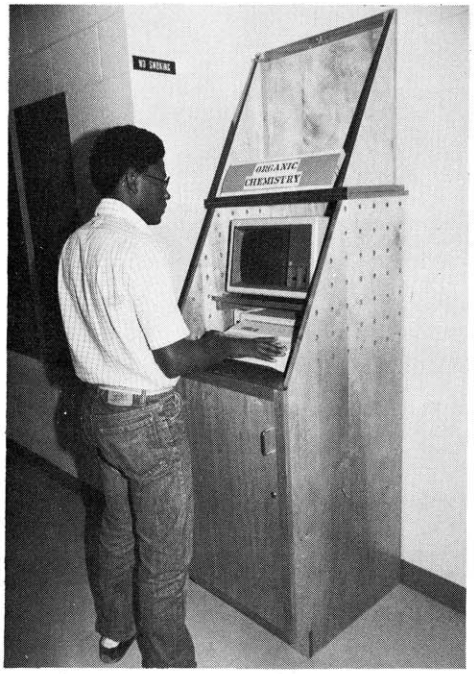

Figure 16. Cabinet designed for Mini CAI.

of the science building. The computer is at standup height with the disk drive in the lower section. The upper section is open during the working day, with the program of the day loaded. In Figure 16 the cabinet is shown in the operating position. A sign designating the type of program loaded is placed on the shelf formed by the opened lid, and a shelf for the student's books is attached to one side of the cabinet. The computer shelf is 100 cm from the floor. Closed, the cabinet measures 155 × 62 × 62 cm.

Each program consists of a number of questions, often multiple choice, but ranging from nomenclature questions to an animated program showing the source of hydrogen spectra. The programs are all original, truly friendly, do not keep score on the student, and of a length to require 3–5 min of the student's time. Student response has been excellent. Plans for the cabinet are availalbe as "Mini CAI Cabinet." Send a check for $1 payable to Project SERAPHIM, acct. 20350, to John W. Moore, Department of Chemistry, Eastern Michigan University, Ypsilanti, MI 48197.

A One-Chip Interface between a Digital Panel Meter and a Microcomputer

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Electronic instruments with digital readouts often have binary coded decimal (BCD) outputs to permit interfacing with other devices. There may be one BCD set of four lines for each digit displayed or there may be one set to sequentially represent each digit. An example of the latter type is Non-Linear Systems' 4½-digit panel meter, NLS PM-450, which has one range of ±1999.9 millivolts making it useful with specific ion and redox electrodes.[7] An interface for this DPM is easily constructed.

Microcomputer interfacing depends upon the use of hardware and software. Software may often substitute for hardware, is more easily altered than hardware, costs nothing, and is probably more familiar to most microcomputer users than hardware. The interface to be described uses very little hardware, which shifts most of the interfacing burden to software and the microcomputer itself. Since the digital panel meter (DPM) has a relatively slow analog to digital conversion rate, the higher speed of machine language is not required and BASIC is adequate. Interfacing is simplified if an interface adaptor chip is used, since it may be treated as a memory location from the computer side and data may be input from the interface side at any time. For detailed discussions of interface adaptor chips consult books that discuss 6502 microprocessors. Commodore computer reference guides are also quite helpful. One half of a 6522 or 6526 interface adaptor is available through the Parallel User Port of Commodore computers (PET, VIC-20, and Commodore 64). Cards with one or more 6522's can be made or purchased for use with Apple II computers (*40*, *41*). Using 6522's for interfacing has the added advantage of making the interfaces transportable between Commodore and Apple II microcomputers.

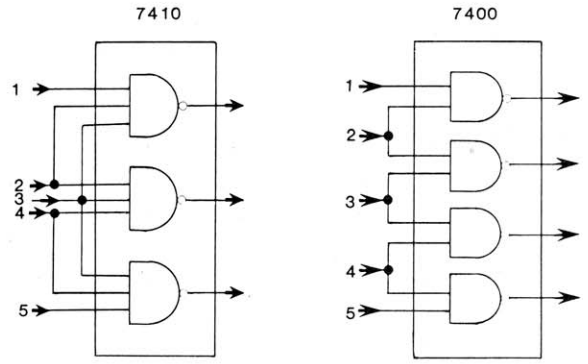

Figure 17. Connections for one-chip interface.

A one-chip DPM interface may be constructed using eight data lines of a 6522 versatile interface adaptor (VIA) as well as a control line, CB2. The CB2 line is connected directly to a "hold" line on the DPM to prevent a change in the digits while reading them with the computer. The four BCD lines are connected to four of the 6522 data lines. The DPM LED's are not actually on continuously but are, instead, turned on one at a time so rapidly that the display appears to be continuous. The BCD output is therefore altered each time a digit is refreshed. In order to indicate which digit is represented by the BCD output, five other DPM output lines are used. The appropriate line goes low when the BCD reading is valid for a particular digit. The apparent dilemma of five output lines from the DPM and only four remaining input lines to the 6522 is resolved when it is realized that there are, in fact, only five different logic state combinations of these lines (11110, 11101, 11011, 10111, and 01111). To detect these five different states requires at least three data lines, since three lines can represent eight different states. A triple, 3-input NAND gate (7410) will work as will a quad 2-input NAND gate (7400) although the latter uses all four of the remaining data lines. For a 7410 the five DPM data valid lines are hooked in triplets (1,2,3; 2,3,4; 3,4,5) to the inputs of the 7410 and the three 7410 outputs are connected to the 6522 (see Fig. 17). For a 7400 the DPM data valid lines are hooked in pairs (1,2; 2,3; 3,4; 4,5) to the 7400 and the four output lines are connected to the 6522. The one-chip interface is now complete. As a matter of personal preference, one additional chip, a 7404 buffer, was used with the BCD data lines and the CB2 line in order to isolate the DPM from the computer, but this precaution is probably unnecessary.

A few comments concerning the software are appropriate.

[7] Non-Linear Systems, Solana Beach, CA 92075.

Of course, the program to read the data has an appropriate POKE or PEEK to set the data direction register of the 6522, to hold or release the DPM, and to read the data lines. There are, however, two software problems. BASIC cannot read the data lines rapidly enough to read the digits while they are being refreshed on one cycle. A solution is to reread the BCD and data valid lines until digit 1 is acquired and then reread the lines until digit 2 is acquired, etc. The digits may then be readily combined to form the correct reading. Another problem is separation of the digit indicator value from the BCD value since they must be read simultaneously. This is readily accomplished with a logical AND statement. The data line value is ANDed with 240 or 15 to obtain the upper or lower four bits, respectively. Commodore BASIC has this AND command while Applesoft does not. Apple users may employ a machine language subroutine since the 6502 microprocessor will do this operation (*42*). The BASIC reading routine averages less than one second per reading.

DPM's are available in which the BCD outputs are from tristate chips which can be enabled as desired.[8] These may also be readily interfaced to microcomputers by, for example, using three 6522 lines as output lines to a 7442 decoder to sequentially enable the tristate chips placing the data on four 6522 lines designated by software as inputs. However, the method used to interface the NLS DPM to a microcomputer is applicable to any similar device with a multiplexed BCD output.

When combined with a timer (built in on Commodore computers; available on cards for Apples) a DPM/computer combination should prove to be a relatively inexpensive yet versatile laboratory data collecting system. A complete list of parts, sources, approximate cost, hardware connections, and a sample program for a VIC 20 are available from the author for the NLS DPM/microcomputer interface.

A grant from the Tower Club of Clarksville was useful and is appreciated.

[8] Datel-Intersil, Mansfield, MA 02048.

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