# Parallel Port on a PC C Programming for Engineers

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- ▶ There are  $2^{16} = 65536$  I/O addesses
- each of these is called an I/O port
- They are accessed with the in and out Intel assembly language instructions
- The I/O ports are separate from ordinary memory addresses
  - We say, "I/O ports have a separate address space from memory addresses".
- I/O ports usually connect to registers on integrated circuits on the motherboard or on cards plugged into the motherboard

or General I/O

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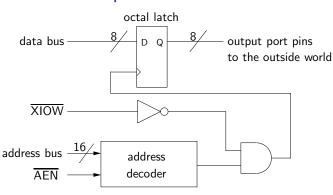
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- We cannot connect hardware directly to the data bus on the CPU
- CPU may not source or sink enough current
- but the main reason is that the data bus is changing all the time
  - Carries instructions and other data, continuously passing back and forth
- For output: need a latch (set of flip-flops) to catch the data when the output instruction is executed, and hold the data steady
- ► For input: a tristate buffer (e.g., 571) that connects input pin to data bus at the time the input instruction is executed

## Hardware of Output Port



- the latch "catches" the data and holds it when the output instruction is executed to the correct address
- ► The XIOW control line from the CPU's control bus is activated by the output instruction
- ► This keeps the I/O addresses separate from memory addresses even when they have the same address number

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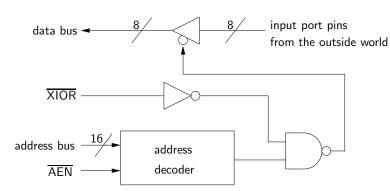
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## Hardware of Input Port



- ➤ The tristate buffer connects the input pin to the data bus only when the input instruction is executed with the appropriate address
- ► The XIOR control line from the CPU's control bus is activated by the input instruction

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# Five modes of Operation

- Newer parallel ports are standardised under IEEE standard 1284
  - released in 1994
- The standard defines five modes of operation:
   Compatibility mode sometimes called "Centronics Mode"
  - can send data out only
  - upper limit: 50 kBps to 150 kBps, depending on hardware

nibble mode Can input 4 bits at a time byte mode can input a byte at a time using parallel port's bi-directional feature

EPP mode (Enhanced Parallel Port) — Uses additional hardware to perform *handshaking* 

ECP Mode (Extended Capabilities Port) Uses DMA and FIFO buffers to move data without using I/O instructions

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# Handshaking with a printer in Compatibility Mode

To output a byte from the parallel port to the printer in *compatibity mode*:

- 1. Write the byte to the Data Port
- 2. Check if the BUSY line is active
  - If the printer is busy, the port will not accept any data, so any data sent to the data port will be lost
- 3. Take the STROBE line low
  - ► Tells printer that valid data is waiting on the data pins 2–9
- 4. Put STROBE high again after about 5 microseconds.

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The Three Printer Port Base Addresses

## The Three Printer Port Base Addresses

Address	Notes
0x3bc - 0x3bf	Used for parallel ports that were incorporated into video cards, and now an option for an additional port. Does not support ECP
0x378 - 0x37f	Usual address for LPT1 (first parallel port)
0x278 - 0x27f	Usual address for LPT2 (second parallel port)
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## There are three I/O Ports

## Data port

- At printer port base address
- all eight bits normally output
- Can input data if port has bi-directional hardware

## Status port

- at base address + 1
- read only

### Control Port

- at base address + 2
- read and write, though was originally intented as a write only port.

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## The Data Port

- At: base address of printer port
- Write only, unless the port hardware is bi-directional

pin number	Bit number	signal name
2	bit 0	$D_0$
3	bit 1	$D_1$
4	bit 2	$D_2$
5	bit 3	$D_3$
6	bit 4	$D_4$
7	bit 5	$D_5$
8	bit 6	$D_6$
9	bit 7	$D_7$

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## The Status Port

At: Base address + 1

Read only

pin number	Bit number	signal name
	bit 0	reserved
	bit 1	reserved
	bit 2	ĪRQ
15	bit 3	ERROR
13	bit 4	SLCT
12	bit 5	PE (Paper End)
10	bit 6	ACK
11	bit 7	BUSY

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## The Control Port

- ► At: base address + 2
- Read and Write

pin number	Bit number	signal name
1	bit 0	STROBE
14	bit 1	AUTOFEED (Auto Linefeed)
16	bit 2	INIT PRN
17	bit 3	SELECT
	bit 4	Enable IRQ via Ack
	bit 5	Enable Bi-Directional Port
	bit 6	Unused
	bit 7	Unused

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## Using the Printer Port for I/O

- ► Here, we use the printer port in compatibility mode
- ► In this mode, the three ports are not available as general purpose 8-bit input/output ports
  - They are set up to talk to a printer
  - But you can still use these ports for many purposes

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# Signals and pin numbers for general purpose I/O

Port		Cianal Nama	DDOE nin number	Commonto
POIL		Signal Name	DB25 pin number	Comments
Data base		D <sub>0</sub> D <sub>1</sub> D <sub>2</sub> D <sub>3</sub> D <sub>4</sub> D <sub>5</sub> D <sub>6</sub> D <sub>7</sub>	2 3 4 5 6 7 8 9	All outputs latched
Status base + 1	bit 3 bit 4 bit 5 bit 6 bit 7	ERROR SLCT PE ACK BUSY	15 13 12 10 11	input input input input inverted input
Control base + 2	bit 0 bit 1 bit 2 bit 3	STROBE AUTOFEED INIT PRN SELECT	1 14 16 17	inverted output inverted output output inverted output
	•	GND	18–25	

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## Pin numbers on DB25 Connector

- ► This views the *female* connector
- i.e., on the back of the computer



View of female DB25 connector

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F	Pin Numb	oers on F	Parallel Po	ort DB25	
	Pin No (D-Type 25)	Pin No (Centronics)	SPP Signal	Direction (In or Out)	
	1	1	STROBE	In/Out	(
	2	2	$D_0$	Out	I

 $D_1$ 

 $D_2$ 

 $D_3$ 

 $D_4$ 

 $D_5$ 

 $D_6$ 

 $D_7$ 

PE

**ACK** 

**BUSY** 

(PaperEnd) **SELECT** 

**AUTOFEED** 

ERROR /

**SELECT** 

Select-In

Ground

Fault **INIT PRN** 

(Auto-Linefeed)

Out

Out

Out

Out

Out

Out

Out

In

In

In

In

In

In/Out

In/Out

In/Out

**GND** 

(In	Register	Inv?
	Control Data Data Data Data Data Data Data Dat	Yes
	Data Status Status Status Status	Yes

Control

Status

Control

Control

Yes

Yes

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# Do not run your programs as root/Administrator

- Normally, to access I/O ports requires administrator priveleges
- ... but it is a bad idea to do everything as the root or administrative user
  - A small mistake can stop the system from functioning correctly
  - In Windows XP/2000/NT, additionally, special unsupported software is required.
  - Linux provides a system call ioperm() that allows the root user to grant normal user access to particular ports
  - The ports must be at port address 0x3ff or below

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# Performing I/O in Windows XP, 2000, NT

- Port I/O on Windows XP, Windows 2000, Windows NT is a complex, barely supported mess.
- Use Linux if you want something simple, standardised and supported:

http://linuxgazette.net/112/radcliffe.html

- Several people have built device drivers to work around the limitations of Windows:
  - inpout32.dll: http://www.logix4u.net/inpout32.htm
  - ► PortTalk: http:

//www.beyondlogic.org/porttalk/porttalk.htm

▶ io.dll:

http://www.geekhideout.com/iodll.shtml

pgiveio.sys: http://www.physik.rwth-aachen.de/group/ IIIphys/CMS/tracker/en/silicon/arcs\_nt.html

b directio: http://www.direct-io.com/

► None of these are Open Source, but inpout32.dll seems to be best supported and have the most open license, so we will use that.

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# Installing Andy Eager's wrapper for logix4u inpout32.dll

Note: this is for use with Microsoft Windows. The procedure with Linux is different, simpler and faster: see the references.

- ► Download Andy's handy package from http://www.linuxivr.com/c/week1/ioports.zip
- Unzip this into a temporary directory
- execute install.bat from a command prompt in that directory as the Administrator

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# Using Andy Eager's wrapper

► See the program ledscan.c in

http://www.linuxivr.com/c/week1/ioports.zip

— use this as a model to see how to perform I/O

► Compile your program with the command:

```
g++ -Wall -lioports -o (program) (program).cpp
```

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# Using inpout32.dll without Andy's wrapper

- ► This could (potentially) give better performance if you initialise the library once at the beginning and free the library once after all I/O is finished
  - However, Andy says the difference in speed is not detectable

### See the test program

```
http://www.hytherion.com/beattidp/comput/pport/test2.c, and also the source to Andy's wrapper at
```

http:

//www.linuxivr.com/c/week1/install-io.html,
and use them as a model for your program.

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