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**DIGITAL INPUT/OUTPUT CARD
MODEL IOD-120
USER MANUAL**

NOTICES

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INSTALLING THE CARD

Before installing the card carefully read the ADDRESS SELECTION and OPTION SELECTION Sections of this manual and configure the card according to your requirements. Use the special software program called **SETUP** provided with the card. It supplies visual aids to configure all areas of the board.

Be especially careful with address selection. If the addresses of two installed functions overlap, you will experience unpredictable computer behavior. If unsure what locations are available, you can use the **FINDBASE** program to locate blocks of available addresses.

To install the card:

1. Remove power from the computer.
2. Remove the computer cover.
3. Remove blank I/O backplate.
4. Install jumpers for selected options. See OPTION SELECTION section of this manual.
5. Select the base address on the card. See ADDRESS SELECTION section of this manual.
6. Loosen the nuts on the strain relief bar and swing top end free.
7. Install the card in an I/O expansion slot. If convenient, select a slot which is adjacent to a vacant slot because this will make cable installation easier.
8. Thread the I/O cables, one by one through the cutout in the mounting bracket and plug them into the headers.
9. Smooth the cables as close as practicable to the card and while holding them close to the card surface, swing the strain relief bar into position and tighten nuts.
10. Inspect for proper fit of the card and cables and tighten screws. *Make sure that the card mounting bracket is properly screwed into place and that there is a positive chassis ground.*
11. Replace the computer cover.

Input/Output connections are via five 50-pin headers on the card. A blank mounting bracket is provided with units that are marked for CE (European) Certification and, for these units, CE-certifiable cable and break-out methodology (cables connected to ground at the aperture, shielded twisted pair wiring, etc.) must be used.

FUNCTIONAL DESCRIPTION

FEATURES

- 120 Channels of Digital Input/Output.
- All 120 I/O Lines Buffered on the Board.
- Four and Eight Bit Groups Independently Selectable for I/O.
- Hysteresis Correction and Pull-Down Resistors on I/O Lines.
- Interrupt and Interrupt-Disable Capability.
- Tri-stateable I/O ports under software control.
- +5V Supply Available to User.
- Compatible with Industry Standard I/O Racks like Opto-22, Potter & Brumfield, etc.

APPLICATIONS

- Automatic Test Systems.
- Security Systems, Energy Management.
- Robotics
- Relay Monitoring and Control.
- Parallel Data Transfer to PC.
- Sensing switch closures or TTL, DTL, CMOS Logic.
- Driving Indicator Lights or Recorders.

The IOD-120 board was designed for industrial applications and should be installed in a long slot of an IBM PC/XT/AT or compatible computer. Each I/O line is buffered and capable of sourcing 15mA, or sinking 24mA (64mA on request). The board contains five Programmable Peripheral Interface chips type 8255-5 (PPI) to provide computer interface to 120 digital I/O lines. Each PPI provides three 8-bit ports A, B, and C. Each 8-bit port can be configured to function as either inputs or output latches. Port C can also be configured as four inputs and four output latches. The I/O line buffers (74LS245) are configured automatically by hardware logic for input or output use according to the PPI 8255-5 Control Register direction software assignment.

The I/O buffers may be tristated under program control. If the BEN/TST jumper on the card is installed in the BEN position, the I/O buffers are permanently enabled allowing transparent backwards compatibility. However, if the jumper is placed in the TST position, enable/disable of the buffers is possible under *software control*.

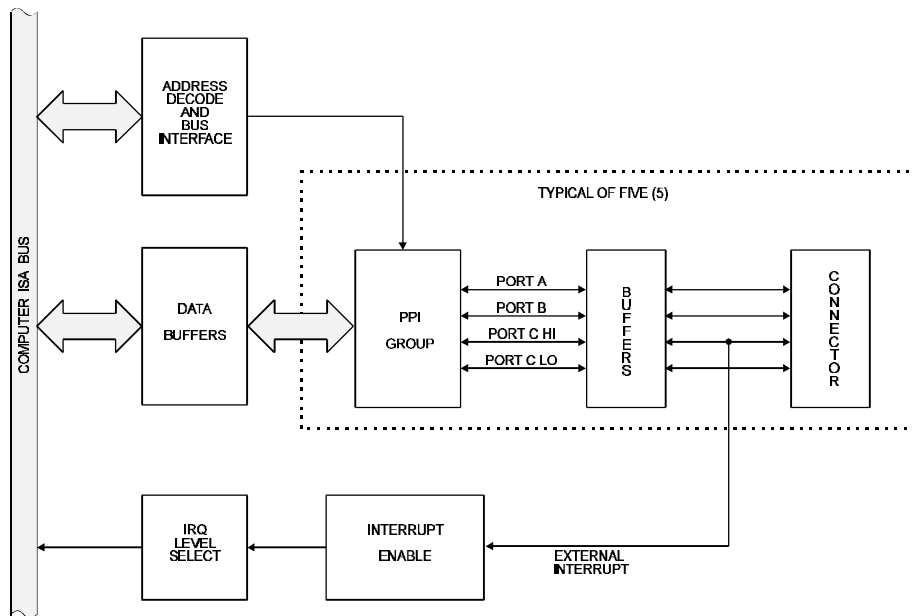
Two I/O lines of each port can be used for interfacing User Interrupts to the computer. Interrupts are buffered and are enabled by jumper installation or by a combination of jumper installation and a digital input line. You can use Interrupts #2 through #7, #10 through #12, #14 and #15. Interrupts of all ports (one per port) are OR'ed together. I/O wiring connections are via 50-pin headers on the board. Five flat I/O cables connect IOD-120 to termination panels such as ACCES model STA-50. Also, this provides compatibility with OPTO-22, Gordos, Potter & Brumfield, etc. module mounting racks.

Every second conductor of the flat cables is grounded to minimize the effect of crosstalk between signals. If needed for external circuits +5VDC power is available on each I/O connector pin 49. If you use this power, we recommend that you include a 1A fast blow fuse in your circuits in order to avoid possible damage to the host computer.

The board occupies thirty-two consecutive bytes within the I/O address space. The base address is selectable via ADDRESS SETUP DIP switches (A5-A9) anywhere within the hex 000-3FF range. However, if 96 or less I/O lines are to be used, then the IOD-120 board can be configured to occupy only 16 consecutive bytes of I/O space. Refer to the OPTION SELECTION Section of this manual for a detailed description.

Utility software provided with the IOD-120 card is an illustrated setup program. Interactive displays show locations and proper settings of DIP switches and jumpers to set up board address, interrupt levels, and interrupt enable..

IOD-120 BLOCK DIAGRAM



OPTION SELECTION

Refer to the illustrated setup programs provided with the card when reading this section of the manual. Also, refer to the OPTION SELECTION MAP on the following page.

The card comes with jumpers installed at locations marked 120 and 120B. These enable all 120 I/O lines on the card. If 32 bytes of I/O space is not available and 96 or less I/O lines are to be used, then it is possible to configure the card to occupy only 16 bytes in I/O space. This will disable Port 4. To select this option, move the two jumpers to the locations marked 96 and 96B.

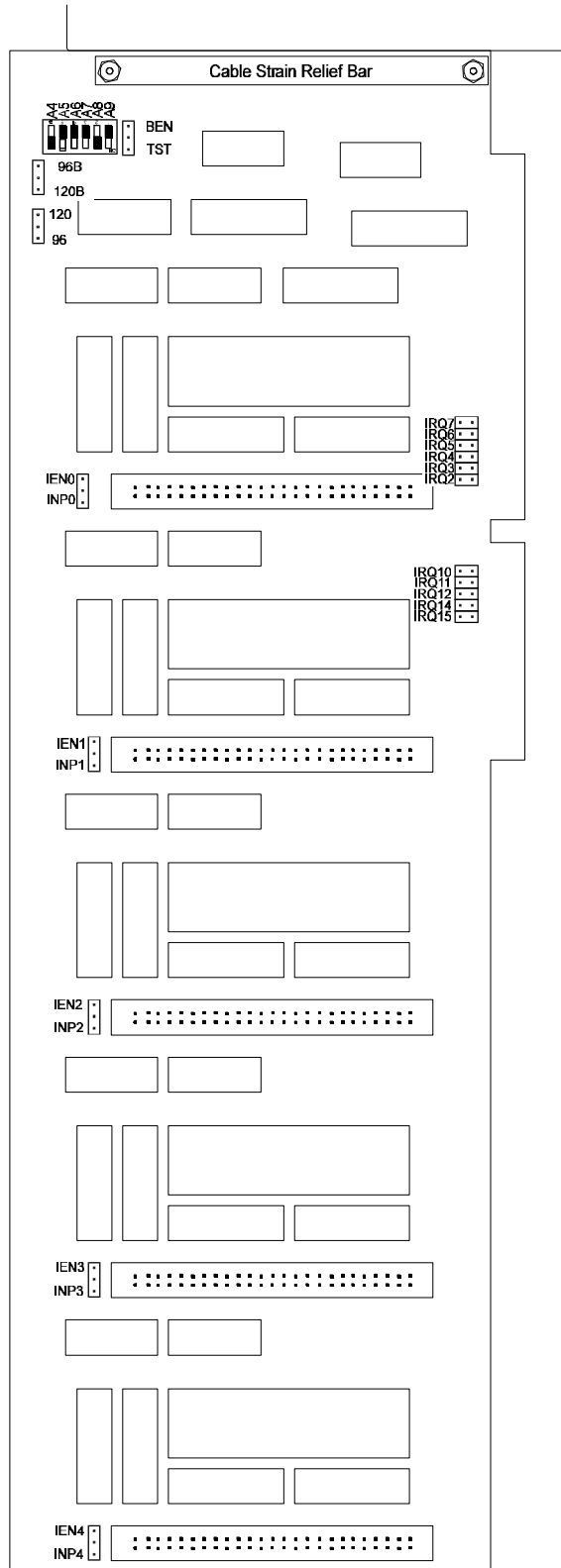
Base address selection is covered in the next section of this manual.

Interrupts are accepted on the I/O connector, pin 9 (port C3). The interrupt signal is positive true. Interrupts are unconditionally enabled if the IEN jumper is installed, or enabled by program if the INP jumper is installed and I/O connector pin 1 (port C) is low. Interrupts are disabled if (a) neither the IEN or INP jumper is installed, or (b) if the INP jumper is installed but I/O connector pin 1 (port C7) is held high. User interrupts are directed to interrupts #2 through #7, #10 through #12, #14 and #15 by jumpers installed at locations labelled IRQ2 through IRQ15.

The foregoing are the only manual setups necessary to use the IOD-120. Input/Output selection is done, via software, by writing to the PPI 8255-5 Control Registers as described in the PROGRAMMING section of this manual.

IOD-120 provides a means to enable/disable the tristate I/O buffers under program control. If the BEN/TST jumper on the card is installed in the BEN position, the I/O buffers are permanently enabled. However, if the jumper is placed in the TST position, enable/disable of the buffers is possible under *software control* via the Control Register as described in the Software Programming section of this manual.

OPTION SELECTION MAP



ADDRESS SELECTION

The IOD-120 Input/Output Card occupies 32 bytes of I/O space. The card base address can be selected anywhere within an I/O address range 000-3FF hex. If all 120 bits are to be used in an AT-class computer, the base address can be set anywhere within the address range hex 100-390 (except 1F0 through 1F8). If only 96 bits are to be used, the base address can be anywhere in the range hex 100-3F0. If to be used in an XT-class computer, the starting address can be as above except the lowest starting address is 200 hex.

However two installed options cannot share the same address. If in doubt where to assign the base address of the IOD-120, refer to the tables below and consult the FINDBASE program.

STANDARD ADDRESS ASSIGNMENTS FOR 286/386/486 COMPUTERS

Hex Range	Usage
000-01F	DMA Controller 1
020-03F	INT Controller 1, Master
040-05F	Timer
060-06F	8042 (Keyboard)
070-07F	Real Time Clock, NMI Mask
080-09F	DMA Page Register
0A0-0BF	INT Controller 2
0C0-0DF	DMA Controller 2
0F0	Clear Math Coprocessor Busy
0F1	Reset Coprocessor
0F8-0FF	Arithmetic Processor
1F0-1F8	Fixed Disk
200-207	Game I/O
278-27F	Parallel Printer Port 2
2F8-2FF	Asynchronous Comm'n (Secondary)
300-31F	Prototype Card
360-36F	Reserved
378-37F	Parallel Printer Port 1
380-38F	SDLC or Binary Synchronous Comm'n 2
3A0-3AF	Binary Synchronous Comm'n 1
3B0-3BF	Monochrome Display/Printer
3C0-3CE	Local Area Network
3D0-3DF	Color/Graphic Monitor
3F0-3F7	Floppy Diskette Controller
3F8-3FF	Asynchronous Comm'n (Primary)

To set desired board address, refer to the illustrated Board Address setup program provided with the card. Type the desired address in hexadecimal code and the graphic display shows you how to set the ADDRESS SETUP switches. These switches are marked A4-A9 and form a binary representation of the address in negative-true logic.

Assign '0' to all ADDRESS SETUP switches turned ON, and assign '1' to all ADDRESS SETUP switches turned OFF.

NOTE: The A4 switch is enabled only if the IOD-120 card is configured for 96 I/O lines. The card then occupies 16 bytes of I/O space instead of the normal 32.

The following example illustrates switch selection corresponding to hex 2D0 (or binary 10 1101 xxxx) The "xxxx" represents address lines A3, A2, A1, and A0 used on the card to select individual registers at the PPI's. See Section 6, PROGRAMMING.

Hex Representation	2		D			
Conversion Multipliers	2	1	8	4	2	1
Binary Representation	1	0	1	1	0	1
Setup	OFF	ON	OFF	OFF	ON	OFF
Switch ID	A9	A8	A7	A6	A5	A4

CAUTION

Review the address selection reference table carefully before selecting the card address. If the addresses of two installed functions overlap you will experience unpredictable computer behavior.

SOFTWARE

ACCES supplies several programs to support the IOD-120 Digital I/O card and, also, to help you develop your applications software. These programs are on a CD that comes with your card and consist of a Setup program and three sample programs. The sample programs are in forms suitable for use with QuickBASIC, C, Pascal, C++ Builder, Delphi, Visual Basic, and Visual C++. The programs are as follows:

- FINDBASE: Program locates active and available port addresses.
- SETUP: IOD-120 Board Setup Program
- BSAMPLES: *SAMPLE1* A Quickbasic program that writes a sequence of values to Port A and reads and displays the values in Ports A & B.
SAMPLE2 A Quickbasic program that displays the bits in Ports A & B and, when an interrupt occurs, polls those same bits.
- CSAMPLES: *SAMPLE1* A "C" program that writes a sequence of values to Port A and reads and displays the values in Ports A & B.
SAMPLE2 A "C" program that displays the bits in Ports A & B and, when an interrupt occurs, polls those same bits.
- PSAMPLES: *SAMPLE1* A "Pascal" program that writes a sequence of values to Port A and reads and displays the values in Ports A & B.

SETUP

This program is supplied with the IOD-120 card as a tool for you to use in configuring jumpers and switches on the card. It is menu-driven and provides pictures of the card on the computer monitor. You make simple keystrokes to select the functions. In turn, the pictures then change to show how the jumpers or switches should be placed to effect your choices.

The setup program is a stand-alone program that can be run at any time. It does not require the IOD-120 to be plugged into the computer for any part of the setup. The program is self-explanatory with operation instructions and on-line help.

PROGRAMMING

The IOD-120 is an I/O mapped device that is easily configured from any language and any language can easily perform digital I/O through the card's ports. This is especially true if the form of the data is byte or word wide. All references to the I/O ports would be in absolute port addressing. However, a table could be used to convert the byte or word data ports to a logical reference.

DEVELOPING YOUR OWN SOFTWARE

If you wish to gain a better understanding of the programs listed in the previous section, then the information in the following paragraphs will be of interest to you. Follow the 8255-5 Specification in APPENDIX A to program the PPI's on the IOD-120 Digital Input/Output Card.

A total of 20 address locations are used by the IOD-120 for addressing the PPI's; four for each PPI. The PPI's are addressed using address bits A3 through A0 (See Address Selection, section 4 of this manual.) as follows:

PORT ADDRESS SELECTION TABLE

Address	Port Assignment	Operation
Base Address	PA Port 0	Read/Write
Base Address +1	PB Port 0	Read/Write
Base Address +2	PC Port 0	Read/Write
Base Address +3	Control Port 0	Write Only
Base Address +4	PA Port 1	Read/Write
Base Address +5	PB Port 1	Read/Write
Base Address +6	PC Port 1	Read/Write
Base Address +7	Control Port 1	Write Only
Base Address +8	PA Port 2	Read/Write
Base Address +9	PB Port 2	Read/Write
Base Address +A	PC Port 2	Read/Write
Base Address +B	Control Port 2	Write Only
Base Address +C	PA Port 3	Read/Write
Base Address +D	PB Port 3	Read/Write
Base Address +E	PC Port 3	Read/Write
Base Address +F	Control Port 3	Write Only
Base Address +10	PA Port 4	Read/Write
Base Address +11	PB Port 4	Read/Write
Base Address +12	PC Port 4	Read/Write
Base Address +13	Control Port 4	Write Only

The IOD-120 uses five 8255-5 PPI's to provide a total of 120 bits input/output capability. The card is designed to use each of these PPI's in mode 0 wherein:

- a. There are two 8-bit ports (A and B) and two 4-bit ports (C Hi and C Lo).
- b. Any port can be configured as an input or an output.
- c. Outputs are latched.
- d. Inputs are not latched.

Each PPI contains a control register. This Write-only, 8-bit register is used to set the mode and direction of the ports. At Power-Up or Reset, all I/O lines are set as inputs. Each PPI should be configured during initialization by writing to the control registers even if the ports are going to be used as inputs. Output buffers are automatically set by hardware logic according to the control register. Control registers are located at base addresses +3, +7, +B, +F, and +13. Bit assignments in each of these control registers are as follows:

Bit	Assignment	Function
D0	Port C Lo (C0-C3)	1 = Input, 0 = Output
D1	Port B	1 = Input, 0 = Output
D2	Mode Selection	1 = Mode 1, 0 = Mode 0
D3	Port C Hi (C4-C7)	1 = Input, 0 = Output
D4	Port A	1 = Input, 0 = Output
D5,D6	Mode Selection	01 = Mode 1, 00 = Mode 0 1X = Mode 2
D7	Mode Set Flag	1 = Active

NOTE:

Contact ACCES for directions if you wish to operate this card in mode 1. This card cannot be operated in mode 2

IOD-120 provides a means to enable/disable the tristate I/O buffers under program control. If the BEN/TST jumper on the card is installed in the BEN position, the I/O buffers are permanently enabled. However, if the jumper is placed in the TST position, enable/disable of the buffers is possible under *software control* via the Control Register as follows:

- a. The card is initialized in the receive mode by the computer Reset command.
- b. When bit D7 of the Control Register is set high, the direction of the three ports of the associated PPI chip as well as the mode can be set. For example, a write to Base Address+3 with data bit D7 high programs port direction of Port

1 ports A, B, and C. If, for example, hex 80 is sent to Base Address+3, the Port 0 PPI will be configured in mode 0 with ports A, B, and C as outputs.

But, at the same time, data bit D7 is also latched in a buffer controller for the associated PPI chip. A high state disables the buffers and, thus, all associated buffers will be put in the tristate mode; i.e., disabled.

- c. When you wish to enable the output buffers, send a normal PPI mode command with bit D7 low. For, example, if a control byte of hex 80 had been sent as previously described, and it is now desired to open the three ports, you can send a control byte of hex 00 to Base Address+3 to enable the port 0 buffers.

NOTE

All data bits except D7 must be the same for the two control bytes

- c. Those buffers will now remain enabled until another control byte with data bit D7 high is sent to Base Address+3.

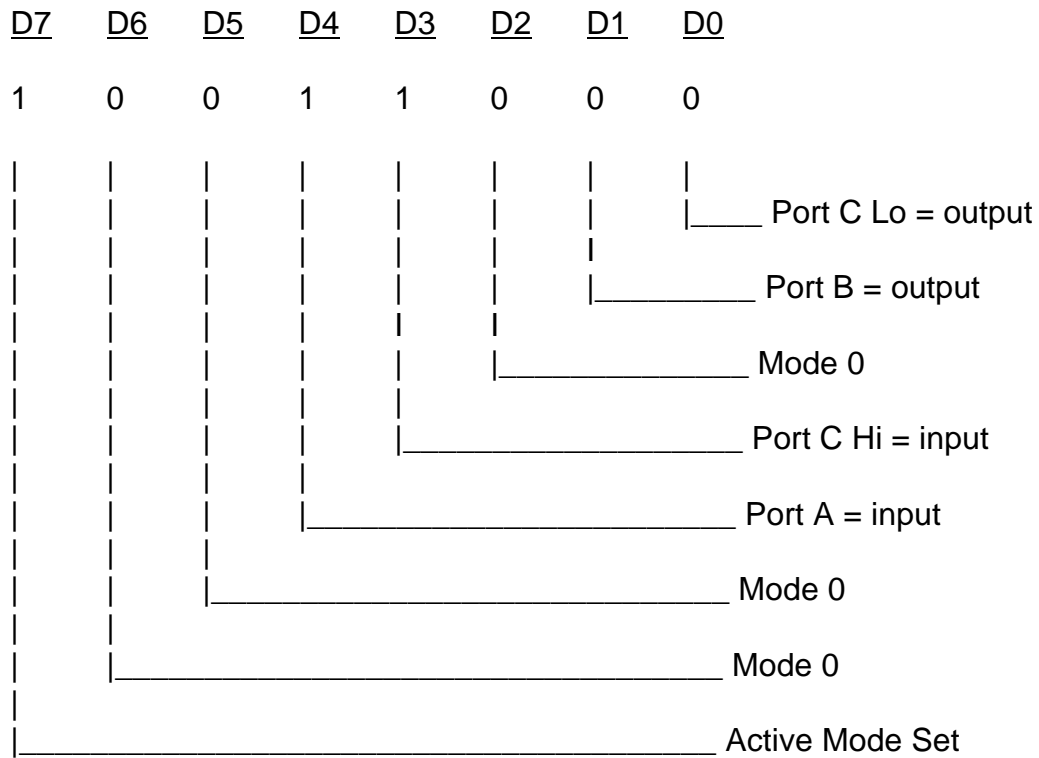
Those buffers will now remain enabled until another control byte with data bit D7 high is sent to Base Address +3.

PROGRAMMING EXAMPLE

The following programming example is provided as a guide to assist you in developing your working software. In this example, the card base address is 2D0 hex and I/O lines of Port 0 are to be setup as follows:

```
port A    = Input
port B    =Output
port C hi = Input
port C lo =Output
```

Configure bits of the Control Register as:



This corresponds to 98 hex. If the card base address is 2D0 hex, use the C command to write to the control register as follows:

```
BASEADDR=0x2D0;
OUTPORTB(Baseaddr,0x98);
```

To read the inputs at Port A and the upper nybble of Port C, use the C INPUT command:

```

X=INP(BASEADDR)           //Read Port A           X= inportb(Baseaddr);
Y=INP(BASEADDR+2)/16      //Read Port C Hi       Y= inportb(Baseaddr+2)>>4;

```

To set outputs high ("1") at Port B and the lower nybble of Port C:

```

OUTPORTB(Baseaddr +1,0xFF); //Turn on all Port B bits
OUTPORTB(Baseaddr +2,0x0F); //Turn on all bits of Port C Lo

```

SAMPLE PROGRAMS

The following sample programs are in TURBO-C and TURBO-PASCAL languages. They cover a security system that allows you to monitor the status of 16 switches and to automatically trigger four alarms that can be used to turn on lights, activate a siren, or send a signal to a silent alarm. The alarm system in this demonstration has four arming stations which toggle the alarm on or off. These programs are also provided with your IOD card.

TURBO-PASCAL PROGRAM

```

CONST BASEADDR = $300;      {declare base address for IOD card}
CONST ON       = 1;        {declare some useful constants}
CONST OFF     = 0;        { " " " " " " }

TYPE sensor_array = array[0..15] of integer; {creates a type of variable used for}
                                           { sensor data}
VAR sensors_at_arm : sensor_array; {bit-by-bit status of sensors when alarm is}
                                   {activated. Used to notify user of open windows, etc}
VAR sensors_now : sensor_now; {bit-by-bit status of sensors at current time. When}
                               {compared against sensors_at_arm, indicates}
                               { break-in if there is a change.}
VAR arming_stations : integer; {variables representing all four arming stations}
VAR old_arming_stations: integer; {If value changes toggle alarm on/off}
VAR hour, min., sec., hun. : word; {variables used to retrieve time}
VAR key : char;                {useful temporary variable}
VAR i : integer;               {useful temporary variable, used in loops}
VAR j : integer;               { " " " " " " }
procedure initialize_board;    {this procedure sets MODE 0 as active and sets}
                               {and sets Port A, B, and C LO as input and Port }
                               {C HI as output}

begin
  port[BASEADDR+3] :=$93;      {port[X] is Pascal's method of accessing the port}
                               {memory. This code sets the port memory at}
                               {address 303 hex, and the control register, to 93}
                               {hex because the bit pattern to set the desired}

```



```

                                {mode and port designations is 10010011 which}
                                {equals 93 hex}
    end; {procedure initialize_board}

procedure read_sensors(VAR ary:sensor_ary);
    VAR tempA : byte;           {this procedure fetches data from Ports A }
    VAR tempB : byte;           {and B and returns a binary representation}
                                {of each sensor}
begin
    tempA := port[BASEADDR];    {this procedure loads tempA and tempB} {with cor-
                                responding inputs from the Card}
    tempB := port[BASEADDR+1];
    for i := 0 to 7 do begin
        if ((tempA shr i) AND ON) > 0 then {this tests to see if bit #i is ON and sets the}
            ary[i]:=ON                    {corresponding array element to ON if it is}
        else                                {else, the array element is set to OFF}
            ary[i]:=OFF
        end;
    for i:=0 to 7 do begin
        if ((tempB shr i) AND ON) > 0 then
            ary[i+8]:=ON                  {in order to get Port B into array, elements}
        else                                {8 thru 15, we add 8 to the bit numbers in }
            ary[i+8]:=OFF;                {in the assignment}
        end;
    end;{procedure read_sensors}
function get_status:integer;
    var temp:integer;
begin
    temp:=port[BASEADDR+2];    {this sets status to the lower nybble of Port}
    get_status:=temp AND $0F;  {;the half defined by Initialize to be input for}
                                {four arming switches}
end; {function get_arming_status}

procedure ALARM
    var temp:longint;
begin
    sound(2000);                {this starts the computer's speaker which }
                                {acts as siren for the alarm}

    temp:=0
    port[BASEADDR+2]:=$F;       {this sets Port C's lower nybble bits to ON}
    repeat
        arming_stations:=get_status {this activates four alarm outputs and then}
        if arming_stations <> old_arming_stations then {toggles Port C Hi's LSB which}
            temp:=2000000000; {disarmed}{might be used with an external siren}
        port[BASEADDR+2]:=port[BASEADDR+2] XOR $10;
        temp:=temp+1;

```

```

    until temp>=2000000000;
    nosound;
end; {procedure ALARM}

begin
  initialize_board;
  clrscr;
  gotoxy(5,5);
  writeln('This is the IOD card demonstration program. This ');
  writeln('program will simulate an alarm system program for ');
  writeln('sixteen sensors and four arming stations, along with');
  writeln('four separate alarm outputs which could be routed to');
  writeln('a siren, lights, silent alarm,etc');
  writeln;
  writeln('THIS PROGRAM IS INTENDED FOR DEMONSTRATION PURPOSES,');
  writeln('ONLY AND IS NOT MEANT TO BE USED AS AN ACTUAL ALARM ');
  writeln('SYSTEM. ');
  writeln;writeln;
  writeln('Press any key to begin program. ');
  key:=readkey;
  old_arming_stations:=get_status; {this loads the status of the arming switches}
  repeat
    clrscr;
    read_sensors(sensors_now); {this reads the current status of the sensors}
    for i=0 to 15 do begin
      if sensors_now[i]=OFF then
        writeln('Sensor #',i,'is open');
    end;
    writeln;
    writeln('Press ESC to re-scan, RETURN to begin alarm scanning. ');
    key:=readkey;
  until key=#13;
  clrscr;

  WHILE TRUE do begin
    Writeln('Waiting to be armed, or press any key to halt program. ');

    repeat
      arming_stations:=get_status;
      if key pressed then halt(1);
    until key pressed;
  end;
end;

```

```

until arming_stations <> old_arming_stations;
sound(900);                {short tone indicating alarm has been
armed}
delay(300);                { " " " " " " " " }
nosound;                   { " " " " " " " " }
writeln('Alarm system will activate in 15 seconds');
read_sensors(sensors_at_arm);
old_arming_stations : get_status;
gettime(hour,min,sec,hun); {this code reads the system clock}
i:=sec+15;                 {for the current time which is}
if i > 60 then i :=i-60;   {used to delay for 15 seconds}
repeat
  gettime(hour,min,sec,hun);
until sec = i;             {end of delay loop}
writeln;
writeln('ALARM SYSTEM ACTIVE AND ARMED');
sound(900);                {short tone indicating that alarm}
delay(300);                {is fully activated}
no sound;
j:=0                       {the following code compares current}
                           {status of sensors against status when}
                           {armed to determine if break-in has occurred}
                           {break-in has occurred.. Any change indicates break-in}
repeat
  read_sensors(sensors_now);
  for i:= 1 to 16 do begin
    if sensors_now[i-1] <> sensors_at_arm[i-1] then
      j:=1;
  end;{for}
  arming_stations: get_status;
  if arming_stations <> old_arming_stations then
    j:= -i;                 {flag used to signal that alarm is}
                           {de-activated}
until j <> 0;
if j = -1 then begin      {if j was set to -1 in the above loop, then} {alarm is
                           de-activated}
  gettime(hour,min,sec,hun);
  writeln('Alarm deactivated at ', hour,':',min,':',sec);
  sound(900);              {the following code chirps the speaker to}
                           {indicate disarming}
  delay(100);
  no sound;
  delay(50);
  sound(900);
  delay(100);

```

```

    nosound;
end                                     {end of disarming routine}
else {if alarm}begin
    writeln('Sensor #', j, ' has been activated!!');
    gettime(hour,min,sec,hun);
    writeln('The time of alarm is ',hour,':',min,':',sec);
    ALARM;
end;                                     {else}

end;                                     {WHILE this "end" sends the program back}
                                       {to wait to be re-armed}

end.

```

TURBO-C PROGRAM

```

#define BASEADDR 0x300 /*declare base address for IOD card*/
#define ON      1      /*create useful constant*/
#define OFF    0      /* " " " */
#include "stdio.h"
#include "conio.h"
#include "time.h"
#include "dos.h"

int sensors_at_arm[15];
int sensors_now[15]; /*bit-by-bit status of sensors at current time. When*/
                    /*compared against status of sensors at arm, indicates*/
                    /**/
                    /*break-in if there is a change.*/
int arming_stations; /*variables representing all four arming stations. If the*/
int old_arming_stations; /*value changes, toggle alarm ON/OFF*/
char key; /*useful temporary variable*/
int i; /*useful temporary variable used in loops*/
int j; /*useful temporary variable*/

initialize(){
    outportb(BASEADDR+3,0x93); /*outportb(addr,byte) is C's method of */
                             /*accessing port memory. This procedure sets*/
                             /*cPort A, B, and C LO as inputs and Port C Hi as*/
                             /*outputs. Address hex 303 is the control register */
                             /*The bit pattern needed to set the desired mode */
                             /*and port designation is 10010011, 93 hex */
} /*procedure initialize*/

read_sensors(int *ary){
    unsigned char tempA;

```

```

unsigned char tempB;
    tempA = inportb(BASEADDR);
    tempB = inportb(BASEADDR+1);
    for(i=0;i<8;i++){
        if((tempA>> i) & ON){ /*this determines if bit #i is on and sets the
corresponding*/
            *ary++=ON;} /*array element to ON if it is. If not, sets the array */
        else{ /*to OFF*/
            *ary++=OFF;
        }
    }
    for(i=0;i<8;i++){
        if((tempB>> i) & ON){
            *ary++=ON; }
        else
            *ary++=OFF; }
    }

} /*procedure read_sensors*/

get_status(){
    int temp;
    temp=inportb(BASEADDR+2); /*this sets status to the lower half of Port C, the*/
/*of Port C, half defined in Initialize to be input, */
/*for four arming switches*/

    return temp & 0x0F;
} /*function get_arming_status*/
ALARM(){
    long int temp=0;
    sound(2000); /*this starts the computer's speaker*/

    outportb(BASEADDR+@,0xF0); /*this sets Port C upper nybble bitsto ON*/
/*(1111 binary = F hex).*/

    do{
        arming_stations=get_status(); /*this activates 4 alarm outputs and then toggles*/
        if(arming_stations !=old_arming_stations) /*Port C Hi LSB which might be used*/
temp=2000000000; /*dis-armed*/ /*with an external speaker*/
        outportb(BASEADDR+2,inportb(BASEADDR+2)^0x10);
    }while(temp++ !=2000000000);
    nosound();
} /*procedure ALARM*/

-----

main()
{

```

```
time_t start;
initialize();
clrscr();
goto(5,5);
printf("This IOD-card demonstration program simulates an alarm\n");
printf("system program for 16 sensors, four arming stations and\n");
printf("four separate alarm outputs which could be routed to a\n");
printf("siren, lights, silent alarm, etc.\n");
printf("\n");
printf("THIS PROGRAM IS FOR DEMONSTRATION PURPOSES ONLY, AND
IS\n");
printf("NOT MEANT TO BE USED AS AN ACTUAL ALARM SYSTEM.\n");
printf("\n");printf("\n");
printf("Press any key to begin program.\n");
key=getch();
    old_arming_stations=get_status();
    do{
    clrscr();
    read_sensors(sensors_now);
    for(i=0;i<=15;i++){
        if (!sensors_now[i]) printf("Sensor #%d %s\n,i,"is open");
    }

    printf("\n");
    printf("Press ESC to re-scan, RETURN to begin alarm scanning.");
    key=getch();
}while(key!=13);
clrscr();
for(;;){                                /*this creates an infinite loop*/
printf("Waiting to be armed. Press any key to halt program.\n");
do{
    arming_stations=get_status();
    if(kbhit()) abort(0);
}while(arming_stations== old_arming_stations);
sound(1000);
delay(300);
nosound();
printf("Alarm system will activate in 15 seconds");
read_sensors(sensors_at_arm);
old_arming_stations=get_status();
start=time(NULL);
do{
}while(difftime(time(NULL),start) !=15);
printf("\n");
printf("ALARM SYSTEM ACTIVE AND ARMED\n\n");
```

```
sound(900);
delay(300);
nosound();
j=0;
do{
  read_sensors(sensors_now);
  for(i=1;i<=16;i++){
    if(sensors_now[i-1] !=sensors_at_arm[i-1])
      j=i;
  } /*for*/
  arming_stations = get_status();
  if (arming_stations != old_arming_stations)
    j=-1                               /*flag used to signal alarm is
de-activated*/
  while(!j);
  if(j == -1){
    start=time(NULL);
    printf("Alarm deactivated at %s,(asctime(gmtime(&start)))));
    sound(900); delay(300);
    nosound(); delay(50);
    sound(900); delay(100);
    nosound();
  }
  else {
    printf("Sensor #%d has been activated!!\n\n",j);
    start=time(NULL);
    printf("The time of alarm is %s", asctime(gmtime( &start)));
    old_arming_stations=get_status();
    ALARM();
  } /*else*/
} /* for(;;) this "end" used to send program back to await re-arm*/
}
```

SHARING INTERRUPTS ON THE ISA BUS

As noted on pages 2-1 and 3-1, IOD-120 can accept external interrupts via bit C3 at each 24-bit group. On occasion, however, a system application will require more interrupt levels than are available on the ISA bus. While not recommended, IRQ sharing is possible. Each card that is going to share an IRQ ***must strictly adhere to a special standard for accessing the IRQ line as follows:***

- a. The interrupt must be held in a high impedance state until asserting an interrupt.
- b. The interrupt must be asserted in the form of a low signal lasting at least 500 nanoseconds followed by a rising edge and then immediately returning to a high impedance condition.
- c. The card must contain a status register or flag of some kind to indicate that it generated the interrupt. There is an exception to this rule. This is the case where only one card of those sharing the interrupt level does not provide a status bit to indicate that it asserted the interrupt but is otherwise capable of sharing the IRQ. In this case, it may share the interrupt level with other cards if (a) it is the only card on that IRQ level that does not have a status bit, and (b) it is installed onto the IRQ vector first. (This makes it the last card to be called in the vector chain.) This scheme will work because it can be assumed that, if every other card in the vector chain did not cause the interrupt, then the last card must be the one that did.

Note that, if two cards assert the IRQ line within 500 nanoseconds of each other, the second card in the ISR chain will not be serviced. It's possible to alleviate this problem by writing a single ISR that can detect the bit flag on every card and, therefore, detect the fact that two (or more) cards report generating an interrupt even though only one interrupt was processed by the CPU.

CONNECTOR PIN ASSIGNMENTS

Five 50-pin headers are provided on the IOD-120 card; one for each group of 24 I/O lines. The mating connector is an AMP type 1-746285-0 or equivalent. Connector pin assignments are listed below. Notice that every second line is grounded to minimize crosstalk between signals.

Assignment	Pin	Assignment	Pin
Port C Hi PC7*	1	Ground	2
Port C Hi PC6	3	"	4
Port C Hi PC5	5	"	6
Port C Hi PC4	7	"	8
Port C Lo PC3**	9	Ground	10
Port C Lo PC2	11	"	12
Port C Lo PC1	13	"	14
Port C Lo PC0	15	"	16
Port B PB7	17	Ground	18
Port B PB6	19	"	20
Port B PB5	21	"	22
Port B PB4	23	"	24
Port B PB3	25	"	26
Port B PB2	27	"	28
Port B PB1	29	"	30
Port B PB0	31	"	32
Port A PA7	33	Ground	34
Port A PA6	35	"	36
Port A PA5	37	"	38
Port A PA4	39	"	40
Port A PA3	41	"	42
Port A PA2	43	"	44
Port A PA1	45	"	46
Port A PA0	47	"	48
+5 VDC	49	Ground	50

NOTES

* This line is an I/O port and also an Interrupt Enable.

** This line is an I/O port and also a User Interrupt.

SPECIFICATIONS

Features

- 120 Channels of Digital Input/Output.
- All 120 I/O Lines Buffered on the Board.
- Four and Eight Bit Groups Independently Selectable for I/O.
- Hysteresis Correction and 1K Ω Pull-Down Resistors on I/O Lines.
- Interrupt and Interrupt-Disable Capability.
- Tristate-able outputs
- +5V Supply Available to User.
- Compatible with Industry Standard I/O Racks like Opto-22, Potter & Brumfield, etc.

Digital Inputs

- Logic High: 2.0 to 5.0 VDC.
- Logic Low: -0.5 to +0.8 VDC.
- Input Load (Hi): 20 μ A.
- Input Load (Lo): -200 μ A.

Digital Outputs

- Logic High: 2.5 VDC min., source 15 mA.
- Logic Low: 0.5 VDC max., sink 24 mA.(64 mA optional)

Power Output: +5 VDC from computer bus (ext. 1A fast blow fuse recommended).

Power Requirements: +5 VDC at 200 mA typical.

Size: 13.1" long (333 mm).

Environmental

- Operating Temperature Range: 0 degr. to 60 degr.C.
- Storage Temperature Range: -50 degr. to +120 degr.C.
- Humidity: 0 to 90% RH, non-condensing.

WARRANTY

Prior to shipment, ACCES equipment is thoroughly inspected and tested to applicable specifications. However, should equipment failure occur, ACCES assures its customers that prompt service and support will be available. All equipment originally manufactured by ACCES which is found to be defective will be repaired or replaced subject to the following considerations.

TERMS AND CONDITIONS

If a unit is suspected of failure, contact ACCES' Customer Service department. Be prepared to give the unit model number, serial number, and a description of the failure symptom(s). We may suggest some simple tests to confirm the failure. We will assign a Return Material Authorization (RMA) number which must appear on the outer label of the return package. All units/components should be properly packed for handling and returned with freight prepaid to the ACCES designated Service Center, and will be returned to the customer's/user's site freight prepaid and invoiced.

COVERAGE

First Three Years: Returned unit/part will be repaired and/or replaced at ACCES option with no charge for labor or parts not excluded by warranty. Warranty commences with equipment shipment.

Following Years: Throughout your equipment's lifetime, ACCES stands ready to provide on-site or in-plant service at reasonable rates similar to those of other manufacturers in the industry.

EQUIPMENT NOT MANUFACTURED BY ACCES

Equipment provided but not manufactured by ACCES is warranted and will be repaired according to the terms and conditions of the respective equipment manufacturer's warranty.

GENERAL

Under this Warranty, liability of ACCES is limited to replacing, repairing or issuing credit (at ACCES discretion) for any products which are proved to be defective during the warranty period. In no case is ACCES liable for consequential or special damage arriving from use or misuse of our product. The customer is responsible for all charges caused by modifications or additions to ACCES equipment not approved in writing by ACCES or, if in ACCES opinion the equipment has been subjected to abnormal use. "Abnormal use" for purposes of this warranty is defined as any use to which the equipment is exposed other than that use specified or intended as evidenced by purchase or sales representation. Other than the above, no other warranty, expressed or implied, shall apply to any and all such equipment furnished or sold by ACCES.

APPENDIX A

PPI DATA SHEETS

The data sheets in this Appendix are provided to help your understanding of the 8255-5 PPI which is manufactured by several companies. These data sheets are reprinted with permission of Mitsubishi Electric Corporation. (Copyright 1987).

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