

**1781-PXB481**  
**48-POINT DIGITAL INPUT / OUTPUT CARD**  
**USER'S MANUAL**

Rev. 2.E2a

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## INSTALLATION

### BACKING UP THE DISK

Software is provided with the 1781-PXB481. As with any software package, you should make backup copies for everyday use and place the master diskette in a safe location.

The easiest way to make a backup copy is to use the DOS DISKCOPY utility.

In a single-drive system the command is:

DISKCOPY A: A:

In a two-disk system the command is:

DISKCOPY A: B:

This will copy the contents of the master disk in drive A to the backup disk in drive B.

### HARD DISK INSTALLATION

The files contained on the master diskette may also be copied onto your hard disk. To do this perform the following:

- 1) Place the master diskette into a floppy drive.
- 2) Change the active drive to the drive that has the master diskette installed. For example, if the diskette is the A drive, type A:.
- 3) Type INSTALL and follow the screen prompts.

Files contained on the disk are stored in separate as follows:

ROOT DIRECTORY:	Contains the FINDBASE PROGRAM that will help you to decide what base address to use with the card. Also contains the 1781-PXB481 setup program.
PSAMPLES:	Contains Pascal samples and the Pascal-linkable driver.
CSAMPLES	Contains "C" samples and a "C" -linkable driver.
BSAMPLES:	Contains the BASIC and QuickBASIC samples as well as the binary and linkable drivers.
VB_WRC:	Contains a VisualBASIC sample as well as a VisualBASIC linkable driver.

### 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 PXB481ST provided on diskette 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 provided on our diskette 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
5. Select the base address on the card. See ADDRESS SELECTION
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 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 possible to the card and, while holding them close to the surface of the card, swing the strain relief bar into position and tighten nuts.
10. Inspect for proper fit of the card and cables and tighten screws.
11. Replace the computer cover.

## FUNCTIONAL DESCRIPTION

### FEATURES

- 48 Bits of Digital Input/Output
- Interrupt Generation on Input Change-of-State
- Change-of-state Interrupt Software Enables in Six 8-Input Ports
- All 48 I/O Lines Buffered on the Board
- I/O Buffers Can Be Enabled/Disabled under Program Control
- Four and Eight Bit Ports Independently Selectable for I/O
- Pull-Ups on I/O Lines
- +5V Supply Available to the User
- Compatible with Industry Standard I/O Racks from WRC,  
and other vendors like Gordos, Opto-22, Potter & Brumfield, etc.

### APPLICATIONS

- Automatic Test Systems
- Laboratory Automation
- Robotics
- Machine Control
- Security Systems, Energy Management
- Relay Monitoring and Control
- Parallel Data Transfer to PC
- Sensing Switch Closures or TTL, DTL, CMOS Logic
- Driving Indicator Lights or Recorders

A major feature of this card is that the state of all inputs can be monitored and, if any one or more bits change state, a latched interrupt request can be generated. Thus, it is not necessary to use software to continuously poll the inputs to detect a change of state. The change-of-state interrupt is enabled by a software write to an interrupt-enable register. Six bits in that register each control an eight-input port at one of two type 8255-5 Programmable Peripheral Interface chips. The change-of-state interrupt latch can be cleared by a software write.

In addition, bit C3 at each 24-bit port (pin 9 on the connectors) can also be used as an interrupt to the computer if jumpers are installed. When bit C3 goes high (edge triggering), an interrupt is requested. Interrupts from these bits are OR'ed together and OR'ed with the change-of-state interrupt. Interrupts are directed to levels #2 through #7, #10 through #12, #14 and #15 by jumper installation. If enabled via the jumper, each of these two interrupts are designed to allow one signal in each group of 24 signals to act as an interrupt without regard to the interrupt status of the other 23 signals. The functional difference to the user is that these two lines interrupt only on high-going signals.

The 1781-PXB481 card was designed for industrial applications and can be installed in 7", or longer, I/O slots of IBM PC/XT/AT or compatible computers. Each I/O line is buffered and capable of sourcing 15 mA or sinking 24mA (64 mA on request). The card contains two Programmable Peripheral Interface chips type 8255-5 (PPI) to provide computer interface to 48 I/O lines. Each PPI provides three 8-bit ports A, B, and C. Each 8-bit port can be software configured to function as either inputs or output latches. Port C can also be configured as four inputs and four output latches.

Tri-state I/O line buffers (74LS245) are configured automatically by hardware logic for input or output use according to direction assignment from a control register in the PPI. Further, if a jumper is properly placed on the card, the tri-state buffers may be enabled/disabled under program control. (See the Option Selection section to follow.)

I/O wiring connections are via 50-pin headers on the board. Two flat I/O cables connect 1781-PXB481 to mounting boards, such as WRC's 1781-A24A. Every second conductor of the flat cables is grounded to minimize the effect of crosstalk between signals. If needed for external circuits, +5 VDC 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 or cable in the event of a malfunction in those external circuits.

The 1781-PXB481 occupies sixteen bytes of I/O address space. The base address is selectable via a DIP switch anywhere within the range of 000-3FF hex. An illustrated setup program is provided on diskette with the 1781-PXB481 card. Interactive displays show locations and proper settings of DIP switches and jumpers to set up board address, interrupt levels, and interrupt enable. Also, sample programs in Turbo-C and Turbo-Pascal are presented in the Software section of this manual.

## OPTION SELECTION

Refer to the setup programs on the diskette provided with the card. Also, refer to the 1781-PXB481 BLOCK DIAGRAM SCHEMATIC on the previous pages and the OPTION SELECTION MAP on the following page when reading this Section of the manual.

External Interrupts are accepted on the I/O connector pin 9 (port C, bit 3). The Interrupt signal is positive true. These External Interrupts are enabled if the IEN jumper is installed. Interrupts are directed to levels #2 through #7, #10 through #12, #14 and #15 by jumpers installed locations labeled IRQ2 through IRQ7, IRQ10 through IRQ12, IRQ14 and IRQ15, respectively.

A means of enabling or disabling the 74LS245 input/output buffers under program control is provided at the jumper position labeled TST/BEN. When the jumper is in the BEN (Buffer Enable) position, the I/O buffers are always enabled. When the jumper is in the TST (Tristate) position, enabled/disabled state is controlled by a control register. (See the programming section of this manual for a description.)

An LED, CR1, is provided at the top-center of the card to assist you in program development. Each time an interrupt is generated, the LED will illuminate and remain on until the interrupt is reset. If there is an immediate reset of the interrupt, it is likely that the LED will not remain on long enough to be observed.

<b>NOTE</b>
-------------

A jumper must be installed either the TST or the BEN position for the card to function.
---

There is a wire jumper installed on the card at a position labeled WAIT. The associated circuitry asserts a WAIT signal to the CPU in order to provide a longer write cycle. In this way, there is assurance that the 8255 PPI will have adequate time to accept inputs from the CPU in fast AT computers. If this extra wait state will cause a problem in your application and if you deem it non-essential, then this wire jumper may be clipped.

The foregoing are the only manual setups necessary to use the 1781-PXB481. Input/Output selection and the change-of-state Interrupt Enable is done via software by writing to a control register in each PPI as described in the PROGRAMMING section of this manual.

## ADDRESS SELECTION

The 1781-PXB481 card occupies 16 bytes of I/O space. The card base address can be selected anywhere within the I/O address range 100-3F0 hex in AT's (except 1F0 to 1F8) and 200-3F0 in XT's. However two installed options cannot share the same address. If in doubt where to assign the base address, refer to the following tables and the FINDBASE program to find an available address for your system.

**TABLE 1. STANDARD ADDRESS ASSIGNMENTS FOR PC AND PC/XT COMPUTERS**

<b>Hex Range</b>	<b>Usage</b>
000-00F	DMA Chip 8237A-5
020-021	Interrupt 8259A
040-043	Timer 8253-5
060-063	PPI 8255A-5
080-083	DMA Page Register
0AX	NMI Mask Register
0CX	Reserved
0EX	Reserved
100-1FF	Not Usable
200-20F	Game Control
210-217	Expansion Slot
220-24F	Reserved
278-27F	Reserved
2F0-2F7	Reserved
2F8-2FF	Asynchronous Communication (secondary)
300-31F	Prototype Card
320-32F	Fixed Disk
378-37F	Printer
380-38C**	SDLC Communications
380-389**	Binary Synchronous Comm. (secondary)
3A0-3A9	Binary Synchronous Comm. (primary)
3B0-3BF	IBM Monochrome Display/Printer
3C0-3CF	Reserved
3D0-3DF	Color/Graphics
3E0-3E7	Reserved
3F0-3F7	Diskette
3F8-3FF	Asynchronous Communication (primary)

\*\* These options can not be used together - addresses overlap

**TABLE 2. STANDARD ADDRESS ASSIGNMENTS FOR 286/386/486 COMPUTERS**

<b>Hex Range</b>	<b>Usage</b>
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 Coprocessor
1F0-1F8	Fixed Disk
200-207	Game I/O
278-27F	Parallel Printer Port 2
2F8-2FF	Asynchronous Communication (secondary)
300-31F	Prototype Card
360-36F	Reserved
378-37F	Parallel Printer Port 1
380-38F	SDLC or Binary Synchronous Communications 2
3A0-3A9	Binary Synchronous Communications 1
3B0-3BF	IBM Monochrome Display/Printer
3C0-3CF	Local Area Network
3D0-3DF	Color/Graphics Monitor
3F0-3F7	Diskette Controller
3F8-3FF	Asynchronous Communication (primary)

To set desired board addresses, refer to the illustrated Board Address setup program on the Utility diskette provided with the card. Type the desired address in hexadecimal code and the graphic display will show you how to set the ADDRESS SETUP switches. These switches are marked A4-A9 and form a binary representation of the address in negative-type logic. (Assign '0' to all ADDRESS SETUP switches turned ON, and assign '1' to all ADDRESS SETUP switches turned OFF.)

Switch Identification	A9	A8	A7	A6	A5	A4
Address Line Controlled	A9	A8	A7	A6	A5	A4

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 3, PROGRAMMING.

<b>Hex representation</b>	<b>2+0=2 (hex)</b>		<b>8+4+0+1=13=D(hex)</b>			
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. (label)	A9	A8	A7	A6	A5	A4

**CAUTION**

Carefully review the address selection reference table on the previous page before selecting the card address. If the address of two installed functions overlap you will experience unpredictable computer behavior.

## SOFTWARE

WRC supplies three programs to support the 1781-PXB481 Digital I/O card and, also, to help you develop your applications software. These programs are on a diskette that comes with your card and are as follows:

- \*PXB481ST            This is a menu-driven, pictorial program to help you set the card address, interrupt level, change-of-state interrupt, and high level    interrupt enable.
- \*FINDBASE           Reports active and available address locations in your computer for assignment as the 1781-PXB481 base address.
- \*SAMPLE1.C         This program is under a directory titled CSAMPLES. It is a C-language software program that demonstrates how to program the change-of-state function.
- \*PXB48              This is a demonstration program which is listed under a directory titled    DEMO.
- \*VB\_WRC            This directory contains a VisualBASIC sample and a .DLL to create VisualBASIC applications with the 1781-PXB481.

### **PXB481ST**

This program is supplied with the 1781-PXB481 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 functions. The picture on the monitor then changes to show how the jumper 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 that the card be plugged into the computer for any part of the setup. The program is self-explanatory with operation instructions and on-line help.

To run this program, at the DOS prompt, enter PXB481ST followed by the [Enter].

## PROGRAMMING

The 1781-PXB481 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 APPLICATION SOFTWARE

If you wish to gain a better understanding of the programs on diskette, then the information in the following paragraphs will be of interest to you. Refer to the data sheets and 8255-5 specification in Appendix A.

A total of 16 address locations are used by the 1781-PXB481. The PPI's are addressed consecutively with Address bits A3 through A0 as follows:

**TABLE 3. ADDRESS SELECTION TABLE**

<b>Address</b>	<b>Port Assignment</b>	<b>Operation</b>
Base Address +0	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	Enable/Disable Buffer, Group 0	Write Only
Base Address +9	Enable/Disable Buffer, Group 1	Write Only
Base Address +B	Enable Chg-of-State Interrupt	Write Only
Base Address +F	Clear Chg-of-State Interrupt	Write Only

The 1781-PXB481 card uses two 8255-5 PPI's to provide a total of 48 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 only going to be used as inputs. Output buffers are automatically set by hardware according to the control register state. Note that control registers

are located at base address +3 and base address +7. Bit assignments in each of these control registers are as follows:

**TABLE 4. CONTROL REGISTER BIT ASSIGNMENT**

Bit	Assignment	Code
D0	Port C LO (C0-C3)	1 = Input, 0 = Output
D1	Port B	1 = Input, 0 = Output
D2	Mode Select	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 Select	01 = Mode 1, 00 = Mode 0, 1X = Mode 2
D7	Mode Set Flag	1 = Active

Note: Mode 1 and Mode 2 cannot be used by the 1781-PXB481 without modification (Consult factory). Thus, bits D2, D5, and D6 should always be set to “0” and bit D7 to “1”.

At Power-Up or Reset, the change-of-state interrupt-enable register is set to zero. This enables all inputs to generate change-of-state interrupts. During initialization this register should be programmed to prevent interrupt generation by ports programmed as outputs or by inputs that you do not want to cause change-of-state interrupts. In order to program the change-of-state interrupt-enable register, write to it at base address +B. Data bits D0 through D5 are used to enable inputs corresponding to ports A, B, and C of the 8255 PPI's. Writing a “one” disables the port; writing a “zero” enables it.

**TABLE 5. CHANGE-OF-STATE-INTERRUPT-ENABLE REGISTER**

Bit	Port Controlled
D0	Group 0, Port A
D1	Group 0, Port B
D2	Group 0, Port C
D3	Group 1, Port A
D4	Group 1, Port B
D5	Group 1, Port C

The change-of-state interrupt is latched. To clear this latch, write anything at location (Base Address +F).

**ENABLING/DISABLING I/O BUFFERS**

1781-PXB481 provides a means for enabling/disabling the tri-state I/O buffers under program control. If the TST/BEN jumper on the card is installed in the BEN position, the I/O buffers are permanently enabled. However, if that jumper is in the TST position, the buffers are software controlled 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, 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 allows programming of port direction at Group 0 ports A, B, and C. If, for example, hex 80 is sent to base address +3, the PPI will be configured in mode 0 with Ports A, B, and C as outputs.

c. Now, if any of the ports have been set as outputs, you may set the initial values to the respective port with the outputs still in the tri-state condition. (If all have been set as inputs, this step is not necessary).

d. If data bit D7 is low when the control byte is written, ONLY the associated buffer controller is addressed. If, for example, a control byte of hex 80 has been sent as previously described, and the data to be output are correct, and it is now desired to open the three ports, then it is necessary to send a control byte of hex 00 to base address +3 to enable the Group 0 buffers. When you do this, the buffers will be enabled.

**NOTE**

Note that all data bits except D7 must be the same for the two control bytes

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

Similarly, the Group 1 ports can be enabled/disabled via the control register at base address +7. the following program fragment in C language illustrates the foregoing:

```
const BASE_ADDRESS +3, 0x300;

outputb(BASE_ADDRESS +3, 0x89);    /*This instruction sets the mode to Mode 0, ports A and
                                   B as output, and port C as input. Since bit D7 is high, the
                                   output buffers are set to tri-state condition. See item b.
                                   above.*/

outputb(BASE_ADDRESS, 0);
outputb(BASE_ADDRESS+1, 0);        /*These instructions set the initial state of ports A and B
                                   to all zeroes. Port C is not set because it is configured as
                                   an input. See item c. above.*/

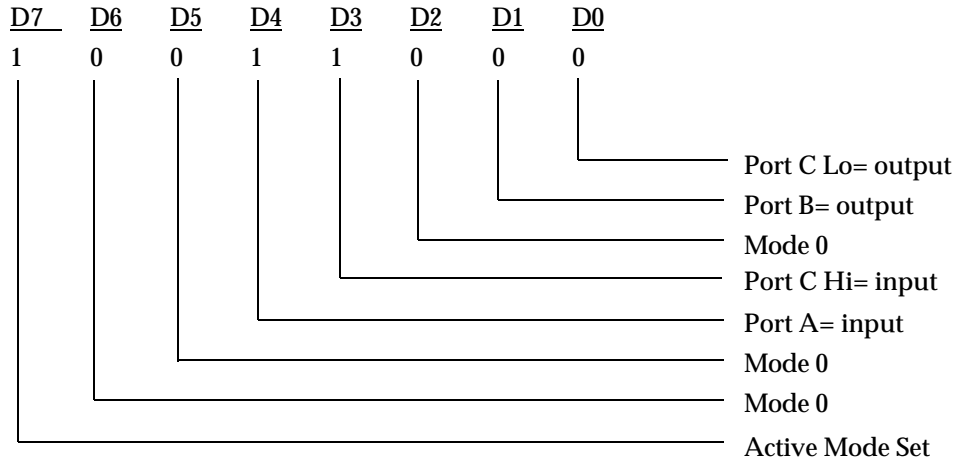
outputb(BASE_ADDRESS +3, 0x09);    /*Enable the tri-state output buffers by using the same
                                   control byte used to configure the PPI, but now set bit D7
                                   low. See item d. above.*/
```

**PROGRAMMING EXAMPLE (BASIC)**

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

Port A = Input  
 Port B = Output  
 Port C Hi = Input  
 Port C Lo = Output

The first step is to configure the control register. Configure bits of the control register as:



This corresponds to 98 hex. If the card address is 2DO hex, use the BASIC OUT command to write to the control register as follows:

```
10  BASEADDR=&H2DO
20  OUT BASEADDR+3, &H98
```

To read the inputs at Port A and the upper nibble of Port C:

```
30  X=INP(BASEADDR)           'Read Port A
40  Y=INP(BASEADDR+2)/16      'Read Port C Hi
```

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

```
50  OUT BASEADDR+1, &HFF      'Turn on all Port B Bits
60  OUT BASEADDR +2, &HF      'Turn on all bits of Port C lower nibble
```

## CONNECTOR PIN ASSIGNMENTS

Two 50-pin headers are provided on the 1781-PXB481; one for each 24 I/O group. The mating connector is an AMP type 1-499776-0 or equivalent. Connector pin assignments are listed below. Notice that every second line is grounded to minimize crosstalk between signals.

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

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

## SPECIFICATION

### Features

48 Bits of Digital Input/Output.  
Interrupt Generation on Input Change-of-State.  
Change-of-State Interrupt Software Enabled in Six 8-Input Ports.  
All 48 I/O Lines Buffered on the Board.  
I/O Buffers Can Be Enabled/Disabled under Program Control.  
Four and Eight Bit Ports Independently Selectable for I/O.  
10k $\Omega$  Pull-Ups on I/O Lines.  
+5V Supply Available to the User.  
Compatible with Industry Standard I/O Racks like Gordos, Opto-22, Potter & Brumfield, etc.

### Digital Inputs (TTL Compatible)

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

+5 VDC at 200 mA typical.

### Size:

7.15" Long.

### Environmental:

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

## ADDENDIX A

### WHEN YOU WISH TO USE THIS CARD WITH VISUALBASIC

WRC provides extensions to the VisualBASIC language on the diskette provided with your card. The extensions are in a directory named VB\_WRC. These extensions are in the form of a .DLL, a .GBL, a .BAS, and a .LIB file. Together these files allow you to access the port memory space in a fashion similar to BASIC, QuickBASIC, Pascal, C, C\*\*, Assembly, and most other standard languages.

To use these files in a VisualBASIC program, you must create a .MAK file (File 1 New Project) similar to the sample provided (or else, modify your existing project file to include the .GBL file). Once this has been done, VisualBASIC will be enhanced with the addition of four functions. Those functions and their calling method are listed below.

#### **InPortb**

Function: Reads a byte from a hardware port. Due to limitations of VisualBASIC, the number is returned in an integer.

Declaration: function InPortb (byval address as integer) as integer

#### **InPort**

Function: Reads an integer from a hardware port. This function returns the 16-bit value obtained from reading the low byte from address and the high byte from address+1.

Declaration: function InPort (byval address as integer) as integer

#### **OutPortb**

Function: Writes the lower eight bits of value to the hardware port at address. This function returns the value output.

Declaration: function OutPortb (byval address as integer, byval value as integer) as integer

#### **OutPort**

Function: Writes all 16 bits of value to the hardware port at address. This function returns the value output.

Declaration: function Outport (byval address as integer, byval value as integer) as integer

#### **Peek**

Function: Reads a byte from main memory (DRAM)..

Declaration: function Peek(byval segment as integer, byval offset as integer) as integer.

**Poke**

Function: Writes the lower eight bits of *value* to *segment: offset*.

Declaration: function Poke(byval segment as integer, byval offset as integer) as integer

Note that in all of the above functions, an inherent limitation of BASIC in general and VisualBASIC in particular makes the values sent less intuitive. All integers in BASIC are signed numbers, wherein data are stored in two's complement form. All bit patterns must be converted to-and-from this two's complement form if meaningful display is required. Otherwise, values returned from the InPortb function will be -128 to 127, rather than 0 to 255.

Before the program will execute, the .GBL file must be modified to include the path to the VB\_WRC.DLL as appropriate for your system. Merely replace the statement "VB\_WRC.DLL" with "drive:path\VB\_WRC.DLL.

An alternative to changing the source code, you can copy the VB\_WRC.DLL file into your Windows directory. This will allow multiple programs to find the same .DLL without having to know where it is located. Just leave off all references to a port in the .GBL file as shown in the sample.

## **APPENDIX B**

### **PROGRAMMABLE PERIPHERAL INTERFACE DATA SHEETS**

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

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