3.7.5 Memory Speed Facts

Memory is rated based on its guaranteed stable operating frequency and bandwidth (the rate at which data can be read or written). Memory ratings help you to differentiate between slower and faster RAM. The following rating systems are used:

- For all DDR memory (DDR, DDR2, and DDR3), a new designation was introduced to identify that twice the data was being transferred with each bus clock cycle.
  - The number following the DDR-, DDR2-, and DDR3- prefixes is the data transfer rate (twice the bus frequency).
  - For example, DDR-400 matches a bus frequency of 200 MHz; DDR2-800 has a bus frequency of 400 MHz; and DDR3-1600 has a bus frequency of 800 MHz.
- For DDR past 150 MHz (and for all DDR2 and DDR3 memory), the PC- designation was changed to identify the *bandwidth* instead of a number derived from the bus frequency.
  - The bandwidth is 16 times the bus frequency, or 8 times the DDR- designation.
  - For example, DDR-400 has a bandwidth of 3200 MB (PC-3200); DDR2-800 has a bandwidth of 6400 MB (PC-6400); and DDR3-1600 has a bandwidth of 12800 MB (PC-12800).
  - For a brief time, the double-frequency designation used the PC- prefix for early DDR modules. For example, PC-200 used with DDR indicates a bus frequency of 100 MHz, not a bandwidth of 100 MB (PC-200 is equivalent to DDR-200 which is equivalent to PC-1600).

When listing the frequency, the frequency value usually indicates the bus speed, not the internal frequency (DDR designation) used by the memory.

The following table lists the various memory speed designations for the most common memory types:

Memory Type	Bus Speed	Designations
DDR	100 MHz	PC-200 or PC-1600 or DDR-200
	133 MHz	PC-266 or PC-2100 or DDR-266
	166 MHz	PC-2700 or DDR-333
	200 MHz	PC-3200 or DDR-400
DDR2	200 MHz	PC2-3200 or DDR2-400
	266 MHz	PC2-4200/4300 or DDR2-533
	333 MHz	PC2-5300/5400 or DDR2-667
	400 MHz	PC2-6400 or DDR2-800
	533 MHz	PC2-8500/8600 or DDR2-1066
DDR3	400 MHz	PC3-6400 or DDR3-800

	533 MHz	PC3-8500 or DDR3-1066
	667 MHz	PC3-10600/10666 or DDR3-1333
	800 MHz	PC3-12800 or DDR3-1600
	900 MHz	PC3-14400 or DDR3-1800
	1000 MHz	PC3-16000 or DDR3-2000
DDR4	800 MHz	PC4-12800 or DDR4-1600
	933 MHz	PC4-14900 or DDR4-1866
	1066 MHz	PC4-17000 or DDR4-2233
	1200 MHz	PC4-19200 or DDR4-2400
	1333 MHz	PC4-21300 or DDR4-2666
	1600 MHz	PC4-25600 or DDR4-3200

When comparing the speed of memory modules, be aware of the following:

- The most useful way to compare most DDR modules will be to compare the amount of data that can be transferred per second (bandwidth), as indicated by the PC- designations. For example, PC-3200 will always indicate a "faster" memory module than one with a PC-2700 rating.
- PC- numbers up to PC-266 identify the frequency (or double the frequency), not the bandwidth. For example, a PC-266 module has a greater bandwidth than a PC-1600 module (PC-266 = PC-2100).
- Comparing DDR- numbers can also give you an idea of the relative bandwidth. For example, DDR-600 can transfer more data than a DDR2-400 module.
- The bandwidth identifies a theoretical maximum that the memory can transfer in a given time period, and is directly related to the front size bus frequency.
- If you can derive the bus frequency, you can also get a relative idea of the amount of data a module can handle.
    - When comparing DDR modules, the frequency is relative to the bandwidth.
    - For example, a DDR2 module operating on a 533 MHz bus is faster than a DDR3 module on a 400 MHz bus.
- Other memory characteristics besides the frequency could affect the effective bandwidth or actual speed of the memory module.

Another method for increasing memory bandwidth is by providing multiple channels within the memory controller.

- Dual-channel systems use two memory controllers, while triple-channel systems use three memory controllers. Quadruple-channel (quad-channel) systems use four memory controllers. Each memory controller can communicate with one or more memory modules at the same time.

- To operate in dual-channel mode, install memory in pairs; to operate in triple-channel mode, install memory in sets of three. To operate in quad-channel mode, install memory in sets of four
- Dual-channel systems theoretically double the bandwidth. However, in practice, only a 5–15% increase is gained.
- Dual-channel, triple-channel, and quad-channel support is mainly a function of the motherboard (e.g., the memory controller), not the memory itself. DDR, DDR2, DDR3, and DDR4 can all work in dual-channel systems (depending on the memory supported by the motherboard); both a triple-channel and a quad-channel system use DDR3 and DDR4.