Troubleshooting Guide

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Outline

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- **Knowing Your Operating System**
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- **Diagnostic, Troubleshooting and Repair Tools**
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- **Summary**

Troubleshooting and your Mental State

- **Don't Panic or Overestimate the Magnitude of the Problem**
- **Don't Jump to the Solution Before You Understand the Problem**
- **Don't Be Stubborn**
- **Keep an Open Mind**
- **Give Yourself Time**
- **Be Wary of Fatigue**
- **If You're Stuck, Try Using Your "Background Processing Capabilities"**
- **Two Heads are Better Than One**
- **It Isn't Personal...**

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Steps to Take First When Troubleshooting

- **Let the Vendor Do the Work!**
  - Take advantage of warranty
- **Scan For Viruses**
  - use whatever antivirus software you own to do a full scan of the system
  - use a clean boot floppy if possible
- **Read the Documentation**
  - Many, if not most problems are a result of hardware or software that has just been installed into the PC
- **Double-Check Any Recent Changes**
  - having a problem with your PC that was not present before a change to the system, the chances are 99% that the change is the cause of the problem
- **Simplify, Simplify, Simplify**

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Knowing Your Operating System

- **Best troubleshooter knows entire system - Hardware and Software**
- **PCs**
  - how DOS & Win95 (Win98) boot
  - how they interface with hardware
- **Win95 & DOS share same structure on disk**
  - few enhancement to directory structure in Win95 and Win98
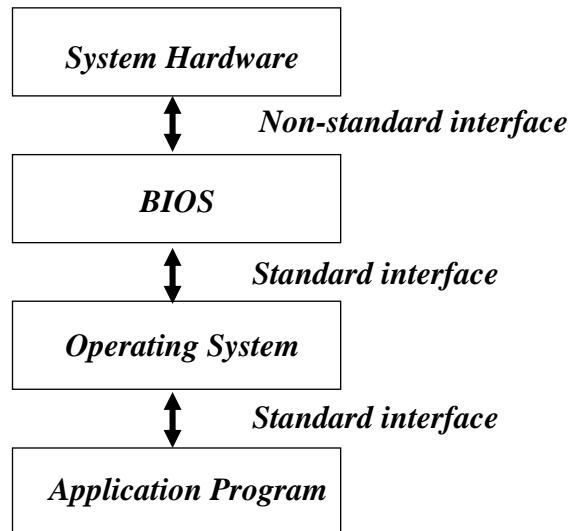
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System BIOS

- **A set of programs always present in system**
- **BIOS routines most primitive in a computer**
  - Talks directly to system hardware
  - Hardware specific - must know exact port address and control bit configuration for I/O devices
- **BIOS supplied by computer manufacturer and resides in ROM**
- **Provides services to O.S. or application**
- **Enables O.S. to be written to a standard interface**

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Software Layers

```
        ┌──────────────────────┐
        │   System Hardware    │
        └──────────┬───────────┘
                   ↕        Non-standard interface
        ┌──────────────────────┐
        │        BIOS          │
        └──────────┬───────────┘
                   ↕        Standard interface
        ┌──────────────────────┐
        │  Operating System    │
        └──────────┬───────────┘
                   ↕        Standard interface
        ┌──────────────────────┐
        │  Application Program │
        └──────────────────────┘
```

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DOS/Windows Components

- **Two primary components:**
  - I/O system and Shell

- **I/O System**
  - 2 files in DOS: IO.SYS and MSDOS.SYS
  - 1 file in Win95: IO.SYS
  - loaded when DOS/Win95 boots

- **Shell - portion with which users interact**

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DOS/Windows Components

- **IO.SYS**
  - interacts directly with devices and BIOS
  - remains in memory
- **MSDOS.SYS**
  - Contains disk handling programs
  - remains in memory
- **IO.SYS in Windows**
  - contains all code in IO.SYS and MSDOS.SYS

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Boot Process

- **Method by which PC becomes operational**
- **Error messages can come from:**
  - BIOS
  - boot sector
  - System files
  - Device drivers
  - Shell program (not in WIN95)
  - Programs run by AUTOEXEC.BAT (not in WIN95)
  - Windows

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How DOS/Windows Starts

1. Power supply performs a self-test.
- When voltages and current levels acceptable, sends Power_Good

2. Power_Good resets processor

3. Execute ROM BIOS code from location FFFF0h, right at the end of the system memory

4. BIOS performs the <u>power-on self test (POST)</u> of central hardware
- Errors indicated by audio beep codes

5. Performs a video ROM scan looking for the video card's built in BIOS program and runs it.
- This BIOS is normally found at location C000h in memory.

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How DOS/Windows Starts

6. The BIOS then looks for other devices' ROMs to see if any of them have BIOSes.
- Normally, the IDE/ATA hard disk BIOS will be found at C8000h and executed. If any other device BIOSes are found, they are executed as well.

7. The BIOS displays its <u>startup screen</u>.
- **The BIOS Manufacturer and Version Number.**
- **The BIOS Date**
- **Setup Program Key**
- **System Logo**
- **The "Energy Star" Logo**
- **The BIOS Serial Number**

8. The BIOS does more tests on the system, including the memory count-up test which you see on the screen
- Errors by audio and displayed messages

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How DOS/Windows Starts

9. The BIOS performs a "system inventory" of sorts, doing more tests to determine what sort of hardware is in the system.

10. If the BIOS supports the Plug and Play standard, it will detect and configure Plug and Play devices at this time and display a message on the screen for each one it finds.

11. The BIOS will display a <u>summary screen about your system's configuration</u>.
- **Processor (CPU) Type**
- **Coprocessor**
- **Clock Speed**
- **Floppy Drive A**
- **Floppy Drive B**
- **IDE/ATA Drives**
- **Base Memory Size**

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How DOS/Windows Starts

- **Extended Memory Size**
- **Cache Size**
- **Memory Type and Configuration**
- **Display Type**
- **Serial Port(s):**
- **Parallel Port(s):**
- **Plug and Play Devices**

12. The BIOS begins the search for a drive to boot from.
- Most modern BIOSes contain a setting that controls if the system should first try to boot from the floppy disk (A:) or first try the hard disk (C:).
- Some BIOSes will even let you boot from your CD-ROM drive or other devices, depending on the <u>boot sequence BIOS setting</u>.

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How DOS/Windows Starts

13. Having identified its target boot drive, the BIOS looks for boot information to start the operating system boot process.
- If it is searching a hard disk, it looks for a <u>master boot record</u> at cylinder 0, head 0, sector 1 (the first sector on the disk);
- if it is searching a floppy disk, it looks at the same address on the floppy disk for a volume boot sector.

14. If it finds what it is looking for, the BIOS starts the process of booting the operating system, using the information in the boot sector. At this point, the code in the boot sector takes over from the BIOS.
- If the first device that the system tries (floppy, hard disk, etc.) is not found, the BIOS will then try the next device in the boot sequence, and continue until it finds a bootable device.

How DOS/Windows Starts

15. If no boot device at all can be found, the system will normally display an error message and then freeze up the system.
- the error message depends entirely on the BIOS, and can be anything from the rather clear "No boot device available" to the very cryptic "NO ROM BASIC - SYSTEM HALTED".

16. The BIOS loads the boot code in the master boot record and transfers control to it. The master boot record code begins execution. If the boot device is a floppy disk, the process continues with step 21.

17. The master boot code examines the master partition table. It is searching for two things.
- First, it must determine if there is an extended DOS partition.
- Second, it must determine if there is a bootable partition specified in the partition table.

How DOS/Windows Starts

18. If the master boot code finds an <u>extended partition</u> on the disk, it loads the extended partition table that describes the first logical volume in the extended partition.

- This extended partition table is examined to see if it points to another extended partition table.
- This process is continued until all of the extended partitions have been loaded and recognized by the system.

19. After loading the extended partition information (if any), the code attempts to boot the primary partition that is marked active (bootable).

- If there are no partitions marked active, then the boot process will terminate with an error.
- The error message is often the same one that occurs if the BIOS finds no boot device, and is generally something like "No boot device", but can be the infamous "NO ROM BASIC - SYSTEM HALTED".

How DOS/Windows Starts

20. If there is a primary partition marked active, the code will boot it. The rest of the steps assume this is a DOS primary partition.

21. The volume boot sector is loaded into memory and tested, and the boot code that it contains is given control of the remainder of the boot process.

22. The volume boot code examines the structures on the disk that it is booting to ensure that everything is correct and in the right place. If not, the boot process will end in an error here as well.

23. The code searches the root directory of the device being booted for the operating system files that contain the operating system. For a system running MS-DOS these are the files "IO.SYS", "MSDOS.SYS" and "COMMAND.COM".

How DOS/Windows Starts

24. If the operating system files are not found, the boot program will display an error message, which is usually something like "Non-system disk or disk error - Replace and press any key when ready".

25. If the operating system files are found, the boot program will load them into memory and transfer control to them.

- First, IO.SYS is loaded and its code executed.
- IO.SYS will then executed MSDOS.SYS (in pure DOS systems--MSDOS.SYS is just a text file in Windows 95 and   later.)
- Then the more complete operating system code loads and initializes the rest of the operating system structures. For MS-DOS, this means loading the command interpreter (COMMAND.COM) and then reading and interpreting the contents of the CONFIG.SYS and AUTOEXEC.BAT system control files.

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How DOS/Windows Starts

- Filing system is active
- IO.SYS reads CONFIG.SYS and SYSTEM.DAT
  - CONFIG.SYS processes in order
  - DEVICE and INSTALL statements
  - SHELL statements. If no SHELL, COMMAND.COM is loaded
  - In Win 95, COMMAND.COM is loaded only if AUTOEXEC.BAT exists
- AUTOEXEC.BAT executed
- IO.SYS loads (in WIn95)
  - HIMEM.SYS, IFSHLP.SYS, SETVER.EXE, and WIN.COM.

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Hardware vs. Software Problems

- **Software problems often caused by**
  - device drivers, memory-resident programs
  - loaded by CONFIG.SYS and AUTOEXEC.BAT

- **To see if software problem:**
  - boot system from a system disk with none of these files
  - restore drivers and memory resident programs one at a time
  - in Win95, also SYSTEM.DAT

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Hardware Troubleshooting

- **Work from most likely to cause problem to least**

- **Check environment**
  - incoming power, temperature fluctuations, humidity, static electricity

- **Try to solve intermittent problems**
  - use hair dryer to warm up motherboard
  - spray the suspected component cooler or freon

- **Three types of programs can help**
  - POST (Power-On Self Test)
  - Manufacturer supplied diagnostics software
  - Advanced diagnostics software

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General Diagnostic Techniques

- **Get to the Root Cause: Ask "Why" Five Times**
  - One of the keys to truly solving a problem is to first understand it
  - people are quick to jump to solve a problem before they really understand what it is
  - The goal is not to correct effects of the problem, but to find out the root cause of why the problem is occurring so that we can ensure that it will not happen in the future
  - avoid "quick fix" solutions that are really just band-aids and don't resolve anything

General Diagnostic Techniques

- **Example: Let's suppose your hard disk is having a problem with bad sectors showing up**
  - The knee-jerk reaction to this happening is "the hard disk is bad, replace it".
  - Why are bad sectors showing up when they didn't before?"
  - "The hard disk is being corrupted somehow; something has changed." "Why?"
  - "The timing of the system probably has been changed in some way." "Why?"
  - "Hmm, I installed a new hard drive in that system just last week, perhaps it is causing the problem." "Why?"
  - "The hard drive may not have been installed correctly, or perhaps I should have used a different channel. Or maybe it was the bus-mastering driver that came with the new drive, the old drive may not be able to support it".

General Diagnostic Techniques

- **Example: imagine an office that has just had a catastrophic data loss due to a PC crashing after an electrical storm**
  - The initially identified cause of this problem was a lack of a UPS on the PC, which would have protected the system from the electrical storm
  - "Remember that the problem here was the *data loss*, not the crashing of the PC. Why was the data lost?"
  - "The PC's hard disk crashed."
  - "Why would that cause the data to be lost?"
  - "Because we didn't have a backup."
  - "Why wasn't there a backup?"
  - "There is a tape backup unit on every PC in the building but very few of them are being used." "Why?"
  - "Because most of the PC users do not know how to use them." "Why?"
  - "They have never been given any training in their use." "Why?"
  - "Because we don't have a budget for PC hardware training."

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General Diagnostic Techniques

- **Be Observant and Look For Evidence**
  - subtle signs can provide triggering piece of information that leads to discovering the source of a problem
  - investigate anything that seems "unusual", "wrong" or "surprising".

- **Use the Process of Elimination**
  - all problems with PCs involve more than one component or subsystem
  - using the process of elimination you can narrow the problem down
  - The key is to make only one change at a time and then see if the problem goes away
  - first check the most probable sources of the problem, and also the things that are easiest to change

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General Diagnostic Techniques

- **Do One Upgrade or Assembly Step At a Time**
  - Changes made to the system are the most frequent cause of problems
  - do not do major software or operating system upgrades at the same time that you make hardware changes
- **Make Use of Components That You Know Work**
  - extra components can be useful when you are employing <u>the process of elimination</u> to resolve problems
- **Write Things Down**
  - Keeping a history of what you discover and what your symptoms are will help you not only with this problem but also with any future difficulties

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General Diagnostic Techniques

- **Determine Repeatability**
  - Most problems with a PC fall into one of two categories: either they are *repeatable* or they are *intermittent*.
  - A repeatable problem is one where the problem occurs all the time, or always in response to a specific user action
  - Intermittent problems are ones which appear to happen spontaneously or randomly
  - <u>Intermittent problems are much more difficult to deal with</u>
- **Dealing With Intermittent Problems**
  - Intermittent problems seem not to be caused by anything obvious and are not repeatable
  - can be extremely difficult and frustrating to diagnose
  - you may not be able to systematically work your way towards the ultimate cause
  - you may have to employ trial-and-error, making a change and then waiting to see if the problem recurs

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General Diagnostic Techniques

- **Correlation May Not Imply Causation**
  - two strange things happening at the same time on your PC, does not mean that one of them has caused the other
  - Example: you have frequent file system corruption on your hard disk, and you have a lot of system lockups (hangs, crashes)
    - you may think that the crashes are causing the file system errors
    - it is possible for the file system errors to cause the lockups
    - it is also possible that both are just symptoms of another underlying cause
- **Scan For File System Problems**
  - If the problem you are looking at is anything that involves the hard disk, files, operating system problems, crashes or similar behavior, <u>scan the file system for errors</u>
- **Use Diagnostic Tools**

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Diagnostic, Troubleshooting and Repair Tools

- **Diagnostic Software**
  - use of diagnostic software tools can save you a great deal of time
  - often provide hints or at least valuable information about what is in the system and how it is working
  - **Power-On Self Test (POST):**
    - it is <u>built into your system BIOS</u> and it runs every time you start up your PC automatically.
    - It is often the best indicator of system problems; make sure you pay attention to its audio and video messages. Don't disable its error-reporting functions unless you really need to.
  - **MEM.EXE:**
    - provides you with details about your memory configuration, as well as what is currently using your memory.
    - It is especially useful when run with the "/C" parameter (use the "/P" parameter as well to make the output pause when it is scrolling).

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Diagnostic, Troubleshooting and Repair Tools

- **Microsoft Diagnostics:**
  - Better known as "MSD.EXE",
  - very useful for seeing what disks are in the system, how much memory is installed, and also for checking system resource usage such as LPT ports and IRQs.
  - It will show you what type of BIOS you are using and also what UART chip you have in your serial ports.
- **The Windows 95 Device Manager:**
  - the most useful tool for identifying system configuration and resource usage information under Windows 95.
  - To access it, open the Control Panel and select the "System" icon. Then select the "Device Manager" tab. You will see a graphical "tree" structure showing you all of your PC hardware. If you select "Properties" while "Computer" (the top-level item) is selected, you will be able to see all the IRQs, DMA channels and I/O addresses in use in your PC;
  - very useful for resolving <u>resource conflicts!</u> The same "Properties" button, pressed after selecting a specific hardware device, will show you driver information, resource settings for the hardware item chosen, and much more.

Diagnostic, Troubleshooting and Repair Tools

- **Norton System Information:**
  - SI is similar to the Microsoft Diagnostics, only more detailed in its later versions.
  - SI shows a great deal of information about what is in the PC, going well beyond what MSD gives you, but really is still an information utility as opposed to a true diagnostic. This program is part of Symantec's Norton Utilities.
- **Microsoft ScanDisk and Norton Disk Doctor:**
  - used to check for hard disk problems. This includes <u>file system corruption</u> and <u>hard disk read errors</u>. They should be used when hard disk problems are suspected.
- **Norton Diagnostics:**
  - perform tests on the hardware to identify problems.
  - It includes tests of the processor and motherboard and system memory, and will identify some types of resource conflicts.
  - In reality it is still quite limited in terms of the numbers of problems it will find.

Diagnostic, Troubleshooting and Repair Tools

- **QAPlus:**
  - QAPlus from *DiagSoft* is a more advanced diagnostic suite that comes in several flavors, depending on what you need to do and how you want to do it.
  - a more expensive package but can give you much more detailed information about your system and help identify problem situations as well.
- **Diagnostic Hardware**
  - there are available several pieces of hardware that can be very helpful in troubleshooting some specific hardware problems.
  - **Loop-Back Plugs:**
    - These are small plugs that go onto the serial and parallel ports on your computer and connect the receive to transmit lines to simulate a connection (they connect the port to itself).
    - Using these with a program like Norton Diagnostics allows for full testing of the operation of these ports, whereas without them only the internal portions of the port can be tested.

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Diagnostic, Troubleshooting and Repair Tools

- **Multimeter/Ohmmeter:**
  - An ohmmeter is a device that measures electrical resistance;
  - a multimeter can measure resistance, voltage and current.
  - A simple ohmmeter is useful primarily for checking for short circuits or open circuits (broken connections, damaged cables, etc.)
  - Multimeters can be used for more extensive electronics testing.
- **BIOS POST Cards:**
  - It is well-known that the BIOS will, if it finds a problem during its power-on self-test (POST), produce audio "beep codes" and/or video messages that indicate what the trouble is that it found.
  - the BIOS of most PCs is designed to send a stream of test codes to a special memory location as it performs its tests, usually 80h.
  - By using a special card designed to capture and display these codes, you can pinpoint exactly where in the power-on self-test a system is hanging up. This can be extremely helpful in debugging very stubborn systems

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Diagnostic, Troubleshooting and Repair Tools

- **Test Bed:**
  - Some experienced PC repair people keep around an older system that they can use as a test bed for components.
  - It can be very useful to be able to test an unknown device with other components that are known to work, to cut down on the guesswork.

- **To do any reasonable amount of work upgrading, building, troubleshooting or repairing PCs, a proper tool kit is a good investment**

- **PC Toolkit**
  - **A Good Screwdriver: a good screwdriver with magnetic, interchangeable bits and a comfortable handle**
  - **Additional Screwdrivers: An additional Philips screwdriver and an additional flat blade screwdriver**

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Diagnostic, Troubleshooting and Repair Tools

- **Needle-Nose Pliers:** These are useful for grasping small items and for removing and replacing jumpers on circuit boards.
- **Wire Snips:** A pair of wire snips for cutting wire and stripping insulation. Some kits include wire strippers for the latter purpose.
- **A Small Flashlight:** *Very* useful; the insides of PC boxes are quite dark and there are lots of very small things you will need to see, such as the "pin 1" marking on a connector for example
- **A Roll of Black Electrical Tape:** They never include this in the kits but they should. Used for wrapping wire ends and insulating components.
- **A Can of Compressed Air:** Very handy for cleaning things hands-free and without using any hazardous liquids.
- **A Soft, Lint-Free Cloth:** For cleaning the monitor and other components.

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Diagnostic, Troubleshooting and Repair Tools

- **A 3/16" Nut Driver:** 3/16" is the size of nut most commonly used on PCs. These hexagonal nuts are used as mounting hardware for motherboards and serial and parallel ports.
- **Vice Grips:** These are incredibly neat tools that have all sorts of uses.
- **Torx Screwdrivers or Bits:** These are the star-shaped screwdriver heads that are used to make equipment "tamper-proof".
- **An ESD (Electrostatic Discharge) Wrist Strap:** This is more of a safety device than a tool; it is used to greatly reduce the chances of static damage to components.
- **A Knife:** A cutting blade or utility knife of some sort.
- **Soldering Irons:** Essential if you are going to try to do repair of circuit boards, but virtually nobody does this (and with good reason). They are also quite dangerous if used improperly.

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Diagnostic, Troubleshooting and Repair Tools

- **Hex (Allen) Keys:** included in virtually every commercial tool kit but rarely used.
- **Chip Extractors:** These are used to remove chips from regular (non-ZIF) sockets, but modern PCs do not generally use these sockets any more.
- **Screws:** screws of all shapes and sizes come in handy when working on various machines.
- **Mounting Kits:** These sometimes come with retail hard disks and allow you to put a 3.5" drive into a 5.25" bay. Useful when your case has more free 5.25" bays than 3.5" ones.
- **Cables:** Save any power, IDE, floppy, CD-ROM, or other cables that you accumulate in case you need them later on.
- **Keyboard, Mouse, 3.5" Floppy Drive:** Keep an extra one of each of these components around to aid in troubleshooting problems by swapping.

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Troubleshooting Flowcharts

- **Power Supply**
  - check Power Good pin for 2.4 to 5.4 dc
  - measure voltage ranges on motherboard and drive power connectors
- **System Board**
  - check all power connectors
  - make sure board is clean
  - check all system-board switch settings
  - check resistance values at motherboard power connectors
  - run advanced diagnostics - 1xx

Troubleshooting Flowcharts

- **Video Board/Adapter**
  - problem indicated by one long and two short beeps
  - run advanced diagnostics - 4xx and 5xx
- **Keyboard**
  - cable defective or stuck key
  - observe POST for 3xx error
  - 3xx preceded by two-digit hexadecimal number, indicates failing key
  - check voltages at system-board keyboard connector

Troubleshooting Flowcharts

- **Battery**
  - defective if error 161 by POST
  - system unable to maintain date and time with power off
- **Fixed Disk Drive**
  - problems indicated by 17xx errors
  - check for proper configuration
  - check cables and measure voltages
  - attempt low level format
- **Floppy Drive**
  - problems indicated by 6xx errors
  - check for proper configuration

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Troubleshooting Flowcharts

- **Serial and Parallel Ports**
  - run advanced diagnostics communications
  - 9xx and 10xx for Parallel printer adapter
  - 11xx for serial port COM1
  - 12xx for COM2, COM3, and COM4

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Summary

- **Best troubleshooter knows entire system - Hardware and Software**
- **Knowing how operating system boots helps pinpointing problem**
- **Check installation and configuration**
- **Start with items most likely to cause problem**
- **Check environment**
- **Get help of diagnostic tools**
- **Keep system documentation and manuals nearby**