Chapter12 Microprocessor

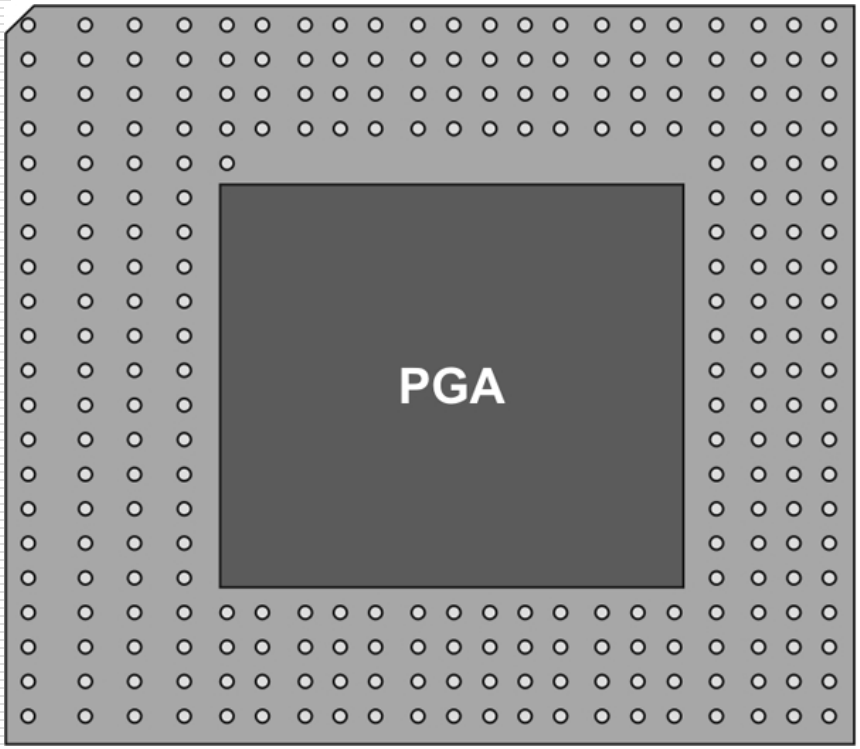
- This chapter examines the system board's main component, the microprocessor.
- The chapter describes the different Pentium class microprocessors in terms of their capabilities, speeds, and physical appearance
- the chapter deals with configuring system boards to work with different microprocessor types

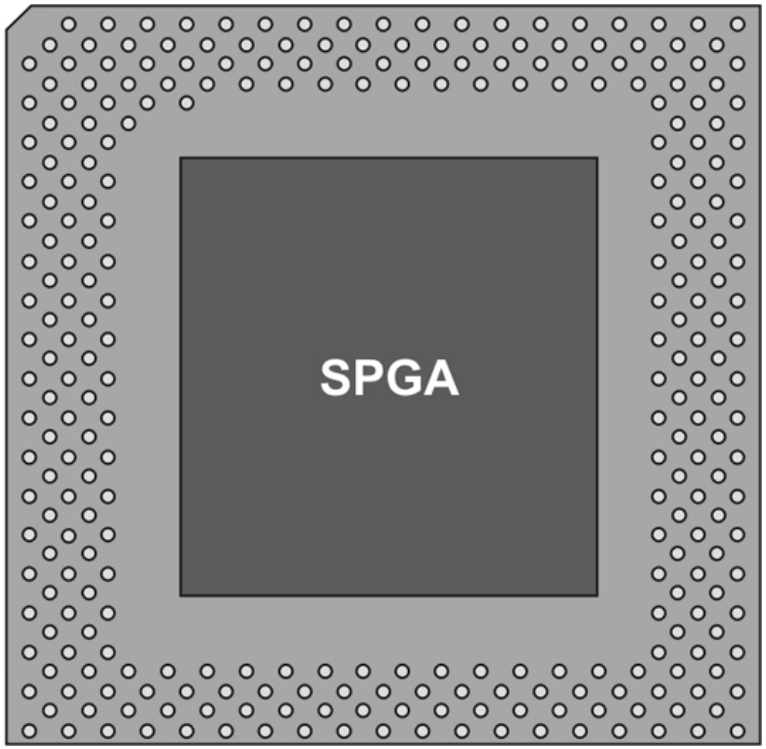
THE PENTIUM PROCESSOR

- The original *Pentium processor was a 32/64-bit design housed in a* Ceramic Pin Grid Array package
- It also contained two separate 8KB caches, One cache was used for instructions or code, whereas the other was used for data.
- This original Pentium architecture has appeared in three generations :
  - The first generation, code named the P5, it operated at 60 or 66MHz speeds. It used a single +5V (DC) which caused it to consume large amounts of power and generate large amounts of heat. It generated so much heat during normal operation that an additional CPU cooling fan was required.

- The second generation of Pentiums, referred to as P54Cs, *operated at* 75, 90, 100, 120, 133, 150, and 166MHz in different versions. Intel reduced the power-supply voltage level to +3.3V (DC) to consume less power and provide faster operating speeds, which moves the processor's high- and low-logic levels closer together, requiring less time
- The third generation of Pentium designs, (P55C), operated at 166, 180, 200, and 233MHz, This generation of Pentium devices operated at voltages below the +3.3 level established in the second generation of devices. The P55C is known as the *Pentium MMX (Multimedia Extension) processor* .

PGA and SPGA(*Staggered Pin Grid Array*) arrangements.





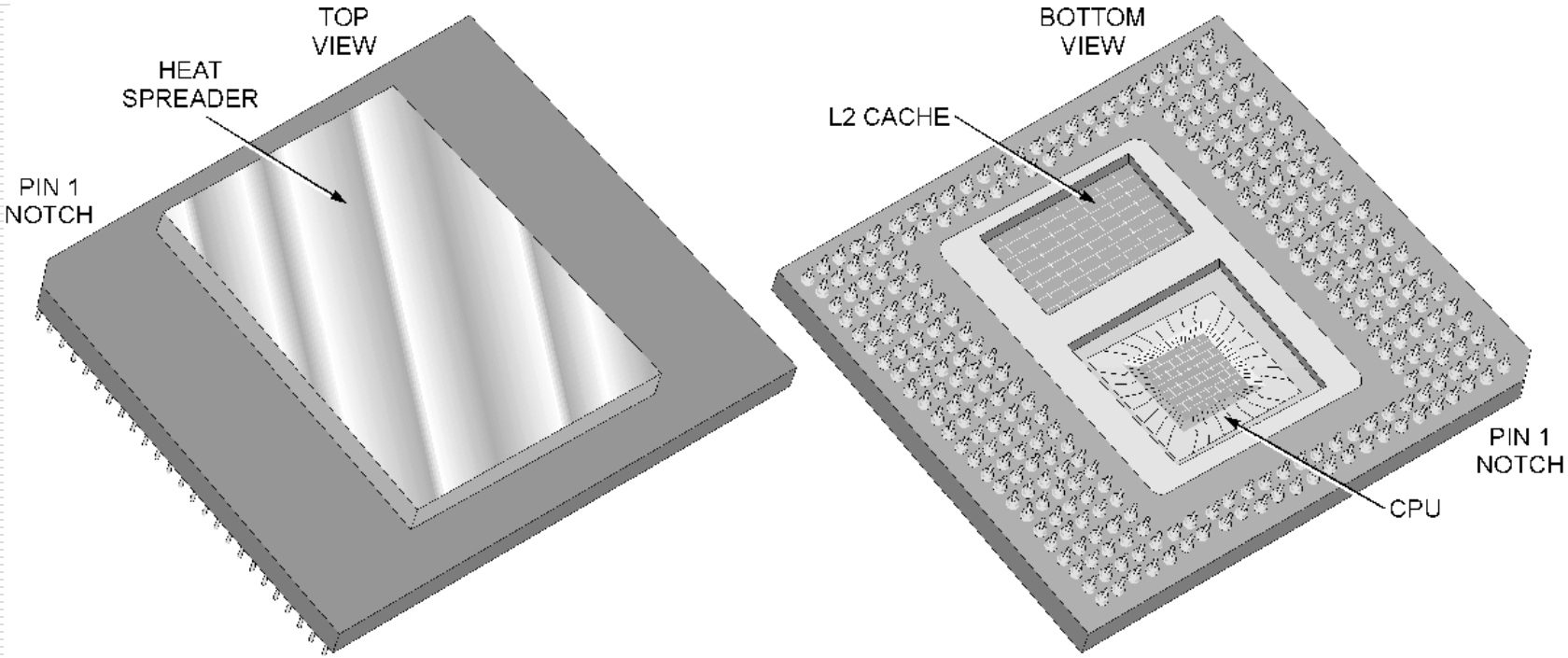
ADVANCED PENTIUM ARCHITECTURES

- including the following
  - Pentium MMX,
  - Pentium Pro,
  - Pentium II,
  - Pentium III,
  - Pentium 4 processors

Pentium MMX

- The multimedia and communications processing capabilities were extended by the addition of 57 multimedia-specific instructions to the instruction set.
  - *L1 cache size increased to* 32KB.
  - The cache has been divided into two separate 16KB caches: the instruction cache and the data cache.
  - The typical *L2 cache used* with the MMX was 256KB or 512KB, and it employed a 66MHz
  - system bus. The Pentium MMX processor was available in 166, 200, and 233MHz versions, and it uses a 321-pin, SPGA *Socket-7 format. It*

Pentium Pro


TOP
VIEW
HEAT
SPREADER
PIN 1
NOTCH
BOTTOM
VIEW
L2 CACHE
PIN 1
NOTCH
CPU

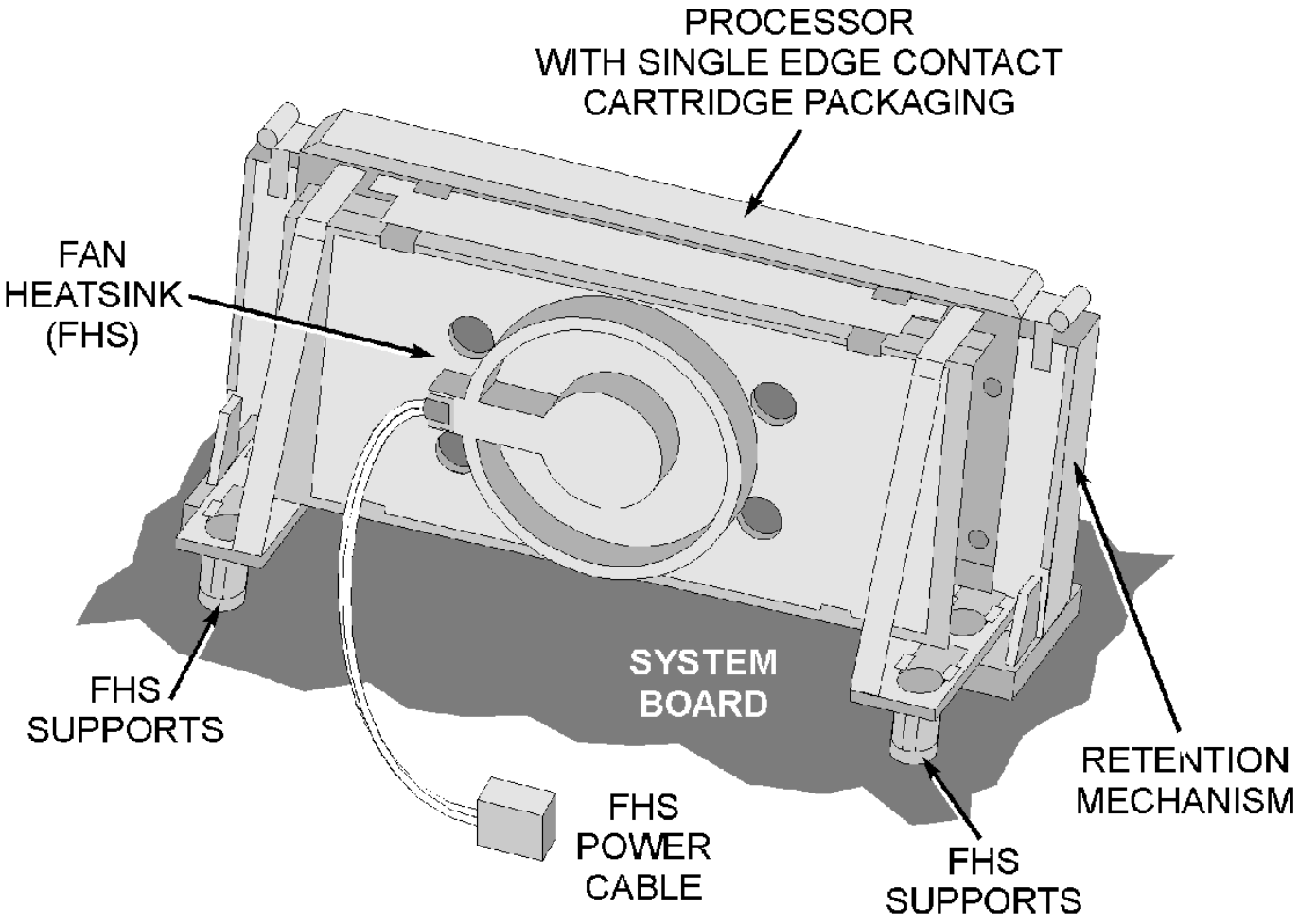
Pentium Pro

- Intel adopted a 2.46x2.66 inches, 387-pin PGA configuration to house a Pentium Pro processor core and an onboard 256KB (or 512KB) L2 cache
- The L2 onboard cache stores the most frequently used data not found in the processor's internal L1 cache

Pentium II

- Intel changed the form factor of the Pentium processors by housing the *Pentium II processor in a new, Single-Edge Contact* (*SEC) cartridge.*
- The cartridge consist of the Pentium II processor core, a tag RAM, and an L2 burst SRAM. *Tag RAM is used to track the attributes (read, modified,*
- and so on) of data stored in the cache memory.
- The cartridge also requires a special *Fan Heat Sink (FHS) module* and fan. Like the SEC cartridge, the FHS module requires special support mechanisms to hold it in place.

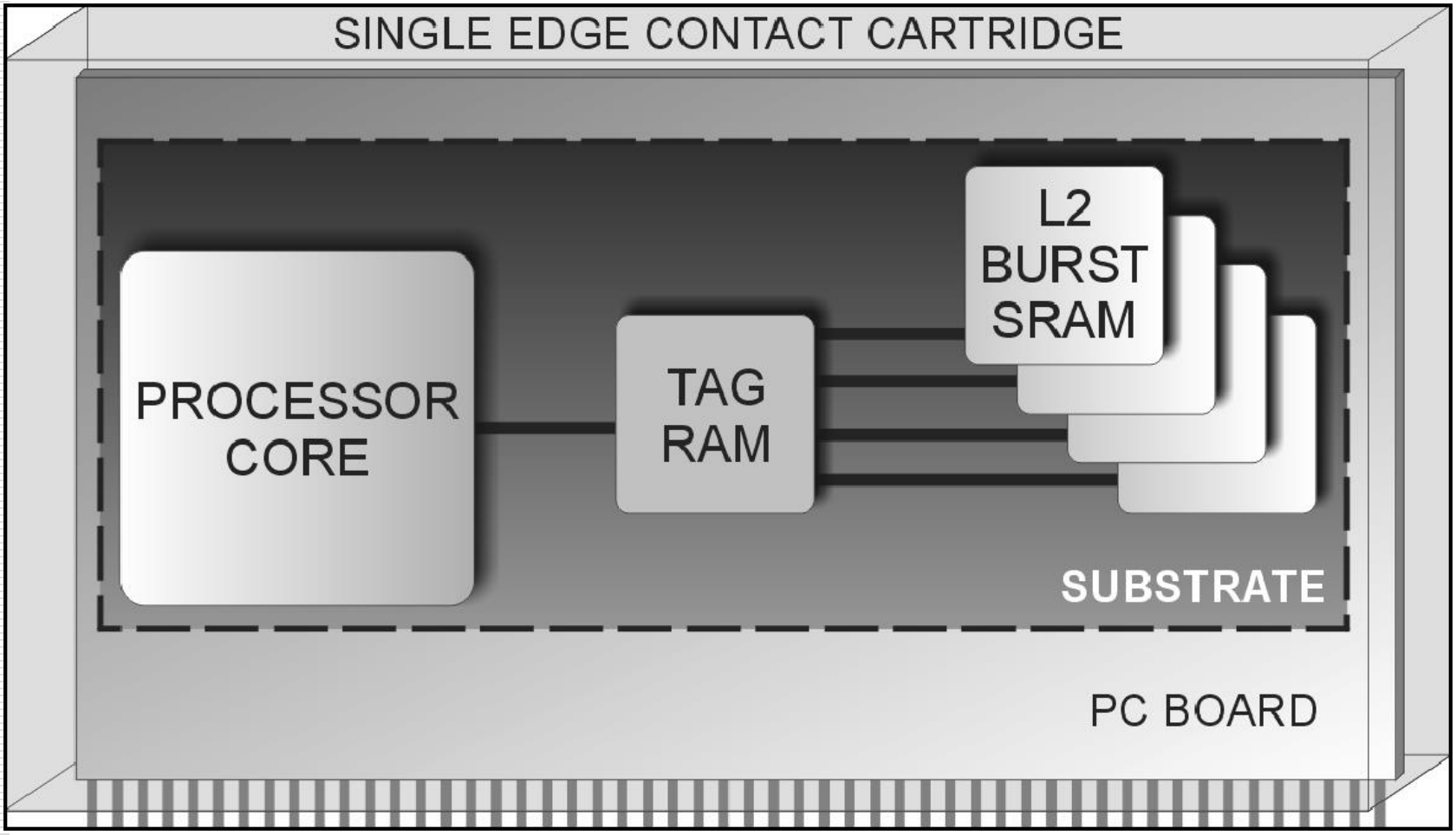
The Pentium II cartridge.



Cont.

- The Pentium II includes all the multimedia enhancements from the MMX processor, as well as retaining the power of the Pentium Pro's dynamic execution and 512KB L2 cache features, and it employs a 66 or 100MHz system bus. The L1 cache is increased to 32KB, whereas the L2 cache operates with a half-speed bus.

contents of the Pentium II cartridge



Pentium III(600 MHz)

- It was designed around the Pentium II core, but increased the L2 cache size to 512KB. It also increased the speed of the processor to 600MHz, including a 100MHz *front side bus speed.*
- There is a less expensive version that it named the *Pentium Celeron. Unlike the original Pentium III*, the Celeron version featured a 66MHz bus speed and only 128KB of L2 cache, Initially, the Celeron Mendocino was packaged in the SECC cartridge.
- It uses a standard called the *Plastic Pin Grid Array* (*PPGA) 370 specification.*
- Pentium III and Celeron processors designed with the 0.18 micron technology are referred to as the *Coppermine and Coppermine 128* processors

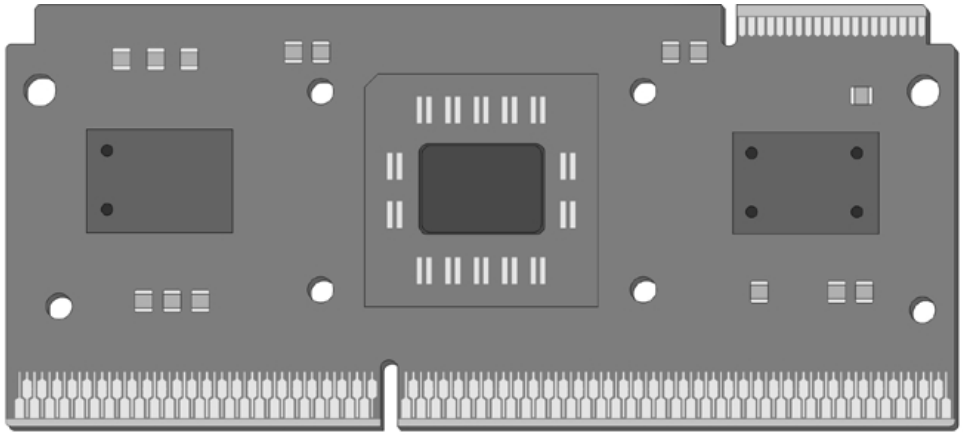
Pentium 4

- Late in 2000, it boasts operating speeds above 1.3GHz.
- The system bus has been increased from 64 to 128 bits and operates at 400MHz. Advanced plans for the Pentium 4 call for an improved 478-pin/533MHz bus version.
- In reality, the Pentium 4 is not a continuation of the Pentium design. It is actually a new design (IA-32 NetBurst architecture) based on .18 micron IC manufacturing technology.
- The L1 cache size has been reduced from 16KB in the Pentium III to 8KB for the Pentium 4. The L2 cache is 256KB and can handle transfers on every clock cycle.
- The operating voltage level for the Pentium 4 core is 1.7 volts. To dissipate the 55 watts of power (heat) that the microprocessor generates at 1.5GHz,

AMD Processors

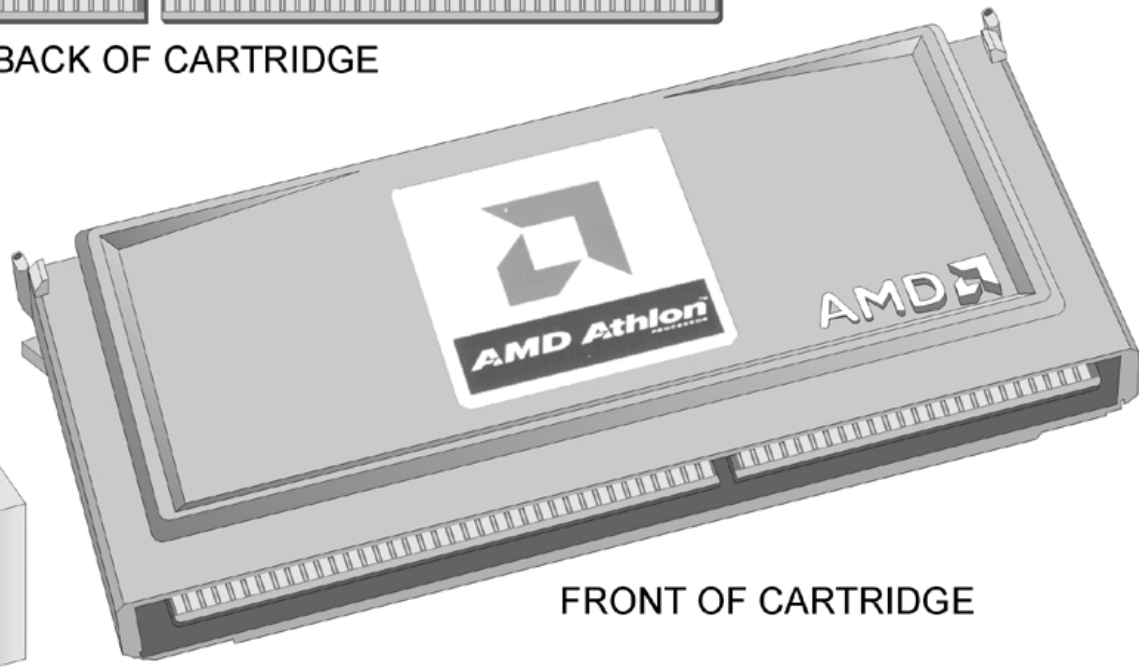
- *Advanced Micro Devices (AMD) offers several clone microprocessors:* the 5x86 (X5), the 5x86 (K5), the K6, the K6PLUS-3D, and K7 microprocessors.
- For example, The X5 offers operational and pin compatibility with the DX4, but neither of these units have a pin-out compatibility with another processor.
- Two notable AMD Pentium clone processors are the Athlon and the Duron.
- The *Athlon is a Pentium III clone processor. It is available in a Slot 1* cartridge clone, called the *Slot-A specification.*

Athlon Processor



BACK OF CARTRIDGE

SLOT A
CONNECTOR



FRONT OF CARTRIDGE

Duron Processor

- The *Duron processor is a Celeron clone processor that conforms to* the AMD Socket-A specification.
- The Duron features processor speeds between 600MHz and 800MHZ.
- It includes a 128KB L1 cache and a 64KB L2 cache and employs a 100MHz system bus.
- Like the newer Celerons, the Duron is constructed using 0.18 micron IC manufacturing technology

Cyrix Processors

- Like AMD, the Cyrix company has continued to develop clones of the various Pentium products.
- These clones include the Socket 370 compatible Celeron clone processor called the *Cyrix III (originally* called the Joshua Processor).
- Next table shows the relationship between the various numbering systems.

relationship between the various numbering systems

CLONE PROCESSORS

Intel	*Cyrix*	*AMD*	*NextGen*
Pentium (P5/P54C)	M1 (6X86)	-K5(5X86)	NX586/686
Pentium MMX (P55C)	M2 (6X86MX)	-K6	
Pentium Pro (P6)	MXi	-K6PLUS-3D	
Pentium II	M3	-K7	
Pentium III	N/A	K75/Thunderbird	
Pentium Celeron	Cyrix III	Duron	

SOCKET SPECIFICATIONS

- In addition to the clone processors, Intel has developed a line of
- upgrade microprocessors for its original units. These are referred to as *OverDrive processors.*
- *The OverDrive unit might just be the same* type of microprocessor running at a higher clock speed, or it might be an advanced architecture microprocessor designed to operate from the same socket/pin configuration as the original.
- To accommodate this option, Intel created specifications for eight socket designs, designated Socket-1 through Socket-8.
- Socket-1 through Socket-3 were developed for 80486SX, 80486DX, and 80486 OverDrive versions that use different pin numbers and power-supply requirements

attributes of the various industry socket and slot specifications

INDUSTRY SOCKET/SLOT SPECIFICATIONS

Number	*Pins*	*Voltages*	*Microprocessors*
Socket 1	169 PGA	5	80486 SX/DXx, DX4 Overdrive
Socket 2	238 PGA	5	80486 SX/DXx, Pentium Overdrive
Socket 3	237 PGA	5/3.3	80486 SX/DXx, Pent Overdrive
Socket 4	237 PGA	5	Pentium 60/66, 60/66 Overdrive
Socket 5	320 SPGA	3.3	Pentium 75-133, Pent Overdrive
Socket 6	235 PGA	3.3	Never Implemented
Socket 7	321 SPGA	VRM (2.5v-3.6v)	Pentium 75-200, Pent Overdrive
Socket 8	387 SPGA	VRM (2.2v-3.5v)	Pentium Pro

CLOCK SPEEDS

- In the Pentium processor, two speed settings can be established for the microprocessor:
  - speed for its internal core operations
  - speed for its external bus transfers.

  These two operational speeds are tied together through an internal clock multiplier system.
- The Socket-7 specification enabled system boards to be configured for different types of microprocessors using different operating speeds.
- In older systems, the operating speed of the microprocessor
- was configured through external settings.

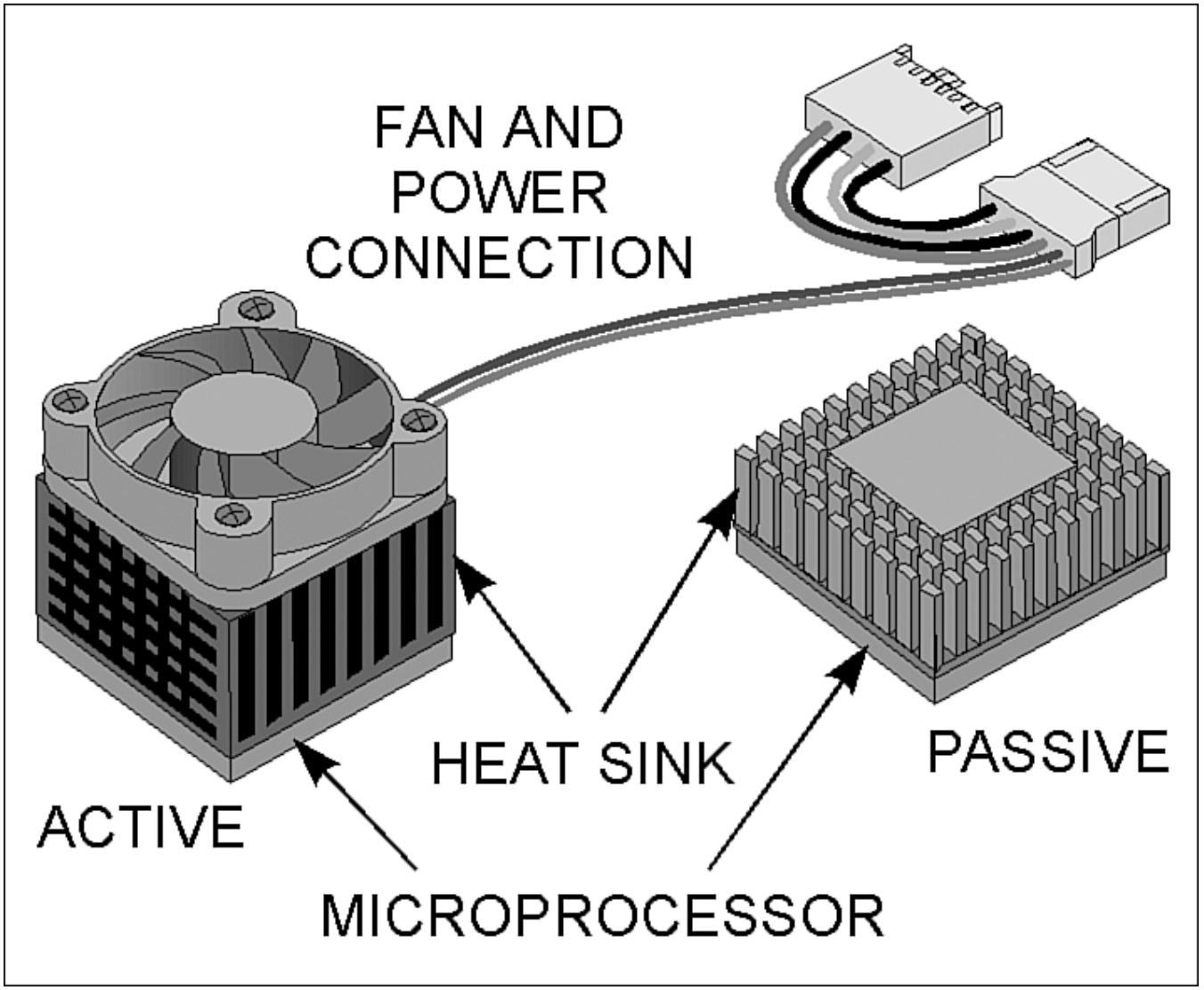
POWER-SUPPLY LEVELS

- Beginning with the Pentium MMX, Intel adopted dual-voltage supply levels for the overall IC and for its core.
- Common Intel voltage supplies are +5/+5 for older units and +3.3/+3.3, +3.3/+2.8, +3.3/+1.8 for newer units. Clone processors can use compatible voltages (especially if they are pin compatible.
- Common voltages for clone microprocessors include +5, +3.3, +2.5, and +2.2

HEAT SINKS AND FANS

- The Pentium processor requires the presence of a heat-sinking device and a microprocessor fan unit for cooling purposes.
- These devices come in many forms including
  - simple *passive heat sinks which is* a finned metal slabs that can be clipped or glued with a heat-transmitting adhesive onto the top of the microprocessor
  - *fan-cooled, active heat sinks* add a fan unit to move air across the heat sink
- ATX-style systems employ power supplies that use a reverse-flow fan that brings in cool air from the back of the unit and blows it directly on the microprocessor

Pentium III


FAN AND
POWER
CONNECTION
HEAT SINK
PASSIVE
ACTIVE
MICROPROCESSOR

CONFIGURING MICROPROCESSORS

- Most Pentium system boards are designed so that they can support a number of different microprocessor types and operating speeds.
- In older Pentium systems, the microprocessor's configuration settings were established largely through jumpers on the system board.
- These settings typically included such items as:
  - *Microprocessor Type*
  - *Core-to-bus Speed Ratio*
  - *Bus Frequency Setting*
  - *Core Voltage Level*

Microprocessor Type

- *This setting manually tells the system* what type of processor is installed. If this setting is incorrect, the system will assume that the installed processor is the one specified by the setting and try to interact with it on that basis.
- Depending on which microprocessor is indicated, the system POST might identify the processor incorrectly and still run but not properly.
- In other cases, the processor might lock up during the POST or not run at all. In either case, the processor could be damaged.

Core-to-bus Speed Ratio

- depending on the exact mismatch, the system might over clock the processor and run but erratically بعصبية. If the over clocking is less than 20%, the system
- might run without problems.
- However, the processor's life expectancy will be decreased. If the deviation is greater than 20%, the system might not come up at all and the processor might be damaged.

Bus Frequency Setting

- Configuring this setting incorrectly will cause the processor to run faster or slower.
- This is a common method employed by users to increase the operating speed of their older systems. If the variation is less than 20%, the system will probably work with a shortened processor life.
- Greater levels of over clocking the bus might cause the system to have random lock ups.

Core Voltage Level

- *This setting establishes the voltage level that the microprocessor core will operate at.*
- *The setting is linked to the processor's speed and power dissipation.*
- *Normally, the microprocessor will not operate at all if the voltage level is more than 20% too low.*
- *Conversely, if you operate a processor at a voltage level that is higher than its specified value, this can cause physical damage to it.*

However

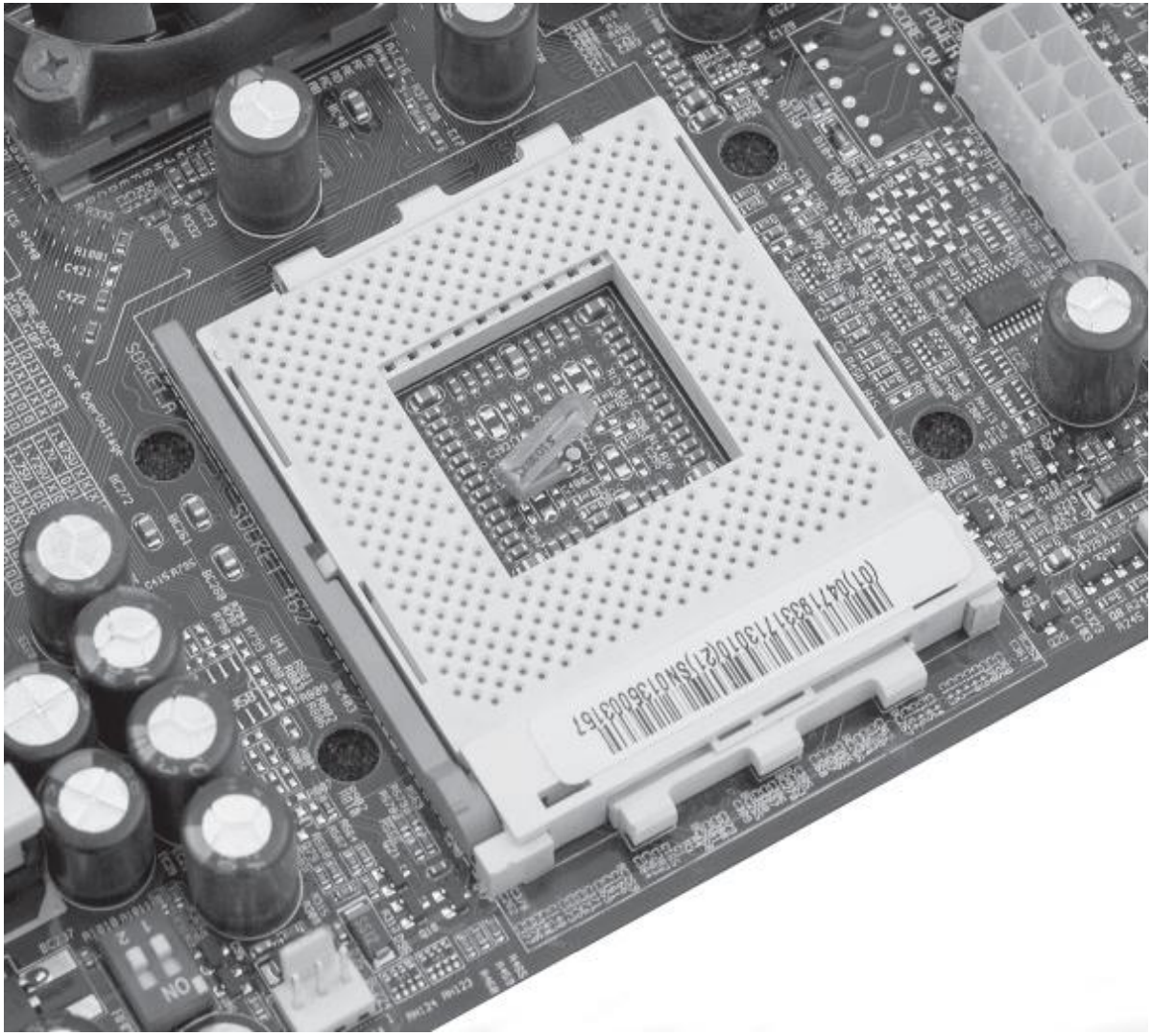
- In newer systems, interrogates تستجوبthe processor during startup and configures it appropriately.
- This prevents the user from subjecting the processor to potentially destructive conditions, such as over clocking.
- In addition, these systems can monitor the health of the processor during operation and take steps to compensate for problems such as overheating.
- The BIOS version must support the parameters of the microprocessor

CHARACTERISTICS OF THE VARIOUS MICROPROCESSORS

MICROPROCESSOR CHARACTERISTICS

Microprocessor	Diameter Size (mm)	VRM (volts)	Speeds (MHz)	Cache on Die (KB)	Cache on Cartridge	Cache on Board (KB)	Sockets or Slot Types
Pentium	23.1x23.1	2.5–3.6	75–299	L1—8+8	-	L2—256/512	Socket 7
Pentium MMX AMD - K6-2:K6-3	25.4x25.4	2.0–3.5	166–550	L1—16+16 32+32	- -	L2—255/1000	Socket Super 7
Pentium II/III Celeron (.25 micron)	25.4x25.4 18x62x140 Box	1.5–2.6	233–1000	L1—16+16	L2—256/512 128KB	- -	Slot 1
Xeon II/III (330) (.25 micron)	27.4x27.4 18x87x125 Box	1.5–2.6	500/550 700/900	L1—16+16	L2—512KB 1MB 2MB	- -	Slot 2
Pentium III Celeron (.25 micron)	25.4x25.4 Slug 27.4x27.4 Opening	1.1–2.5	300–566	L1—16+16 L2—128/256	- -	- -	Socket 370 PPGA
Pentium III (Copermine) Celeron (.18 micron)	9.3x11.3	1.1–2.5	566–1000	L1—16+16 L2—128/256	- -	- -	Socket 370 FC-PGA

ZIF socket with arm on side



ZIF socket with cage over the top