CS 3468 – Homework 3

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Chapter 6

What is the purpose of I/O on a board?

To move information from an input device to the master processor and/or to move information from the master processor to an output device.

List five categories of board I/O with two real-world examples under each category.

- Networking and communications I/O
  - Ethernet controllers
  - WLAN controllers
- Input
  - keyboard
  - mouse
- Graphics and output I/O
  - CRT display
  - printer
- Storage I/O
  - optical disk controllers
  - magnetic disk controllers
- Debugging I/O
  - JTAG
  - serial I/O

What is the difference between serial and parallel I/O?

I/O performed by transmitting one bit at a time is *serial* I/O. I/O performed by transmitting multiple bits simultaneously is *parallel* I/O.

Give a real-world I/O example of each.

A USB mouse communicates serially, while legacy ATA devices communicate over a parallel bus.

What is the difference between simplex, half-duplex, and full duplex transmission?

Simplex transmission limits communication to one direction. Half-duplex allows bidirectional communication, but in only one direction at any given time. Full duplex transmission allows simultaneous bidirectional communication.

Indicate which transmission scheme is shown in Figures 6-27a, b, and c.

- *Figure 6-27a* — Half-duplex transmission
- *Figure 6-27b* — Simplex transmission
- *Figure 6-27c* — Full duplex transmission

What is asynchronous transfer of serial data?

Asynchronous transfer of serial data refers to when I/O transfers occur intermittently at irregular intervals.

Draw a diagram that describes how asynchronous transfer of serial data works.

See attached.

What is synchronous transfer of serial data?

Synchronous transfer of serial data refers to when I/O transfers occur steadily at regular intervals.

Draw and describe how synchronous transfer of serial data works.

See attached.

How can board I/O negatively impact a system's performance?

Board I/O can negatively impact a system's performance by *bottlenecking* the system. For example, a disk controller with high response times could degrade the performance of a system which makes many small disk accesses.

Additional Questions

0.1 Assume a CPU has pins connected to a AD7304 chip. The CPU will send `0x7D` to channel C of the chip.

What is in the data frame?

SA	SI	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0
1	1	1	0	0	1	1	1	1	1	0	1

What is the timing diagram for this transmission?

See attached.

0.2 Assume two devices are using UART for communication. The sending device has a clock of 9600 Hz and sends data at $9600\,\mathrm{bit\,s^{-1}}$. The receiving device has a clock of 200 kHz and uses a counter to generate a slower clock for receiving data. For example, the device lets the counter count from 0 to 9 periodically. Then, the device generates a clock of 20 kHz. Assume the counter must be a multiple of 16 due to the design inside the hardware. Hence, the receiving device can only generate a receiving clock close to 9600 Hz.

Assume the receiving clock is faster than 9600 Hz. What is the maximum frame size (including all start and stop bits)?

Frame size is bounded by the inequality

$$\text{frame size} < \frac{f_s}{|\Delta f|}.$$

From this, it can be seen that the frame size is maximized when $|\Delta f|$ is minimized— that is, when f_s and f_r are closest. f_s is fixed at 9600 Hz. The closest possible value of f_r above this is $\frac{1}{16} \cdot 200\,\mathrm{kHz} = 12\,500\,\mathrm{Hz}$. This gives $|\Delta f| = 2900\,\mathrm{Hz}$. Then,

$$\begin{aligned}
\text{frame size} &< \frac{f_s}{|\Delta f|} \\
\text{frame size} &< \frac{9600\,\mathrm{Hz}}{2900\,\mathrm{Hz}} \\
\text{frame size} &< {\sim}3.310.
\end{aligned}$$

Because the frame size must be an integer, the maximum frame size is $\boxed{3}$.

Assume the receiving clock is slower than 9600 Hz. What is the maximum frame size (including all start and stop bits)?

The closest possible value of f_r below f_s is $\frac{1}{32} \cdot 200\,\mathrm{kHz} = 6250\,\mathrm{Hz}$. This gives $|\Delta f| = 3350\,\mathrm{Hz}$. Then,

$$
\begin{aligned}
\text{frame size} &< \frac{f_s}{|\Delta f|} \\
\text{frame size} &< \frac{9600\,\mathrm{Hz}}{3350\,\mathrm{Hz}} \\
\text{frame size} &< {\sim}2.866.
\end{aligned}
$$

Then, the maximum frame size is $\boxed{2}$.