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ABSTRACT

This learning module for a secondary electronics course contains two lessons that teachers can use to help students do the following: (1) access an Apple II computer with a PZ-90 interface to read input ports and send information to output ports with the aid of a computer program; and (2) demonstrate the use and relationship of binary numbers in computers. The six sections of the module are the following: two lesson plans ("Using the PZ-90" and "Using the switch modules") that include objectives, activities, and information sheets; module worksheets, answer keys, and overhead masters; teacher notes; evaluation, including a pretest and posttest with keys and evaluation activities; and a list of three suggested resources. (KC)

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ED347335

High-Technology Training Module

Module Title: INTERFACING THE APPLE II AND THE PZ-90

Unit:

Course: ELECTRONICS II

Grade Level (s): SECONDARY

Developed by: DAVE PETERSON

Date: MAY, 1990

School: OSSEO-FAIRCHILD HIGH SCHOOL

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CE 061 563

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INTERFACING THE APPLE II AND THE PZ -90

Input and output devices are connected to an Apple II computer through a PZ - 90 interface. Students use a program to check input and output information and modify the program. By doing the activities, students will be able to demonstrate input and output, interface to a computer, and demonstrate the use and relationship of binary numbers in computers.

DEVELOPED BY

DAVE PETERSON

OSSEO-FAIRCHILD HIGH SCHOOL
OSSEO, WI. 54758

CONTENT OUTLINE

I. Lesson 1 -Using the PZ -90

- A. Lesson objectives
- B. Computer systems
  1. input
  2. processing
  3. output
- C. ports
  1. input
  2. output
- D. Interface/hardware
  1. cables and enclosure
  2. power supply
  3. interface slots
  4. ports A,B, and C
- E. Control word

II. Lesson 2 - Using the switch modules

- A. Lesson Objectives
- B. Digital Voltages
  1. high
  2. low
- C. Activity directions
- D. Advanced activities
  1. additional switches
  2. modification of program

III. Module worksheets,keys,and overhead masters

A. Connection diagrams
B. Lesson 2 worksheet and key
C. Advanced worksheet and key
D. Binary to decimal conversion table
E. Switch demo program listing
F. Calculating the control word

IV. Teacher notes

V. Evaluation

A. Pretest and key
B. Activities (included in part III)
    1. observation
    2. "hands on"
    3. worksheet
C. Post test and key

VI. Resources

MODULE OBJECTIVE

After completion of the module, the students will be able to interface the Apple II computer with the PZ - 90 to read input ports and send information to output ports with the aid of a computer program.

LESSON 1 OBJECTIVES

Upon completion of lesson 1 the student will be able to:

1. define the terms port and initialization
2. determine if a device is an input or an output based on its use
3. compute the control word with the aid of computational table
4. locate and identify the position of ports A , B, and C

80% correct on the post test and activities is considered a mastery level

LESSON 2 OBJECTIVES

After completion of lesson 2 the student will be able to:

1. Correctly attach the switch modules to the interface
2. Demonstrate that the position the switches are in, are interpreted by the computer as a number between 0 and 255
3. Set the switches so that the computer will (through the use of a program) display any number you choose between 0 and 15
4. Use an equivalency table to compare the action of the switch module to binary numbers.

80% correct on the post test and a correctly operating interface observed by the instructor will indicate mastery

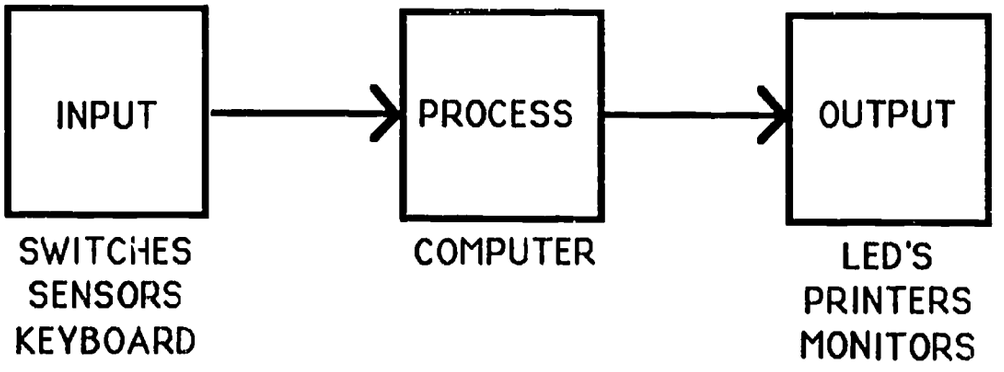
LESSON 1

USING THE PZ - 90

At the end of the lesson you will be able to:

1. define the terms port and initialization
2. determine if a device is an input or an output based on its use
3. compute the control word with the aid of computational table
4. locate and identify the position of ports A , B, and C

PORTS AND PARTS OF THE PZ - 90



Computer interfacing contains three major systems. Input is information being put into the computer. The computer looks or reads locations connected to external devices. Typical devices used for input include sensors, switches, and keyboards. Once the computer processes the information, it must then output it to the world outside the computer. Typical output devices include LED's, buzzers, printers, and video monitors.

Any communication into or out of a computer is done through locations called ports. The Apple II has slots in the computer which will accept interface cards. Depending where these cards are placed, the location of the ports may be at several locations. (Refer to the chart on page 3-3 of the PZ - 90 lab manual) Lessons 1 & 2 are programmed to use the PZ - 90 in slot number 5 of the computer. Your instructor will have already placed the interface card in the computer. The pages immediately preceeding chapter one of the PZ - 90 Lab Manual, give instructions on how the process is accomplished.

A flat, gray ribbon cable extends from the interface card to the plastic enclosure that serves as a base to attach the electronic modules. (for input or output) Also the black transformer needs to be inserted into a 110 volt receptacle to provide power for the interface. No power from the Apple power supply is used to meet the needs of the interface.

Slot 5 is used for the PZ - 90 interface. It starts at location 49360. Port A is located at 49368, port B at 49369, port C at 49370, and the control word is at 49371. This is also discussed in further detail in the lab manual on pages 3 - 2 and 3 - 3. The listing of the computer program Switch Demo shows how the necessary information to activate the interface is programmed into the computer. The process of identifing the location of the ports and storing the appropriate control word is called intialization or intializing the card.

The PZ - 90 has locations for port A input and output. (male and female connector receptacles) Port B and port C are primarily set up for output as the connectors have male ends. Note the raised numbers that have been imprinted into the plastic of the interface. They will make it easier to determine which lines are 0 - 3 and which are 4 - 7. The 0 - 3 are usually called lower bits and 4 - 7 are sometimes called the upper bits.

(REFER TO THE PZ - 90 PORT DIAGRAM AT THE END OF THE LESSON)

DETERMINING THE CONTROL WORD

The PZ - 90 has 3 ports called port A, port B, and port C. These ports can be used to read information (input ports), or send information from the computer to the outside world. (output ports) However, the computer must be told which port the user would like to be input and which will be output. This information can be conveyed to the computer in a single number that is stored in location 49371.

Page 2 -2 of the lab manual contains table 2 - 1 which shows how the control word, or CW, as it is sometimes shown, is calculated.
The following example shows how the table is used to calculate the control word (CW) when port A is used as input, and port B and port C is used for output.

output =0 input =1

port C (lower bits)
1 * 0 = 0

port B
2 * 0 = 0

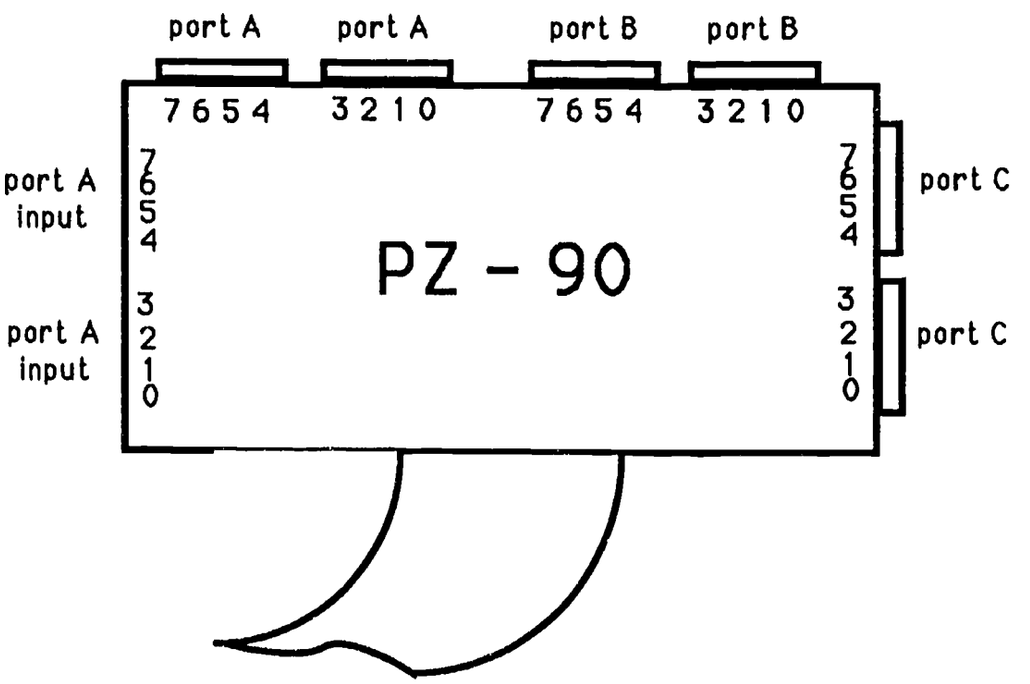
port C (upper bits)
8 * 0 = 0

port A
16 * 1 = 16
<u>+128</u>

CW = 144

144 is the number that is stored in location 49371, as the control word in the program Switch Demo, that will be used in lesson 2.

PZ - 90 PORT DIAGRAM



LESSON 2

USING THE SWITCH MODULES

At the end of the lesson you will be able to:

1. Correctly attach the switch modules to the interface

2. Demonstrate that the position the switches are in, are interpreted by the computer as a number between 0 and 255

3. Set the switches so that the computer will (through the use of a program) display any number you choose between 0 and 15

4. Use an equivalency table to compare the action of the switch module to binary numbers.

All of the modules of the PZ system use a voltage of +5 volts DC or 0 volts to signal different conditions to the computer. 5 volts is also called a "1" or a "high". 0 volts is called a "0" or a "low". Any number between 0 and 255 is possible using the 8 lines associated with each port. Using the switch module it is possible to demonstrate this principle.

By moving the switches 0,1,2, or 3, two possible positions are availible for each switch. (5 volts or 0 volts) Depending on the combination of positions, the switches can have 16 different signals going to the computer. the computer will see these as numbers. (0 to 15)

MATERIALS NEEDED:

APPLE II computer equipped with PZ-90 interface
wave form switch module
disk containing the program SWITCH DEMO or a listing of the program
h/l signal display module

DIRECTIONS: (see also Lesson 2 connection diagram)

1. Attach the WAVE FORM SWITCH module to port A and the H/L SIGNAL DISPLAY module to port C OF THE PZ-90 INTERFACE. Be sure that the transformer that supplies power to the interface is connected.

2. Load the program SWITCH DEMO into the computer as instructed, either by keyboarding it in, or from a disk supplied by your instructor.

3. Run the program. The toggle switch at the top of the switch module should be pointing to the right.

4. Move the switches (0,1,2,&3) to the different settings and observe the action of the LED's on the H/L SIGNAL DISPLAY.

5. Refer to the lesson 2 worksheet. The left column shows all the possible positions of four switches. The black boxes represent a closed switch. Move the switches until you have demonstrated all the possibilities shown. Look at the screen and record the number associated with each possibility. These numbers are what the computer "sees" when the switches are moved. The circles represent the LED's. Fill in the circles that correspond to lighted LED's at each switch possibility.

6. Using the binary to decimal conversion table, notice how the position of the switches are similar to the 0's and 1's of the binary numbers. Directly across from the binary number is its decimal equivalent. Toggling the switches is a binary action. Depending on the position of the switch in the port, the decimal equivalent changes with switch positions.

NOTE: A switch is a form of a sensor. Other sensors include photoresisters (changes resistance due to light intensity), thermisters (changes resistance due to tempature changes), and many others to numerous to list. A calibration circuit is also needed to adjust these sensors to differing situations. All sensors are used as input devices. The computer reads a sensor's condition as a binary number in a manner similar to the way the switches were read.

ALL INFORMATION THAT IS INPUTED TO A COMPUTER, MUST AT SOME POINT, BE CONVERTED TO A NUMBER.

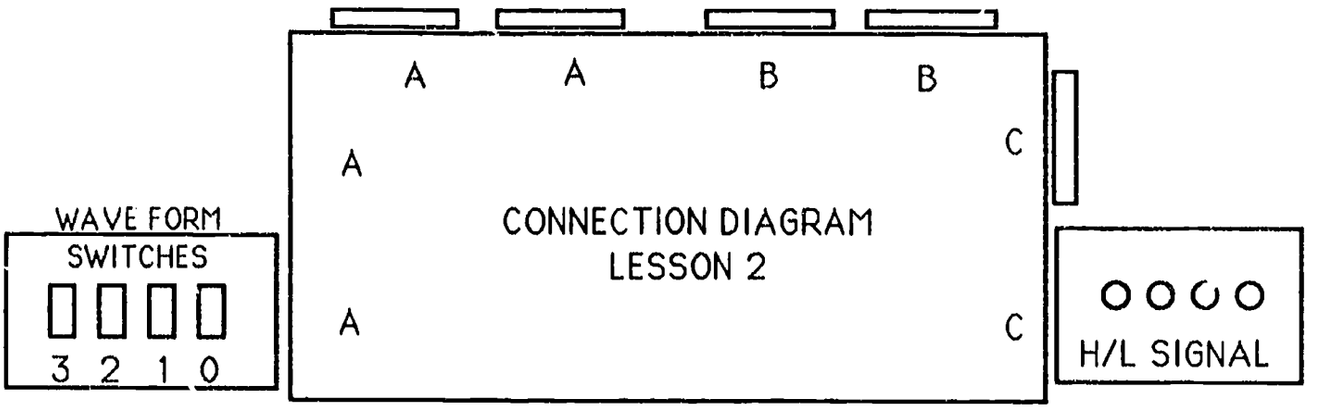
ADVANCED ACTIVITIES

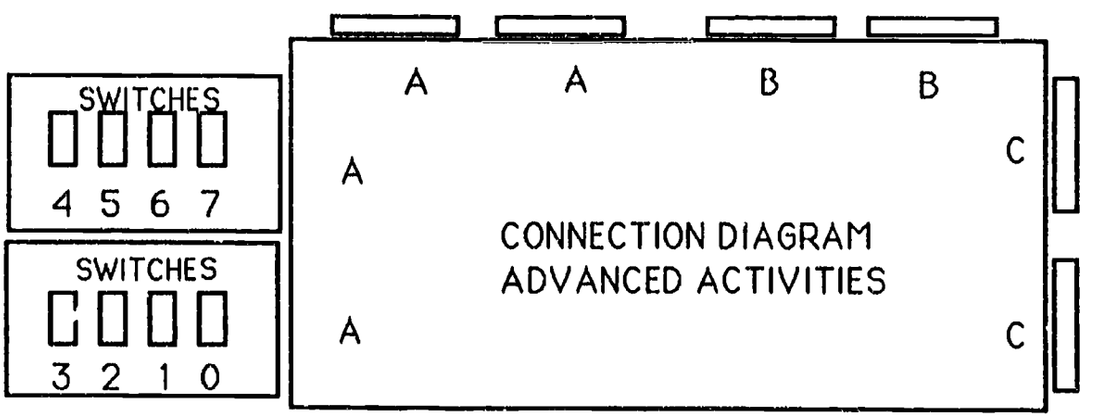
Experiment by adding another set of switches to port A. They could be another set of wave form switches or the PUSH BUTTON SWITCH module. These swiches will now enable the computer to read 256 different combinations.

1. It will also be necessary to delete lines 140 and 145 from the switch demo program.
2. This can be accomplished by typing ***140***, then return
3. Type ***145*** and press the return key
4. Finally type ***150 PRINT SS*** then press return

This will cause the program to now be able to read both sets of switch modules. Without those three changes the computer will not recognize the switches 4 through 7. Using the advanced activity worksheet, show the switch positions for the numbers listed by filling in the boxes corresponding to the switch positions 0 to 7.

CONNECTION DIAGRAMS
LESSON 2
AND
ADVANCED ACTIVITIES





LESSON 2 WORKSHEET

NAME INSTRUCTOR KEY

SWITCH POSITION	H/L SIGNAL DISPLAY	COMPUTER SCREEN
		0 (EXAMPLE)
		1
		2
		3
		4
		5
		6
		7
		8
		9
		10
		11
		12
		13
		14
		15

LESSON 2 WORKSHEET

NAME INSTRUCTOR KEY

SWITCH POSITION	H/L SIGNAL DISPLAY	COMPUTER SCREEN
		0 (EXAMPLE)
		1
		2
		3
		4
		5
		6
		7
		8
		9
		10
		11
		12
		13
		14
		15

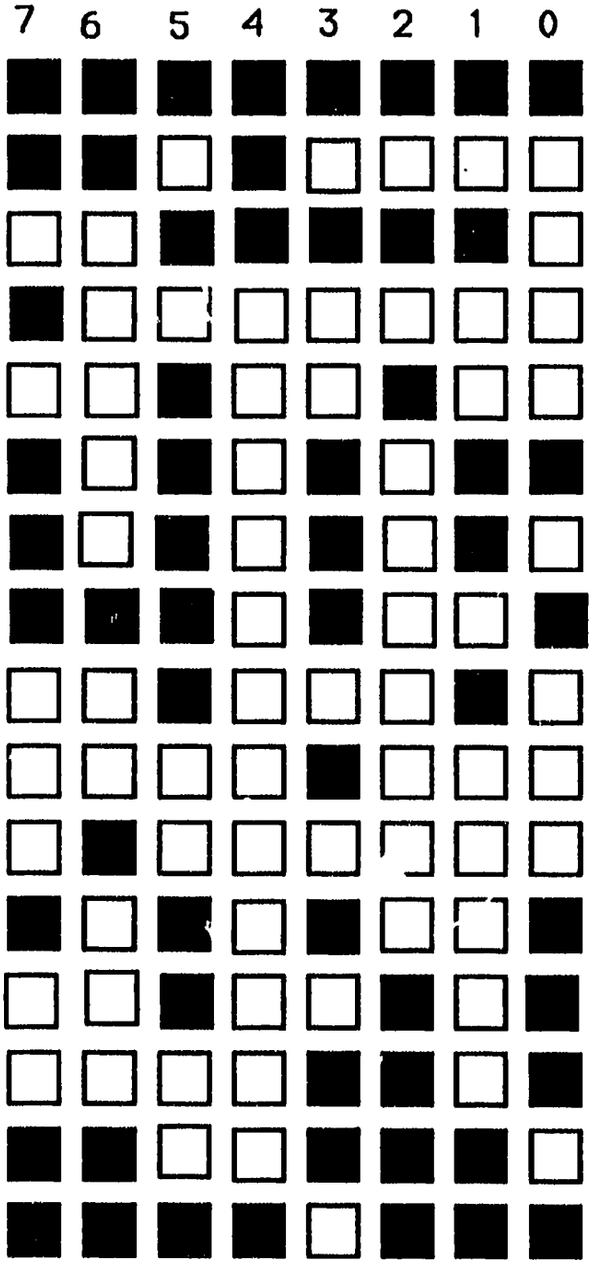
ADVANCED EXERCISES WORKSHEET NAME _____

SWITCH POSITION	NUMBER DISPLAYED
	255 EXAMPLE
	208
	62
	128
	36
	171
	170
	233
	34
	8
	64
	169
	37
	13
	206
	247

ADVANCED EXERCISES WORKSHEET

NAME INSTRUCTOR KEY

SWITCH POSITION



NUMBER DISPLAYED

255 EXAMPLE

208

62

128

36

171

170

233

34

8

64

169

37

13

206

247

BINARY TO DECIMAL CONVERSION TABLE

0000	0
0001	1
0010	2
0011	3
0100	4
0101	5
0110	6
0111	7
1000	8
1001	9
1010	10
1011	11
1100	12
1101	13
1110	14
1111	15
10000	16

SWITCH DEMO PROGRAM LISTING

```
100     REM:  PZ-90 PROGRAM TO READ SWITCHES AND OUTPUT SAME TO
        LED'S
110     REM:  USE PORT A FOR INPUT-- PORT B AND PORT C (UPPER AND
        LOWER) FOR OUTPUT--CHECK PAGE 2-2 OF PZ-90 MANUAL FOR
        PROCEDURE TO ESTABLISH CONTROL WORD
115     REM:  INITIALIZE FOR PZ-90 CARD IN SLOT 5 OF APPLE
120     PA=49368:PB=PA+1:PC=PA+2:CW=PA+3
125     POKE CW,144
135     SS=PEEK(PA)
140     S=SS - 255
145     S=ABS (S)
150     PRINT S
155     POKE PC,S
160     GOTO 135
1000    END
```

EXPLANATION OF LINES OF PROGRAM

LINES 100 THROUGH 115 EXPLAIN WHAT THE PROGRAM IS ABOUT AND WHERE PORTS AND OTHER IMPORTANT LOCATIONS ARE

LINE 120 AND 125 TELLS THE CARD WHERE THE INPUT AND OUTPUT PORTS ARE LOCATED AND PUTS THE CONTROL WORD (144) INTO THE PROPER LOCATION IN THE COMPUTER TO INITALIZE THE CARD

LINE 135 TELLS THE COMPUTER TO LOOK AT THE SWITCHES LOCATED AT PORT A AND STORE THE VALUE IN VARIBLE SS

LINE 140 AND 145 MAKE THE PROGRAM MATHEMATICALLY IGNORE THE UPPER 4 LINES OF PORT A BY SUBTRACTING 255 FROM THE VALUE THE COMPUTER "SEES" AND TAKING THE ABSOLUTE VALUE OF THE NUMBER

LINE 150 PRINTS THE VALUE THE COMPUTER "SEES" AT PORT A TO THE SCREEN

LINE 155 SENDS THE NUMBER TO PORT C WHICH THEN "LIGHTS UP" THE LED'S

LINE 160 SENDS PROGRAM BACK TO LINE 135 TO START THE PROCESS OVER

CALCULATING THE CONTROL WORD

output =0 input =1

port C (lower bits)	1 * 0 = 0
port B	2 * 0 = 0
port C (upper bits)	8 * 0 = 0
port A	16 * 1 = 16
	+128
	CW = 144

144 is the number that will be stored in location 49371 as the control word in the program Switch Demo that will be used in lesson 2.

NOTES TO THE TEACHER

The PZ 90 manual will answer most questions associated with the system. In using this system, it is prudent to have back up copies of all software and to encourage students to change the programs to accomadate different situations or personal styles. Some programming experience in BASIC is helpful in order to do this. When using the interface, be certain that the transformer power supply is properly connected. The interface is not connected to the Apple power supply. All power for the interface and modules is obtained from the "plug in" transformer.

These lessons are designed to be used in classes where an introduction to sensors and computer interfacing is needed but the time element does not allow students to use the manual chapter by chapter, from chapter one to the last chapter. It is not intended to be global in covering all the applications of the PZ 90. The lab manual will address these applications and other considerations as well.

An appropriate use of these lessons might be in an Introductory Communications course or a beginning Electronics course. They may be used with an entire class (multiple stations with 2 to 3 srudents per station) or with a self paced individual station approach.

PRETEST

The pretest can be given if desired before any student work is done with the interface. Be sure to caution students that this is for informational purposes only, not for a grade. Students will perform better if they feel that they will be able to master the subject matter. If students are not confident with interfacing it may not be in the best interest to use the pretest. An instructor key is included for instructor convenience.

LESSON 1

The purpose of lesson 1 is to give the students a background before actual use of a program. Instruction that would be beneficial before using lesson 1 would include: using an overhead to introduce the students to the PZ - 90 interface, opening the computer to show the interface slots inside the Apple II, and general presentations on ports, input, output, processing, and computer input and output devices. The instructor should make a determination if it is necessary to discuss calculating the control word. An overhead master is included to aid in the discussion if needed.

LESSON 2

The purpose of lesson 2 is to enable students to experiment with switches, and a computer program, to see that binary action on the switches can be translated into decimal numbers and outputed. If the students are to use a disk, make a copy by keyboarding the program, using the listing of switch demo. Many students will be able to do this themselves if they have had experience in BASIC programming. The advanced exercises section requires that changes be made to the orginal program. The instructor will have to make a decision as to the amount of demonstrations that will be needed, to be certain that the students know proper disk care, program commands, etc.

5 electronic modules are included with the PZ - 90

1. wave form switch
2. push button switch
3. H/L signal
4. inverter
5. LED/buzzer

14 experiments are included on the diskette/manual to make use of these modules. By acquiring a PZ - 90 AM kit, 16 additional modules are availible.

This will allow students to do additional experiments on the diskette/manual. It will allow greater chances for problem solving and for more student experimentation with sensors. As an example, a photosensor module, shaping module (calibration circuit), and a relay module will allow a student to use light to activate a DC motor. By switching the sensor, heat,magnetism,touch, etc can all be used to activate the motor using the same program.

Persons with ability to assemble components, can also prototype any digital circuit, to make use of additional sensors or make modules, rather than purchasing them. Additional background information can be acquired from the manufacturer as listed in the resource section.

NAME_____

PRETEST FOR PZ - 90

1. What is a port called that reads information into a computer?

2. What does output mean when refering to computers?

3. Initializing a card is a manufacturing process. (T or F)

4. Switches attached to a computer can be used to send information to it because the computer sees the switches as _____.

5. Sensors are _____.
   A. input devices
   B. output devices
   C. only found on the human body
   D. made entirely of plastic

6. The largest number that can be read by a computer with an eight bit port is _____.
   A. 65535
   B. 128
   C. 255
   D. 8

7. The greatest number that can be read by a computer using only 4 lines of input is _____.
   A. computer can't do it with only 4 lines
   B. 4
   C. 65535/4
   D. 15

8. Turning a switch on and off can be a form of binary action. (T or F)

NAME_____ _*KEY*_____

PRETEST FOR PZ - 90

1. What is a port called that reads information into a computer?
   INPUT PORT

2. What does output mean when refering to computers?
SENDING INFORMATION FROM THE COMPUTER TO THE OUTSIDE WORLD

3. Initializing a card is a manufacturing process. (T or F)
   FALSE

4. Switches attached to a computer can be used to send information to it because the computer sees the switches as _____.
   INPUT DEVICES OR NUMBERS

5. Sensors are ____***A***_____.
   A. input devices
   B. output devices
   C. only found on the human body
   D. made entirely of plastic

6. The largest number that can be read by a computer with an eight bit port is _____***C***_____.
   A. 65535
   B. 128
   C. 255
   D. 8

7. The greatest number that can be read by a computer using only 4 lines of input is __***D***_____.
   A. computer can't do it with only 4 lines
   B. 4
   C. 65535/4
   D. 15

8. Turning a switch on and off can be a form of binary action. (T or F)
   TRUE

NAME_____

POST TEST PZ - 90

1. If all 8 switches were sending 1's to the computer through an input port what number would the computer read? _____

2. If x's are "lit" LED's and 0's are "unlit" LED's, what would the following number be, if seen on the output port of a computer. (assume that the computer is sending out a number to be seen on the H/L Signal module)

000X0000

_____

3. Assume that the user of a computer wished to initialize the PZ - 90 interface card. What would the user need to know about ports A, B, and C?

4. What is CW when it is used in a reference to the PZ - 90?

5. What is the largest number that can be read on 4 lines of input?

6. Define a port as it is used in reference to computer interfacing.

7. Define a sensor.

8. 1000 is a _____ number that has a decimal value of _____.

9. The computer can read numbers as large as _____ by using 4 swiches on an input port.

A. 255
B. 4
C. 128
D. 15

10. A sensor can be used on an output port. (T or F)

NAME_____*KEY*_____

POST TEST PZ - 90

1. If all 8 switches were sending 1's to the computer through an input port what number would the computer read? ____*255*_____

2. If x's are "lit" LED's and 0's are "unlit" LED's, what would the following number be, if seen on the output port of a computer? (assume that the computer is sending out a number to be seen on the H/L Signal module)

000X0000

____*16*_____

3. Assume that the user of a computer wished to initialize the PZ - 90 interface card. What would the user need to know about ports A, B, and C? WHICH PORTS WILL BE USED AS INPUT AND OUTPUT-- THEN CALCULATE THE CONTROL WORD BASED ON THAT INFORMATION

4. What is CW when it is used in a reference to the PZ - 90?

CONTROL WORD

5. What is the largest number that can be read on 4 lines of input?

15

6. Define a port as it is used in reference to computer interfacing.

A LOCATION IN THE COMPUTER THAT IS CONNECTED TO THE INTERFACE THAT ALLOWS THE COMPUTER TO READ OR SEND INFORMATION TO THE OUTSIDE WORLD

7. Define a sensor.

A DEVICE THAT CAN DETECT A CHANGE IN THE WORLD OUTSIDE THE COMPUTER AND SEND A SIGNAL TO THE INPUT PORT.

8. 1000 is a _*BINARY*_ number that has a decimal value of __*8*___.

9. The computer can read numbers as large as ____*D*___ by using 4 swiches on an input port.

A. 255
B. 4
C. 128
D. 15

10. A sensor can be used on an output port. (T or F)

FALSE

ERIC

RESOURCES

1. Feedback Incorporated
   620 Springfield Ave.
   Berkeley Heights, New Jersey 07922

   PZ - 90 Manual and 5 1/4" diskette, "REAL TIME MICROCOMPUTER APPLICATIONS" copyright 1987 issue 1 revision 0

   (Information presented is used by written permission of Feedback Inc.)

2. Hoekstra, Robert I. "ROBOTICS AND AUTOMATED SYSTEMS" Southwestern Publishing Co. copyright 1986

3. Tokheim, Roger I. "DIGITAL ELECTRONICS" second edition McGraw Hill Inc. copyright 1984

FEEDBACK INC.

620 Springfield Ave.
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New Jersey 07922
Tel.: (201) 464-5181

September 21, 1989

Attn: Mr. Dave Peterson
Osseo - Fairchild High School
13th & Francis Streets
Osseo, WI 54758

Dear Mr. Peterson,

Further to our conversation of 20 September, I am pleased to confirm that you have permission to use any material from the PZ10 and PZ90 equipment manuals in your project with Univ. Wisconsin - Stout.

We further authorize dissemination of texts containing extracted material, or derivative material by Univ. Wisconsin - Stout for any bona fide educational purposes.

I am pleased to hear that the PZ units have proved satisfactory for you. If there is any other way we can be of help please don't hesitate to call me at (800) 526-8783.

Very truly yours,

FEEDBACK INCORPORATED

M. J. Lawson
President

MJL/dml
cc: Edutec