

# MEMORY BASICS – AN INTRODUCTION

All computers require memory to operate, but understanding the different types and how much you should have can be an issue. This Tech Tip will take a look at some of the common forms of modern computer memory and the different features they bring to the table.

## The Basics

Before looking at a few of the specific types of memory, let's cover some of the basics that pertain to all of them.

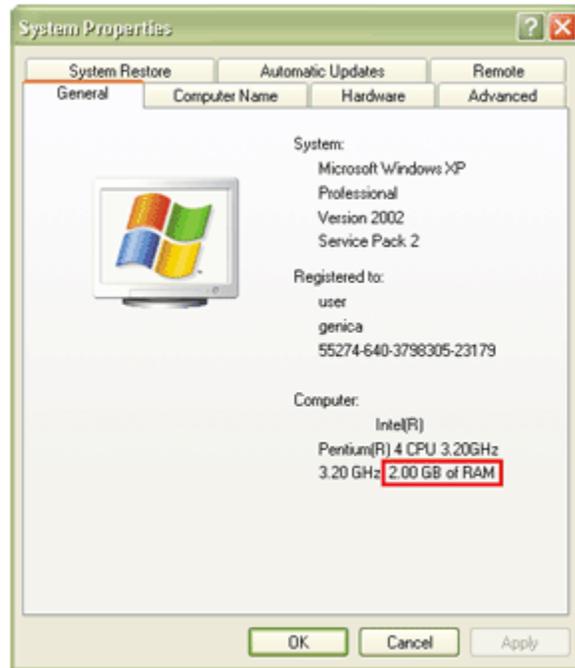
Memory, or more specifically Random Access Memory (RAM), is a type of computer storage that allows the information to be accessed in any order. This allows for quick access to data that programs need to operate. The contrasting format would be sequential access memory, such as a tape drive, that forces the system to go through all preceding data to get to the piece it wants.

As computers and software have advanced, the memory requirements have also changed. Most users have a version of Microsoft's Windows as their operating system, and each carries a unique set of memory requirements. Microsoft's website recommends a minimum of 128MB for the popular Windows XP operating system, but many other sources will argue that 256MB is the minimum and that 512MB is a better number to shoot for. Older versions of Windows required far less memory, with Windows 98 doing well with a minimum of 64MB and Windows 2000 getting by with 128MB. A 'minimum' number may be misleading, as it may allow the system to operate, but perhaps not perform anywhere near its optimum capability.

Those with Linux-based computers may experience successful installations with less memory than a typical Windows operating system, but Penguin power requires a certain amount of memory too. As little as 16MB of memory can successfully power a Linux system with a command line interface, and 64MB may be recommended for adding one of the common graphical interfaces. Some of the various distributions will recommend even more memory, such as Xandros recommending 128MB, Linspire recommending 256MB (128MB minimum), and the CentOS forum mentions 256MB

## SDRAM

SDRAM, or Synchronous Dynamic Random Access Memory, is a few generations old at this point, but may still be found in a good number of computers. This type of memory is/was available in approved speeds of 66 MHz, 100 MHz, and 133 MHz, and was sold based on these speeds ratings, ie. PC66, PC100, and PC133. SDRAM for desktop computers features 168 pins for electrical/data transfer on a module measuring roughly 5 ¼" long. SDRAM for notebook computers features 144 pins for electrical/data transfer on a module measuring roughly 2 5/8" long. SDRAM could be found in early Intel Pentium and AMD K6/Athlon systems.

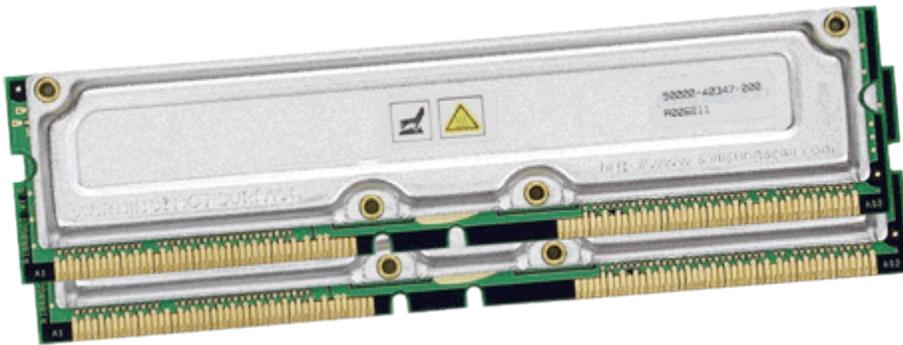




SDRAM was a big improvement over previous generations of computer memory, as the memory and processor were now 'synchronized' and data was available as needed. Later generations of system memory (DDR and DDR-2) are built off of the foundation laid by SDRAM, while obviously adding more speed and greater performance.

### **RIMM**

RIMM (Rambus Inline Memory Module), also known as Rambus or RDRAM, was a format launched by Rambus as a successor to SDRAM. Desktop RIMM modules feature 184 pins for electrical/data transfer on a module measuring roughly 5 1/4" long. The rating for RIMM memory is based on the maximum theoretical bandwidth (in MHz) and included speed ratings of 800 MHz, 1066 MHz, 1200 MHz, 1333 MHz, and 1600 MHz.



Early Intel Pentium 4 processors adopted the technology, but that was about the extent of RIMM's desktop popularity. Some server applications and home electronics devices (such as the PlayStation II) also utilize RIMM memory, but DDR memory was launched at about the same time and eventually stole the show.

### **DDR**

DDR, or Double Data Rate SDRAM, was the follow up to SDRAM which is still in use today. All present AMD-based systems utilize DDR memory, and some Intel-based systems still use it (despite most being transitioned to DDR-2).

The 'Double' part of DDR comes from its ability to transfer twice the data of an SDRAM module operating at the same speed. This is accomplished by the fact that DDR technology can send data on both the rise and the fall of a clock pulse, while SDRAM only sends data on the rise.



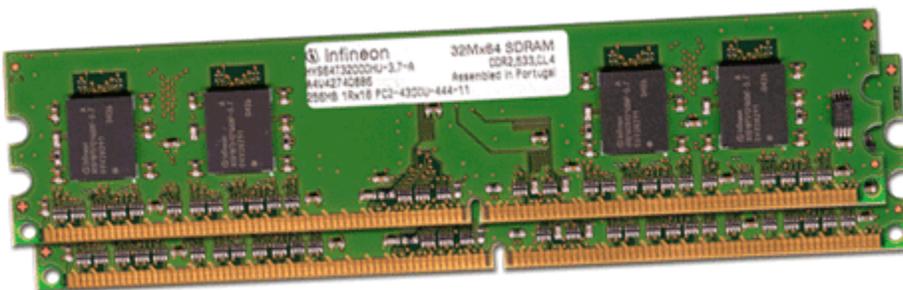
DDR is marketed much like RIMM, as it uses its maximum theoretical bandwidth (again in MHz) to describe the various speeds available. Standard speeds of DDR include PC1600, PC2100, PC2700, and PC3200. The bandwidth can be tied directly to a memory clock speed, with the following correlation: PC1600 – 100 MHz, PC2100 – 133 MHz, PC2700 – 166 MHz, and PC3200 – 200 MHz. Many times, these speeds are referenced by a DDR rate instead of these straight clock speeds, so PC3200 would actually be called 400 MHz DDR, for example.

Seen in other memory types, but perhaps most prominent in DDR, are specifications for modules operating at speeds other than the official ones listed above. Memory standards are governed by a group called JEDEC (<http://www.jedec.org>), but manufacturers can design products outside of these specifications for computing enthusiasts. This non-standard DDR may be capable of much higher speeds, and products carrying ratings such as PC4000 or PC4400 are readily available.

DDR memory for desktop computers features 184 pins for electrical/data transfer on a module measuring roughly 5 1/4" long. DDR for notebook computers features 200 pins for electrical/data transfer on a module measuring roughly 2 5/8" long. You may have noticed that a module of DDR and a module of SDRAM have the same lengths. In order to prevent a user from installing the wrong type of memory in their system, the modules are notched differently to act as a key. SDRAM features 2 notches, while DDR features 1 notch at a different location.

## DDR-2

DDR-2, or Dual Data Rate Two SDRAM, is the second generation of DDR memory and is just now reaching a price and performance level to make it more viable for mainstream computer systems. DDR-2 provides almost double the (theoretical) data transfer as DDR, but it still sends data on the rise and fall of the clock pulse. The improvements are achieved through an increased number of memory buffers, lower electrical consumption, improved physical design, and an improved prefetch. The problem with most present DDR-2 is that these improvements are wiped out by a higher latency within the memory, and the actual improvements over DDR at the same speed may only be 5% or so.



DDR-2 uses a similar naming structure to DDR, in that the maximum theoretical bandwidth is the typical method of describing a module. Instead of just a "PC" prefix, we now have a "PC2" to describe modules such as PC2-3200, PC2-4200, and PC2-5300. PC2-3200 has a DDR-2 speed of

400 MHz (4x100 MHz), PC2-4200 has a DDR-2 speed of 533 MHz (4x133 MHz), and PC2-5300 has a DDR-2 speed of 667 MHz (4x166 MHz). As with DDR (and others), overclocking memory is available in DDR-2, such as Corsair's DDR-2 PC2-8000, which operates at 1000 MHz!

DDR-2 for desktop computers features 240 pins for electrical/data transfer on a module measuring roughly 5 1/4" long. DDR-2 for notebook computers features 200 pins for electrical/data transfer on a module measuring roughly 2 5/8" long. Like DDR, DDR-2 is keyed with one notch (located at a different position than the one DDR notch) to prevent using the wrong type of memory.

Source : <http://www.geeks.com/techtips/2005/techtips-JUL28-05.htm>