

DIGITAL I/O BOARDS

CyINT 32P

PCI-Bus Programmable Interrupt Controller

USER'S MANUAL

REVISION 4 – OCTOBER 2000

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1.0 INTRODUCTION

This manual provides technical information for the CYINT 32P. It is intended to be used in conjunction with the ZILOG 8536 integrated circuit data sheet and programming manual.

The CYINT 32P can accept up to 32 vector interrupts and output an interrupt to the PC. The board contains two Z8536 chips each of which accepts up to 16 independent inputs that can be used to generate interrupts from bit patterns or individual bit states or transitions.

The interrupt outputs from two X8536 chips can be ANDed by selecting that option programmatically.

Many other functions can be performed by the CYINT 32P including digital pattern recognition, counting with six, 16-bit counters, and up to 40 bits of digital I/O.

The 16-bit counters can be set up independently or chained together in groups of three.

The CYINT 32P is shipped with *Insta*Cal™, a package of software for installation and testing of the board

In addition, the board can be supported by the CYDAS UDR which provides programming support for all Windows languages.

The CYINT 32 has a pair of Z8536 I/O chips interfaced to the PCI bus. All of its I/O lines are accessible through a 50-pin header connector. The I/O pins of an Z8536 are TTL levels. Connections to the board typically use the CBL 50xx cable and the CySTP 50 terminal board.

2.0 SOFTWARE INSTALLATION

In order to easily test your installation, it is recommended that you install *Insta*Cal, the installation, calibration and test utility that was supplied with your board. Refer to the Software Installation Manual for information on the initial setup, loading, and installation of *Insta*Cal and optional Universal Library software.

3.0 HARDWARE INSTALLATION

3.1 INSTALLING THE CYINT 32P IN THE COMPUTER

The CYINT 32P is completely plug and play. There are no switches or jumpers to set. Configuration is controlled by your systems' BIOS. Follow the steps shown below to install your PCI board.

Turn your computer off, unplug it, open it up and insert the CYINT 32P board into any available PCI slot.

Close your computer up, plug it back in and turn it on.

If you are using an operating system with support for Plug and Play (such as Windows 95 or 98), a dialog box will pop up as the system loads indicating that new hardware has been detected. If the information file for this board is not already loaded onto your PC, you will be prompted for a disk containing it. The InstaCal™ software that was supplied with your board contains this file. Just insert the disk or CD and click OK..

3.2 CABLING TO THE CONNECTOR

The CYINT 32P connector is accessible through the PC expansion bracket. The connector is a standard 50-pin header connector. The CBL 50xx cable and a screw terminal board, the CySTP 50 provide easy access for wiring to the board through 50 12-22 AWG screw terminals on a 4" X 4" terminal board.

3.3 SIGNAL CONNECTION

All the digital outputs inputs on the CYINT 32P connector are TTL. TTL is an electronics industry term, short for Transistor-Transistor-Logic, which describes a standard for digital signals which are either at 0V or 5V (nominal).

Under normal operating conditions, the voltages on the Z8536 pins range from near 0 to volts for the low state to near 5.0 volts for the high state. The current handling capability of these inputs / outputs is limited to a few milliamps. This is typical of TTL devices.

The voltages and currents associated with external devices range from less than a hundred mA at a few volts for a small flash light bulb to 50 Amps at 220 volts for a large electric range. Attempting to connect either of these devices directly to the CYINT 32P would destroy the I/O chip.

In addition to voltage and load matching, digital signal sources often need to be de-bounced. A complete discussion of digital interfacing will be found in the section on Interface Electronics in this manual.

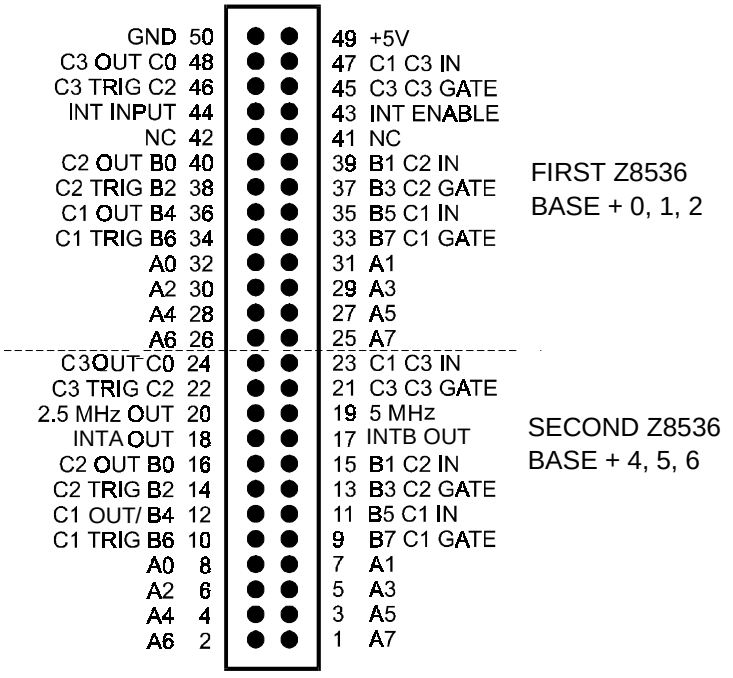
IMPORTANT NOTE
The Z8536 digital I/O chip initializes all ports as inputs on power up and reset. A TTL input is a high impedance input. If you connect another TTL input device to the Z8536 it will probably be turned ON every time the Z8536 is reset, or, it might be turned OFF instead. Remember, and Z8536 which is reset is in INPUT mode.

To protect against unwanted signal levels, all devices being controlled by an Z8536 should be tied low (or high, as required) with 2.2 Kohm resistors.

You will find positions for pull up and pull down resistor SIPs on the CYINT 32P board. To implement these, turn to the application note on pull up/down resistors.

3.4 CONNECTOR DIAGRAM

The CYINT 32P I/O connector is a 50-pin header type connector accessible from the rear of the PC through the expansion backplate. The signals available are direct connections to the Z8536 digital I/O chips.



If frequent changes to signal connections or signal conditioning is required, please refer to the information on the CySTP 50 screw terminal board.

4.0 REGISTER DESCRIPTION

4.1 CONTROL & DATA REGISTERS

The CYINT 32P register map is identical to that of the CyINT 32, with the only exception being the Interrupt Control and Interrupt Status register being added to the PCI version. This functionality is added here in order to eliminate the hardware strap settings that exist on the ISA version. Refer to Table 4-1 for a summary of the board's control and data registers.

Table 4-1. Control and Data Registers

REGISTER	READ FUNCTION	WRITE FUNCTION	Operations
BADR1+4Ch	Interrupt Status	Interrupt Control	32-bit Dbl. Word
BADR2 + 0	Port C Data 8536 #1	Port C Data 8536 #1	8-bit Byte
BADR2 + 1	Port B Data 8536 #1	Port B Data 8536 #1	8-bit Byte
BADR2 + 2	Port A Data 8536 #1	Port A Data 8536 #1	8-bit Byte
BADR2 + 3	Status Register	Control Register	8-bit Byte
BADR2 + 4	Port C Data 8536 #2	Port C Data 8536 #2	8-bit Byte
BADR2 + 5	Port B Data 8536 #2	Port B Data 8536 #2	8-bit Byte
BADR2 + 6	Port A Data 8536 #2	Port A Data 8536 #2	8-bit Byte
BADR2 + 7	Status Register	Control Register	8-bit Byte
BADR2 + 8	No Read-back function	Interrupt Control Register	8-bit Byte
BADR2 + 9	Interrupt Status Register	No Write function	8-bit Byte

4.2 INTERRUPT STATUS/CONTROL

BADR1 + 4Ch

This 9052 register is 32-bits in length. To access only the interrupt control functions, mask off the remaining register bits since they have specific control functions.
READ/WRITE

31:8	7	6	5	4	3	2	1	0
x	x	PCIINT	x	x	x	INT	INTPOL	INTE

INTE is Interrupt Enable: 0 = disabled, 1 = enabled (default).

INTPOL is Interrupt Polarity: 0 = active low (default), 1 = active high.

INT is Interrupt Status: 0 = interrupt is not active, 1 = interrupt is active.

PCIINT is PCI Interrupt Enable: 0 = disabled, 1 = Enabled (default).

4.3 Z8536 #1

PORT C DATA

BADR2 + 00h

READ/WRITE

7	6	5	4	3	2	1	0
X	X	X	X	CL3	CL2	CL1	CL0

PORT B DATA

BADR2 + 01h

READ/WRITE

7	6	5	4	3	2	1	0
B7	B6	B5	B4	B3	B2	B1	B0

PORT A DATA

BADR2 + 02h

READ/WRITE

7	6	5	4	3	2	1	0
A7	A6	A5	A4	A3	A2	A1	A0

CONTROL REGISTER

BADR2 + 03h

READ/WRITE

7	6	5	4	3	2	1	0
D7	D6	D5	D4	D3	D2	D1	D0

See the Zilog 8536 Technical Manual for Control Register description and operation.

4.4 Z8536 #2

PORT C DATA

BADR2 + 04h

READ/WRITE

7	6	5	4	3	2	1	0
X	X	X	X	CL3	CL2	CL1	CL0

PORT B DATA

BADR2 + 05h

READ/WRITE

7	6	5	4	3	2	1	0
B7	B6	B5	B4	B3	B2	B1	B0

PORT A DATA

BADR2 + 06h

READ/WRITE

7	6	5	4	3	2	1	0
A7	A6	A5	A4	A3	A2	A1	A0

CONTROL REGISTER

BADR2 + 07h

READ/WRITE

7	6	5	4	3	2	1	0
D7	D6	D5	D4	D3	D2	D1	D0

See Zilog 8536 Technical Manual for Control Register description and operation.

4.5 INTERRUPT CONTROL REGISTER

BADR2 + 08h

WRITE ONLY

7	6	5	4	3	2	1	0
X	X	X	X	PRTY	IS3	IS2	IS1

IS3:1 Interrupt Select:

IS3	IS2	IS1	Interrupt Selected
0	0	0	None
0	0	1	Interrupts OR'ed from both Z8536's
0	1	0	Interrupt from Z8536 #1
0	1	1	Interrupt from Z8536 #2
1	0	0	External Interrupt

PRTY Interrupt Priority Routing Select:

= 0, No priority. Interrupt Enable Output from Z8536 #1 independent from Z8536 #2.

= 1, Priority selected. Interrupt Enable Output from Z8536 #1 connected to Z8536 #2 Interrupt Enable Input. Therefore Z8536 #1 interrupt has priority over the interrupt from Z8536 #2.

4.6 INTERRUPT STATUS REGISTER

BADR2 + 09h

READ ONLY

7	6	5	4	3	2	1	0
X	X	X	X	X	X	INT2	INT1

This register reports the status of the Interrupt signals from the two Z8536's. This allows the software to read this register to determine the source of the interrupt when the OR'ed selection for the interrupt source is used, instead of having to read both devices to determine the source of the interrupt.

INT1 Interrupt from Z8536 #1

INT2 Interrupt from Z8536 #2

5.0 SPECIFICATIONS

Typical for 25°C unless otherwise specified.

Power consumption

+5V Operating	620 mA typical, 925 mA max

Counter/Timer and Parallel I/O

Device	Zilog Z85C36 (2)
Output High	2.4 volts min @ –250 uA
Output Low	0.5 volts max @ +3.2 mA
Input High	2.0 volts min, 7 volts absolute max
Input Low	0.8 volts max, –0.3 volts absolute min
Power-up / reset state	Input mode (high impedance)

Configured as Digital Input/Output Ports:

Digital Configuration	4 banks of 8 (Ports A and B), 2 banks of 4 (Port C), programmable by bit or bank as input or output
Number of channels	40 I/O

Configured as Counter/Timers: (Port A is a Digital I/O port only)

Counter type	Zilog Z85C36
Counter Configuration	6, 16-bit counter/timers (Port B - High and Low nibble - and Port C) All Trigger (C1-C3 TRIG), Source (C1-C3 IN), Gate (C1-C3 GATE), and Output (C1-C3 OUT) available at user connector.
Clock input frequency	3 MHz max
High pulse width (clock input)	150 ns min
Low pulse width (clock input)	150 ns min
Trigger pulse width (high,low)	130 ns min

Interrupts:

The Z8536 is programmable to generate interrupts based on bit change, pattern recognition, level or edge triggered, whether configured as a digital I/O port or counter port. See Z8536 manual for further options.

Interrupts	INTA# - mapped to IRQn via PCI BIOS at boot-time
Interrupt enable	Programmable (enabled by default) and external (INT ENABLE), active low (pulled high through resistor).

Interrupt sources	Programmable: 8536A interrupt output, 8536B interrupt output, 8536A OR'ed with 8536B, external (INT INPUT, active low) or None.
Interrupt output	Buffered output for each chip available at user connector (INTA OUT, INTB OUT).
Interrupt priority	Programmable: No priority or 8536A interrupt has priority over 8536B interrupt.

Environmental

Operating temperature range	0 to 50°C
Storage temperature range	–20 to 70°C
Humidity	0 to 90% non-condensing

6.0 ELECTRONICS AND INTERFACING

This short introduction to the electronics most often needed by digital I/O board users covers the following important topics:

Pull up/pull down resistors
Voltage dividers
Low pass filters for digital inputs.

IMPORTANT NOTE
It cannot be stated often enough to those unfamiliar with the Z8536.
WHENEVER THE Z8536 IS POWERED ON OR RESET, ALL PINS ARE SET TO HIGH IMPEDANCE INPUT.

The implications of this fact is that if you have output devices such as solid state relays, they may be switched on whenever the computer is powered-on or reset. To prevent unwanted switching and to drive all outputs to a known state after power-on or reset, pull pins either high or low with a 10 Kohm resistor.

To install pull up/down resistor packs, see the application note.

6.1 PULL UP & PULL DOWN RESISTORS

This section describes pull-up/pull-down resistors and Z8536 digital I/O chips on CYINT 32P boards.

When the Z8536 is powered-on or reset, the control register is set to a known state.

When used as an output device to control other TTL input devices, the Z8536 applies a voltage level of 0V for low and 2.5V to 5V for high. It is the output voltage level of the Z8536 that the device being controlled responds to.

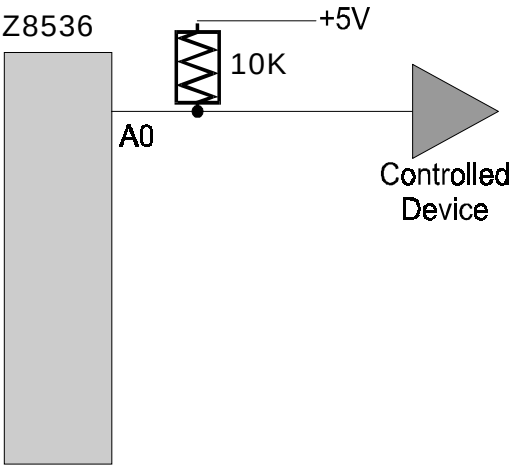
The concept of voltage level of an Z8536 in input mode is meaningless. Do not bother to connect a volt meter to the floating input of an Z8536. It will show you nothing of meaning. In input mode, the Z8536 is in 'high Z' or high impedance. If your Z8536 was connected to another input chip (the device you were controlling), the inputs of that chip are left floating whenever the Z8536 is in the input mode.

If the inputs of the device you are controlling are allowed to float, they may float up or down. Which way they float is dependent on the characteristics of the circuit and is

unpredictable. This is why it often appears that the Z8536 has gone 'high' after power up. The result is that the controlled device gets turned on.

That is why you need pull up/down resistors.

Shown here is one Z8536 digital output with a pull-up resistor attached.



The pull-up resistor provides a reference to +5V while its value of 10000 ohms allows only a little current to flow through the circuit.

If the Z8536 is reset and enters high impedance input, the line is pulled high. At that point, both the Z8536 AND the device being controlled will sense a high signal.

If the Z8536 is in output mode, the Z8536 has more than enough power to override the pull-up resistor's high signal and drive the line to 0 volts (nom.). If the Z8536 asserts a high signal, the pull-up resistor guaranties that the line goes to +5V.

Of course, a pull-down resistor accomplishes the same task except that the line is pulled low when the Z8536 is reset. The Z8536 has more than enough power to drive the line high.

The CYINT 32P boards are equipped with positions for pull-up/down resistors Single Inline Packages (SIPs). The positions are marked A, B and C and are located beside the Z8536.

In a 10 kΩ, eight-resistor SIP, one side of all resistors are connected to a single common point and brought out to a pin. The common line, marked with a dot, is at one end of the SIP. The other ends of the resistors are brought out to pins on the SIP. When installed, the SIP either pulls-up or pulls-down a group of eight inputs. At each board location, A, B and C, there are 10 holes in a line. One end of the line is marked HI (+5V). The other end (LO) is GND. The eight holes in the middle are connected to the eight lines of the ports, A, B, or C.

Install the SIP with the common pin (dot) in either the HI or LO hole, then solder the SIP in place. Mount the SIP at an angle rather than vertical to allow space for the cable connection.

A resistor value of 10k (10000 ohms) is recommended. Use other values only if you have determined the necessity of doing so.

6.2 VOLTAGE DIVIDERS

If you wish to measure a signal which varies over a range greater than the input range of a digital input, a voltage divider can drop the voltage of the input signal to the level the digital input can measure.

A voltage divider takes advantage of Ohm's law, which states,

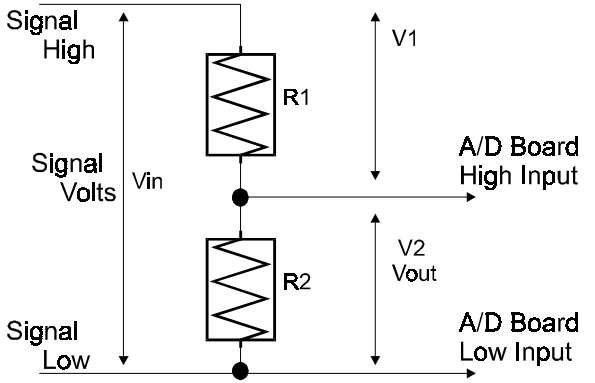
> Voltage = Current * Resistance

and Kirkoff's voltage law which states,

> The sum of the voltage drops around a circuit will be equal to the voltage drop for the entire circuit.

Implied in the above is that any variation in the voltage drop for the circuit as a whole will have a *proportional* variation in all the voltage drops in the circuit.

A voltage divider takes advantage of the fact that the voltage across one of the resistors in a circuit is proportional to the voltage across the total resistance in the circuit.



SIMPLE VOLTAGE DIVIDER - $\frac{Vin}{Vout} = \frac{R1+R2}{R2}$

The object in using a voltage divider is to choose two resistors with the proper proportions relative to the full scale of the digital input and the maximum signal voltage. The action of dropping the voltage proportionally is often called attenuation. The formula for attenuation is:

$$\text{Attenuation} = \frac{R1 + R2}{R2}$$

The variable Attenuation is the proportional difference between the signal voltage max and the full scale of the analog input.

$$2 = \frac{10K + 10K}{10K}$$

For example, if the signal varies between 0 and 20 volts and you wish to measure that with an analog input with a full scale range of 0 to 10 volts, the Attenuation is 2:1 or just 2.

$$R1 = (A-1) * R2$$

For a given attenuation, pick a handy resistor and call it R2, the use this formula to calculate R1.

Digital inputs may require the use of voltage dividers:

For example, if you wish to connect a digital signal that is at 0 volts when off and 24 volts when ON, you cannot connect that directly to the CYINT 32P digital inputs. The voltage must be dropped to 5 volts max. when high. The Attenuation is 24:5 or 4.8. Use the equation above to find an appropriate R1 if R2 is 10K. Remember that a TTL input is "ON" when the input voltage is greater than 2.5 volts.

$$R1 = (4.8 - 1) * 10K$$
$$R1 = 38K \text{ ohms}$$
$$4.8 = \frac{(38K + 10K)}{10K}$$

IMPORTANT NOTE: The resistors, R1 and R2, are going to dissipate all the power in the divider circuit according to the equation Current = Voltage / Resistance, and Power = Current squared * Resistance. The higher the value of the resistance (R1 + R2) the less power dissipated by the divider circuit.
Here are two simple rules:

For Attenuation 5:1 or less, no resistor should be less than 10K.

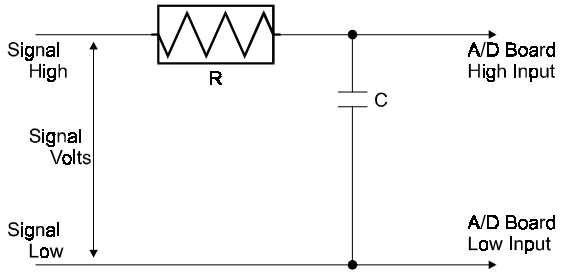
For Attenuation greater than 5:1, no resistor should be less than 1K.

The STA 01 has the circuitry on board to create custom voltage dividers. It is a 16" by 4" screw terminal board with two, 37-pin D type connectors and 56 screw terminals (12 to 22 AWG). Designed for table top, wall or rack mounting, the board provides prototype, divider circuit, filter circuit and pull-up resistor positions which you may complete with the proper value components for your application.

6.3 LOW PASS FILTERS DE-BOUNCE INPUTS

A low pass filter is placed on the signal wires between a signal and an A/D board. It stops frequencies greater than the cut off frequency from entering the A/D board's analog or digital inputs.

The key term in a low pass filter circuit is *cut-off frequency*. Essentially, the cut-off frequency is that frequency above which no variation of voltage with respect to time can exit the filter circuit. For example, if a low pass filter had a cut-off frequency of 30 Hz, the kind of interference associated with line voltage (60 Hz) would mostly be filtered out but a signal of 25 Hz would be allowed to pass.



Also, in a digital circuit, a low pass filter might be used to de-bounce an input from a momentary contact button pushed by a person.

A simple low-pass filter may be constructed from one resistor (R) and one capacitor (C). The cut-off frequency is determined by the formula:

$$Fc = \frac{1}{2 * \pi * R * C}$$

Where π (Pi) = 3.14
R = ohms
C = Farads

$$R = \frac{1}{2*\pi* C * Fc}$$

EC Declaration of Conformity

We, the manufacturer, declare under sole responsibility that the product:

Part Number	Description
CYINT 32P	Interrupt vector board

to which this declaration relates, meets the essential requirements, is in conformity with, and CE marking has been applied according to the relevant EC Directives listed below using the relevant section of the following EC standards and other normative documents:

EU EMC Directive 89/336/EEC: Essential requirements relating to electromagnetic compatibility.

EU 55022 Class B: Limits and methods of measurements of radio interference characteristics of information technology equipment.

EN 50082-1: EC generic immunity requirements.

IEC 801-2: Electrostatic discharge requirements for industrial process measurement and control equipment.

IEC 801-3: Radiated electromagnetic field requirements for industrial process measurements and control equipment.

IEC 801-4: Electrically fast transients for industrial process measurement and control equipment.

For your notes.