Upgrade or repair a PC by yourself

PREFACE

This workshop will show you how to assemble a complete IBM-compatible computer system from individual components and subsystems. It will also show you how to configure and test your new system.

Most manufacturers' manuals accompanying computer products do an adequate job of showing you how to use their specific hardware or software.

But the very nature of computing places these products as parts of a larger system of equipment and programs.

In addition to showing you how to install your new computer equipment and get it up and working, this workshop will try to put the installation and testing into the context of a complete system. To accomplish this, the following has been added to the course:

1. The basic terminology and concepts of integrating and installing a personal computer system are presented. This is for those who are new to computing or new to working inside the box.
2. Your are shown how to install all the components of a PC, not just the motherboard. For example you are shown how to configure your floppy disk drives to work with your motherboard and how to add a hard disk to your system.
3. Your are shown how to adapt your motherboard for your specific system (if required).
4. Testing is done at the system level (e.g. within the context of the operating system)
5. The computer's interfaces are described and their connector and cable types are described in detail.

INTRODUCTION

The heart of most microcomputer systems is a general-purpose single board computer. Because these single board computers usually have several special-purpose electronics card plugged into them, they are often called motherboards.

This documentation shows you how to start with a motherboard an assemble a complete microcomputer system. It starts with a tutorial section an goes on through assembling, configuring and testing the system.

BASIC CONCEPTS

When all the logic needed for a computer is placed on one circuit board the computer is called a **single board computer** or **SBC**. Virtually all *SBCs* are built around one integrated-circuit **central processing unit** or more commonly **CPU**. Integrated circuits are often called **chips** because of their origin in chips of silicon. This microelectronic computer-on-a chip is called a **microprocessor**. Thus, the *CPU* for virtually all SBCs is a *microprocessor*. When a complete computing system is built around a microprocessor, the system is called a **microcomputer**.

Most *SBCs* are not really 100% *single board computers*. In the extreme this would put all the interfaces between the computer and its input/output devices permanently on the computer's circuit board. Since computer interfaces are regularly evolving and improving, this could lock us into an old technology or be needlessly expensive.

Most SBCs have essential interfaces (such as power) and interfaces which are not expected to change (such as the keyboard) on the SBC's circuit board. The remaining interfaces (such as to its disk drives, printer, communications, and display) are on their own circuit boards which are plugged into the SBC. These less-expensive circuit boards are often called just **cards**. These *cards* can be changed to new interfaces for less money and trouble than if they were permanently on an SBC: just pull out the old interface and plug in the new one. Nowadays, some manufacturers put more and more intelligent interfaces directly onto the motherboard - which is sometimes annoying for you can't change defective parts easily or upgrade to a better interface.

When computers are built such that additional interface cards can be plugged into their circuit boards, the computer's circuit board is called a **system board** or more commonly a **motherboard**. Most SBCs are built this way.

The interface cards plug into sockets on the motherboard. Since many of the devices connected to SBCs are input/output (**I/O**) devices, the interface available at these sockets is said to be the SBC's **I/O channel interface** and the sockets are called **I/O adapter sockets**. Depending on model and brand a motherboard has between two (normally eight) and up to 12 *I/O adapter sockets*.

The cards which plug into the *I/O adapter sockets* go by a lot of different names. Common among these are **I/O adapter** and **interface adapter**. Interfaces to specific devices are often named by the device name followed by **controller** or *adapter*. For example: **floppy disk controller** (or **floppy disk adapter**) and **VGA graphics adapter**). An interface adapter for a parallel printer might be called a **parallel port** and an RS-232 serial adapter might be called a **serial port** or an **RS-232 card**.

About 80% of all personal computer motherboards are built around processors from Intel (8088, 8086, 80286, 80386, 80486 and the latest processor, 80586, called Pentium). But there are other manufacturers of Intel-compatible processors, too (e.g. Cyrix, NEC).

UNPACKING NEW PC COMPONENTS

Always check for obvious shipping damage and make sure you have everything needed. The sooner you detect problems the faster they will be resolved.

WARNING: Unpack with great care. Save the packing materials in case you have to return some component. Especially inspect the packing for small parts. You may want to save everything until you are certain you have every nut, bolt, connector, and other needed parts. Handle all computing components with card. DO NOT handle the exposed connectors on the edges of adapter cards. DO NOT handle any *chips* until you have read the instructions.

If you are building a PC from the scratch, check for the following:

1. Obvious shipping damage.
2. Be sure you have everything needed: motherboard, case, power supply, keyboard, disk drive, disk drive cable, disk drive controller, monitor (display), display cable, display controller, power cords, etc.
3. Check to be sure the connectors match throughout your system. Most connectors are standard but a few are not: especially check the motherboard power connectors on the cables coming out of your power supply and be sure they are compatible with the connectors on the motherboard. The exact style of connector is not critical but they should have the same number of pins and the pins should have the same spacing.
4. Check your power supply with your case's chassis and be sure they match (there are two styles of each, one has the power switch on the side and one has it on the back). Be sure the air outlet in your power supply matches and opening in your chassis.

SOME MORE WARNINGS

1. NEVER connect a device to the power supply or insert or remove an I/O adapter card while the power is on. This is very important.
2. Incorrect placement of IC chips can cause damage to the motherboard of destroy the chip. It is easy to bend chips' pins. Use care when you straighten the pins and insert them into their sockets. Check to be sure no pins bend under the chip or go outside the socket. Be sure the notch in the chip points toward the back of the motherboard.
3. Do not apply power to your power supply until it is connected to the motherboard. You can damage a switching power supply by turning it on when it is not connected to the motherboard or a similar load (Advanced users: If you must apply power to your unconnected power supply: Connect a 5 Ohm, 5 Watt resistor from +5 Volts to ground and a 60 Ohm, 3 Watt resistor from +12 Volts to ground before turning the power supply on).
4. While most of the material in IBM's manuals can be directly applied to your IBM-compatible motherboard, the option switch settings differ from one brand and model to the other.
5. Before you touch electronic equipment, be careful of your own static load. It is a good bet to touch some grounded metal like a power supply to "unload" yourself.

MOTHERBOARD

A typical motherboard consists of power, speaker, battery, keyboard connector and four functional areas: a microprocessor subsystem, a read-only memory (*ROM*) subsystem, a read/write *RAM* (random-access-memory) memory subsystem, and the I/O adapter sockets.

PROCESSOR: The heard of a motherboard is a 80xx microprocessor. The old Intel 8088 is a 8-bit external bus version of Intel's 16-bit 8086 processor, and is software-compatible with the entire Intel iAPX family. The 8088 supports 16-bit operations internal to the chip, and supports 20-bit addressing (1 megabyte of storage). Only its external bus is 8-bits wide. The 80286 supports 16-bit external bus (up to 16 megabytes of storage). The 80386 is a 32-bit processor and supports 32-bit external bus (SX version only 16-bit external). The 80486 in also a 32-processor, but includes a math co-processor. The 80586 (Pentium) is a 64-bit processor.

READ-ONLY MEMORY: Software which is used very frequently can be stored in **read-only memory** (**ROM**) integrated circuits and plugged into *ROM* sockets. Some software is needed to make the PC compatible with earlier versions

of the IBM PC and IBM XT. This software is called the **Basic Input/Output System** or **BIOS**. It provides control over major I/O devices and relieves the programmer from concern about characteristics of specific hardware devices. In XT-models the *BIOS* is stored in a 2764 ROM chip in one of the ROM sockets. In newer models, the ROM has been replaced by the **EPROM** (erasable programmable read-only memory). The *EPROM* can be updated so that the user can add, delete or modify BIOS information. Some of the BIOS manufacturers are: Phoenix, AMI,
WARNING: Updateable BIOS are to be handled with care! If you store the wrong information (e.g. wrong hard disk type) you may no longer start the PC or you will receive error messages. It is a good bet to write down all initial BIOS settings down on a piece of paper before you make any changes.

RANDOM-ACCESS MEMORY: The original IBM-PC accommodated only up to 256 KB of RAM on the motherboard. The IBM PC/XT had up to 640 KB, the IBM PC/AT up to 1024 KB (= 1 megabyte). Nowadays most system can accommodate between 4 MB and 32 MB on the motherboard. How much RAM memory you can plug into you PC depends on:

- if you have to use DRAM chips (have pins/"legs", mostly found in AT models): 256 Kbit x 9, 256 Kbit x 4 or 1 MBit x 1 versions
- if you can use SIMM (do not have pins; chips are on some kind of a plastic board) the choices are: 256 Kbit x 9, 1 Mbit x 9, 1 Mbit x 3, 4 Mbit x 9

MEMORY

There are three types of memory that can be installed on a PC:

CONVENTIONAL MEMORY: Is memory between 0 KB and 1024 KB (1 MB). It's the area of memory in which all programs must run (at least under MS-DOS 2.0/3.3). The first 640 KB of memory is used to run programs, and the remaining 384 KB is reserved for the system (e.g. ROM BIOS and hardware devices, such as display adapter boards, network boards and hard disk controllers). This memory is called *reserved memory*. With DOS 5.0 or higher you can make some of this part of the RAM - also called **upper memory** - available for programs, i.e. you can store parts of DOS itself in this **high memory area** (*HMA*). The device driver for this is called HIMEM.SYS.

EXTENDED MEMORY: The memory above 1 MB and between 16 MB. A PC-AT or 386 PC (but not a PC or PC-XT) can have up to 15 MB of this type of memory called **extended memory**. Extended memory is severely limited in utility, however, by the fact that existing programs (running under DOS) can't use it, either to run themselves or to store data. It can only be used for RAM disks, print spoolers, and disk caches. However, with DOS 5.0 or higher, you will receive a driver called EMM386.SYS which converts the respective memory on the motherboard into extended memory. This memory is then called **XMS** (for expanded memory specifications).

EXPANDED MEMORY: To get around the 640 KB barrier, another type of memory was invented - called **expanded memory**. There are two standard types of expanded memory:

- expanded memory that follows the Lotus/Intel/Microsoft Expanded Memory Specification. This is usually abbreviated as **EMS memory** or **LIM memory**.
- expanded memory that follows the AST/Quadram/Ashton-Tate Enhanced Expanded Memory Specification. This is usually abbreviated as **enhanced expanded (EEMS) memory**.

Both EMS and EEMS memory provides the capability to break the 640 KB barrier, but only when used in conjunction with a control program that can both multitask existing programs and take advantage of EMS/EEMS memory's ability to run multiple 640 KB programs concurrently.

If you have the chance to use either expanded or extended memory, we suggest that you configure the system for the latter.

MEMORY CACHE

You can improve performance using a memory cache, which is also called an external cache or secondary cache on a 80486/80586 where a primary cache is built into the chip. Like a disk cache, a memory cache keeps often-used data where it can be accessed quickly - in this case in extremely fast static RAM (SRAM) - near the CPU. SRAM is very expensive, however. A 64 KB cache speeds up most user applications by about 14 per cent

SYSTEM BUS

There are four major PC bus systems:

ISA: the oldest technology (also called *AT- bus*), but still holds the bus majority of all installed PCs. A 8 MHz, 16-bit data transfer bus. Note: the original IBM PC was developed on the so-called *PC bus*, running 8-bit wide at 4.77 MHz.

MCA: Micro Channel Architecture, a bus developed by IBM in 1987 and found in PS/2 models; did not get a break-through. MCA is offering a 32-bit interface, a 10 MHz clock speed, and features such as auto-configuration and bus mastering.

EISA: Extended Industry Standard Architecture The answer of leading PC manufacturers to MCA. Announced in 1989. A 32-bit bus offering auto-installation and bus mastering. but unlike IBM's MCA bus, EISA is fully ISA compatible. It runs at 8 MHz and allows any ISA card to work in any EISA slot.

VESA: Video Electronics Standards Association. Also called VESA Local Bus (abbr. VL). A 32-bit bus, bypassing the ISA-bus and giving graphic subsystems and other peripherals a faster (direct) path to the CPU (thus avoiding the ISA bus). The VL bus generally moves data at speeds of between 25 MHz and 40 MHz., VL cards must be able to handle different clock rates. Problem: each VL card adds a load to the CPU bus, therefore reducing the bus's signals and limiting VL to just two or three peripherals. Throughput speed of 132 MB/sec

PCI: Peripheral Component Interconnect, the most current technology allowing PCI components to operate on a 32-bit bus system at 33 MHz. PCI has been designed to supplement existing ISA and EISA bus systems, while being 100% compliant. PCI architecture provides increased performance for network cards, hard disk drives, full motion video, graphics and other high speed peripherals directly to the CPU (bypassing the ISA bus). PCI adds a controller and an accelerator chip to create a bus <u>separate</u> from the ISA bus. Throughput speed of 120 MB/sec. The PCI chip is currently only manufactured by Intel.

MCA and EISA boards are designed that the PC can configure it automatically. That means, you don't have to set jumpers or worry about interrupts, **DMA** (*direct memory access*) channels and I/O addresses. Normally, these boards come with a software but which you can run <u>after</u> you have installed the board.

<u>The latest no I</u>: Version 2.0 of the VL bus architecture has been introduced, adding such features as a multiplexed 64-bit data path, signal buffering for operation with high-speed motherboards, and a higher maximum clock rate of 50 MHz.

<u>The latest no II</u>: Some PC companies joined the so-called "plug-and-play initiative", **PnP**. The initiative was launched by Microsoft. The concept behind PnP is simple. When you install a new hardware device, your PnP system will automatically identify the new component. PnP will then take the device through a configuration process that automatically allocates the interrupts, I/O, and memory addresses without making you fumble with jumpers or pins. A PnP compliant system requires a PnP-BIOS (Phoenix and others have already developed), PnP add-in boards and a PnP operating system (Windows 4, code-named Chicago, will support PnP).

A FEW TERMINOLOGY EXPLANATIONS

I/O address: storage location to whom the processing will be given when an interrupt must be handled. The I/O address is used for identification of program using port.

CMOS: battery-backed integrated circuit which stores information about floppy disks, hard disks, memory, and date and time. Always check battery - otherwise you may lose access to your PC.

IRQ: Interrupt Request Line. The IRQ suspends the CPU if an outside signal comes (e.g. by keyboard, mouse, printer, modem etc.). Interrupt can be handled immediately or stored for later processing. There are 16 hardware interrupts, starting from hex 00 to hex 0F.

Software interrupt: Is a routine called by a program. Device drivers and TSRs often install their own routines for fetching certain hardware interrupts. There are 256 software interrupts, from hex 00 to hex FF.

GRAPHIC ADAPTER CARDS

Every point on the screen is called a pixel. Therefore for each character some pixels are needed. The more pixel you can display on your screen the better the resolution. But: don't chose a too high resolution on a 14" monitor - otherwise you have difficulties to read text. The amount of pixels that can be displayed depends on two factors: the monitor, and the graphic adapter. There are different graphic adapter cards:

- Monographic card, 640x200 pixels (no graphics can be displayed)
- MDA Hercules monographic card, 720x348
- CGA colour graphic adapter, 320x200, 16 colours
- EGA colour graphic adapter, 640x350, 16 or more colours
- VGA colour graphic adapter, 640x480, 64 or more colours (SVGA colour graphic adapter, 640x480 up to 1024x768, up to 256 colours from a palette of 262,144)
- XGA colour graphic adapter, 1024x768, 64 or more colours

HARD DISKS

In our opinion the most important part of a PC. The hard disk, a mechanical device with moving parts, suffers wear and tear, and it is comparatively slow. You spend more time waiting for you hard disk than for any other part of your computer. Nowadays, one should chose a hard disk of about 200 MB. A 120 MB disk may be enough but with new software versions to come you may soon outgrow.

Up to 520 MB disks the so-called IDE drives are the one with the least problems. If you want a bigger hard disk than that go for SCSI drives.

CHARACTERISTICS OF A HARD DISK

Each hard disk has its own characteristics. Underneath an example of a 80 MB IDE disk drive.

Physical size:	82 MB	
Heads:	10	
tracks/cylinder:	964	
sectors/track:	17	(total sectors 163867)
bytes/sector:	512	
total clusters:	40878	
sectors/cluster:	4	(16 if compressed with DBLSPACE)
FAT type:	16 bit	
No of FATs:	2	
FAT start sector:	1	(320 sectors)
Root start sector:	321	(32 sectors)
Data start sector:	353	(163508 sectors)

DISK CONTROLLER INTERFACES

We have to know the following interface standards:

MFM: The oldest technology

RLL: Run Length Limited. Based on the MFM standard, allows to increase the amount of space up to 50 %.

SCSI: Small Computer System Interface. A standard found up to mini-computer level. Allows to 'daisy-chain' (drives are connected after each other, i.e. from the SCSI controller to the first device in, then from this device out to the next drive) up to 8 devices.

ESDI: A older standard developed by IBM.

PCMCIA: a interface standard found in notebooks and laptops.

Tip: If a SCSI adapter card will fit in an XT-style 8-bit adapter slot and can't transfer data at 5 MB/sec or faster, it is not good enough to control your hard disk. A 16-bit SCSI adapter is always more expensive. One good brand is the Adaptec 1542B. This SCSI card is supported by a wide range of applications and motherboard or system manufacturers. Another

Note that DOS can't access SCSI drives without special drivers. COREL is offering a good neutral SCSI software which plenty drivers for various hard disk brands, types, and other storage media like

BOOT PROCESS

To load MS-DOS you have to understand the so-called **boot procedure**. During that procedure the BIOS is loaded into RAM memory, then the two boot files IO.SYS and MSDOS.SYS are loaded into RAM, followed by the loading of the command processor (usually COMMAND.COM). The two boot files IO.SYS and MSDOS.SYS must reside at the beginning of a hard disk or a floppy disk. This area is called To make a floppy disk or a hard disk bootable you can use the FORMAT command with the /s switch (FORMAT [drivename:]/s). Or you can use the SYS command (not for hard disks).

The exact loading steps up to DOS 5.0 are:
ROM BIOS -> IO.SYS and MS-DOS.SYS -> CONFIG.SYS -> COMMAND.COM -> AUTOEXEC.BAT
Since DOS 6.x the system looks during the boot process also for compressed drives. The steps now are:
ROM BIOS -> IO.SYS and MS-DOS.SYS -> DBLSPACE.BIN and DBLSPACE.INI -> CONFIG.SYS and DBLSPACE.SYS -> COMMAND.COM -> AUTOEXEC.BAT

COMPRESSED DRIVES

To keep data compression as transparent as possible to the user (and to the application) it's best implemented as a background process that hooks into the normal file system and automatically compresses and decompresses files as they're saved on disk. If the compression software installs itself as a virtual drive on the system (similar to a logical partition), it can recede even further into the background. On PCs, however, that requires finding room in memory for yet another device driver and then protecting it from other drivers, programs and territorial TSRs (terminate-stay-resident) programs.

Contrary to file-level compression (e.g. files compressed with PKZip), a real-time compressor must rely on a device driver to reroute all file I/O through their compression routines.

Before MS-DOS 6.0, most third-party compressors used the same method employed for years by RAM disks, which are also virtual drives: they loaded the device driver from the CONFIG.SYS file during bootup. However, to swap drive letters so that the compressed drive appears as drive C, both the virtual drive and the physical drive need duplicate copies of CONFIG.SYS, AUTOEXEC.BAT and all files they reference. This leads to synchronization problems when you make any changes to the files.

Another potential problem is the competition for memory. Firstly, your may not have enough conventional memory. Secondly, if you modify the CONFIG.SYS to load the compressed drive's device driver to lead the compressed drive's device driver into *upper memory* (between 640 KB - 1024), it may conflict with other device drivers or TSRs competing for the same memory area.

Previous versions of MS-DOS couldn't load a device driver before CONFIG.SYS, but DOS 6 has a modified IO.SYS boot file that automatically preloads a device driver called DBLSPACE.BIN before CONFIG.SYS executes.

DBLSPACE.BIN reads a new configuration file called DBLSPACE.INI, mounts any compressed drives it finds listed there, assigns the appropriate drive letters and only then passes control to CONFIG.SYS. Even if DBLSPACE.SYS (needed to load DBLSPACE.BIN into upper memory) doesn't run or CONFIG.SYS file is trashed, DBLSPACE.BIN still preloads and mounts the DoubleSpace drive.

Once the compressed drive is mounted, it appears to the system as a virtual drive. All file I/O happens normally, except the device driver intercepts the I/O to compress and decompress files as they are saved and loaded from the compressed drive.

<u>Tip</u>: Always leave about 10 MB disk space on your system uncompressed. If you use a swap file (normally the case) for Windows 3.x, you even have to have some uncompressed space for it.

EXAMPLE OF CONFIGURATION FILES FOR A COMPRESSED DRIVE

Content of CONFIG.SYS

```
DEVICE=C:\DOS\HIMEM.SYS
DEVICE=C:\DOS\EMM386.EXE NOEMS
BUFFERS=15,0
FILES=60
DOS=UMB
LASTDRIVE=E
FCBS=4,0
DEVICEHIGH /L:1,12048 =C:\DOS\SETVER.EXE
DOS=HIGH
STACKS=9,256
device=c:\dos\interlnk.exe /lpt1
DEVICEHIGH=C:\DOS\DBLSPACE.SYS /MOVE
```

Content of AUTOEXEC.BAT

```
LH /L:0;1,42384 /S C:\DOS\SMARTDRV.EXE
@ECHO OFF
SET PCTOOLS=C:\PCT7\DATA
PROMPT $p$g
PATH = C:\;C:\BAT;C:\DOS;C:\WP51;C:\W31;C:\PM4;C:\ALDUS;C:\WORD20;C:\EXCEL4;C:\PCT7;C:\pct5;c:\nc
SET TEMP=C:\temp
LH /L:1,16528 KEYB SG
C:\DOS\SHARE.EXE
mouse
```

SYSTEM INTEGRATION AND INSTALLATION

Take the warnings about handling chips and other components seriously, follow the instruction mentioned in your technical handbook or reference guide with car, and you will find integrating your own system to be an interesting experience. You will be more at ease with your system and be more able to diagnose later problems than those who bought their systems completely assembled and tested.

Completing the Motherboard

It is easier to complete the motherboard before than after installing it in the case's chassis. If your motherboard is complete, you can skip this section.

If you have RAM chips or other motherboard options to install, set up a enough big work area. Unpack the board as described in the introduction. Handle it with care.

RAM INSTALLATION. You will destroy your RAM chips if you handle them improperly. The main threat is static electricity. If possible, seat yourself then touch a large metal object before installing any chips.

"Old" RAM chips have a notch, indentation, or other marker on one end. This notch marks the location of Pin 1. When old RAM chips are installed, the notched end must face toward the rear of the motherboard (toward the I/O adapter sockets.

SIMM chips are easier to install. In both cases, however, you have to fill the chips starting with Bank 0. Note that on some motherboards you cannot mix different RAM sizes together. In older motherboards, you may have to set a switch telling the system how much memory you have installed.

When you have finished installing the RAM chips, take time to inspect your work.

1. Make sure each pin (with old RAM chips) went into its socket completely and correctly. Be sure it didn't bend under the RAM chip or go outside the socket.
2. Check each inserted chip or SIMM module one more time.

80x87 MATH PROCESSOR INSTALLATION. Use the same handling rules described above for RAM chips. Straighten the chip's pins and insert it into its socket with care. Check your installation. When you add to your system be sure cables cannot touch the 80x87 chip (it can get very hot).

MOTHERBOARD. Remove the chassis from the outher case. While case styles vary, most are secured to their chassis by four to six screws around the edge of the rear panel of the chassis. Some of the newer motherboards have plastic flip-in "screws".

The metal conductors on the printed circuit board are called *printed circuit lays*. I you use metal stand-offs, be sure screws and stand-offs do not touch any of the lays on top or under the motherboard.

Place your motherboard in the chassis. The I/O adapter sockets should line up with the cutouts in the rear of the chassis.

Secure the motherboard to the chassis. Use care not to strike the components on the motherboard while installing it. Be sure to keep the I/O adapter sockets and the keyboard connector aligned with the cut outs in the chassis.

Insert one of your adapter cards into one of the I(O adapter sockets and be sure the motherboard is at the correct height. Make two tests: First see if the L-shaped lip on the card's metal mounting bracket comes down to touch the chassis. Second, see if the card's edge connector seats well into the I/O adapter socket.

This is a good time to complete your case. Mount the rest of your case hardware including the card guides and speaker.

Connect the included cables to the power-on manual reset switch, the keyboard lock and other lights or switches as mentioned in your installation manual.

POWER SUPPLY. Chose at least a 150 Watt power supply. Before you begin to install (better: check when ordering) your power supply, check and be sure it is the proper style for your case. Also check the power supply for a primary-winding switch: it permits the power supply to use either 110 or 220 volts AC. Once in place, secure the power supply by running the necessary screws through the rear panel of the chassis into the matching threads in the power supply.

The motherboard receives power from two power supply cables. Normally they are called P8 and P9. It depends on the motherboard, which power connector is needed.

Connect these two power cables from the power supply to the motherboard. Check your work several times. Especially check the wire colors (normally red wire to the front and orange to the rear). Improperly connected power is one of the easiest ways of damaging your motherboard.

Check to be sure the air intake for your power supply is not blocked.

Never connect a device to the power supply or insert or remove an I/O adapter card while the power is on.

FLOPPY DISKS. Installing a floppy disk controller and one or more floppy disk drives consists of the following steps:

1. Mounting and connecting the floppy disk drive(s)
2. Installing the floppy disk controller card (or HD/FD controller card with newer systems)
3. Cabling the controller and the drives together

Slide the floppy disk drive through the panel opening. Just leave it loose in its slot while you attach its power and signal cables. Attach one of the power supply's disk-drive power cables to the disk drive's power connector. Both connectors are keyed to fit only one way. Examine your signal cable and locate the proper connectors for drives A and B and the floppy disk controller. The connector for drive A is on the far end of the cable with the two connectors on it. Be sure the side of drive A's connector closest to the colored stripe is on the side of the drive's connecting which has a locating notch cut in it. The connector may have a key in it which matches the notch.

If you have a second drive to install at his time repeat the above instructions. Notice that the cable will be routed from the controller to connect to drive B then back to connect to drive A. Again, the drive at the far end of the cable is drive A and the one in the middle is drive B.

A terminating resistor pack is required in the disk drive at the end of the signal cable. Be sure disk drive a has a terminating resistor pack. When you install disk drive B, be sure to remove its terminating resistor pack. The resistor packs vary from one drive to another but are normally the only component on the disk drive's circuit board which is removable.

Connect the cable's controller connector to the floppy disk controller. Be sure the side of the connector closest to the colored stripe is connected to the side of the controller's connector with the notch or closest to Pin 1.

Select and I/O adapter socket for the floppy disk controller. Insert the controller firmly. Place the screw. Route the cables and check that they are securely located.

DISPLAY ADAPTER. Insert the adapter the same way you did the floppy disk adapter.

Configuration and Testing

You have now a system which allows to run the boot procedure. Before you do that you have to set the jumpers and option switches (only if available) accordingly. Otherwise when booting your system you may directly go to the CMOS setup routine. You can now connect the keyboard, the monitor and then connect the power supply to a power outlet. You should now be able to boot MS-DOS from a floppy disk.

INSTALLING A HARD DISK DRIVE

With different hard disk drives on the market for different hard disk controllers (AT/ISA, IDE, SCSI, EDSI) you have to follow the installation guide for your particular hard disk and your particular controller card. Installing the hard disk drive physically in a bay is similar as the floppy disk drive installation.

Sometimes you may have to configure your controller manually (jumpers and/or switch). Older disk drive models, you may need to configure manually, too (normally only jumpers). Always check your installation carefully. Check to ensure the colored stripe on your cables is closest to the notched side of the hard drive's edge connector and closest to Pin 1 of the controller's data and control connectors. Push the drive in and mount it with its screws. the

Formatting your hard disk

Your hard disk must be formatted at three levels:

1. HARD FORMAT. This step is specific to your drive and its controller. Your disk drive has to be initialized for use with its controller. This initialization is called drive initialize, hard-format, low-level-format, primary-format, initial-format, and the like. We will use the term hard-format. The hard-format defines address fields and data fields on each track of the hard disk. If you obtained your hard disk drive and controller combined as a kit, the drive may already be hard-formatted for use with its controller.

   To hard format your disk, you may used the supplied program. Some hard disks can be hard-formatted using DEBUG. After starting DEBUG, you would enter the following line:
   g=c800:5 <return>

   Note: be careful with the hard-format. All your data may be irreparably destroyed!

2. A hard disk's storage area can be divided into separate blocks called partitions. MS-DOS has a hard disk setup program called FDISK, which will set up the DOS partition. Only after you run FDISK (and reboot, since it is at boot time when DOS decides what hard disks are available) will DOS provide access to your hard disk drive. Prior to that time you will receive an "Invalid drive specification" error message if you try to use it.
3. In the third and final level of formatting, media defects are flagged and a directory is created. This is done using the same FORMAT command you use to format floppy diskettes.

DIAGNOSTICS UTILITIES

Some of the software utilities for repair and upgrade of a personal computer you can - or even you should buy - are:

- Check-It
- Norton Utilities
- PC Tools
- QA Plus Diagnostic Software

IDENTIFYING AND FIXING PROBLEMS

Common Problems

PROBLEM IDENTIFICATION. We will start by trying to discover the general type of problem. If you already know what isn't working, skip ahead to the proper paragraphs.

If you have little or no idea of the cause of your system's problem:

1. Set your system up in a cleared work area: about 3' wide by 2' deep.
2. Remove the case or open the top so you can check the installation and get to the option switches.
3. Have all your technical documentation and a bootable DOS floppy (plus utility software, if available) ready.
4. Turn the system's power switch off. Connect the system to a power outlet.
5. Connect your keyboard and display to the system unit. Connect the display to a power outlet. Turn the display on. Let it warm up.
6. Insert a bootable DOS floppy in your floppy disk drive A. Close the door, if necessary.
7. urn the system's power switch on.

POWER.

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