Diagnosing And Fixing Motherboard Faults

Modern PC motherboards are very modular in their design, and so easily accessible. Anyone with a basic understanding of how they work should be able to diagnose and repair basic motherboard-related faults on a PC.

By Bryan Betts

When a PC fails or exhibits intermittent faults, the first resort is often to send for a specialist engineer. Yet there is a lot that PC support staff with the right level of competence and understanding can do to filter out easily-fixed problems, leaving only those that absolutely require the services of a professional repair-shop. Failure of a socketed part is one thing, but replacing a surface mounted component normally demands specialist equipment.

Record-Keeping

When you're diagnosing faults, it is important to keep a record of what you have done. If nothing else, this will help a specialist later on if you are not able to fix the system yourself. In addition, it is vital to know what was happening when the problem occurred, particularly with intermittent faults.

As long as the PC is still in its case, static safety shouldn't be a problem, but ideally you should ground yourself with a static strap attached to the wrist and earthed to the workbench (which itself should be earthed). Failure to take the necessary precautions can cause intermittent faults and/or damage components on the motherboard.

Starting Work

Does the PC do anything at all or is it dead? If you have a dead PC, the first thing to check is obviously the power supply. Is the fan running? If it is, is the power connection to the motherboard OK? Most PSUs connect to the motherboard with two connectors, with the black cables meeting in the middle. It's a good idea to keep a spare power supply handy, as it's not unusual for them to burn out completely or for the fan to fail. Removing the case from a power supply normally involves removing four small screws to expose the circuit board. There's nothing on the board that you can fix, but it's worth looking at the board in order to check for obvious signs of damage such as a blown fuse or some gunge leaking from the large cylindrical capacitors.

Never replace a blown fuse on a power supply. If the fuse blows, it has probably blown for a good reason (such as one of the PSU components burning out). Replacing the fuse is dangerous, and can also damage components on the PC's motherboard. Fit a new power supply instead - they don't cost more than around US$30.

Assuming the power supply checks out, try a different monitor. Maybe the PC is working fine, but the monitor is broken. If this turns out to be the case, you should not attempt to fix the monitor yourself. Taking the case off a monitor exposes you to voltages that can kill, and it's best left to a specialist who knows which areas are safe to touch. Remember that, because of the high capacitance of a monitor, those lethal voltages can exist even if the monitor has been turned off for many hours.

The next step is to remove all the expansion cards and disconnect the hard and floppy drives to see if they are holding the power rails down. (With EISA systems, make a note of which boards were in which slots to avoid the need to rebuild the system configuration later.) If the system starts to boot without the drives attached, re-attach them one by one until it no longer boots, to see which is the problem. Known-good cables should also be tried with the drives, while the reset and other switches should be disconnected, in case they are causing problems. Leave the speaker connected - those beeps might be your only clue as to where the fault lies.

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Physical Checks

A visual check of the motherboard should look for discoloured components and other obvious signs of overheating. Socketed components should be carefully pressed down to make sure they are securely seated - this is particularly important if the system has failed after being moved. Ensure too that they do not have bent legs: these can cause intermittent failures if they make contact to begin with but go open circuit as the system warms up.

After this, the processor and memory can be swapped for known-good equivalents, ensuring that the processor clock speed jumpers are correctly set and that the memory is the correct speed and compatible with the board. Wrongly setting the BIOS jumpers can in some cases wipe a Flash EPROM, so the BIOS should be verified by swapping it with a known-good chip.

If the BIOS is OK, the system will normally beep when it completes its power-on self test (POST). Most systems also have a range of other recognisable beep codes to report certain faults. A list of these should be supplied in the motherboard or system manual and is essential for fault finding.

A high-impedance oscilloscope can be used to check that the clock is working, by probing onto the underside of the crystal or the capacitors around it. It should typically be producing a frequency in the region of 14 MHz which is then multiplied up by other circuitry to the PC's bus frequency.

If the board fails to beep at all, and the processor and BIOS have been replaced and verified, it may mean that the processor cannot access the BIOS. In this case, a major fault such as a broken PCB track or a loose SMT component should be suspected, and the board will need specialist analysis and repair.

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Subsystem Faults

If the POST beep is present and the disk access light is active but nothing appears on the screen, a video fault is possible. (Incidentally, if the floppy disk light ever remains permanently active after you've put the machine back together, this is a sure sign that you've plugged in the floppy drive connector the wrong way round.)

If the screen is indeed blank, the on-board video should be disabled and a known-good video card installed instead. (Again, keep a known-good video card in your spares box. They don't cost more than $50, and it saves having to take someone else's machine apart to borrow their video card.)

The video subsystem comes in two parts: the controller generates the digital image, and the DAC (digital to analogue converter) turns this into the analogue signal understood by the monitor.

If there are synch signals present but no output, the DAC may have failed. If there is no synch signal a controller problem is more likely. A blown DAC will get hot, but testing for this

The Toolkit

Alongside screwdrivers and the like, the PC engineer's toolkit should include the following:

- A good software test suite such as PC-Check, Checkit or QA+.
- Serial and parallel loopback connectors.
- Multimeter.
- Known-good components, including processors, SIMMs and batteries, plus video, IDE and serial / parallel cards.
- Anti-static wrist strap.

An oscilloscope is useful but probably overkill - the sort of problems it can locate will probably require specialist equipment to fix, anyway.

Checklist

- Start with the power supply. Ensure that it's working, and that it's supplying power to the motherboard.
- Next, try a different monitor.
- Remove all expansion cards. If the machine boots, replace the cards one by one until it doesn't.
- Check motherboard for signs of blow components.
- Try swapping the CPU with a known-good one.
- If the video controller is built in, disable it and try another video card.
- Buy or borrow a POST card.
- Check the CPU fan.
- Check the RAM chips by replacing them with known-good ones.
- Disable external cache.
- Remember to keep a record of everything you do.
- Take anti-static precautions.

Motherboard Faults

needs caution as failed chips can be hot enough to burn flesh. In any case, some modern video chipsets combine the DAC and controller, making fault-finding harder.

A DPMS power-managed monitor could be useful as it will usually indicate, either with an on-screen message or by varying the colour or blink pattern of the power LED, whether it is receiving synch signals or not.

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Keyboard Fuse

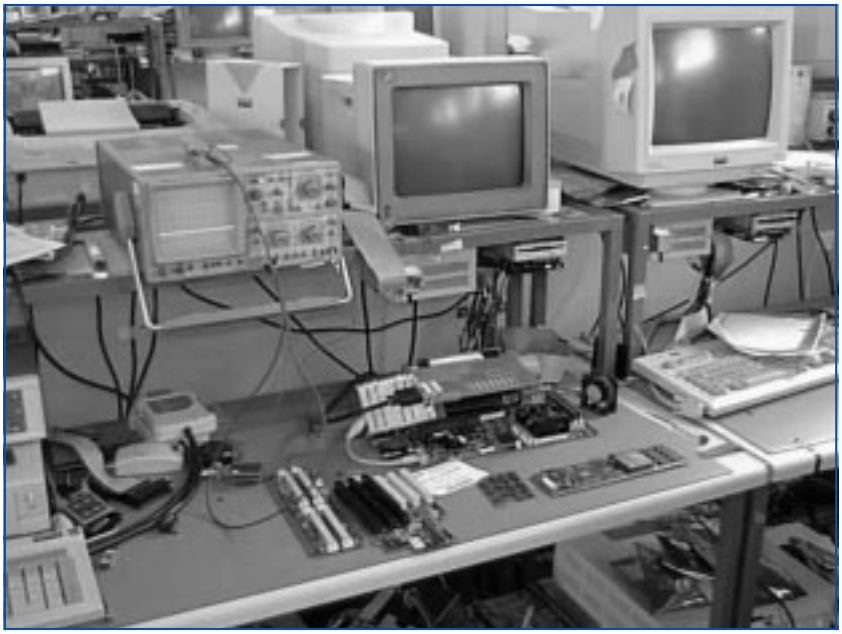
A common problem is the keyboard fuse, which often blows if a keyboard is plugged in or removed when the PC is running. The keyboard fuse is usually a subminiature surface-mounted component that is not immediately recognisable as such. Look for something labelled F1 or F2 and located near the keyboard connector (on the motherboard, not in the PC). The best way to test it is with a multimeter or with a spare keyboard - if the keyboard lights flash as the system powers on, the fuse is OK.

As always, don't replace the fuse unless you have a pretty good idea of why it blew in the first place. The whole idea of the fuse blowing is to protect the other components. Replacing it will expose the rest of the motherboard to the same fault again, unless you fix it first (eg, by replacing the keyboard or remembering not to plug it in while the PC is running).

Send A Postcard

A useful diagnostic tool is a POST card, though good versions are hard to come by and you should be wary of paying too much for one that you have not had a chance to evaluate. PCs send their POST results out on a particular I/O port - most use port 80, while Compaqs may use port 84 and IBMs use 300. The POST card, which plugs into the ISA bus, decodes these signals and displays them either on a set of LEDs or a seven-segment numeric display. A list of POST codes is needed, and can be used to identify the results being produced by the self-test routine.

If the POST card shows FF, an oscilloscope can be used to see if the processor is accessing the BIOS, looking for clock signals, the address and data strobes on the CPU, and for resets.



No Clock

Real-time clock (RTC) failure can be fixed fairly simply, by replacing the battery or, if it is a combined clock / battery unit, by replacing the whole module. However, if this would require soldering, it should not be attempted: motherboards contain heavy ground planes that require a lot of heat to be applied very quickly to avoid damage. If this heat is applied too slowly, the longer exposure to it can burn the board.

It is also important to replace the battery with the correct type. Some PCs use non-rechargeable Lithium cells and others rechargeable NiCads, and if the former is substituted for the latter an explosion could result.

Some clock modules allow you to simply connect a standard household battery or two (eg, as used in a Walkman) to override the exhausted built-in battery. However, you normally need to set a jumper before doing this. If you are in any doubt, don't do it.

Intermittent Faults

Intermittent faults are the hardest to detect. If the system runs for a while but then halts, check the CPU fan. If this has failed the CPU will overheat until its thermal cut-out shuts it down. Although this cut-out protects the chip

to some extent, continued attempts to use the system in this state may cause thermal damage to the processor chip.

Unfortunately, CPU fans seem to burn out with alarming regularity. Be sure to keep one or two in your spares box, along with some of that special heat-conducting glue to fix them to the CPU chip itself.

Faulty joints or components can also make the system hang as it warms up and causes them to expand and go open-circuit, but testing for this requires a temperature chamber and is a specialist job. It is possible to diagnose some faults of this kind by bending the board but this is highly inadvisable as it can cause more problems by breaking components, joints and tracks. For a long life the board should be properly supported and kept well cooled.

A motherboard that boots and then hangs may have cache problems, in which case the level 1 and 2 cache should be disabled in the BIOS. Cache problems show more often when booting from the floppy drive. If the problem goes away, the caches can then be re-enabled one at a time to see where the fault lies. Alternatively, if the system will not boot from floppy, this can be a sign of component failure or a dry joint on the motherboard.

If the cache is OK, the main memory needs to be tested with diagnostic software, as a memory parity error will cause the system to hang, usually with a warning message. You also need to check that the memory fitted matches the specifications laid down by the board or system manufacturer and is compatible. Adding a wait state in the CMOS set-up may alleviate a memory timing problem. Check also whether the motherboard supports or requires parity memory, and whether this is indeed fitted.

Once the base system is working, the expansion cards can be put back one at a time. However, before doing this the test and diagnosis software should be run to determine the free I/O space and resources on the PC. These programs will not find problems such as timing errors but can prove base system functionality. Loopback connectors for the serial and parallel ports are another essential diagnostic tool needed here. If built-in ports or controllers are faulty it may be possible to disable them and fit a card instead.

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