OPERATIONS MANUAL
PCM-UIO48A

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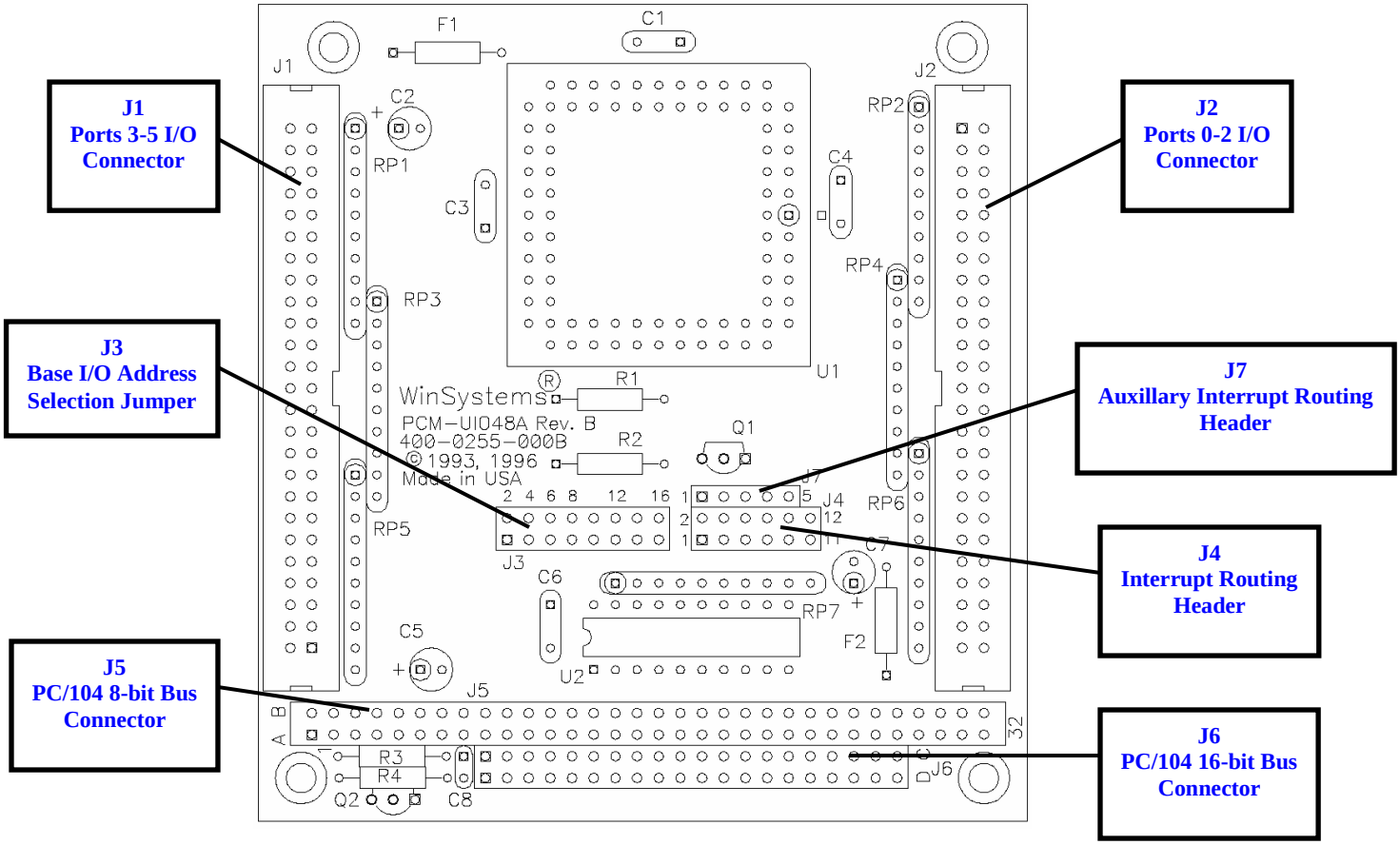
Warranty and Repair Information

Visual Index – Quick Reference

For the convenience of the user, a copy of the Visual Index has been provided with direct links to connector and jumper configuration data.



1 GENERAL INFORMATION

1.1 FEATURES

- 48 Digital I/O Lines
- PC/104 8-bit interface
- Each line can serve as an input or an output
- Readback capability on all output lines
- Programmable polarity event sense on 24 lines
- Compatible with standard I/O racks
- +5 Volt only operation
- Extended temperature range -40°C to +85°C

1.2 GENERAL DESCRIPTION

The PCM-UIO48A is a highly versatile PC/104 input/output module providing 48 lines of digital I/O. It is unique in its ability to monitor 24 lines for both rising and falling digital edge transitions, latch them, and then issue an interrupt to the host processor. The application interrupt service routine can quickly determine, through a series of interrupt identification registers, the exact port(s) and bit(s) which have transitioned. The PCM-UIO48A utilizes the WinSystems' WS16C48 ASIC High Density I/O Chip (HDIO). The first 24 lines are capable of fully latched event sensing with the sense polarity being software programmable. Two 50-pin I/O connectors allow for easy mating with industry standard I/O racks.

1.3 SPECIFICATIONS

1.3.1 Electrical

Bus Interface : PC/104 8-Bit (Optional -16 model allows access to IRQ8 through IRQ15)

VCC : +5V +/-5% @ 12mA typical with no I/O connections.

I/O Addressing : 12-bit user jumperable base address. Each board uses 16 consecutive addresses.

1.3.2 Mechanical

Dimensions : 3.8" X 3.6" X 0.5"

PC Board : FR-4 Epoxy glass with 2 signal layers, 2 power planes, screened component legend, and plated through holes.

Jumpers : 0.025" square posts on 0.10" centers

Connectors : 50 Pin 0.10" grid RN type IDH-50-LP

1.3.3 Environmental

Operating Temperature: -40°C to +85° C

Non Condensing Humidity : 5% to 95%

2 PCM-UIO48A TECHNICAL REFERENCE

2.1 Introduction

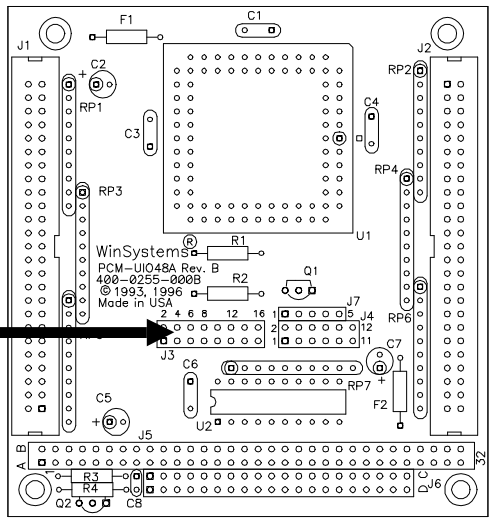
This section of the manual is intended to provide the necessary information regarding configuration, and usage of the PCM-UIO48A. WinSystems maintains a Technical Support Group to help answer questions regarding configuration, usage, or programming of the board. For answers to questions not adequately addressed in this manual, contact Technical Support at (817) 274-7553 between 8AM and 5PM Central Time.

2.2 I/O Address Selection

I/O Address Select Jumper J3

J3

2	4	6	8	10	12	14	16
o	o	o	o	o	o	o	o
o	o	o	o	o	o	o	o
1	3	5	7	9	11	13	15



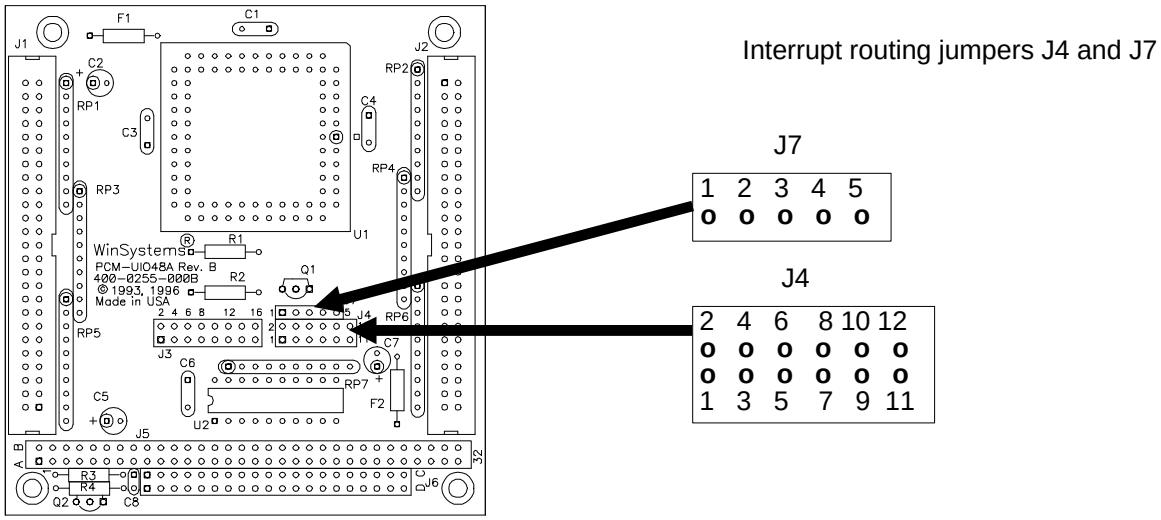
The PCM-UIO48A requires 16 consecutive I/O addresses beginning on a 16 byte boundary. The jumper block at J3 allows for user selection of the base address. Address selection is made by placing a jumper on the jumper pair for the address bit if a '0' is desired or leaving the address bit open if a '1' is required for the desired address. The illustration below shows the relationship between the address bit and the jumper positions and a sample jumpering for a base address of 200H.

I/O Base Address Select Jumper
J3 shown jumpered for 200H

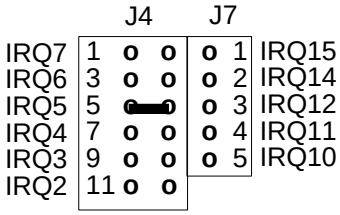
J3

1 ●—●	2	A11
3 ●—●	4	A10
5 o o	6	A9
7 ●—●	8	A8
9 ●—●	10	A7
11 ●—●	12	A6
13 ●—●	14	A5
15 ●—●	16	A4

2.3 Interrupt Routing Selection



When desired the PCM-UIO48A can generate an interrupt on up to 24 different lines each with its own polarity select. This interrupt can be routed to the PC/104 bus via the jumper at J4. 16-bit versions of the board will also have the auxillary jumper at J7 installed. The interrupt routing header is shown here along with sample jumpering for IRQ5.



2.4 I/O Connector Pinout

The PCM-UIO48A routes its 48 lines to 50-pin IDC connectors at J1 and J2. The pin definitions for J1 and J2 are shown here :

J2

P2-7	1	2	GND
P2-6	3	4	GND
P2-5	5	6	GND
P2-4	7	8	GND
P2-3	9	10	GND
P2-2	11	12	GND
P2-1	13	14	GND
P2-0	15	16	GND
P1-7	17	18	GND
P1-6	19	20	GND
P1-5	21	22	GND
P1-4	23	24	GND
P1-3	25	26	GND
P1-2	27	28	GND
P1-1	29	30	GND
P1-0	31	32	GND
P0-7	33	34	GND
P0-6	35	36	GND
P0-5	37	38	GND
P0-4	39	40	GND
P0-3	41	42	GND
P0-2	43	44	GND
P0-1	45	46	GND
P0-0	47	48	GND
+5V	49	50	GND

J1

P5-7	1	2	GND
P5-6	3	4	GND
P5-5	5	6	GND
P5-4	7	8	GND
P5-3	9	10	GND
P5-2	11	12	GND
P5-1	13	14	GND
P5-0	15	16	GND
P4-7	17	18	GND
P4-6	19	20	GND
P4-5	21	22	GND
P4-4	23	24	GND
P4-3	25	26	GND
P4-2	27	28	GND
P4-1	29	30	GND
P4-0	31	32	GND
P3-7	33	34	GND
P3-6	35	36	GND
P3-5	37	38	GND
P3-4	39	40	GND
P3-3	41	42	GND
P3-2	43	44	GND
P3-1	45	46	GND
P3-0	47	48	GND
+5V	49	50	GND

NOTE : Pin 49 on each connector can supply +5V to the I/O rack. The supply on each connector is protected from excessive current by a 1A miniature fuse F1 for J1 and F2 for J2.

2.5 PC/104 Bus Interface

The PCM-UIO48A connects to the processor through the PC/104 bus connector at J5. The 16-bit versions of the board will also have the J6 connector installed. The pin definitions for the J5 and J6 connectors are shown here for reference :

J5

GND	B1	o o	A1	IOCHK
RESET	B2	o o	A2	BD7
+5V	B3	o o	A3	BD6
IRQ9	B4	o o	A4	BD5
-5V	B5	o o	A5	BD4
DRQ2	B6	o o	A6	BD3
-12V	B7	o o	A7	BD2
0WS	B8	o o	A8	BD1
+12V	B9	o o	A9	BD0
GND	B10	o o	A10	IOCHRDY
MEMW	B11	o o	A11	AEN
MEMR	B12	o o	A12	SA19
IOW	B13	o o	A13	SA18
IOR	B14	o o	A14	SA17
DACK3	B15	o o	A15	SA16
DRQ3	B16	o o	A16	SA15
DACK1	B17	o o	A17	SA14
DRQ1	B18	o o	A18	SA13
REFRESH	B19	o o	A19	SA12
SYSCLK	B20	o o	A20	SA11
IRQ7	B21	o o	A21	SA10
IRQ6	B22	o o	A22	SA9
IRQ5	B23	o o	A23	SA8
IRQ4	B24	o o	A24	SA7
IRQ3	B25	o o	A25	SA6
DACK2	B26	o o	A26	SA5
TC	B27	o o	A27	SA4
BALE	B28	o o	A28	SA3
+5V	B29	o o	A29	SA2
OSC	B30	o o	A30	SA1
GND	B31	o o	A31	SA0
GND	B32	o o	A32	GND

J6

GND	C0	o o	D0	GND
SBHE	C1	o o	D1	MEMCS16
LA23	C2	o o	D2	IOCS16
LA22	C3	o o	D3	IRQ10
LA21	C4	o o	D4	IRQ11
LA20	C5	o o	D5	IRQ12
LA19	C6	o o	D6	IRQ15
LA18	C7	o o	D7	IRQ14
LA17	C8	o o	D8	DACK0
MEMR	C9	o o	D9	DRQ0
MEMW	C10	o o	D10	DACK5
SD8	C11	o o	D11	DRQ5
SD9	C12	o o	D12	DACK6
SD10	C13	o o	D13	DRQ6
SD11	C14	o o	D14	DACK7
SD12	C15	o o	D15	DRQ7
SD13	C16	o o	D16	VCC
SD14	C17	o o	D17	MASTER
SD15	C18	o o	D18	GND
KEY	C19	o o	D19	GND

2.6 WS16C48 Register Definitions

The PCM-UIO48A uses the WinSystems' exclusive ASIC device, the WS16C48. This device provides 48 lines of digital I/O. There are 17 unique registers within the WS16C48. The following table summarizes the registers and the text that follows provides details on each of the internal registers.

I/O Address Offset	Page 0	Page 1	Page 2	Page 3
00H	Port 0 I/O	Port 0 I/O	Port 0 I/O	Port 0 I/O
01H	Port 1 I/O	Port 1 I/O	Port 1 I/O	Port 1 I/O
02H	Port 2 I/O	Port 2 I/O	Port 2 I/O	Port 2 I/O
03H	Port 3 I/O	Port 3 I/O	Port 3 I/O	Port 3 I/O
04H	Port 4 I/O	Port 4 I/O	Port 4 I/O	Port 4 I/O
05H	Port 5 I/O	Port 5 I/O	Port 5 I/O	Port 5 I/O
06H	INT_PENDING	INT_PENDING	INT_PENDING	INT_PENDING
07H	Page/Lock	Page/Lock	Page/Lock	Page/Lock
08H	N/A	POL_0	ENAB_0	INT_ID0
09H	N/A	POL_1	ENAB_1	INT_ID1
0AH	N/A	POL_2	ENAB_2	INT_ID2

Register Details

Port 0-5 I/O - Each I/O bit in each of these 6 ports can be individually programmed for input or output. Writing a '0' to a bit position causes the corresponding output pin to go to a High- Impedance state (pulled high by external 10K ohm resistors). This allows it to be used as an input. When used in the input mode, a read reflects the inverted state of the I/O pin, such that a high on the pin will read as a '0' in the register. Writing a '1' to a bit position causes the output pin to sink current (up to 12mA), effectively pulling it low.

INT_PENDING - This read only register reflects the combined state of the INT_ID0 through INT_ID2 registers. When any of the lower 3 bits are set, it indicates that an interrupt is pending on the I/O port corresponding to the bit position(s) that are set. Reading this register allows an Interrupt Service Routine to quickly determine if any interrupts are pending and which I/O port has an interrupt pending.

PAGE/LOCK - This register serves two purposes. The upper two bits select the register page in use as shown here :

D7	D6	Page
0	0	Page 0
0	1	Page 1
1	0	Page 2
1	1	Page 3

Bits 5-0 allow for locking of the I/O ports. A '1' written to the I/O port position will prohibit further writes to the corresponding I/O port.

POL0 - POL3 - These registers are accessible when page 1 is selected. They allow interrupt polarity selection on a port-by-port and bit-by-bit basis. Writing a '1' to a bit position selects rising edge detection interrupts while writing a '0' to a bit position selects falling edge detection interrupts.

ENAB0 - ENAB3 - These registers are accessible when page 2 is selected. They allow for port-by-port and bit-by-bit enabling of the edge detection interrupts. When set to a '1' the edge detection interrupt is enabled for the corresponding port and bit. When cleared to a '0' the bit's edge detection interrupt is disabled. Note that this register can be used to individually clear a pending interrupt by disabling and reenabling the pending interrupt.

INT_ID0 - INT_ID2 - These registers are accessible when page 3 is selected. They are used to identify currently pending edge interrupts. A bit when read as a '1' indicates that an edge of the polarity programmed into the corresponding polarity register has been recognized. Note that a write to this register (value ignored) clears ALL of the pending interrupts in this register.

2.7 Connector/Jumper Summary

Connector/ Jumper	Purpose	Page Reference
J1	Ports 3-5 I/O connector	2-3
J2	Ports 0-2 I/O connector	2-3
J3	Base I/O Address select jumper	2-1
J4	Interrupt routing header	2-2
J5	PC/104-8 bus connector	2-4
J6	PC/104-16 bus connector	2-4
J7	Auxillary interrupt routing header	2-2

3 PCM-UIO48A Programming Reference

3.1 Introduction

This section provides basic documentation for the included I/O routines. It is intended that the accompanying source code equip the programmer with a basic library of I/O functions for the PCM-UIO48A or can serve as the basis from which application-specific code can be derived.

The sample I/O routines and sample programs were compiled and tested using the Borland C/C++ compiler Version 3.1. The routines should readily port to any compiler supporting basic port I/O instructions.

3.2 Function Definitions

This section briefly describes each of the functions contained in the driver. Where necessary, short examples will be provided to illustrate usage. Any application making use of any of the driver functions should include the header file “uio48.h”, which includes the function prototypes and the needed constant definitions.

Note that all of the functions utilize the concept of a “bit_number”. The “bit_number” is a value from 1 to 48 (1 to 24 for interrupt related functions) that correlates to a specific I/O pin. Bit_number 1 is port 0 bit 0, and continues though to bit_number 48 at port 5 bit 7.

INIT_IO - Initialize I/O, set all ports to input

Syntax

```
void init_io(unsigned io_address);
```

Description

This function takes a single argument :

io_address - the I/O address of the WS16C48 chip.

There is no return value. This function initializes all I/O pins for input (sets them high), disables all interrupt sensing, and sets the image values.

READ_BIT - Reads an I/O port Bit

Syntax

int read_bit(int bit_number);

Description

This function takes a single argument :

bit_number - This is a value from 1 to 48 that indicates the I/O pin to read from.

This function returns the state of the I/O pin. A '1' is returned if the I/O pin is low and a '0' is returned if the pin is high.

WRITE_BIT - Write a 1 or 0 to an I/O pin

Syntax

void write_bit(int bit_number, int value);

Description

This function takes two arguments

bit_number - This is a value from 1 to 48, which is the bit to be acted upon.

value - is either 1 or 0.

This function allows for the writing of a single bit to either a '0' or a '1' as specified by the second argument. There is no return value and other bits in the I/O port are not affected.

SET_BIT - Set the specified I/O Bit

Syntax

void set_bit(int bit_number);

Description

This function takes a single argument :

bit_number - a value between 1 and 48 specifying the port bit to set.

This function sets the specified I/O port bit. Note that setting a bit results in the I/O pin actually going low. There is no return value and other bits in the same I/O port are unaffected.

CLR_BIT - Clear the specified I/O Bit

Syntax

void clr_bit(int bit_number);

Description

This function takes a single argument :

bit_number - This value from 1 to 48 indicates the bit number to clear.

This function clears the specified I/O bit. Note that clearing the I/O bit results in the actual I/O pin going high. This function does not affect any bits other than the one specified.

ENAB_INT - Enable Edge Interrupt, select polarity

Syntax

void enab_int(int bit_number, int polarity);

Description

This function requires two arguments

bit_number - A value from 1 to 24 specifying the appropriate bit.

polarity - Specifies rising or falling edge polarity detect. The constants RISING and FALLING are defined in “uio48.h”

This function enables the edge detection circuitry for the specified bit at the specified polarity. It does not unmask the interrupt controller, install vectors, or handle interrupts when they occur. There is no return value and only the specified bit is affected.

DISAB_INT - Disable Edge Detect Interrupt Detection

Syntax

void disab_int(int bit_number);

Description

This function requires a single argument “

bit_number - A value from 1 to 24 specifying the appropriate bit.

This function shuts down the edge detection interrupts for the specified bit. There is no return value and no harm is done by calling this function for a bit which did not have edge detection interrupts enabled. There is no affect on any other bits.

CLR_INT - Clear the specified pending interrupt

Syntax

void clr_int(bit_number);

Description

This function requires a single argument :

bit_number - The specified the bit number from 1 to 24 to reset the interrupt.

This function clears a pending interrupt on the specified bit. It does this by disabling and re-enabling the interrupt. The net result after the call is that the interrupt is no longer pending and is rearmed for the next transition of the same polarity. Calling this function on a bit that has not been enabled for interrupts will result in its interrupt being enabled with an undefined polarity. Calling this function with no interrupt currently pending will have no adverse affect. Only the specified bit is affected.

GET_INT - Retrieve bit number of pending interrupt

Syntax

int get_int(void);

Description

This function requires no arguments and returns either a '0' for no bit interrupts pending or a value between 1 and 24 representing a bit number that has a pending edge detect interrupt. The routine returns with the first interrupt found and begins its search at port 0 bit 0 proceeding through to port 2 bit 7. It is necessary to use either clr_int() or disab_int() to avoid returning the same bit number continuously.

This function may either be used in an application's ISR or can be used in the foreground to poll for bit transitions.

3.3 SAMPLE PROGRAMS

There are three sample programs in source code form included on the PCM-UIO48A diskette. These programs are not useful by themselves but are provided to illustrate the usage of the I/O functions provided in UIO48.C.

FLASH.C

This program was compiled with Borland C/C++ version 3.1 on the command line with :

```
bcc flash.c uio48.c
```

This program illustrates the most basic usage of the PCM-UIO48A board. It uses three functions from the driver code. The init_io() function is used to initialize the I/O functions and the set_bit() and clr_bit() functions are used to sequence through all 48 bits turning each on and then off in turn.

POLL.C

This program was compiled with Borland C/C++ version 3.1 on the command line with :

```
bcc poll.c uio48.c
```

This program illustrates additional features of the WS16C48 and the I/O library functions. It programs the first 24 bits for input, arms them for falling edge detection and then polls the I/O routine get_int() to determine if any transitions have taken place.

INT.C

This program was compiled and with Borland C/C++ version 3.1 on the command line with :

```
bcc int.c uio48.c
```

This program is identical in function to the “poll.c” program except that interrupts are active and all updating of the transition counters is accomplished in the background during the interrupt service routine.

Summary

The source code for all three sample programs as well as the I/O routines are included on the accompanying diskette. The source code is also provided in printed form in Appendix C. These I/O routines along with the sample programs should provide a good basis on which to build an application utilizing the features of the PCM-UIO48A.

4 APPENDIX A

I/O Routine & Sample Program Source Listings

```
/* UIO48.H

        Copyright 1996 by WinSystems Inc.

        Permission is hereby granted to the purchaser of the WinSystems
        UIO cards and CPU products incorporating the UIO device, to distribute
        any binary file or files compiled using this source code directly or
        in any work derived by the user from this file. In no case may the
        source code, original or derived from this file, be distributed to any
        third party except by explicit permission of WinSystems. This file is
        distributed on an "As-is" basis and no warranty as to performance,
        fitness of purposes, or any other warranty is expressed or implied.
        In no case shall WinSystems be liable for any direct or indirect loss
        or damage, real or consequential resulting from the usage of this
        source code. It is the user's sole responsibility to determine
        fitness for any considered purpose.
*/
/*************************************************************************
*       Name     : uio48.h
*
*       Project  : PCM-UIO48 Software Samples/Examples
*
*       Date     : October 30, 1996
*
*       Revision: 1.00
*
*       Author   : Steve Mottin
*
*************************************************************************
*
*       Changes :
*
*       Date              Revision Description
*       ________ ________ ___________________________________________
*       10/30/96 1.00              Created
*
*************************************************************************
*/

#define RISING 1
#define FALLING 0

void init_io(unsigned io_address);
int read_bit(int bit_number);
void write_bit(int bit_number);
void set_bit(int bit_number);
void clr_bit(int bit_number);
void enab_int(int bit_number, int polarity);
void disab_int(int bit_number);
void clr_int(int bit_number);
int get_int(void);
```

```
/* UIO48.C

        Copyright 1996 by WinSystems Inc.

        Permission is hereby granted to the purchaser of the WinSystems
        UIO cards and CPU products incorporating the UIO device, to distribute
        any binary file or files compiled using this source code directly or
        in any work derived by the user from this file. In no case may the
        source code, original or derived from this file, be distributed to any
        third party except by explicit permission of WinSystems. This file is
        distributed on an "As-is" basis and no warranty as to performance,
        fitness of purposes, or any other warranty is expressed or implied.
        In no case shall WinSystems be liable for any direct or indirect loss
        or damage, real or consequential resulting from the usage of this
        source code. It is the user's sole responsibility to determine
        fitness for any considered purpose.
*/
/*************************************************************************
*       Name     : uio48.c
*
*       Project  : PCM-UIO48 Software Samples/Examples
*
*       Date     : October 30, 1996
*
*       Revision: 1.00
*
*       Author   : Steve Mottin
*
*************************************************************************
*
*       Changes :
*
*       Date              Revision Description
*       ________ ________ ___________________________________________
*       10/30/96 1.00              Created
*
*************************************************************************
*/

#include <dos.h>

/* This global holds the base address of the UIO chip */

unsigned base_port;

/* This global array holds the image values of the last write to each I/O
   ports. This allows bit manipulation routines to work without having to
   actually do a read-modify-write to the I/O port.
*/

unsigned port_images[6];

/*=======================================================================
*                               INIT_IO
*
*  This function take a single argument :
*
*
*  io_address  :    This is the base I/O address of the 16C48 UIO Chip
*                                          on the board.
*
*
*  This function initializes all I/O pins for input, disables all interrupt
*  sensing, and sets the image values.
*
*=======================================================================*/

void init_io(unsigned io_address)
{
int x;

        /* Save the specified address for later use */

        base_port = io_address;

        /* Clear all of the I/O ports. This also makes them inputs */

        for(x=0; x < 7; x++)
                outportb(base_port+x, 0);

        /* Clear our image values as well */

        for(x=0; x < 6; x++)
                port_images[x] = 0;

        /* Set page 2 access, for interrupt enables */

        outportb(base_port+7,0x80);

        /* Clear all interrupt enables */

        outportb(base_port+8,0);
        outportb(base_port+9,0);
        outportb(base_port+0x0a,0);

        /* Restore normal page 0 register access */
        outportb(base_port+7,0);
```

```
}

/*=========================================================================
*
*                                READ_BIT
*
*
*  This function takes a single argument :
*
*
*  bit_number    :  The integer argument specifies the bit number to read.
*                   Valid arguments are from 1 to 48.
*
*  return value : The current state of the specified bit, 1 or 0.
*
*  This function returns the state of the current I/O pin specified by
*  the argument bit_number.
*
*=========================================================================*/

int read_bit(int bit_number)
{
unsigned port;
int val;

         /* Adjust the bit_number to 0 to 47 numbering */

         --bit_number;

         /* Calculate the I/O port address based on the updated bit_number */

         port = (bit_number / 8) + base_port;

         /* Get the current contents of the port */

         val = inportb(port);

         /* Get just the bit we specified */

         val = val & (1 << (bit_number % 8));

         /* Adjust the return for a 0 or 1 value */

         if(val)
                  return 1;

         return 0;
}

/*=========================================================================
*
*                                WRITE_BIT
*
* This function takes two arguments :
*
*
*  bit_number :  The I/O pin to access is specified by bit_number 1 to 48.
*
*  val  :   The setting for the specified bit, either 1 or 0.
*
*  This function sets the specified I/O pin to either high or low as dictated
*  by the val argument. A non zero value for val sets the bit.
*
*=========================================================================*/

void write_bit(int bit_number, int val)
{
unsigned port;
unsigned temp;
unsigned mask;


         /* Adjust bit_number for 0 based numbering */

         --bit_number;

         /* Calculate the I/O address of the port based on the bit number */

         port = (bit_number / 8) + base_port;

         /* Use the image value to avoid having to read the port first. */

         temp = port_images[bit_number / 8];/* Get current value */

         /* Calculate a bit mask for the specified bit */

         mask = (1 << (bit_number % 8));

         /* Check whether the request was to set or clear and mask accordingly */

         if(val)           /* If the bit is to be set */
                  temp = temp | mask;
         else
                  temp = temp & ~mask;

         /* Update the image value with the value we're about to write */

         port_images[bit_number / 8] = temp;
```

```
        /* Now actually update the port. Only the specified bit is affected */

        outportb(port,temp);
}

/*=========================================================================
*                                SET_BIT
*
*
*  This function takes a single argument :
*
*  bit_number :  The bit number to set.
*
*  This function sets the specified bit.
*
*=========================================================================*/

void set_bit(int bit_number)
{

        write_bit(bit_number,1);
}

/*=========================================================================
*                                CLR_BIT
*
*
*  This function takes a single argument :
*
*  bit_number :  The bit number to clear.
*
*  This function clears the specified bit.
*
*=========================================================================*/

void clr_bit(int bit_number)
{
        write_bit(bit_number,0);
}

/*=========================================================================
*
*                              ENAB_INT
*
*  This function takes two arguments :
*
*  bit_number  : The bit number to enable intterups for. Range from 1 to 48.
*
*  polarity   : This specifies the polarity of the interrupt. A non-zero
*               argument enables rising-edge interrupt. A zero argument
*               enables the interrupt on the flling edge.
*
*  This function enables within the 16C48 an interrupt for the specified bit
*  at the specified polarity. This function does not setup the interrupt
*  controller, nor does it supply an interrupr handler.
*
*=========================================================================*/

void enab_int(int bit_number, int polarity)
{
unsigned port;
unsigned temp;
unsigned mask;

        /* Adjust for 0 based numbering */

        --bit_number;

        /* Calculate the I/O address based uppon the bit number */

        port = (bit_number / 8) + base_port + 8;

        /* Calculate a bit mask based on the specified bit number */

        mask = (1 << (bit_number % 8));

        /* Turn on page 2 access */

        outportb(base_port+7,0x80);

        /* Get the current state of the interrupt enable register */

        temp = inportb(port);

        /* Set the enable bit for our bit number */

        temp = temp | mask;

        /* Now update the interrupt enable register */

        outportb(port,temp);

        /* Turn on access to page 1 for polarity control */

        outportb(base_port+7,0x40);

        /* Get the current state of the polarity register */
```

```
        temp = inportb(port);              /* Get current polarity settings */

        /* Set the polarity according to the argument in the image value */

        if(polarity)              /* If the bit is to be set */
                temp = temp | mask;
        else
                temp = temp & ~mask;

        /* Write out the new polarity value */

        outportb(port,temp);

        /* Set access back to Page 0 */

        outportb(base_port+7,0x0);

}

/*=========================================================================
*
*                               DISAB_INT
*
* This function takes a single argument :
*
* bit_number : Specifies the bit number to act upon. Range is from 1 to 48.
*
* This function shuts off the interrupt enabled for the specified bit.
*
*=========================================================================*/

void disab_int(int bit_number)
{
unsigned port;
unsigned temp;
unsigned mask;

        /* Adjust the bit_number for 0 based numbering */

        --bit_number;

        /* Calculate the I/O Address for the enable port */

        port = (bit_number / 8) + base_port + 8;

        /* Calculate the proper bit mask for this bit number */

        mask = (1 << (bit_number % 8));

        /* Turn on access to page 2 registers */

        outportb(base_port+7,0x80);

        /* Get the current state of the enable register */

        temp = inportb(port);

        /* Clear the enable bit int the image for our bit number */

        temp = temp & ~mask;

        /* Update the enable register with the new information */

        outportb(port,temp);

        /* Set access back to page 0 */

        outportb(base_port+7,0x0);

}

/*=========================================================================
*
*                               CLR_INT
*
*  This function takes a single argument :
*
*  bit_number : This argument specifies the bit interrupt to clear. Range
*               is 1 to 24.
*
*
*  This function is use to clear a bit interrupt once it has been recognized.
*  The interrupt left enabled.
*
*=========================================================================*/

void clr_int(int bit_number)
{
unsigned port;
unsigned temp;
unsigned mask;


        /* Adjust for 0 based numbering */

        --bit_number;
```

```
        /* Calculate the correct I/O address for our enable register */

        port = (bit_number / 8) + base_port + 8;

        /* Calculate a bit mask for this bit number */

        mask = (1 << (bit_number % 8));

        /* Set access to page 2 for the enable register */

        outportb(base_port+7,0x80);

        /* Get current state of the enable register */

        temp = inportb(port);

        /* Temporarily clear only OUR enable. This clears the interrupt */

        temp = temp & ~mask;              /* clear the enable for this bit */

        /* Write out the temporary value */

        outportb(port,temp);

        /* Re-enable our interrupt bit */

        temp = temp | mask;

        /* Write it out */

        outportb(port,temp);

        /* Set access back to page 0 */

        outportb(base_port+7,0x0);

}


/*=========================================================================
*
*                               GET_INT
*
*  This function take no arguments.
*
*  return value : The value returned is the highest level bit interrupt
*                 currently pending. Range is 1 to 24.
*
*  This function returns the highest level interrupt pending. If no interrupt
*  is pending, a zero is returned. This function does NOT clear the interrupt.
*
*=========================================================================*/

int get_int(void)
{
int temp;
int x;

        /* read the master interrupt pending register, mask off undefined bits */

        temp = inportb(base_port+6) & 0x07;

        /* If there are no interrupts pending, return a 0 */

        if((temp & 7) == 0)
                return(0);

        /* There is something pending, now we need to identify what it is */


        /* Set access to page 3 for interrupt id registers */

        outportb(base_port+7,0xc0);

        /* Read interrupt ID register for port 0 */

        temp = inportb(base_port+8);


        /* See if any bit set, if so return the bit number */

        if(temp !=0)
        {
                for(x=0; x <=7; x++)
                {
                        if(temp & (1 << x))
                        {
                                outportb(base_port+7,0);  /* Turn off access */
                                return(x+1);              /* Return bitnumber with active int */
                        }
                }
        }

        /* None in Port 0, read port 1 interrupt ID register */

        temp = inportb(base_port+9);

        /* See if any bit set, if so return the bit number */
```

```
        if(temp !=0)
        {
                for(x=0; x <=7; x++)
                {
                        if(temp & (1 << x))
                        {
                                outportb(base_port+7,0);  /* Turn off access */
                                return(x+9);              /* Return bitnumber with active int */
                        }
                }
        }

        /* Lastly, read status of port 2 int id */

        temp = inportb(base_port+0x0a);       /* Read port 2 status */

        /* If any pending, return the appropriate bit number */

        if(temp !=0)
        {
                for(x=0; x <=7; x++)
                {
                        if(temp & (1 << x))
                        {
                                outportb(base_port+7,0);  /* Turn off access */
                                return(x+17);             /* Return bitnumber with active int */
                        }
                }
        }

        /* We should never get here unless the hardware is misbehaving but just
            to be sure. We'll turn the page access back to 0 and return a 0 for
            no interrupt found.
        */


        outportb(base_port+7,0);
        return 0;
}
```

```
/* FLASH.C

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        fitness for any considered purpose.
*/

#include <stdio.h>
#include <conio.h>
#include <dos.h>
#include "uio48.h"

/* This is where we have our board jumpered to */

#define BASE_PORT 0x200


/* This is an utlra-simple demonstration program of some of the functions
   available in the UIO48 source code library. This program simply sets and
   clears each I/O line in succession. It was tested by hooking LEDs to all
   of the I/O lines and wathching the lit one race through the bits.
*/

void main()
{
int x;


        /* Initialize all I/O bits, and set then for input */

        init_io(BASE_PORT);

        /* We'll repeat our sequencing until a key is pressed */

        while(!kbhit())
        {
                /* We will light the LED attached to each of the 48 lines */
                for(x=1; x <=48; x++)
                {
                        /* Setting the bit lights the LED */
                        set_bit(x);
                        /* The wait time is subjective. We liked 100mS */
                        delay(100);
                        /* Now turn off the LED */
                        clr_bit(x);
                }
        }
        getch();
}
```

```
/* POLL.C

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*/

#include <stdio.h>
#include <conio.h>
#include "uio48.h"


#define BASE_PORT 0x200

/* This program uses the edge detection interrupt capability of the
   WS16C48 to count transitions on the first 24 lines. It does this
   however, no by using true interrupts but by polling for transitions
   using the get_int() function.

*/


/* Our transition totals are stored in this array */


unsigned int_counts[25];

/* Definitions for local functions */

void check_ints(void);

void main()
{
int x;


        /* Initialize the I/O ports.  Set all I/O pins to input */

        init_io(BASE_PORT);


        /* Initialize our transition counts, and enable falling edge
           transition interrupts.
        */

        for(x=1; x<25; x++)
        {
                int_counts[x] = 0;        /* Clear the counts */
                enab_int(x,FALLING);      /* Enable the falling edge interrupts */

        }

        /* Clean up the screen for our display. Nothing fancy */
        clrscr();

        for(x=1; x<25; x++)
        {
                gotoxy(1,x);
                printf("Bit number %02d ",x);
        }


        /* We will continue to display until any key is pressed */

        while(!kbhit())
        {

                /* Retrieve any pending transitions and update the counts */

                check_ints();

                /* Display the current count values */

                for(x=1; x < 25; x++)
                {
                        gotoxy(16,x);
                        printf("%05u",int_counts[x]);
                }
        }
        getch();
}

void check_ints()
{
int current;
```

```
        /* Get the bit number of a pending transition interrupt */

        current = get_int();

        /* If it's 0 there are none pending */

        if(current == 0)
                return;

        /* Clear and rearm this one so we can get it again */

        clr_int(current);

        /* Tally a transition for this bit */

        ++int_counts[current];
}
```

```
/* INTS.C

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         fitness for any considered purpose.

*/

#include <stdio.h>
#include <dos.h>
#include <conio.h>
#include "uio48.h"

#define BASE_PORT 0x200

/* This program like the poll.c sample uses the edge detection interrupt
   capability of the WS16C48 to count edge transitions. Unlike poll.c,
   however this program actually uses interrupts and update all of the
   transition counters in the background.

*/


/* Our transition totals are stored in this global array */

unsigned int_counts[25];

/* Function declarations for local functions */

void check_ints(void);
void interrupt int_handler(void);
void interrupt (*old_handler)(void);

void main()
{
int x;

         /* Initialize the I/O ports. Set all I/O pins to input */

         init_io(BASE_PORT);

         /* Install an interrupt handler for the board */


         /* We disable interrupts whenever we're changing the environment */

         disable();        /* Disable interrupts during initialization */

         /* Get the old handler and save it for later resoration */

         old_handler = getvect(0x0d);       /* Hardwired for IRQ5 */

    /* Install out new interrupt handler */

         setvect(0x0d,int_handler);

         /* Clear the transition count values and enable the falling edge
            interrupts.
         */

         for(x=1; x<25; x++)
         {
                  int_counts[x] = 0;         /* Clear the counts */
                  enab_int(x,FALLING);       /* Enable the falling edge interrupts */
         }


         /* Unmask the interrupt controller */

         outportb(0x21,(inportb(0x21) & 0xdf));      /* Unmask IRQ 5 */

         /* Reenable interrupts */
         enable();


         /* Set up the display */

         clrscr();         /* Clear the Text Screen */

         for(x=1; x<25; x++)
         {
                  gotoxy(1,x);
                  printf("Bit Number %02d  ",x);
         }


         /* We will continuously print the transition totals until a
```

```
            key is pressed */


         /* All of the processing of the transition interrupts, including
            updating the counts is done in the background when an interrupt
            occurs.
         */

         while(!kbhit())
         {
                 for(x=1; x < 25; x++)
                 {
                         gotoxy(16,x);
                         printf("%05u",int_counts[x]);
                 }
         }

         getch();

         /* Disable interrupts while we restore things */

         disable();

         /* Mask off the interrupt at the interrupt controller */

         outportb(0x21,inportb(0x21) | 0x20);        /* Mask IRQ 5 */

         /* Restore the old handler */

         setvect(0x0d,old_handler); /* Put back the old interrupt handler */

         /* Reenable interrupts. Things are back they way they were before we
            started.
    */

         enable();
}


/* This function is executed when an edge detection interrupt occurs */

void interrupt int_handler(void)
{
int current;

         /* Get the current interrupt pending. There really should be one
            here or we shouldn't even be executing this function.
    */

         current = get_int();

         /* We will continue processing pending edge detect interrupts until
            there are no more present. In which case current == 0
    */

         while(current)
         {

                 /* Clear the current one so that it's ready for the next edge */

                 clr_int(current);

                 /* Tally up one for the current bit number */

                 ++int_counts[current];

                 /* Get the next one, if any others pending */

                 current = get_int();
         }

         /* Issue a non-specific end of interrupt command (EOI) to the
            interrupt controller. This rearms it for the next shot.
         */

         outportb(0x20,0x20);      /* Do non-specific EOI */
}
```

APPENDIX B

Cable Drawings

CBL-115-4	4 ft., 50 conductor ribbon cable with edge connector on one end
CBL-129-4	4 ft., 50 conductor ribbon cable with 0.10" socket connection on both ends

Software Examples

Example C functions	UIO48A.ZIP
Linux Driver	linux_uio48_96.zip

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