intel ®

Intel® 186/386/486 Processors

Intel in Communications

In today's communications environment, manufacturers and developers need to bring products to market more quickly and at lower cost. With a broad-range migration path, an array of proven development tools and extended life cycles, Intel's embedded products reduce your time-to-market and protect your hardware and software investment. We are committed to providing the tools and support needed to speed design time for products ranging from handheld devices to industrial control applications.

Intel® x86 Embedded Processor Product Portfolio

The following product portfolio includes the Intel486™, Intel386™ and Intel® 186/188 processor families. This product portfolio helps support the long life-cycle needs of embedded applications.

high performance				i486™ DX4 (write-back) i486™ DX2 (write-through)
low power		80L186/188 EC 80L186/188 EB 80L186/188 EA	i386™ EX i386™ SX	ULP i486™ 1486™ DX4(write-back) ULP i486™ GXSF 1486™ DX2(write-through)
traditional embedded		80C186/188 EC 80C186/188 EB 80C186/188 EA	i386™ EX i386™ DX i386™ SX	i486™ SX
embedded processors	80C186/188 XL	Intel® 186/188 processor	Intel386™ processor	Intel486™ processor
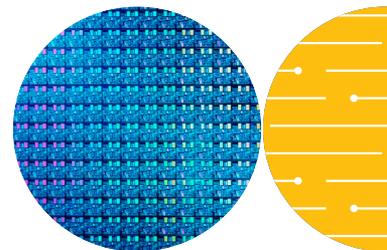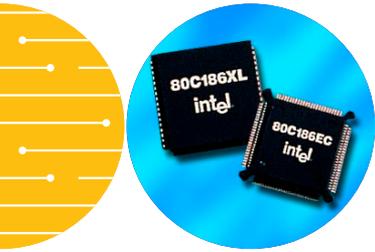
The Intel® 186/188 Processor

Intel® 186/188 Processor Family Product Highlights

· Large addressing space for embedded applications

· Integration enables low-cost and low-chip-count designs

· Use PC for easier software development and debugging

· Improved noise margins

Intel® 186/188 Processor Family Overview

The Intel® 186 processor family, XL, EA, EB, EC, have been accepted in a broad range of applications with more than 10,000 design wins and 100 million units shipped in the past 16 years. The Intel 186 family of products, with its wide variety of options, such as packaging, speed, voltage and memory helps when selecting necessary performance and cost requirements for embedded designs.

The core architecture for these processors is the same as that developed for the PC industry, providing software compatibility and a huge support infrastructure to the embedded designer. Industry-standard tool suites, development platforms, compilers, debuggers, emulators, textbooks and training seminars all contribute to helping an OEM get its product to market more quickly.

The Intel® Enhanced Product Family, 80C18xEX (EA/EB/EC) features an improved 1-micron static core design, and all of the enhanced products run at 25 MHz. In addition, the EX family products incorporate additional features such as serial channels, DRAM refresh control, and power management to provide more functionality. The EX core has also been enhanced to run at 3 volts.

Intel® 186/188 Standard Product Family

FEATURES	BENEFITS
16-bit static CPU	Performance >1 MIP
8086 instructions set	Use PC for easier software development and debugging
1-MB addressing	Large address space (for programs and data) can also use bank switching for >1MB
On-chip peripherals	High x86 integration enables low-cost and low-chip-count designs
8-bit external bus available	Lower memory and system cost
Multiple packaging options 68L (LCC, PLCC, PGA) 80L (QFP, SQFP)	Support varied System requirements
CMOS inputs and outputs	Improved noise margins

Intel® 186/188 Standard Product Family

PRODUCT	SPEED (MHz)	I/O PINS	SERIAL PORTS	TIMERS/ CTRS	STATIC DESIGN	SYS MGT MODE	A20 GATE	ADD SPACE	DMA CHAN	WDT	CLK GEN	PWR OPTIONS	CHIP SELECT	INTERRUPT CTLR	DRAM REFRESH	INPUT LEVELS	VOLTAGE	PACKAGE	TEMP
Intel® Standard Product Family																			
80C186XL/188XL	12, 20	0	NO	3	YES	NO	NO	1M	2	NO	YES	PS	13	YES	YES	TTL	5.0V	A68, N68, R68, S80, SB80	C, E
80C186XL/188XL	25	0	NO	3	YES	NO	NO	1M	2	NO	YES ç	PS	13	YES	YES	TTL	5.0V	A68, N68, R68, S80, SB80	C

Intel® 186/188 Enhanced Product Family

| FEATURES	BENEFITS
3-stage power management unit	Efficient power consumption
3-V versions	Enables portable, battery-powered designs
Watchdog timer (EC only)	Ensures system integrity in hostile environment
Serial channels (EB/EC only)	Facilitates interprocessor communications and modem interface
I/O ports (EB/EC only)	Ability to communicate externally via standard protocols

Intel® 186/188 Enhanced Product Family

PRODUCT	SPEED (MHz)	I/O PINS	SERIAL PORTS	TIMERS/ CTRS	STATIC DESIGN	SYS MGT MODE	A20 GATE	ADD SPACE	DMA CHAN	WDT	CLK GEN	PWR OPTIONS	CHIP SELECT	INTERRUPT CTLR	DRAM REFRESH	INPUT LEVELS	VOLTAGE	PACKAGE	TEMP
Intel® Enhanced Product Family																			
80C186EA/188EA	25	0	NO	3	YES	NO	NO	1M	2	NO	YES	PS, PD, I	13	YES	YES	CMOS	5 0V	N68	C
80C186EA/188EA	13, 20	0	NO	3	YES	NO	NO	1M	2	NO	YES	PS, PD, I	13	YES	YES	CMOS	5.0V	N68	E
80L186EA/188EA	13	0	NO	3	YES	NO	NO	1M	2	NO	YES	PS, PD, I	13	YES	YES	CMOS	3.0V	N68	E
80C186EB/188EB[1]	25	16	2	3	YES	NO	NO	1M	0	NO	YES	PD, I	10	YES	YES	CMOS	5.0V	N84, S80, SB80	C
80C186EB/188EB	13, 20	16	2	3	YES	NO	NO	1M	0	NO	YES	PD, I	10	YES	YES	CMOS	5.0V	N84, S80, SB80	E
80L186EB/188EB	16	16	2	3	YES	NO	NO	1M	0	NO	YES	PD, I	10	YES	YES	CMOS	3.3V	N84, S80, SB80	C
80L186EB/188EB	13	16	2	3	YES	NO	NO	1M	0	NO	YES	PD, I	10	YES	YES	CMOS	3.0V	N84, S80, SB80	E
80C186EC/188EC	25	22	2	3	YES	NO	NO	1M	4	YES	YES	PS, PD, I	10	YES (8259A)	YES	CMOS	5.0V	KU100, S100, SB100	C
80C186EC/188EC	13, 20	22	2	3	YES	NO	NO	1M	4	YES	YES	PS, PD, I	10	YES (8259A)	YES	CMOS	5.0V	KU100, S100, SB100	E
80L186EC/188EC	16	22	2	3	YES	NO	NO	1M	4	YES	YES	PS, PD, I	10	YES (8259A)	YES	CMOS	3.3V	KU100, S100, SB100	C
80L186EC/188EC	13	22	2	3	YES	NO	NO	1M	4	YES	YES	PS, PD, I	10	YES (82SgA)	YES	CMOS	3.0V	KU100, S100, SB100	E

[1] Product is guaranteed to 20 MHz 4V

PACKAGING:
Power Options: PD = Power Down, PS = Power Save, I = Idle
Temperature Ranges: (Degrees Centigrade) C = Commercial (0 to 70°C), E = Extended (-40 to 85°C)

A = Ceramic Pin Grid Array (PGA), KU = Plastic Quad Flat Pack (PQFP), R = Ceramic Leadless Chip Carrier (LCC), N = Plastic Leaded Chip Carrier (PLCC), NG = Plastic Quad Flat Pack (PQFP),
S = Quad Flat Pack (QFP-EIAJ), SB = Shrink Quad Flat Pack (SQFP-EIAJ), FA = Thin Quad Flat Pack (TQFP), FC = Shrink Quad Flat Pack with heat spreader (PQ2 PowerQuad)
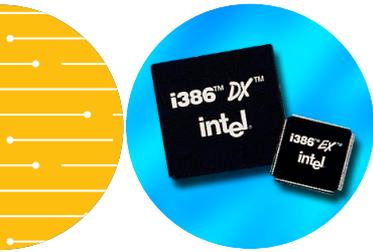
The Intel386™ Processor

Intel386™ Processor Family Product Highlights

· 32-bit cores

· Enhanced functionality for the embedded processor market

· Compatible with DOS and standard graphical windowing operation environments

· 100% binary-compatible with the Intel186/188 CPU

· Available in both commercial and extended temperatures

Intel386™ Processor Family Overview

Intel386™ processors have provided the computer industry with reliability and high performance. Initially built as the host CPU for PCs, these processors are still readily available and continue to provide high-performance, 32-bit processing power for embedded applications. Thanks to a static Intel386 processor core design, the pin-for-pin compatible family enables higher performance and lower power and voltage capabilities for embedded systems.

Intel386™ SX, DX, SXTA Processor Overview

The dynamic Intel386™ SX microprocessor is an entry-level processor with a 16-bit external data bus and a 24-bit external address bus. It provides the performance benefits of a 32-bit architecture with the cost savings of a 16-bit hardware system. The static Intel386 SX microprocessor is a pin-for-pin replacement for the dynamic Intel386 SX processor. The static design offers clock freeze mode, higher speed operation and extended temperatures. This device is commonly called 80386SSX or 80386SXTA.

The dynamic Intel386 DX microprocessor is designed for single-user, multitasking applications. The 32-bit registers and data paths support 32-bit addresses and data types. It addresses 4 gigabytes of physical memory, and 64 terabytes of virtual memory. It offers a 50% performance increase over the Intel386 EX and SX processors.

Intel386™ Processor Family

FEATURES	BENEFITS
32-bit CPU	Performance processing at 5 to 10 MIPS
80386 Instruction set	Compatibility with all PC applications, development and operating system software
16MB-4GB addressability	Head room for software growth for future system product enhancements
Protected Mode	Provides restricted access privileges
SL enhanced SMM support	Application independent power management

Intel386™ Processors

PRODUCT	SPEED (MHZ)	I/O PINS	SERIAL PORTS	TIMERS/ CTRS	STATIC DESIGN	SYS MGT MODE	A20 GATE	ADD SPACE	DMA CHAN	WDT	CLK GEN	PWR OPTIONS	CHIP SELECT	INTERRUPT CTLR	DRAM REFRESH	INPUT LEVELS	VOLTAGE	PACKAGE	TEMP
Intel386™ Processor Family																			
80386SX	20, 25, 33	0	NO	0	NO	NO	NO	16M	0	NO	NO	NO	0	NO	NO	TTL	5.0V	NG100	C
80386DX	20, 25, 33	0	NO	0	NO	NO	NO	4G	0	NO	NO	NO	0	NO	NO	TTL	5.0V	A132, NG132	C
80386SXTA	25, 33, 40	0	NO	0	YES	NO	NO	16M	0	NO	NO	NO	0	NO	NO	TTL	5.0V	KU100	C, E

PACKAGING:
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Temperature Ranges: (Degrees Centigrade) C = Commercial (0 to 70°C), E = Extended (-40 to 85°C)

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S = Quad Flat Pack (QFP-EIAJ), SB = Shrink Quad Flat Pack (SQFP-EIAJ), FA = Thin Quad Flat Pack (TQFP), FC = Shrink Quad Flat Pack with heat spreader (PQ2 PowerQuad)

Integrated Intel386™ EX Processor Overview

The high integration of the Intel386™ EX processor provides many of the peripheral devices previously found with personal computers. To add further value to the system, the Intel386 EX processor implements embedded peripheral functions such as interrupt controllers, chip-select generation, 16-bit timers and counters, DRAM refresh, watchdog timer, serial ports, etc. The integration of the Intel386 EX microprocessor significantly reduces system complexity and hardware design time. The Intel386 EX processor provides 26 address bits for a total of 4 gigabytes. Also given the same clock rate, the Intel386 EX processor performs up to three times faster than that of an Intel186 processor. Since the EX has an Intel® 80386 core, it is code-compatible with Intel186 processors, making it a logical upgrade processor to run your existing software. The System Management Mode (SMM) is built into the Intel386 EX processor. SMM is typically used to execute specific routines for power management. After entering SMM various parts of a system can be shut down or disabled to minimize power consumption. SMM operates independently of other system software, and can be used for additional purposes, too. The Intel386 EX processor also has a power management unit that offers Idle mode and Powerdown mode. The power management modes available on the embedded Intel386 EX micro-processors make it ideal for battery powered, portable applications.

Integrated Intel386™ EX Processors

FEATURES	BENEFITS
PC-compatible peripherals	Easy portability of application software developed on a PC
16450-compatible serial ports	Standard protocol familiar and well supported within the industry
DMA-supported serial transfers	Reduces CPU load
Dynamic bus sizing enables interface to 8- or 16-bit peripherals	Lowers total system cost
Synchronous serial I/O	Provides higher data transfer rates (baud rate generator on-chip) vs standard Intel386™ processors
JTAG boundary scan	Allows for in-system processor diagnostics

Integrated Intel386™ EX Processors

PRODUCT	SPEED (MHZ)	I/O PINS	SERIAL PORTS	TIMERS/ CTRS	STATIC DESIGN	SYS MGT MODE	A20 GATE	ADD SPACE	DMA CHAN	WDT	CLK GEN	PWR OPTIONS	CHIP SELECT	INTERRUPT CTLR	DRAM REFRESH	INPUT LEVELS	VOLTAGE	PACKAGE	TEMP
Integrated Intel386™ Processor Family																			
80386EXTB	25	24	3	3	YES	YES	YES	64M	2	YES	NO	PD, I	8	YES (8259A)	YES	TTL	3.3V	KU132, FA144	E
80386EXTC	25	24	3	3	YES	YES	YES	64M	2	YES	NO	PD, I	8	YES (8259A)	YES	TTL	5.0V	KU132, FA144	E
80386EXTC	33	24	3	3	YES	YES	YES	64M	2	YES	NO	PD, I	8	YES (8259A)	YES	TTL	5.0V	KU132, FA144	E

PACKAGING:
Power Options: PD = Power Down, PS = Power Save, I = Idle
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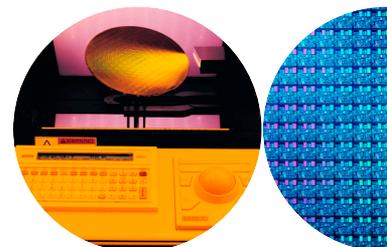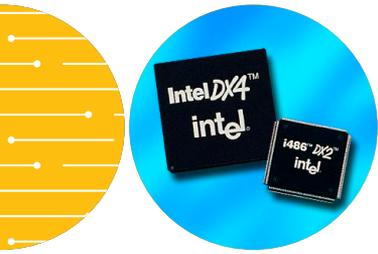
The Intel486™ Processor

Intel486™ Processor Family Product Highlights

· 32-bit architecture

· Intel SL technology

· Static core design

· System management mode

· Burst bus data

Intel486™ Processor Family Overview

All Intel486™ microprocessors provide a rich instruction set for manipulating integer data. Special emphasis has been placed on providing optimized instructions for high-level languages and operating system functions. Multiple addressing modes ensure that high-level languages can be implemented in the most efficient manner possible. The integrated memory management unit supports virtual memory and demand paging. Intel486 processors are capable of addressing up to 4 gigabytes of physical memory and 64 terabytes of virtual memory. The on-chip translation lookaside buffer supports efficient paging.

The Intel486 microprocessors have provided 32-bit performance in increasingly complex application environments for personal computers and network servers. Now the same microprocessors are available for a range of embedded applications, such as terminals, embedded PC boards, industrial control systems, scanners, printers,

medical equipment and entertainment systems. Current customers of the embedded Intel386™ processor can now take advantage of Intel486 architecture to extend the performance of their embedded designs.

High-Performance Intel486™ Processor Family

The Intel® SL Technology features in the Intel486™ processors allow system designers to build intelligent power management capabilities into hardware, making these capabilities independent of application software. Power management becomes an integral part of the system, regardless of what operating system or application is used. Power management is improved because the Intel SL Technology protects the power-management features from conflicting with other software.

The Intel486™ SX processors are enhanced with the Intel SL Technology bringing high levels of performance to lower-cost, entry-level, embedded Intel486 processor designs. Significant architectural enhancements including on-chip cache provide performance enhancements while maintaining code compatibility.

The IntelDX2™ and IntelDX4™ processors are also enhanced with the Intel SL Technology, which allows them even higher levels of performance. Such features as internal clock speed-doubling/-tripling technology on-chip cache and on-ship floating-point unit sustain the IntelDX2 and IntelDX4 processor performance levels.

High-Performance Intel486™ SX, IntelDX2™ and IntelDX4™ Processors

FEATURES	BENEFITS
Complete 32-bit RISC integer core	Performance for the most data-intense applications
8 Kbytes on-chip unified code and data cache	Reduces access cycles to external memory
On-chip floating-point unit single-cycle instruction	Highest Intel® x86 integration reduces inter-chip communication execution
Burst data bus: 80 Mbyte/sec transfer at 25 MHz 106 Mbyte/sec at 33 MHz	For instruction prefetch and filling the internal cache
SL technology for intelligent power-management	Application-independent power management capabilities
32-bit external data bus address range	Performance
4 gigabytes of physical memory	Excellent performance and compatibility with the Intel386™ processor MMU

High-Performance Intel486™ SX, IntelDX2™ and IntelDX4™ Processors

PRODUCT	SPEED (MHZ)	I/O PINS	SERIAL PORTS	TIMERS/ CTRS	STATIC DESIGN	SYS MGT MODE	A20 GATE	DMA CHAN	WDT	CHIP SELECT	INTERRUPT CTLR	DRAM REFRESH	CORE SPEED MULTI	CACHE	BURST DTAT BUS	INPUT LEVELS	VOLTAGE	PACKAGE	TEMP
Intel486™ Processor Family																			
80486DX4 32-bit bus	100	0	NO	0	YES	YES	NO	0	NO	0	NO	NO	3X CLK	16Kb, WB	YES	CMOS, 5-V Tolerant	3.3V	A168, FC208	C
80486DX2 32-bit bus	50, 66	0	NO	0	YES	YES	NO	0	NO	0	NO	NO	2X CLK	8Kb, WT	YES	CMOS	5V-3.3V	A168, SB208	C
80486SX 32-bit bus	33	0	NO	0	YES	YES	NO	0	NO	0	NO	NO	N/A	8Kb, WT	YES	CMOS	5V	A168, KU196	C

Ultra-Low-Power Intel486™ Processor Family

The ultra-low-power embedded Intel486™ SX/GX processors were developed specifically for the embedded market. They bring strong performance to low-cost, entry-level, embedded applications, where maximum energy efficiency is a high concern. These low-power technology improvements allow for new packing options for the Intel486 processor. This is the smallest, lowest-profile Intel486 processor in the world. At 25.4 mm x 25.4 mm x 1.5 mm, the 176-lead TQFP is the same size and thickness as a United States quarter (25-cent coin)!

Ultra-Low-Power Intel486™ SX/GX Processors

FEATURES	BENEFITS
Dual V_{cc} design for standard 3.3V I/O V_{ccp} and lower core V_{cc}	Ideal for battery-powered, portable applications
Digital phase lock loop or DDL for minimum clock start-up time	The DDL is approximately 4,000 times faster than a standard Intel486™ processor with PLL design
On-chip 8K unified code and data cache	Reduces access cycles to external memory
32-bit external data path-Intel486 SX 16-bit external data path-Intel486 GX	Multiple system design options with true 32-bit architecture
Burst data bus capable of: 44 MB/sec transfer at 25 MHz, or 59 MB/sec transfer at 33 MHz	Maintains system throughput with inexpensive DRAMS
176-lead TQFP and product packaging	Ideal for the most compact designs, this is the smallest, lowest-profile Intel486 processor in the world

Ultra-Low-Power Intel486™ SX/GX Processors

PRODUCT	SPEED (MHZ)	I/O PINS	SERIAL PORTS	TIMERS/ CTRS	STATIC DESIGN	SYS MGT MODE	A20 GATE	DMA CHAN	WDT	CHIP SELECT	INTERRUPT CTLR	DRAM REFRESH	CORE SPEED MULTI	CACHE	BURST DTAT BUS	INPUT LEVELS	VOLTAGE	PACKAGE	TEMP
Intel486™ Processor Family																			
80486SXSF 32-bit bus	33	0	NO	0	YES	YES	NO	0	NO	0	NO	NO	N/A	8Kb, WT	YES	CMOS	3.3V	FA176	C
80486GXSF 16-bit bus	33	0	NO	0	YES	YES	NO	0	NO	0	NO	NO	N/A	8Kb, WT	YES	CMOS	3.3V	FA176	C
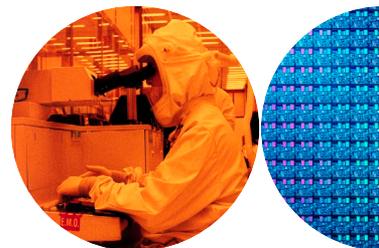
PACKAGING:
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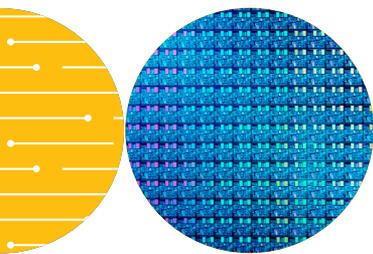
Development Tools and Support

Comprehensive Support for Embedded Products

Intel is proud of the wide variety of hardware and software tools available to support all phases of the development cycle. Some of the industry's leading tool suppliers are providing high-performance Windows*-based software, evaluation boards and kits, and full-featured, real-time emulators; along with flexible, fully integrated device programming support for Intel's embedded products. Intel is committed to providing the tools and support needed to speed the learning curve and reduce design time. To learn more about these tool suppliers and support, visit or call:

· Technical Application Design Center Support
embedded@mailbox.intel.com or (800) 628-8686

· Electronic Tools Catalog
http://appzone.intel.com/toolscatalog

Intel Access

Intel's Developer Site: developer.intel.com

Embedded Intel® Architecture: developer.intel.com/design/intarch

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Intel386™ Processors: developer.intel.com/design/intarch/intel386

Intel186 Processors: developer.intel.com/design/intarch/intel186

Other Intel Support: developer.intel.com/design/litcentr

Intel Literature Center (800) 548-4725, 7 a.m. to 7 p.m. CST (U.S. and Canada); international locations please contact your sales office.

General Information Hotline (800) 628-8686 or (916) 356-3104, 5 a.m. to 5 p.m. PST

For more information, visit the Intel Web site at: developer.intel.com.

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