Chapter 4

Motherboards

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Easily the most important component in a PC system is the main board or *motherboard*. The terminology can be confusing because IBM refers to the motherboard as a *system board* or *planar*. The terms motherboard, system board, and planar are interchangeable. Not all systems have a motherboard in the true sense of the word. In some systems, the components found normally on a motherboard are located instead on an expansion adapter card plugged into a slot. In these systems, the board with the slots is called a *backplane*, rather than a motherboard. Systems using this type of construction are called *backplane systems*.

Backplane systems come in two main types: passive and active. A *passive backplane* means the main backplane board does not contain any circuitry at all except for the bus connectors and maybe some buffer and driver circuits. All of the circuitry found on a conventional motherboard is contained on one or more expansion cards installed in slots on the backplane. Some backplane systems use a passive design which incorporates the entire system circuitry into a single mothercard. The mothercard is essentially a complete motherboard that is designed to plug into a slot in the passive backplane. The passive backplane/mothercard concept allows the entire system to be easily upgraded by changing one or more cards. Because of the expense of the high function mothercard, this type of system design is rarely found in PC systems. The passive backplane design does enjoy popularity in industrial systems which are often rack mounted.

An *active backplane* means the main backplane board contains bus control and usually other circuitry as well. Most active backplane systems contain all of the circuitry found on a typical motherboard except for the *processor complex*. The processor complex is the name of the circuit board that contains the main system processor and any other circuitry directly related, such as clock control, cache, and so forth. The processor complex design allows the user to easily upgrade the system later to a new processor type by changing one card. In effect it amounts to a modular motherboard with a replaceable processor section. Most modern PC systems that use a backplane design use an active backplane/processor complex. Both IBM and Compaq use this type of design in some of their high-end (server class) systems, for example. This allows an easier and generally more affordable upgrade than the passive backplane/mothercard design since the processor complex board is usually much cheaper than a mothercard. Unfortunately, since there are no standards for the processor complex interface to the system, these boards are proprietary and can only be purchased from the system manufacturer. This limited market and availability causes the prices of these boards to be higher than most complete motherboards from other manufacturers.

The motherboard system design and the backplane system design have both advantages and disadvantages. Most original personal computers were designed as backplanes in the late 1970s. Apple and IBM shifted the market to the now traditional motherboard with a slot-type design because this type of system generally is cheaper to mass-produce than one with the backplane design. The theoretical advantage of a backplane system, however, is that you can upgrade it easily to a new processor and new level of performance by changing a single card. For example, you can upgrade a system with a 486-based processor card to a Pentium-based card just by changing the card. In a motherboard-design system, you must change the motherboard itself, a seemingly more formidable task. Unfortunately, the reality of the situation is that a backplane design is often much more expensive to upgrade, and because the bus remains fixed on the backplane, the backplane design precludes more comprehensive upgrades that involve adding local bus slots for example.

Because of the limited availability of the processor complex boards or mothercards, they usually end up being more expensive than a complete new motherboard that uses an industry standard form factor. For this reason, I recommend staying away from any backplane system designs. In most cases a conventional motherboard design makes it much easier to obtain replacement components for repair or upgrade.

Another nail in the coffin of backplane designs is the upgradable processor. Intel has designed all 486 and Pentium processors to be upgradable to faster (usually called OverDrive) processors in the future by simply swapping (or adding) the new processor chip. Changing only the processor chip for a faster one is the easiest and generally most cost-effective way to upgrade without changing the entire motherboard.

Replacement Motherboards

Some manufacturers go out of their way to make their systems as physically incompatible as possible with any other system. Then replacement parts, repairs, and upgrades are virtually impossible to find—except, of course, from the original system manufacturer, at a significantly higher price than the equivalent part would cost to fit an IBM or clone system. For example, if the motherboard in my original IBM AT (or any AT Clone) dies, I can find any number of replacement boards that will bolt directly into the AT chassis, with my choice of processors and clock speeds, at very good prices. If the motherboard dies in your Compaq Deskpro, you'll pay for a replacement available only from Compaq, and you have virtually no opportunity to select a board with a faster or better processor than the one that failed. In other words, upgrading one of these systems is almost out of the question.

Knowing What to Look For (Selection Criteria)

As a consultant, I often am asked to make a recommendation for purchases. Making these types of recommendations is one of the most frequent tasks a consultant performs. Many consultants charge a large fee for this advice. Without guidance, many individuals don't have any rhyme or reason to their selections and instead base their choices solely on magazine reviews or, even worse, on some personal bias. To help eliminate this haphazard selection process, I have developed a simple checklist that will help you select a system. This list takes into consideration several important system aspects overlooked by most such checklists. The goal is to ensure that the selected system truly is compatible and has a long life of service and upgrades ahead.

It helps to think like an engineer when you make your selection. Consider every aspect and detail of the motherboards in question. For instance, you will want to consider any future uses and upgrades. Technical support at a professional (as opposed to a user) level is extremely important; what support will be provided? Is there documentation, and does it cover everything else?

In short, a checklist is a good idea. Here is one for you to use in evaluating any IBM-compatible system. You might not have to meet every one of these criteria to consider a particular system, but if you miss more than a few of these checks, consider staying away from that system. The items at the top of the list are the most important, and the items at the bottom are perhaps of lesser importance (although I think each item is important!). The rest of this chapter discusses in detail the criteria in this checklist.

Processor. A 486 motherboard should be equipped with a 486DX2- or DX4-type processor—the faster the better. The 486 processor should be an SL Enhanced version, which is standard on the most desirable DX4 models. A Pentium motherboard should only use the second generation 3.3v Pentium processor, which has a 296-pin configuration that differs physically from the 273-pin first generation design. All second generation Pentiums are fully SL Enhanced.

Processor Sockets. A 486 motherboard should have a ZIF (Zero Insertion Force) processor socket that follows the Intel Socket 3 or Socket 6 specifications. A Pentium motherboard should have one or two ZIF sockets that follow the Intel Socket 5 specification.

Motherboard Speed. A 486 motherboard should run at 33 MHz for maximum performance and compatibility. Switchable speed selection is a bonus and may allow other speeds to be selected as well. A Pentium motherboard should run at 60 or 66 MHz and be speed-switchable between these two speeds. All components should be rated to run at the maximum allowable speed.

Cache Memory. All motherboards should have a Level 2 cache onboard. 486 motherboards should have 256K and Pentium motherboards should have 512K for maximum performance. The Level 2 Cache should be of a Write-Back design, and must be populated with chips that are fast enough to support the maximum motherboard speed.

SIMM Memory. 486 motherboards should ideally use 72-pin SIMMs which support a single bank per SIMM. 30-pin SIMMs are acceptable for upgrade boards designed to reuse memory from older motherboards. Pentium motherboards must only use 72-pin SIMMs. The SIMMs should be rated at 70 ns or faster.

Bus Type. 486 motherboards should have an ISA (Industry Standard Architecture) bus with either two or three VL-Bus, or ideally three or more PCI local bus slots. Pentium motherboards should have an ISA or EISA primary bus with three or more PCI local bus slots.

BIOS. The motherboard should use an industry standard BIOS such as those from AMI, Phoenix, or Award. The BIOS should be of a Flash ROM design for easy updating, and support Enhanced IDE as well as 2.88M floppy drives. APM (Advanced Power Management) support should be built into the BIOS as well.

Form Factor. For maximum flexibility, the motherboard should come in a Baby-AT form factor. This will allow it to be installed in the widest variety of case designs.

Built-In Interfaces. Ideally a motherboard should contain as many built-in standard controllers and interfaces as possible (except video). A motherboard should have a built-in floppy controller that supports 2.88M drives, a built-in local bus (PCI or VL-Bus) IDE connector, one or two built-in serial ports (must use 16550A type UARTs), and a built-in parallel port (must be EPP or ECP compliant). A built-in mouse port would be a bonus, although one of the serial ports can be used for a mouse as well. A built-in SCSI port is a bonus as long as it conforms to ASPI (Advanced SCSI Programming Interface) standards. Built-in network adapters are acceptable, but usually an ISA slot card network adapter is more easily supported via standard drivers and is more easily upgraded as well. Built-in video adapters are generally undesirable, since there are better choices in external local bus video adapters.

Power Management. The motherboard should fully support SL Enhanced processors with APM (Advanced Power Management) and SMM (System Management Mode) protocols that allow for powering down various system components to different levels of readiness and power consumption.

Documentation. Good technical documentation is a requirement. Documents should include information on any and all jumpers and switches found on the board, connector pinouts for all connectors, specifications for cache RAM chips, SIMMs and other plug-in components, and any other applicable technical information. I would also acquire separate documentation from the BIOS manufacturer covering the specific BIOS used in the system, as well as the Data Books covering the specific chipset used in the motherboard. Additional data books for any other controller or I/O chips on-board are a bonus, and may be acquired from the respective chip manufacturers.

You may note that these selection criteria seem fairly strict, and may disqualify many motherboards on the market, including what you already have in your system! These criteria will, however, guarantee you the highest quality motherboard offering the latest in PC technology that will be upgradable, expandable, and provide good service for many years. Most of the time, I recommend purchasing boards from better known motherboard manufacturers such as Intel, Micronics, AMI, Acer, Alaris, and so on. These boards might cost a little more than others that you have never heard of, but there is some safety in the more well-known brands. That is, the more boards that they sell, the more likely that any problems will have been discovered by others and solved long before you get yours. Also, if service or support is needed, the larger vendors are more likely to be around in the long run.

Documentation

As mentioned, extensive documentation is an important factor to consider when you're planning to purchase a motherboard. Most motherboard manufacturers design their boards around a particular *chipset*, which actually counts as the bulk of the motherboard circuitry. There are a number of manufacturers offering chipsets such as Intel, Micronics, Opti, VLSI, Chips & Technologies, and others. I recommend obtaining the data book or other technical documentation on the chipset directly from the chipset manufacturer.

One of the more common questions I get about a system relates to the BIOS Setup program. People want to know what the "Advanced Chipset Setup" features mean and what will be the effects of changing them. Often they go to the BIOS manufacturer thinking that the BIOS documentation will offer help. Usually, however, people find that there is no real coverage of what the chipset setup features are in the BIOS documentation. You will find this information in the data book provided by the chipset manufacturer. Although these books are meant to be read by the engineers who design the boards, they contain all of the detailed information about the chipset's features, especially those that might be adjustable. With the chipset data book, you will have an explanation of all of the controls in the Advanced Chipset Setup section of the BIOS Setup program.

Besides the main chipset data books, I also recommend collecting any data books on the other major chips in the system. This would include any floppy or IDE controller chips, "super I/O" chips, and the main processor as well. You will find an incredible amount of information on these components in the data books. A word of warning: most chipset manufacturers only make a particular chip for a short time, rapidly superseding it with an improved or changed version. The data books are only available during the time the chip is being manufactured so if you wait too long you will find that such documents may no longer be available. The time to collect documentation on your motherboard is NOW!

ROM BIOS Compatibility

The issue of ROM BIOS compatibility is important. If the BIOS is not compatible, any number of problems can result. Several reputable companies that produce compatibles have developed their own proprietary ROM BIOS that works just like IBM's. These companies also frequently update their ROM code, to keep in step with the latest changes

IBM has incorporated into its ROMs. Because IBM generally does not sell ROM upgrades or provide them for older systems (unless the upgrade is absolutely necessary, and IBM decides if that is the case), keeping current with an actual IBM system is more difficult than with most of the compatible systems on the market. The newer PS/2 systems do use a BIOS that is either stored on the hard disk, or contained in a Flash ROM that is easily updated via a floppy disk. If you have one of these systems, BIOS upgrade disks can be obtained via the IBM National Support Center (NSC) BBS. The number is listed in Appendix B. Also, many of the compatibles' OEMs (original equipment manufacturers) have designed ROMs that work specifically with additional features in their systems while effectively masking the effects of these improvements from any software that would "balk" at the differences.

OEMs. Many OEMs have developed their own compatible ROMs independently. Companies such as Compaq, Zenith, and AT&T have developed their own BIOS product, which has proven compatible with IBM's. These companies also offer upgrades to newer versions that often can offer more features and improvements or fix problems with the older versions. If you use a system with a proprietary ROM, make sure that it is from a larger company with a track record and one that will provide updates and fixes as necessary.

Several companies have specialized in the development of a compatible ROM BIOS product. The three major companies that come to mind in discussing ROM BIOS software are American Megatrends, Inc. (AMI), Award Software, and Phoenix Software. Each company licenses its ROM BIOS to a motherboard manufacturer so that the manufacturer can worry about the hardware rather than the software. To obtain one of these ROMs for a motherboard, the OEM must answer many questions about the design of the system so that the proper BIOS can be either developed or selected from those already designed. Combining a ROM BIOS and a motherboard is not a haphazard task. No single, generic, compatible ROM exists, either. AMI, Award, and Phoenix ship to different manufacturers many variations of their BIOS code, each one custom-tailored to that specific system, much like DOS can be.

AMI. Although AMI customizes the ROM code for a particular system, it does not sell the ROM source code to the OEM. An OEM must obtain each new release as it becomes available. Because many OEMs don't need or want every new version that is developed, they might skip several version changes before licensing a new one. The AMI BIOS is currently the most popular BIOS in PC systems today. Newer versions of the AMI BIOS are called *Hi-Flex* due to the high flexibility found in the BIOS configuration program. The AMI Hi-Flex BIOS is used in Intel, AMI, Alaris and many other manufacturer's motherboards. One special AMI feature is that it is the only third-party BIOS manufacturer to make its own motherboard as well.

Older versions of the AMI BIOS had a few problems with different keyboards and keyboard controller chips, and very early versions also had some difficulty with certain IDE hard disk drives. To eliminate these types of problems, make sure that your AMI BIOS is dated 04/09/90 or later, and has keyboard controller F or later. You will possibly have keyboard lockups and problems running Windows or OS/2 if you have an older keyboard controller chip.

To locate this information, power on the system and observe the BIOS ID string displayed on the lower left of the screen. The primary BIOS Identification string (ID String 1) is displayed by any AMI BIOS during the POST (Power-On Self Test) at the left bottom corner of the screen, below the copyright message. Two additional BIOS ID strings (ID String 2 and 3) can be displayed by the AMI Hi-Flex BIOS by pressing the Insert key during POST. These additional ID strings display the options that are installed in the BIOS.

The general BIOS ID String 1 format for older AMI BIOS versions is the following:

ABBB-NNNN-mmddyy-KK

Position	Description
A	BIOS Option: D = Diagnostics built-in. S = Setup built-in. E = Extended Setup built-in.
BBB	Chipset or Motherboard Identifier: C&T = Chips & Technologies chipset. NET = C&T NEAT 286 chipset. 286 = Standard 286 motherboard. SUN = Suntac chipset. PAQ = Compaq motherboard. INT = Intel motherboard. AMI = AMI motherboard. G23 = G2 chipset 386 motherboard.
NNNN	The manufacturer license code reference number.
mmddyy	The BIOS release date, mm/dd/yy.
KK	The AMI keyboard BIOS version number.

The BIOS ID String 1 format for AMI Hi-Flex BIOS versions is the following:

AB-CCcc-DDDDDD-EFGHIJKL-mmddyy-MMMMMMMM-N

Position	Description
A	Processor Type: 0 = 8086 or 8088. 2 = 286. 3 = 386. 4 = 486. 5 = Pentium.
B	Size of BIOS: 0 = 64K BIOS. 1 = 128K BIOS.
CCcc	Major and Minor BIOS version number.
DDDDDD	Manufacturer license code reference number: 0036xx = AMI 386 motherboard, xx = Series #. 0046xx = AMI 486 motherboard, xx = Series #. 0056xx = AMI Pentium motherboard, xx = Series #.

(continues)

AB-CCcc-DDDDDD-EFGHIJKL-mmddyy-MMMMMMMM-N Continued

Position	Description
E	1 = Halt on Post Error.
F	1 = Initialize CMOS every boot.
G	1 = Block pins 22 and 23 of the keyboard controller.
H	1 = Mouse support in BIOS/keyboard controller.
I	1 = Wait for <F1> key on POST errors.
J	1 = Display floppy error during POST.
K	1 = Display video error during POST.
L	1 = Display keyboard error during POST.
mmddyy	BIOS Date, mm/dd/yy.
MMMMMMMM	Chipset identifier or BIOS name.
N	Keyboard controller version number.

AMI Hi-Flex BIOS ID String 2:

AAB-C-DDDD-EE-FF-GGGG-HH-II-JJJ

Position	Description
AA	Keyboard controller pin number for clock switching.
B	Keyboard controller clock switching pin function: H = High signal switches clock to high speed. L = High signal switches clock to low speed.
C	Clock switching through chip set registers: 0 = Disable. 1 = Enable.
DDDD	Port address to switch clock high.
EE	Data value to switch clock high.
FF	Mask value to switch clock high.
GGGG	Port Address to switch clock low.
HH	Data value to switch clock low.
II	Mask value to switch clock low.
JJJ	Pin number for Turbo Switch Input.

AMI Hi-Flex BIOS ID String 3:

AAB-C-DDD-EE-FF-GGGG-HH-II-JJ-K-L

Position	Description
AA	Keyboard controller pin number for cache control.
B	Keyboard controller cache control pin function: H = High signal enables the cache. L = High signal disables the cache.

Position	Description
C	1 = High signal is used on the keyboard controller pin.
DDD	Cache control through Chipset registers: 0 = Cache control off. 1 = Cache control on.
EE	Port address to enable cache.
FF	Data value to enable cache.
GGGG	Mask value to enable cache.
HH	Port address to disable cache.
II	Data value to disable cache.
JJ	Mask value to disable cache.
K	Pin number for resetting the 82335 memory controller.
L	BIOS Modification Flag: 0 = The BIOS has not been modified. 1–9, A–Z = Number of times the BIOS has been modified.

The AMI BIOS has many features, including a built-in setup program activated by pressing the Delete or Esc key in the first few seconds of booting up your computer. The BIOS will prompt you briefly as to which key to press and when to press it. The AMI BIOS offers user-definable hard disk types, essential for optimal use of many IDE or ESDI drives. The newer BIOS versions also support Enhanced IDE drives and will autoconfigure the drive parameters. A unique AMI BIOS feature is that, in addition to the setup, it has a built-in, menu-driven, diagnostics package, essentially a very limited version of the stand-alone AMIDIAG product. The internal diagnostics are not a replacement for more comprehensive disk-based programs, but they can help in a pinch. The menu-driven diagnostics does not do extensive memory testing, for example, and the hard disk low-level formatter works only at the BIOS level rather than at the controller register level. These limitations often have prevented it from being capable of formatting severely damaged disks.

An excellent feature of AMI is its technical support BBS. You will find the phone number listed in the vendor list in Appendix B. The AMI BIOS is sold through distributors, and any updates to the AMI BIOS or keyboard controller are available through Washburn and Co., also listed in the vendor list in Appendix B.

Award. Award is unique among BIOS manufacturers because it sells its BIOS code to the OEM and allows the OEM to customize the BIOS. Of course, then the BIOS no longer is Award BIOS, but rather a highly customized version. AST uses this approach on its systems, as do other manufacturers, for total control over the BIOS code, without having to write it from scratch. Although AMI and Phoenix customize the ROM code for a particular system, they do not sell the ROM's source code to the OEM. Some OEMs that seem to have developed their own ROM code started with a base of source code licensed to them by Award or some other company.

The Award BIOS has all the normal features you expect, including a built-in setup program activated by pressing Ctrl-Alt-Esc. This setup offers user-definable drive types, required in order to fully utilize IDE or ESDI hard disks. The Power-On Self Test is good, and Award runs a technical support BBS. The phone number for the BBS is listed in the vendor list in Appendix B.

In all, the Award BIOS is high quality, has minimal compatibility problems, and offers a high level of support.

Phoenix. The Phoenix BIOS for many years has been a standard of compatibility by which others are judged. It was one of the first third-party companies to legally reverse-engineer the IBM BIOS using a “clean room” approach. In this approach, a group of engineers studied the IBM BIOS and wrote a specification for how that BIOS should work and what features should be incorporated. This information then was passed to a second group of engineers who had never seen the IBM BIOS. They could then legally write a new BIOS to the specifications set forth by the first group. This work would then be unique and not a copy of IBM’s BIOS; however, it would function the same way. This code has been refined over the years and has very few compatibility problems compared to some of the other BIOS vendors.

The Phoenix BIOS excels in two areas that put it high on my list of recommendations. One is that the Power-On Self Test is excellent. The BIOS outputs an extensive set of beep codes that can be used to diagnose severe motherboard problems which would prevent normal operation of the system. In fact, this POST can isolate memory failures in Bank 0 right down to the individual chip with beep codes alone. The Phoenix BIOS also has an excellent setup program free from unnecessary frills, but that offers all of the features one would expect, such as user-definable drive types, and so on. The built-in setup is activated by typing either Ctrl-Alt-S or Ctrl-Alt-Esc, depending on the version of BIOS you have.

The second area in which Phoenix excels is the documentation. Not only are the manuals that you get with the system detailed, but Phoenix also has written a set of BIOS technical-reference manuals that are a standard in the industry. The set consists of three books, titled *System BIOS for IBM PC/XT/AT Computers and Compatibles*, *CBIOS for IBM PS/2 Computers and Compatibles*, and *ABIOS for IBM PS/2 Computers and Compatibles*. Phoenix is one of few vendors who has done extensive research on the PS/2 BIOS and has produced virtually all of the ROMs in the PS/2 Micro Channel clones on the market. In addition to being an excellent reference for the Phoenix BIOS, these books serve as an outstanding overall reference to any company’s IBM-compatible BIOS. Even if you never have a system with a Phoenix BIOS, I highly recommend these books, published by Addison-Wesley and available through most bookstores.

Micronics motherboards have always used the Phoenix BIOS, and these motherboards are used in many of the popular “name-brand” compatible systems. Phoenix is also one of the largest OEMs of Microsoft MS-DOS. Many of you that have MS-DOS have the Phoenix OEM version. Phoenix licenses its DOS to other computer manufacturers so long as they use the Phoenix BIOS. Because of its close relationship with Microsoft, it has access to the DOS source code, which helps eliminate compatibility problems.

Although Phoenix does not operate a technical support BBS by itself, its largest nationwide distributor does, which is Micro Firmware Inc. The BBS and voice phone numbers are listed in the vendor list in Appendix B. Micro Firmware offers upgrades to many systems with a Phoenix BIOS including Packard Bell, Gateway 2000 (with Micronics motherboards), Micron Technologies, and others.

Unless the ROM BIOS is truly a compatible, custom OEM version such as Compaq's, you might want to install in the system the ROM BIOS from one of the known quantities, such as AMI, Award, or Phoenix. These companies' products are established as ROM BIOS standards in the industry, and frequent updates and improvements ensure that a system containing these ROMs will have a long life of upgrades and service.

Using Correct Speed-Rated Parts

Some compatible vendors use substandard parts in their systems to save money. Because the CPU is one of the most expensive components on the motherboard, and many motherboards are sold to system assemblers without the CPU installed, it is tempting to the assembler to install a CPU rated for less than the actual operating speed. A system can be sold as a 33 MHz system, for example, but when you look "under the hood," you may find a CPU rated for only 25 MHz. The system does appear to work correctly, but for how long? If the company that manufactures the CPU chip installed in this system had tested the chip to run reliably at 33 MHz, it would have labeled the part accordingly. After all, the company can sell the chip for more money if it works at the higher clock speed. When a chip is run at a speed higher than it is rated for, it will run hotter than normal. This may cause the chip to overheat occasionally, which appears as random lockups, glitches, and frustration. I highly recommend that you avoid systems whose operation speed exceeds the design of the respective parts.

This practice is easy to fall into since the faster rated chips cost more money, and Intel and other chip manufacturers usually rate their chips very conservatively. I have taken several 25 MHz 486 processors and run them at 33 MHz, and they seemed to work fine. The Pentium 90 chips I have tested seem to run fine at 100 MHz. Although I might purchase a Pentium 90 system and make a decision to run it at 100 MHz, if I were to experience lockups or glitches in operation, I would immediately return it to 90 MHz and retest. If I purchase a 100 MHz system from a vendor, I fully expect it to have 100 MHz parts, not 90 MHz parts running past their rated speed! These days many chips will have some form of heat sink on them, which helps to prevent overheating, but which can also sometimes cover up for a "pushed" chip. If the price is too good to be true, ask before you buy: "Are the parts really manufacturer-rated for the system speed?"

To determine the rated speed of a CPU chip, look at the writing on the chip. Most of the time, the part number will end in a suffix of –xxx where the xxx is a number indicating the maximum speed. For example, a –100 indicates that the chip is rated for 100 MHz operation.

Motherboard Form Factors

There are several compatible form factors used for motherboards. The form factor refers to the physical dimensions and size of the board, and dictates what type of case the board will fit into. The types of motherboard form factors generally available are the following:

- Full-size AT
- Baby-AT
- LPX

The full-size AT motherboard is so named because it matches the original IBM AT motherboard design. This allows for a very large board of up to 12 inches wide by 13.8 inches deep. The keyboard connector and slot connectors must conform to specific placement requirements to fit the holes in the case. This type of board will fit into full-size AT or Tower cases only. Because these motherboards will not fit into the popular Baby-AT or Mini-Tower cases, and because of advances in component miniaturization, they are no longer being produced by most motherboard manufacturers.

The Baby-AT form factor is essentially the same as the original IBM XT motherboard, with modifications in screw hole positions to fit into an AT-style case (see fig. 4.1). These motherboards also have specific placement of the keyboard connector and slot connectors to match the holes in the case. Note that virtually all full size AT and Baby-AT motherboards use the standard 5-pin DIN type connector for the keyboard. Baby-AT motherboards will fit into every type of case except the low profile or slimline cases. Because of their flexibility, this is now the most popular motherboard form factor. Figure 4.1 shows the dimensions and layout of a Baby-AT motherboard.

Another popular form factor used in motherboards today is the LPX and Mini-LP form factors. This form factor was first developed by Western Digital for some of its motherboards. Although it no longer produces PC motherboards, the form factor lives on and has been duplicated by many other motherboard manufacturers. These are used in the Low Profile or slimline case systems sold widely today. The LPX boards are characterized by several distinctive features. The most noticeable is that the expansion slots are mounted on a *Bus Riser* card that plugs into the motherboard. Expansion cards must plug sideways into the riser card. This sideways placement allows for the low profile case design. Slots will be located on one or both sides of the riser card depending on the system and case design. Another distinguishing feature of the LPX design is the standard placement of connectors on the back of the board. An LPX board will have a row of connectors for video (VGA 15-pin), parallel (25-pin), two serial ports (9-pin each), and mini-DIN PS/2 style Mouse and Keyboard connectors. All of these connectors are mounted across the rear of the motherboard and protrude through a slot in the case. Some LPX motherboards may have additional connectors for other internal ports such as Network or SCSI adapters. Figure 4.2 shows the standard form factors for the LPX and Mini-LPX motherboards used in many systems today.

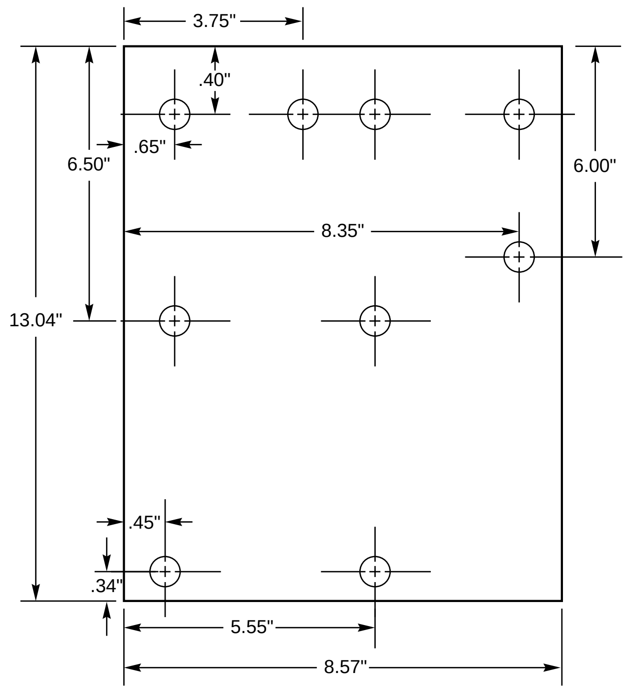

Fig. 4.1
Baby-AT motherboard form factor.

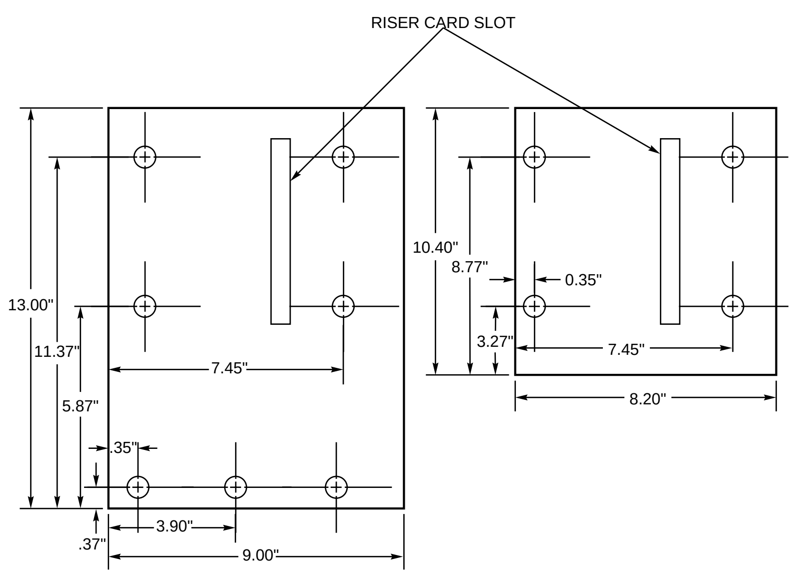

Fig. 4.2
LPX and Mini-LPX motherboard form factors.

There can be some differences between systems with LPX form factor motherboards, so it is possible to find interchangeability problems between different motherboards and cases. I usually do not recommend LPX style systems if upgradability is a factor since it is not only difficult to locate a new motherboard that will fit, but LPX systems are also limited in expansion slots and drive bays as well. Generally, the Baby AT configuration is the most popular and the most flexible type of system to consider.

Summary

The motherboard is obviously the core of your system, and is one component that you do not want to take lightly. There are hundreds of versions available, with a variety of different CPUs, speeds, features, and options. This chapter has covered the basics about different motherboards including a list of desirable features. Also discussed were the different form factors you will encounter and how they can affect other system options.