# Understanding Processor Sockets And Slots

*There are almost as many CPU slots and sockets in use today as there are processor types. And the area is becoming even more confusing.*

**By Phil Morris**

There is a wide variety of processors used in today's PCs. Intel's older Pentium, Pentium II and newer Pentium III, Pentium IV and Itanium processors all use separate and incompatible socket types, as do the offerings from Intel's main competitor, AMD. The purpose of this article is to examine the choices available, plus to list the processors more commonly associated with the slots and sockets used in today's motherboards. In many cases, especially earlier in the life of the PC, Intel led the way with the new processors while others like AMD produced their own compatible clones - AMD has, though, done a lot of catching up and overtaking in recent years, proving a very strong competitor to Intel for the desktop market.

Figure 1 shows a list of Intel and AMD socket types from the early days of the PC to the present. I have mainly listed those that were used in the majority of desktop PCs. In order to make the lists as easy to read as possible I have left out the many clones from manufacturers such as AMD and Cyrix. I don't wish Figure 1 to appear Intel-centric but it is safe to assume that, especially in AMD's case, it produced clones of Intel's processors from the 8086 onwards and started to take the lead in recent years. In addition to Figure 1, for a link to some very useful Web sites listing CPU information, pins, pin layouts, and all socket types from Socket 1 to Socket 7 (and including Slot 1) see the Web Resources section.

There are, of course, architectural differences between the main types of slot / socket, but the line has become more blurred over the years. For example, the older Socket 7 CPUs require separate cache modules while the others do not, having for example the L2 either built into the chip or still separate but on the same cartridge. Other than that, there are no performance advantages inherent in Slot 1 or Slot 2 designs over, for example, the older but historically very popular Socket 7 or Super7. While it is true that Slot 1 and 2 motherboards often have better features (higher bus speeds, AGP) it should not be assumed that they are superior to, for example, the older Socket 7 boards. Various slot and socket designs can support multiple CPUs, for example, Socket 7 and Slot 1 designs can support a pair of CPUs - Socket 8 and Slot 2 can go up to four or even eight CPUs, with the right motherboard and supporting hardware.

## *Intel Socket 7 And AMD Super7*

Even though very few Socket 7 and Super7 boards are produced these days, it would be an oversight not to very briefly mention these extremely popular and prolific sockets. There is still a great number of Socket 7 / Super7 motherboards in existence and they aren't going to fade away that quickly, even against usurpers such as the newer and increasingly popular Intel Socket 370 and AMD Socket A.

Socket 7 was LIF-based and featured 296 pin holes. It supported a wide choice of available CPUs from Intel, AMD, Winchip, Cyrix, Evergreen, Kingston and Power-Leap. Motherboards were available with CPU speeds up to 450 MHz and bus speeds of up to 124 MHz (a few boards went higher than this, but reliability then became a factor). The Intel Pentium Classic ceased production at the end of 1998 and the Pentium MMX 200 and 233 MHz CPUs continued production until the end of 1999.

AMD naturally produced CPUs for Socket 7, the most popular being the K6 range in its assorted versions, also the somewhat disappointing K5, the improved K6, K6-2 and K6-III. Super7, also known as Super Socket 7, was AMD's enhanced version of Intel's Socket 7 - the advantages with Super7 being the additional AGP support and a 100 MHz FSB.

## Intel's Socket 370

Socket 370 was originally designed by Intel to support its new socketed Celeron processors (as opposed to the Celeron versions that utilised a Slot 1 connector). One of the reasons that Intel introduced Socket 370 was due to the competition then afforded by AMD's K6 range of CPUs. Another reason that Slot 1 came about was because of the then separate L2 cache on earlier Slot 1 CPUs.

The 370 socket itself consists of a square SPGA socket with 370 pin holes arranged in a 37 x 37 configuration (which is also sometimes referred to as 19 x 19). More recent Socket 370 motherboards also support FC-PGA Celeron and Pentium III CPUs - the earliest Celeron to use the FC-PGA package was the Celeron 566. Electrically the two differ slightly: the voltage requirements were changed from Intel's VRM 8.2 to VRM 8.4, plus some of the pins have a different use. A 66 MHz FSB is required for Celeron CPUs, while Pentium III units require a 100/133 MHz FSB. As for the chipset, Intel has developed the 815 chipset for Socket 370 motherboards, other compatible Intel chipsets being the 440BX, 440ZX, 810, 810e and 810e2. It does though have strong competition from manufacturers producing an assortment of compatible chipsets, some examples being from Ali, SiS and VIA.

Socket 370 has proved to be one of the more popular socket types, partly because of the popularity of the cheap and overclockable Celeron range. However, Intel is not the only processor manufacturer which produces CPUs that require Socket 370 - the Cyrix MIII (VIA C3) range also utilises it. No AMD CPUs will run in Socket 370 equipped motherboards, instead the K6 range requires the older Super7 sockets while the newer Athlons and Durons are tied to Socket A. Figure 2 contains a list of some of the more common Socket 370 CPUs.

## Socket 370 Into Slot 1

Even though Socket 370 is widely used, there are still plenty of instances where there is a requirement to plug a Slot 1-based CPU into a Socket 370-equipped motherboard - this can easily be accomplished by means of a Socket 370 to Slot 1 converter. There is, by definition, also a Slot 1 to Socket 370 converter that enables Socket 370-based CPUs to be plugged into a Slot 1 motherboard. Such converters are made by various outlets, some of the more popular ones are produced by IWill, Asus, MSI, Powerleap

| CPU | Slot, Socket or number of pin holes |
|---|---|
| 8086 | 40-pin DIP (Dual In-Line Package) |
| 8088 | 40-pin DIP |
| 80286 | 68-pin DIP |
| 80386/80386DX | 132-pin PGA (Pin Grid Array) |
| 80386SX | 100-pin QFP (Quad Flat Package) |
| 80486SX/DX/DX2/DX4 and 486 Pentium Overdrive | Socket 1, 2 and 3 |
| Pentium 60/66/75-133 and Overdrive | Socket 3, 4, 5 and Super7 (for AMD) |
| Pentium 75-300 and Overdrive | Socket 7 |
| Pentium Pro | Socket 8 |
| Pentium II | Slot 1 |
| Pentium II Xeon | Slot 2 |
| Celeron | Slot 1 and Socket 370 |
| Pentium III | Slot 1 and Socket 370 |
| Pentium III Xeon | Slot 2 |
| VIA C3 | Socket 370 |
| Pentium IV | Socket 423 |
| AMD Athlon | Slot A |
| AMD Thunderbird (Athlon) and Duron | Socket A (Socket 462) |
| Itanium | PAC418 |
| AMD Hammer series | Possible new socket type |

*Figure 1 - Past, Present and future Intel and AMD slot and socket types used in PCs.*

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and Abit. Where required, these converters don't just provide the appropriate connector, they also make provision for voltage conversion.

Socket 370 motherboards are produced by all of the major motherboard manufacturers, so it shouldn't be hard to find one. Just to give some examples, try manufacturers such as Gigabyte, IWill, MSI, Soltek and Elitegroup. These all use VIA's Apollo Pro 133A chipset.

## AMD Slot A

AMD's Slot A had a relatively short life, being fairly rapidly superseded by Socket A due to the introduction of AMD's socket-based Thunderbird and Duron processors. Slot A featured a SECC slot with 242 leads and used the Voltage ID Voltage Regulator Module (VID VRM) which puts the onus on the CPU to set the VRM to the correct operating voltage. In the case of Slot A CPUs, this allowed voltages to be set between 1.3 and 2.05.

The Athlon K7 was released in August 1999 and became available at clock speeds between 500 and 700 MHz. A later version followed, called the K75, this was available at clock speeds between 550 MHz and 1 GHz. Finally there was the OEM-only release of the Slot A Athlon / Thunderbird which would go on to achieve even greater things in its Socket A incarnation. Figure 3 lists the Slot A CPUs.

When AMD announced that Slot A would be replaced with Socket A due to the imminent launch of the new socket-based CPUs, some people were understandably upset, most notably motherboard manufacturers. After all, here was a fairly new socket being replaced by a totally new socket type within the span of one year. We all know that PC technology moves at a rapid pace, but sometimes you have to draw the line somewhere. Still, AMD pushed on regardless with its plans for a rapid phase-out of Slot A - after all, it didn't have much choice if it was to compete strongly with Intel. Socket A of course went on to much success.

## AMD's Socket A

Socket A was designed by AMD to accommodate its new revision of the Athlon which used the new Thunderbird core / design. This basically places the second level cache and the CPU core onto just one die, so not only is the package smaller (so it can sit in a socket instead of a slot) but it is faster too. To avoid confusion, AMD decided to name its newly revised Athlon core Thunderbird in order to distinguish it from the Slot A-based K7 Athlon, therefore you will encounter instances where Athlon can be interpreted as referring to the Socket or Slot incarnations, whereas Thunderbird is more likely to refer to the newer socket-based CPU.

AMD's other CPU to use Socket A is the Duron, which is basically an Athlon / Thunderbird with less L2 cache. Production costs on cartridge-based microprocessors are higher, which is one of the reasons that AMD moved away from the old Athlon's Slot A design and implemented the socket-based Athlon / Thunderbird. See Figure 4 for a list of common Socket A CPUs.

Socket A is a square PGA socket consisting of 462 pin holes, of which 453 are used by the CPU. Several chipsets are capable of being used with Socket A, some examples being AMD's AMD760, VIA's Apollo KT133A, SiS 735, VIA KT266 and Ali Magik 1. Note that AMD does not recommend using VIA's KX133 chipset with Socket A CPUs as intermittent system errors can occur. There is an interesting review of Socket A chipsets at the x-bit lab's Web site where a selection of Socket A chipsets are reviewed - see the Web Resources box (*this will appear in next month's issue of PCSA - Ed.*) for the exact URL.

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| Name | Clock Speed (MHz) | Comments |
|---|---|---|
| Celeron | 300 to 533 | A series, Obsolete |
| Celeron II | Up to 900 | A series, Coppermine core |
| Pentium III | Up to 1.13 GHz | Mobile version also available |
| Cyrix MIII | Up to 800 | Officially called the VIA C3 |

*Figure 2 - Socket 370 CPUs.*

Due to the success of the Thunderbird and Duron, Socket A is proving to be very popular and prolific - most of the major motherboard manufacturers produce a board that is capable of supporting these new CPUs. Not only are the new processors faster than the competition from Intel but they are also cheaper.

If you are looking for a suitable converter so that a similar type of compatible processor, such as the original Athlon, can be used in a Socket A motherboard then don't bother - there isn't such a device and isn't likely to be either. Socket A motherboards work with Socket A CPUs only. Conversely, there is no converter which would allow Thunderbird or even Duron to work in an older Slot A motherboard. All is not lost, though, if you really want to use a Thunderbird in a Slot A motherboard, as Slot A specific versions are available, although these are OEM versions and are not available at such high clock rates as their Socket A brethren.

Even if you do manage to source a Slot A version, it is worth noting that they don't work on all Slot A motherboards. Socket A motherboards are, though, in plentiful supply and are produced by manufacturers such as ABit, Gigabyte, IWill, Soltek, Asus, MSI, Acorp, QDI, NMC and AOpen.

When it was first introduced, Socket A caused quite a few raised eyebrows, as it replaced the then relatively new Slot A. Various manufacturers had invested money in developing suitable motherboards for the new processor type and AMD came along and, in a manner of speaking, pulled the rug out from under their feet. However, the future of Socket A looks very good - AMD has stated that it will support it through 2002 and beyond.

## Slot 1

Intel's Slot 1 CPUs have been around for a while now and use the GTL+ bus protocol from the Pentium Pro CPU. This hosts the dual independent bus (DIB). The DIB allows Slot 1 CPUs to use one bus to communicate with memory and system devices external to the CPU (the PCI and AGP buses) and another bus for communication with the second level cache, which is built into the Pentium II CPU cartridges. Along with Slot 1, GTL+ is patented by Intel. These two patents have cut down Intel's competition in the Slot 1 marketplace, as chipset and CPU manufacturers have to license them from Intel. Supported bus speeds vary considerably from 60 MHz up to 133 MHz plus there is also a great variety of multipliers which are dependant on the CPU in use, varying from 3.5 up to 11.5.

Like Socket 8, no third party has produced a Slot 1 CPU. One early disadvantage of Slot 1 was that systems could only use up to 512 MB of RAM. This was seen as a failing of Slot 1, when in fact it was the early CPUs which could not cope. In any case, it was a serious problem for large servers where the 512 MB limit could be exceeded quite easily.

With Intel's newer Socket 370 processors these are all moot points now, due to the demise of processors that require Slot 1. These were processors such as the earlier Celerons (prior to the A series), the Celeron A series, the Pentium Pro (requiring an adapter/converter), Pentium II and Pentium III. However, there are still a great number of Slot 1 machines out in the field - due to the availability of Slot 1 to Socket 370 converters it is possible to upgrade some PCs with Socket 370 CPUs without having to purchase a new motherboard.

## Intel's Slot 2

Slot 2 is designed for servers, particularly multiprocessor configurations. Quad-processor Pentium II systems are also possible. Slot 2 CPUs use a CSRAM second-

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| Name | Clock Speed (MHz) | Comments |
|---|---|---|
| Athlon K7 | 500 to 700 | Obsolete |
| Athlon K75 | 550 to 1 GHz | Obsolete |
| Athlon (Slot A Thunderbird) | 750 to 1 GHz | OEM version only |

*Figure 3 - Slot A CPUs.*

level cache running at the full CPU clock speed. Slot 2 will handle the obsolete Pentium II Xeon (400 - 450 MHz), Pentium III Xeon (500 - 550 MHz), and the Coppermine revision of Pentium III Xeon which is available at speeds between 600 MHz to 1 GHz. Bus speeds of 100 MHz and 133 MHz are supported, along with clock multipliers between 4.0x and 7.0x. Chipset support is provided by Intel's 440GX, 450NX, 840 and Profusion.

For those confused by the differences between Slot 1 and Slot 2, Slot 2 has thermal sensing, longer product life (according to Intel), on-cartridge VRM (the voltage regulator), enhanced management options, scalability, and some other differences within the CPU cartridge itself. Slot 2 doesn't look like being dropped any time soon - Intel has Pentium III Xeon CPUs lined up for well into 2002. However, with the advent of the Socket 603-based Pentium 4 Xeon, the Pentium III Xeon is being relegated to the position of a workstation and one- and two-way server processor.

## *Intel Socket 423 And Socket 478*

With the release of the Pentium 4, Intel introduced yet another socket to its line-up, namely Socket 423. Socket 423 has, as the name implies, 423 pin holes arranged in a 20 x 20 configuration to accommodate Intel's new 0.18 micron processor. The VID VRM operational range is 1.0 volts to 1.85 volts, with a Quad-Pumped FSB of 100 MHz. Possible multipliers range from 13.0x up to 20.0x while the bus protocol used is GTL+. The supporting Intel chipset is the new i850 (code-named Tehama), although there is some competing chipset support from manufacturers such as VIA (P4X266), Ali (M1661), Acer Labs (Aladdin P4) and SiS (645). At the time of writing there are some interesting legal rumblings regarding VIA's P4X266, along the lines that it wasn't "authorised" by Intel. Legal proceedings are a possibility. VIA is also working on an integrated version of the chipset, the P4M266.

As for the CPU itself, the Pentium 4 is a large processor even by today's standards. The heatsink is so big and heavy that it requires extra support to prevent the weight from distorting and maybe damaging the socket and motherboard. This support is gained by the provision of four screws - these go through four pre-fabricated holes in the motherboard, they are then fixed to the motherboard's tray.

So far the Pentium 4 hasn't enjoyed a particularly remarkable take-up, one of the reasons being the necessity for it to be supplied with RDRAM and the implications thereof (in other words having to replace existing RAM, extra expense etc). Intel's solution to this particular conundrum is to release a new chipset which will support the somewhat slower and older PC133 RAM. This newer chipset is the i845 (code-named Brookdale) but, as is to be expected, using the older RAM type ensures that the P4 takes something of a performance hit. This is a shame, but it at least brings down the price of P4 systems, even though it's at a cost. Intel officially announced the 2 GHz Pentium 4 on August 27th 2001, along with large price cuts across the whole Pentium 4 desktop line. Entry-level 1.4 GHz P4 machines are now available at extremely attractive prices.

Just to muddy the P4's waters even further, Intel also has a newer P4, codenamed Northwood, and a newer socket and chipset, which will be launched at the end of 2001. The new socket is Socket 478, a micro-PGA socket that has 478 pin holes to accommodate the new 0.13 micron P4. Intel has a number of chipsets for this newer P4, namely the i845A (Brookdale), i845B (Brookdale DDR), i845G (Brookdale DDR) and i850E (Tehama-E). Manufacturers such as Ali, SiS and VIA also have chipsets for this newer P4. It appears that Northwood is going to be the future of the P4 and as a result it should enjoy good support from manufacturers with a plentiful supply of chipsets and motherboards.

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| Name | Clock Speed (MHz) | Bus Speed (MHz) | Comments |
|---|---|---|---|
| Duron | Up to 950 | Up to 133 | Less L2 cache than Athlon |
| Athlon | Up to 1.4 GHz | Up to 266 | Also known as Thunderbird |

*Figure 4 - Socket A CPUs.*

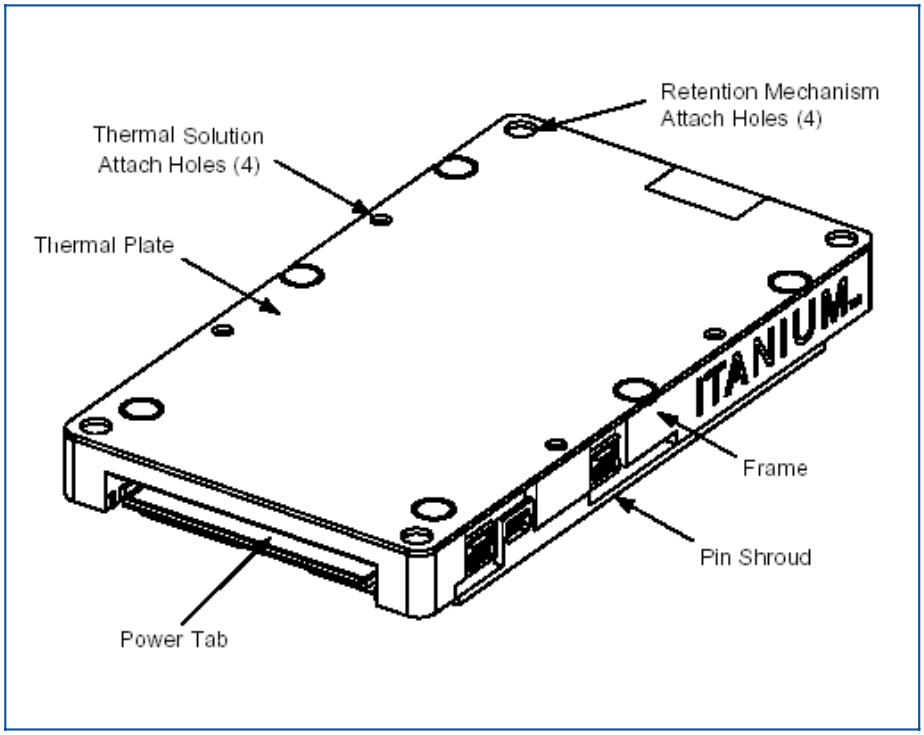


*Figure 5 - Top view of the PAC418 Cartridge.*

## *Intel PAC418*

The means of connection used for Intel's new Itanium is a new departure for those who are used to Intel's Slots and Sockets. It's called PAC418, with PAC being an acronym for Pin Array Cartridge. As the name implies, there are 418 pins and holes. The cartridge houses the CPU core and the L3 cache, plus other required components. Required cooling (such as a fan) is attached to the top of the cartridge where the thermal plate is located. There are two sets of holes on the cartridge, one for attaching whatever is being used for cooling purposes, the other set for attaching it to the motherboard. Looking underneath the cartridge will show the two rectangular pin arrays, plus there is a protective shroud around said pins to prevent any damage - this shroud stands proud of the pins so affording the necessary protection if the cartridge is place pin-side down onto a flat surface (therefore resting on the shroud, not the pins). There are also two alignment pegs to ensure the cartridge is inserted correctly. In terms of its size, the cartridge is similar to a Slot 1 cartridge but effectively placed on one side. To be exact, it is 129mm (length) x 72 mm (width) x 17mm (thickness). See Figures 5 and 6 for top and bottom drawings of the new cartridge.

*This article will be concluded in a future issue of PCSA.*

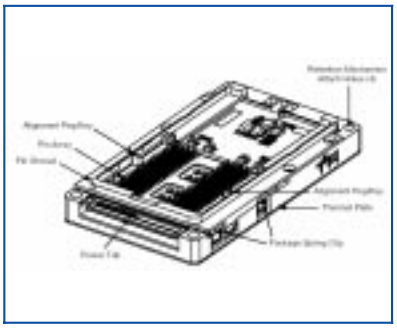

*Figure 6 - Bottom view of the PAC418 Cartridge.*

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