Don't Forget to Check Your Memory!

> With the information in this article you can:
> - Recognise the symptoms of RAM failure
> - Trace a memory fault to a specific RAM module
> - Save time and money by locating and replacing only the RAM modules that have actually failed

RAM (Random Access Memory) problems are extremely hard to diagnose. When the symptoms are intermittent, there is a tendency to assume that the problem is software-related. This article will help you to ascertain whether your system has a memory problem. By following the steps outlined, you will be able to confirm that your computer's symptoms are consistent with RAM failure. Next, you will learn the likely causes of your particular memory error. If your problem is occasional and hard to replicate, diagnostic software will help you to find out more about the nature of the failure. Finally, you will need to open up your computer's case. This article will help you to locate a specific faulty module, whilst ruling out the possibility that other hardware components are contributing to the fault.

Dr Steve North:

"Computers are all about memory. Much of the early research into computer hardware focused on the best possible way to remember the result of a mathematical operation. PC processors need to be able to leave a value at a specific memory address and to find it is still there (and unmodified) when it is required. Keeping the RAM in good working order will help you to get the most out of your PC."

!?

Confirm that
the error is
memory-related.

Trace the faulty
module.

Too little RAM can
cause memory
performance
problems.

Diagnosing Faulty RAM

When RAM modules fail, or start to become unreliable, they are said to have 'gone bad'. With the help of this article, you will learn how to confirm that an error is memory-related. You will also find out how to trace the error to a specific RAM module. Once a damaged module has been located, you will be able to consult your PC and/or motherboard manuals to help you order an appropriate replacement.

Not enough RAM: what to look for

A great deal of importance is often placed on a PC's processor speed. Whilst the CPU (Central Processing Unit) model and clock speed are relevant to achieving satisfactory performance, most users will notice the biggest improvement by upgrading the installed RAM. A common memory-related problem is not having enough RAM installed. If your system is sluggish and the hard drive indicator light is constantly illuminated, it is likely that you don't have enough RAM to support your operating system and applications. The benefits of having more RAM installed include: smoother multi-tasking, faster Web surfing, enhanced printing (a printing bottleneck can be easily fixed with a simple memory upgrade), rapid video editing and overall improvement in system performance.

The following table provides suggested RAM values for the common Windows variants. To achieve optimum performance, many experts would recommend applying a factor of up to four to the minimum figures. For example, Windows XP works very happily with 512 MB of RAM.

Windows version	Minimum RAM required in Megabytes	Optimum RAM in Megabytes
98SE	16 MB	64 MB
Me	32 MB	128 MB
2000	64 MB	256 MB
XP	128 MB	512 MB

Bad RAM: what to look for

If you definitely have enough memory for your operating system, the following are indicators of memory-related problems:

- A blue screen with an error code (known as the Blue Screen of Death, or BSOD) when installing Windows.
- Random crashes or BSOD instances during typical Windows operation. This can also be a symptom of overheating. Laptops are particularly prone to exhibiting these symptoms when warm. They will often recover when allowed to cool.
- Regular crashes when the memory is placed under heavy load. For example: 3D gaming, video editing.
- Screen display becoming distorted (assuming a video card fault has been ruled out).
- Windows failing to start accompanied by long audio beeps (the BIOS code for a memory problem).
- When you start your PC, it runs a continuous RAM count, without loading Windows. On-screen, you will see a counter start at zero and run through the total amount of RAM. At a certain point, it will start all over again.

Blue Screens of Death, crashes or display distortions can all be symptoms of RAM problems.

Common Causes of RAM Problems

If your PC is suffering from any of the symptoms in the last section, then it almost certainly has a RAM fault. So what is likely to have caused this problem?

Sudden complete failure

Where the onset of the symptoms has been very sudden, there are several possible causes:

- The complete failure of a memory module.
- A mains power surge or unexpected supply interruption.
- A lightning strike via the telephone line (thankfully, this is very rare).

Displacement or failure of a memory module, or damage from electrical discharge are both common causes of memory-related symptoms.

- Static electrical damage while the computer case is open (during the installation of new hardware, for example).
- The BIOS settings have been changed (corruption of the CMOS data is a possibility) and the PC is no longer reading the memory correctly.
- Displacement of a memory module in a motherboard socket (again during hardware installation).

The last two of these can be easily remedied. The other possibilities are likely to require diagnosis and replacement memory.

Graceful failure

Gradual memory failure can suggest a poor connection due to atmospheric dirt or dust.

In computing terms, 'graceful failure' describes a situation where hardware or software slowly stops working, in a manner that allows the user time to notice the problem and to take appropriate action. In the last section, we looked at the possible causes of sudden memory failure. In some situations, memory will fail slowly, with the symptoms becoming more severe as time progresses. The most common reasons for slow memory failure are:

- Dust or dirt on the memory modules or sockets.
- Erosion to the electrical contacts of the memory modules or sockets. This can happen in a smoky atmosphere or where salt or moisture has encouraged oxidisation.
- A RAM module is still operational but about to fail.
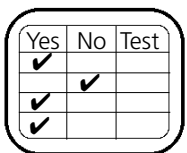
Free Software that Checks Your Memory

If a suspected RAM fault has been identified, you can find out more about the error using various diagnostic software tools. The CD accompanying this update includes two of these pieces of software: MemTest and Windows Memory Diagnostic, both of which are freeware. The following table compares the features available in these tools. The relevance

of these abilities will become more apparent as each application is described.

RAM testing software tool	Can rapidly test more RAM (as not Windows-based)	The longer it runs, the better the accuracy of the fault detection	Can identify the specific faulty RAM module
MemTest	No	Yes	No
Windows Memory Diagnostic	Yes	No	Yes

MemTest

MemTest is a RAM reliability tester. It evaluates the ability of your computer's memory to store and retrieve data accurately. MemTest works by storing patterns of information in the elements of the RAM. It then checks to see how well these patterns have been remembered. The tool checks both immediately and then periodically. The intention is to test how well the RAM retains information over time and with varying loads. This is a reason to run tests for as long as possible. An intermittently faulty piece of memory may only reveal itself when it has been required to store a value for a prolonged period.

This software is flexible enough to be used in a variety of ways. A serious fault is likely to be detected within a single checking cycle (indicated by 100% in the status bar). This means that all free RAM has been checked once. A longer test (one hour) should detect most types of memory error. If you want to be absolutely sure that nothing has been missed, run MemTest overnight. It is perfectly safe to stop this software at any point during a test (even before 100% has been reached).

Initially, tests should be conducted with all other applications closed and just Windows running. If initial
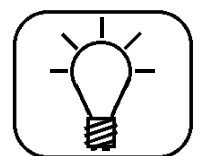
For a thorough test, run MemTest overnight.

MemTest errors are displayed as they are detected.

testing does not show any errors, you might also consider running MemTest while carrying out regular tasks (for example, checking email, or writing a document in Word). If you have noticed that a specific task tends to precede symptoms that you suspect are memory-related, carry out this task with MemTest active. It should be noted that MemTest will stop and display an error as soon as it occurs, rather than reporting at the close of a testing session.

MemTest cannot test RAM that is currently being used by Windows.

The default setting for MemTest is to test **All Unused RAM**. It is important to note that MemTest should only test RAM that is currently not in use. This can be entered as a specific value (in megabytes) or left set to the default. Programs (including Windows) dynamically change their use of RAM. Therefore, memory that is currently occupied will become available with time. Therefore, MemTest should be given the maximum possible time to test, to ensure that all RAM locations have been examined. It is a physical limitation of modern operating systems (such as Windows) that they reserve RAM, making it impossible to check it in its entirety from a Windows-based tool. Software running in MS-DOS, or a self-contained bootable environment, will have access to far more RAM. However, even these tools, will not be able to check the RAM within which they are currently operating. To use an analogy, it's a case of being unable to check the colour of the carpet directly under your own feet.

Non–Windows diagnostic tools will be able to test more RAM immediately, without waiting for Windows to slowly release the memory.
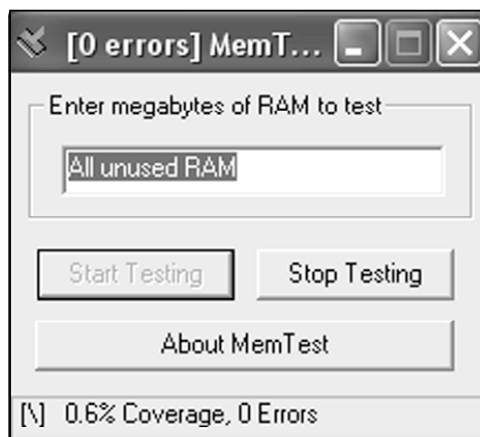
MemTest with analysis in progress

To test your RAM with MemTest in Windows 98SE/Me/2000/XP:

1. Shut down all applications except for Windows.

2. Start MemTest.

3. Click **Start Testing**.

4. When the counter in the status bar of MemTest reaches 100%, click **Stop Testing**. Any detected errors will be reported, as the test progresses.

When an error occurs, MemTest cannot identify the specific memory module with the fault. However, when a fault is detected you will need to find where the problem lies, so that you can either rectify or replace the RAM. There will be further discussion on fault location later in this article.

Windows Memory Diagnostic

Microsoft provides a free RAM-testing tool called Windows Memory Diagnostic. This tool works by running a series of different tests. These fall into two main groups:

- **Memory retention errors** – these happen when a RAM address fails to retain its assigned value. The tool writes a pattern of zeroes and ones into a memory address and then reads it back. If the actual value does not match the original pattern, then the RAM is faulty.

- **Coupling fault errors** – this is when one RAM address is written to and another address that should remain unchanged, incorrectly modifies its own value to correspond with the first address. To test this, Windows Memory Diagnostic performs the same test as for a memory retention error. It then writes a different pattern to an address neighbouring the first address. If, when checked, the first address has changed to the second value, the memory is not reliable.

Despite using the name 'Windows', this software does not actually run inside the operating system. It is necessary to create a bootable CD or floppy disk. It is recommended that

MemTest cannot identify the specific faulty RAM module.

Windows Memory Diagnostic is run from a bootable 3.5–inch floppy disk.

you go down the floppy disk route, as the CD needs to be written as a disk image and requires more than just a CD writer.

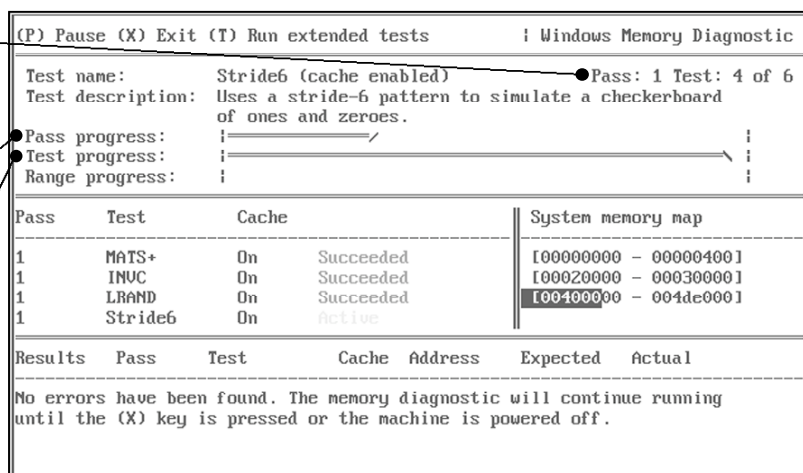To create a bootable floppy disk with Windows 98SE/Me/2000/XP:

1. Double-click **MTINST.EXE** to start Windows Memory Diagnostic Setup.

2. Click **Accept** if you are happy with Microsoft's End-User Licence Agreement.

3. Click **Create Startup Disk...** to install Windows Memory Diagnostic on a floppy disk.

4. Select the floppy disk drive that you want to use from the list provided (this is usually **A:**).

5. Insert a formatted floppy disk into the specified drive and then click **Create**. When the installation is complete, the **Success** dialogue box will appear.

Using Windows Memory Diagnostic should be straightforward. Just restart your PC with the floppy disk in the drive and it should run. If this doesn't work and Windows starts, even with the floppy in the drive, you may need to make a change to your computer's BIOS. Consult your motherboard's manual for details of how to do this.

There are eight tests in each complete pass.

This indicates how much of each pass remains.

This indicates how much of each test remains.

```
(P) Pause (X) Exit (T) Run extended tests      │ Windows Memory Diagnostic

Test name:           Stride6 (cache enabled)      ●Pass: 1 Test: 4 of 6
Test description:    Uses a stride-6 pattern to simulate a checkerboard
                     of ones and zeroes.
●Pass progress:      │════════════/                               │
●Test progress:      │═══════════════════════════════════\        │
 Range progress:     │                                            │

Pass    Test        Cache              System memory map
_____
1       MATS+       On    Succeeded    [00000000 - 00000400]
1       INVC        On    Succeeded    [00020000 - 00030000]
1       LRAND       On    Succeeded    [00400000 - 004de000]
1       Stride6     On    Active
_____
Results  Pass      Test          Cache  Address    Expected   Actual
_____
No errors have been found. The memory diagnostic will continue running
until the (X) key is pressed or the machine is powered off.
```

Windows Memory Diagnostic

To run Windows Memory Diagnostic (Windows 98SE/Me/2000/XP):

1. Insert the Windows Memory Diagnostic floppy disk.

2. Restart your PC.

3. After the Windows Memory Diagnostic interface appears, leave the software running until one pass has been completed (when **Pass: 2** is shown at the top right of the interface). In the default mode, there are eight tests to each pass. As shown in the previous screenshot, the progress for each test and the overall pass is displayed. If left running, Windows Memory Diagnostic will keep on doing passes indefinitely. Other key options to try include: (P) for pause, (T) for an extended set of seventeen tests and (M) for the main menu.

4. Press (X) to exit or turn off the computer using the power button. Interrupting Windows Memory Diagnostic while still running will not damage your machine.

5. Remember to remove the floppy disk before restarting Windows.

When Windows Memory Diagnostic finds an error in your RAM, the details are displayed on the interface. As a general rule, any error suggests that a memory module needs to be replaced. However, it is just possible that the fault might lie elsewhere in the hardware (see the next section in this article – Identifying the Faulty RAM Module). Whatever the cause, it is not necessary that you understand the nature of the error. Any error in your RAM is likely to be serious.

Windows Memory Diagnostic differs from MemTest in that repeatedly running the tests will not reveal any more information. There are two reasons for this. Firstly, Windows Memory Diagnostic does not run inside Windows and so has immediate access to nearly all the RAM installed. Unlike MemTest, it doesn't need to wait until Windows releases

Unlike MemTest, Windows Memory Diagnostic does not keep checking memory retention over a prolonged period.

memory addresses, so that it can test them. Secondly, Windows Memory Diagnostic performs immediate tests for memory retention (it writes a value and then verifies it), but it doesn't follow the MemTest approach of periodically rechecking until the session is terminated.

Whilst MemTest is unable to locate the specific RAM module causing an error, Windows Memory Diagnostic is sometimes able to do this. When Windows Memory Diagnostic is able to ascertain that one module is at fault, this will be indicated by the presence of the **View errors by memory module** option in its main menu (press M⃞).

Identifying the Faulty RAM Module

If you have determined that your PC seems to have RAM problems (either because of the symptoms it is exhibiting, or as a result of testing with diagnostic software), the next step is to pinpoint the exact module that is faulty. RAM comes as several microchips on a small circuit board. Each of these boards is known as a 'memory stick'. The term 'stick' is used interchangeably with 'module'. Depending on the make and model of your PC's motherboard, you may have one or more sticks. If you only have one stick (and are experiencing errors) then it is very likely that it will need replacing. It is just possible that a problem with a connection, failed socket, motherboard or processor is causing your fault. So, it is a good idea to follow the initial cleaning and socket switching tests before rushing out to buy a new RAM module. However, if you have two or more sticks, then you will need to identify which one has gone bad. In either case, you will need to open the case to your PC. To do this (and for the rest of this project), you will need:

- A small Phillips screwdriver.
- If possible, an anti-static wristband (available from computing and electronics suppliers).

A RAM module is often called a 'stick'.

Don't rush out and buy new RAM before you have cleaned all of the contacts.

- The manuals for both your PC and motherboard (if available).
- A can of compressed air for cleaning computers (if available). If not, a very soft bristled, small paintbrush.

- Isopropyl alcohol – this is the active ingredient in most tape head cleaning solutions, which itself would be fine for this purpose. It is also available in larger containers over the counter from pharmacies. You should carefully read any provided safety guidelines. If you don't have access to this product, you will need an ordinary pencil rubber (eraser).

Do not touch the circuit boards in your computer unless you are touching a well-earthed metal object. This is not for your safety; even small amounts of static electricity can ruin sensitive microchips. An anti-static wristband provides a reliable earth. Some wristbands clip onto the chassis of your PC. Others are fitted with a mains plug and use the earth in a wall socket. If you don't have a wristband, alternative instructions are provided later in this section. Remember that mains electricity is dangerous and you should only proceed if you understand how to do so safely.

To open the case for your computer:

1. Shutdown Windows and turn off any power buttons on the front panel of your PC.

2. If fitted, turn the small (usually black) rocker switch on the PC's back panel from '1' to '0'.

3. If the PC is plugged into a domestic mains socket with a switch, turn it off (but leave the plug in the socket to use its earth connection). If the socket does not have a switch, unplug the plug from the socket.

4. Open your PC's case.

5. If you have an anti-static wristband with a mains plug attached, plug it into an available power socket. If your wristband has a crocodile clip, attach it to the

Take anti-static precautions to avoid damaging your PC.

chassis of your PC. Note: if your PC mains plug was removed from the wall at step (3), then your PC chassis is no longer earthed. You will need to find an alternative earth for your crocodile clip, such as a water pipe. If you don't have an anti-static wristband, then you must keep one hand on an unpainted part of your PC's chassis (or a good earth) while touching the internal components of your PC.

Windows Memory Diagnostic users may know which module has the suspected fault.

Note: if you have previously used Windows Memory Diagnostic, you may have already know which module is likely to be at fault. You should particularly focus your cleaning and testing on this memory stick.
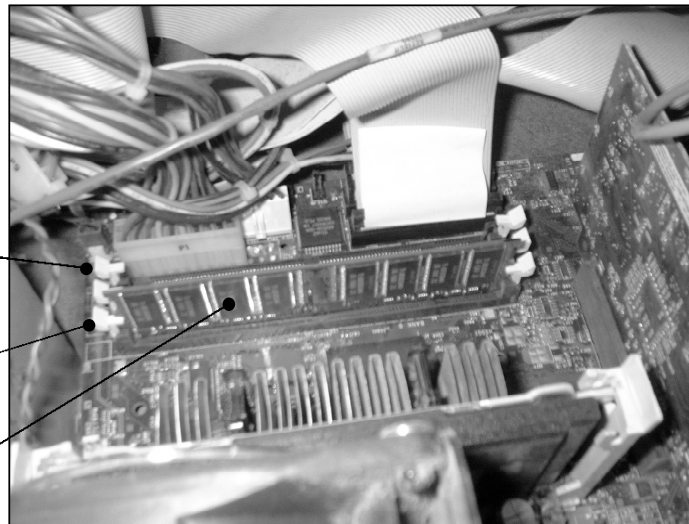
RAM modules on the motherboard

This motherboard has three RAM sockets.

Module retaining clips (in white)

RAM module or stick

Now that the computer case is open, you should be able to see the RAM modules located in parallel slots on the motherboard. You may have to gently move some of the ribbon cables to one side, in order to gain access. We will start by ruling out all of the possible problems that might save you from unnecessary expenditure. The following sequence will rule out cleaning and connectivity issues:

1. Very gently (using the compressed air or paintbrush) remove all the loose dust from inside the computer case. Pay particular attention to the RAM modules.

2. Remove all of the memory sticks, making a note of their current locations. Also, remember which way round they are inserted, as only one orientation will be correct.
You may need to pull back the two memory retention levers in order to remove each memory module.

3. Clean the metal contacts on the sockets and modules. Look for signs of corrosion. Dust, fluff, smoke or oxidisation can coat the contacts preventing a good connection. Use either the isopropyl alcohol or the pencil rubber to clean the gold or tin contacts.

4. Re-insert the memory sticks into their original sockets, pushing them firmly into place (a poor connection could be the cause of the fault). If fitted, the memory retention levers should snap into place. If they do not, you probably have the stick the wrong way round.

5. Leave the case off but **DO NOT TOUCH ANY INTERNAL COMPONENT OR THE CHASSIS, WHILE POWER IS APPLIED TO THE PC.** Warn any other people present, not to touch the inside of the PC. If leaving the PC running and unattended, consider putting a note on the machine to warn against touching the internal components.

6. Remove your anti-static wristband or stop touching the earth point, as appropriate.

7. Reconnect mains plug, as appropriate.

8. If fitted, turn the back panel rocker switch from '0' to '1'. From this point on, assume that the PC is 'live'.

9. If using the software tool Windows Memory Diagnostic, insert the floppy disk into the drive.

10. Turn on your PC.

11. Either run Windows Memory Diagnostic, or replicate the computing activities that have previously

revealed memory-related symptoms. If necessary leave the PC running with the case removed for several hours to verify that the fault has been resolved.

12. When testing is completed, shutdown Windows or switch off your PC, as appropriate.

13. If fitted, turn the back panel rocker switch from '1' to '0'.

14. Disconnect the mains plug, as appropriate.

15. Leave the PC standing for several minutes before touching the internals or the chassis (to allow components to discharge any residual voltages).

16. Reinstate your anti-static protection arrangement, as used before.

17. If the error has now disappeared, switch off your PC (shutting down Windows if necessary) and replace the computer's case.

Testing with just one memory stick

Testing and diagnosing with only one RAM module.

Now that you have eliminated some of the more common problems affecting memory sticks, it is time to further investigate the cause of the errors. If you only have one stick installed:

1. Remove the RAM module from its current socket.

2. Insert the RAM module into a free memory socket. Push it firmly into place. If fitted, the memory retention levers should snap into place. If they do not, you probably have the stick the wrong way round.

3. Follow the Power-down/Test/Power-up procedure detailed in steps 5 to 17 starting on page R 15/13.

4. Repeat steps 1 to 3 until there are no more free sockets.

If you have one or more failed sockets, then make sure that you have followed the cleaning instructions provided earlier. Failure may be caused by bad connections between the socket and motherboard. A 'dry' solder joint, corrosion or even spilled beverages can cause this. On a modern PC, the motherboard is likely to be beyond economic repair.

Now use the table below to work out the possible causes of a problem that you might find with one memory stick.

Result	Possible Cause	Solution
The module works without errors in at least one of the sockets but not in one or more of the others.	One or more of the sockets has failed.	Leave the module in the working socket, but you will never be able to increase the RAM on your PC.
The module doesn't work or works with errors in all of the sockets.	The module has gone bad.	Replace the module.
	All sockets have failed.	Replace the motherboard and/or processor.
	The sockets are ok but the motherboard or processor is faulty.	

Testing with two or more memory sticks

1. Remove all RAM modules from their current sockets.

2. Insert a RAM module into a free memory socket. Push it firmly into place. If fitted, the memory retention levers should snap into place. If they do not, you probably have the stick the wrong way round.

3. Follow the Power-down/Test/Power-up procedure detailed in steps 5 to 17 starting on page R 15/13.

4. Repeat steps 1 to 3 until there are no more free sockets.
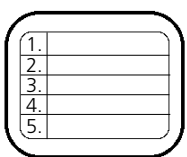   If the current module has failed on all sockets, make

Testing and diagnosing with two or more RAM modules.

sure that you put it safely to one side, so that you don't later confuse it with the others!

5. Repeat steps 1 to 4 for the remaining modules.

This table will help you to work out the possible causes of a problem with two or more memory sticks.

Result	Possible Cause	Solution
One or more modules don't work or work with errors in all of the sockets.	One or more modules have gone bad	Replace the module(s).
All modules work without errors in at least one of the sockets but not in one or more of the others.	One or more of the sockets has failed.	If you have enough sockets to leave the faulty socket(s) empty, then this is not a problem. If you need the socket and it is damaged, then you will need to consider a new motherboard and/or processor.
None of the modules work or they work with errors in all of the sockets.	All modules have gone bad. This is very unlikely unless they have been damaged by heat, lightning, static or a mains power surge.	Replace all of the modules.
	All sockets have failed.	Replace the motherboard and/or processor.
	The sockets are OK but the motherboard or processor is faulty.	

That's it! You now know which RAM modules will need to be replaced (if any). With the help of your PC's manuals you will now be able to buy an appropriate replacement module for your computer.