

# Explaining MT/s (data rate) and MHz (frequency) in RAM

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Random Access Memory (RAM) is an essential component in any computer. RAM is a short-term memory bank for all the data your processor is currently working with. Since a computer processor is a fast switching device that processes data at gigahertz speeds, it needs fast memory to keep providing all the data it needs to execute tasks at lightning speed.

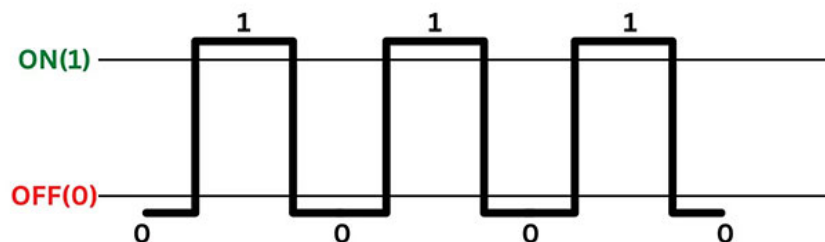
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So what is the correct unit for RAM?

## What is Megahertz (MHz)?

Megahertz (MHz) is a unit of frequency. Mega means one million, while hertz is a unit of frequency equal to one cycle per second. So if you put them together, it means one million cycles per second.

Megahertz can be used in almost any situation where an object is repeated. However, for RAM, MHz is used to measure the frequency of a digital signal in the form of a square wave. Here is what a square wave looks like:



Peaks indicate that there is voltage, while lines indicate that there is no voltage. The computer uses these rising and falling voltages to create square waves, which are then converted to binary (1s, 0s).

## What is Megatransfers Per Second (MT/s)?

Megatransfer is a unit of measurement for data transfer speed in megabytes. One megatransfer is equal to one megabyte. If you time large data transfers in seconds, you have a reasonable way to measure the speed of RAM in terms of the amount of data it can transfer per second.

## Data Rate and Frequency Explained

RAM speed is one of two important factors when deciding to buy RAM. RAM speed is measured in MHz or MT/s. To understand why RAM manufacturers use MHz and why some people disagree with this unit of measurement, let's talk about data rate and frequency, how they measure speed and communicate the overall performance of RAM.

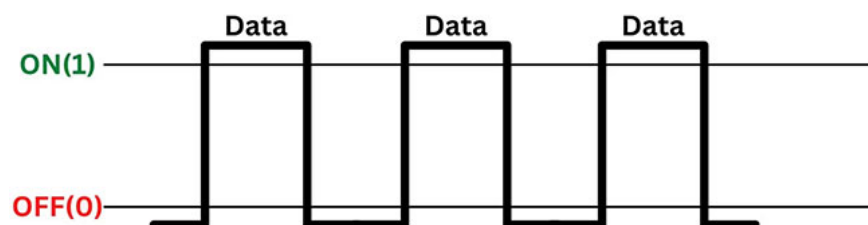
RAM modules, like any other modern digital storage device, are made of transistors that act like switches. These switches work similarly to the regular switches you use to turn the lights in a room on and off. In electronics, a switch on means 1 and a switch off means 0. These 1s and 0s (also known as binary numbers) sum up all the data running on your system.

When you measure RAM speed by frequency, you're measuring how fast these transistors can switch each second. So if your RAM says it's 3600MHz, then logically you can expect its transistors to switch a total of 3,600,000,000 times per second.

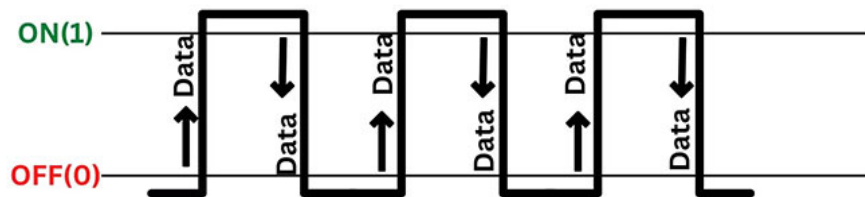
When measuring RAM speed using data rate metrics like MT/s, the frequency or clock speed of the RAM does not necessarily indicate how much data it can transfer per second. When measuring RAM speed using data rate, you are measuring the total bandwidth that the RAM can transfer across its memory modules. So if RAM says it has a speed of 3,600MT/s, you can expect it to transfer a maximum of 28.8 Gigabytes of data per second.

## Why is using Megatransfers technically correct?

As discussed earlier, MHz is a measurement of frequency, while MT/s is a measurement of data rate. If you look at today's top RAM manufacturers, such as Samsung, Micron, and SK Hynix, you'll see that their RAM products are all measured in MHz (frequency). While most PC builders agree with this way of advertising RAM speeds, that doesn't mean it's correct.



When Synchronous Dynamic Random Access Memory (SDRAM) was first introduced in the early 90s, using frequency numbers like MHz was the correct way to indicate RAM speed. This is because data is transferred synchronously with the RAM's clock speed. So if RAM runs at 400MHz, then its data rate must be equal to the clock speed, which is 400MT/s.



But with the introduction of Dual Data Rate (DDR) in RAM, the data rate (MT/s) and frequency (MHz) are no longer 1:1 in sync. Instead, DDR is a technology that doubles the data rate in conventional SDRAM. By moving data on both the rising and falling signals of the square wave, DDR RAM can transfer twice as much data while running at the same clock speed.

However, this does not mean that measuring RAM speed in MHz or using MT/s is wrong. Both data rate and frequency are good measurements to indicate RAM speed. The problem is that the numbers RAM manufacturers use are primarily for product advertising purposes.

It has become standard for RAM manufacturers to advertise their products as running at double the clock speed. For example, if you check your computer's RAM speed, you'll likely see standard RAM speeds like 2400 - 4000MHz - which is incorrect. These numbers actually come from the amount of data DDR RAM can transfer per second (MT/s) rather than the clock speed (MHz). So instead of 3,600MHz, it should be 3600MT/s or 1800MHz.

## Why do people still use MHz?

Although using MT/s is the proper way to measure RAM speed, RAM manufacturers and many people still prefer to use MHz.

Before the introduction of DDR, RAM modules transferred data at Single Data Rate (SDR). This means that RAM used to transfer data every clock cycle. So if the RAM speed was 800MHz, then the data rate was also 800MT/s. But with the advent of DDR, RAM can now transfer twice as much data per clock cycle.

This created a problem for RAM manufacturers in terms of advertising specifications. Unlike today, where information can easily flow over the Internet, many people back then would not be impressed if you advertised DDR RAM with specifications that were roughly the same as last year. Consumers might even choose to buy SDR RAM.

Using MT/s instead of the usual MHz can also cause further confusion. So, to convey the speed and impression of new DDR RAM products, manufacturers have to display a larger number (MT/s) while still using the usual MHz for easy understanding. Of course, this continues to this day, where MHz is still used instead of MT/s.

## Both MHz and MT/s are good measures of RAM speed.

Both frequency (MHz) and data rate (MT/s) are good measures of RAM speed. MHz measures RAM speed by the number of times it can switch voltages per second, while MT/s measures RAM speed by the amount of data it can transfer per second.

While RAM speeds are now advertised in MHz, the numbers refer to MT/s. So as long as the numbers tell you how fast your RAM is running, it doesn't matter which units you use. The best thing to do is ignore the label and just look at the actual numbers.

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