD
/A/C
B/D
* logic hazard covers:
/CD
AB

Notice that two logic hazard covers are produced for equation F1 as expected.

As an example of the use of the program HAZARD.EXE, consider the following logic function F2HIGHOUT:

F2HIGHOUT(WENABLE,XENBLE, YENABLE,ZENABLE) =
m (0,1,2,5,7,10,14,15).

Again, from a graphical point of view, the Karnaugh map in Fig. 2 shows that the function F2HIGHOUT contains four logic hazards. A much easier and straightforward way to obtain the logic hazard covers is to first obtain a minimum SOP form of equation F2HIGHOUT, and then run the HAZARD program. A minimum SOP form for equation F2HIGHOUT is represented as follows:

F2HIGHOUT =
WENABLE*YENABLE*/ZENABLE
+ /WENABLE*/XENABLE*/ZENABLE
+ /WENABLE*/YENABLE*ZENABLE
+ XENABLE*YENABLE*ZENABLE

The input source file supplied to the program HAZARD.EXE is stored using the format ame.LI2. For our example, the input source file equation F2HIGHOUT contains the following information:

input signals: WENABLE, XENABLE, YENABLE, ZENABLE;
reduced equation:
= WENABLE*YENABLE*/ZENABLE
+ /WENABLE*/XENABLE*/ZENABLE
+ /WENABLE*/YENABLE*ZENABLE
+ XENABLE*YENABLE*ZENABLE;

The output file produced by the program HAZARD.EXE is stored using the format ame.OUT. For our example, the output file produced HAZARD.EXE contains the following information for equation F2HIGHOUT:

input signals: WENABLE, XENABLE, YENABLE, ZENABLE;
reduced initial equation:
= WENABLE*YENABLE*/ZENABLE
+ /WENABLE*/XENABLE*/ZENABLE
+ /WENABLE*/YENABLE*ZENABLE
+ XENABLE*YENABLE*ZENABLE

logic hazard covers:
= /XENABLE*YENABLE*/ZENABLE
+ WENABLE*XENABLE*YENABLE
+ /WENABLE*/YENABLE*/YENABLE
+ /WENABLE*XENABLE*ZENABLE

Notice that four hazard covers are produced for equation F2HIGHOUT, as expected. Karnaugh maps are useful for perhaps up to five or six variables; however, the programs HAZ.EXE and HAZARD.EXE are useful up to 128 variables. In the curriculum taught at the University of Wyoming, the authors use the synthesis tool PLDesigners-XL by MINC Inc. To make the program HAZARD more user friendly, the program can read PLDesigner-XL's documentation file containing the reduced equations, and generate the hazard covers for the first equation in the list of reduced equations. To take advantage of this feature, simply change the DOC file to a .LI2 file. To obtain the logic hazard covers for a particular reduced equation in the documentation file, simply place that reduced equation first in the list.

I close this column, as always, by inviting you, the reader, to participate. Send me your programs for review and let me hear from you regarding any ideas you may have for increasing PC usage in the academic and industrial sections of the electrical engineering community. **CD**

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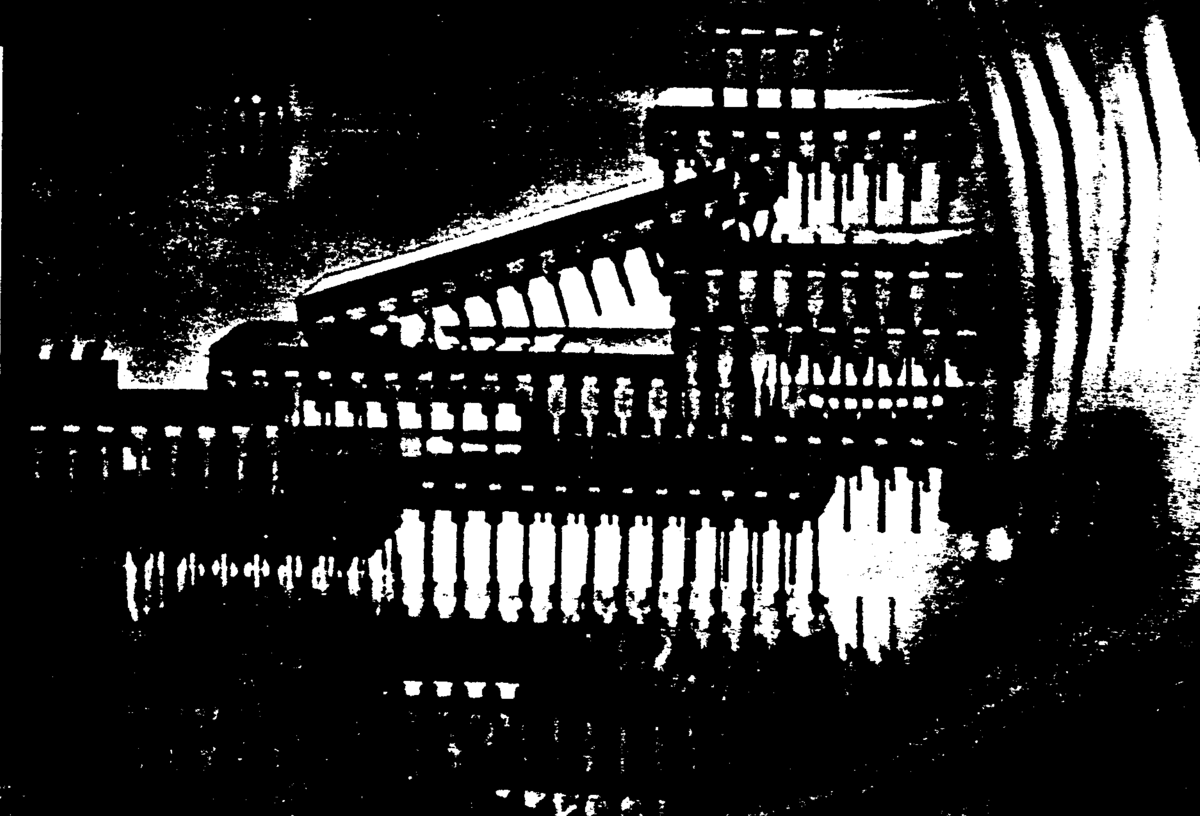
New AlN Ceramics Beat the Heat



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