Microprocessors & CPUs

Microprocessor

A required part of all modern personal computers is one, or more, microprocessors.

The microprocessor is the chip that contains the CPU, Cache Memory (Fast RAM), and connects to all of the other components on the computer through the motherboard.

Several important aspects of computer speed and power are linked to the microprocessor.

Purpose of the Microprocessor

- organizes and controls the flow of information (data)
- connected to every component in the computer
  - those components receive all, or most, of their instructions from the microprocessor
- contains one or more CPUs (central processing units)
- *the microprocessor is like the brain in the human body, connected to and controlling almost everything on the computer*

Central Processing Unit (CPU)

- if the microprocessor is the brain, the CPU is where higher thinking (i.e., intelligence) occurs
- the CPU is part of the microprocessor
- interprets all commands from the 'program' that is running on the computer
  - calculations
  - moving data between components
  - deciding which information to display

Single Core Processor

Dual Core Processor

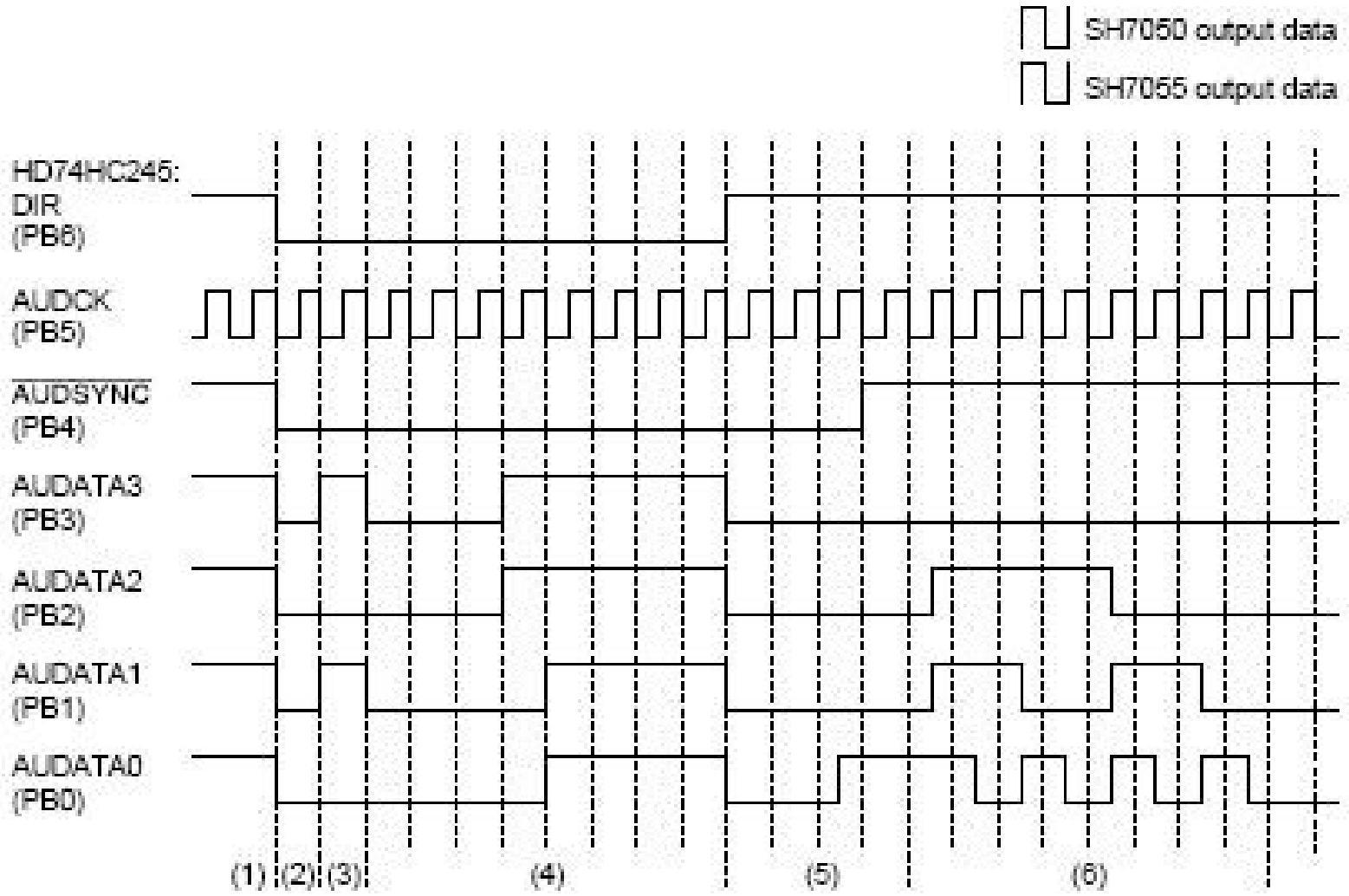
Quad Core Processor

Microprocessor Clock

The clock is a timing mechanism inside the computer that controls how quickly actions happen. For each clock tick, something happens.

It is similar to the metronome used to help with timing in music.

In the microprocessor, a faster clock means that the CPU can be asked to process more instructions in less time. In theory, this should make the computer “think” faster.



(1): Initialization, start of clock input
(2): Dummy bit input (B'0000)
(3): DIR command input (B'1010)
(4): Address input
(H'FFFFC000: A[3:0] → A[31:28])
Input/output switchover
(HD74HC245: DIR pin level switchover)
(5): Ready flag output
(Ready = B'0001 → $\overline{\text{AUDSYNC}}$ level switchover)
(6): Data output (H'01234567: D[3:0] → D[31:28])

Clock Speed

The most basic measure of computer performance is the speed of the microprocessor.

Measured in kilohertz (kHz), megahertz (MHz), and now gigahertz (GHz), the clock speed determines the rate at which instructions are processed.

1 GHz = 1 billion clock ticks per second
1 MHz = 1 million clock ticks per second
1 kHz = 1 thousand clock ticks per second

Number of CPUs

Clock speeds are not increasing as quickly as they used to. Instead, gains in speed are coming from changes to the layout of microprocessors.

Rather than a single CPU, many processors now have two or even four “cores” (CPUs + extras).

By dividing the work to be done, processing tasks can be completed more quickly. It takes work to divide a task, so two CPUs do not double the speed.

Cache Memory

Each microprocessor has a small amount of RAM built right into the chip. This memory is used to store short-term data, and is known as cache.

There are different types of cache, but it is enough to know that cache RAM is very fast and very expensive.

The cache RAM is on the microprocessor, right next to the CPUs, which also improves the speed at which data is exchanged by minimizing the distance the signal has to travel.

Types of Cache Memory

- Level 1 (L1) cache memory
  - smallest but fastest cache memory available
  - each core has its own dedicated L1 cache
- Level 2 (L2) cache memory
  - slower but larger
  - each core also has its own L2 cache
- Level 3 (L3) cache memory
  - slowest and largest cache memory
  - shared across all cores in the CPU

How It's Made Microprocessors

http://www.youtube.com/watch?v=YITsrpOZsL0