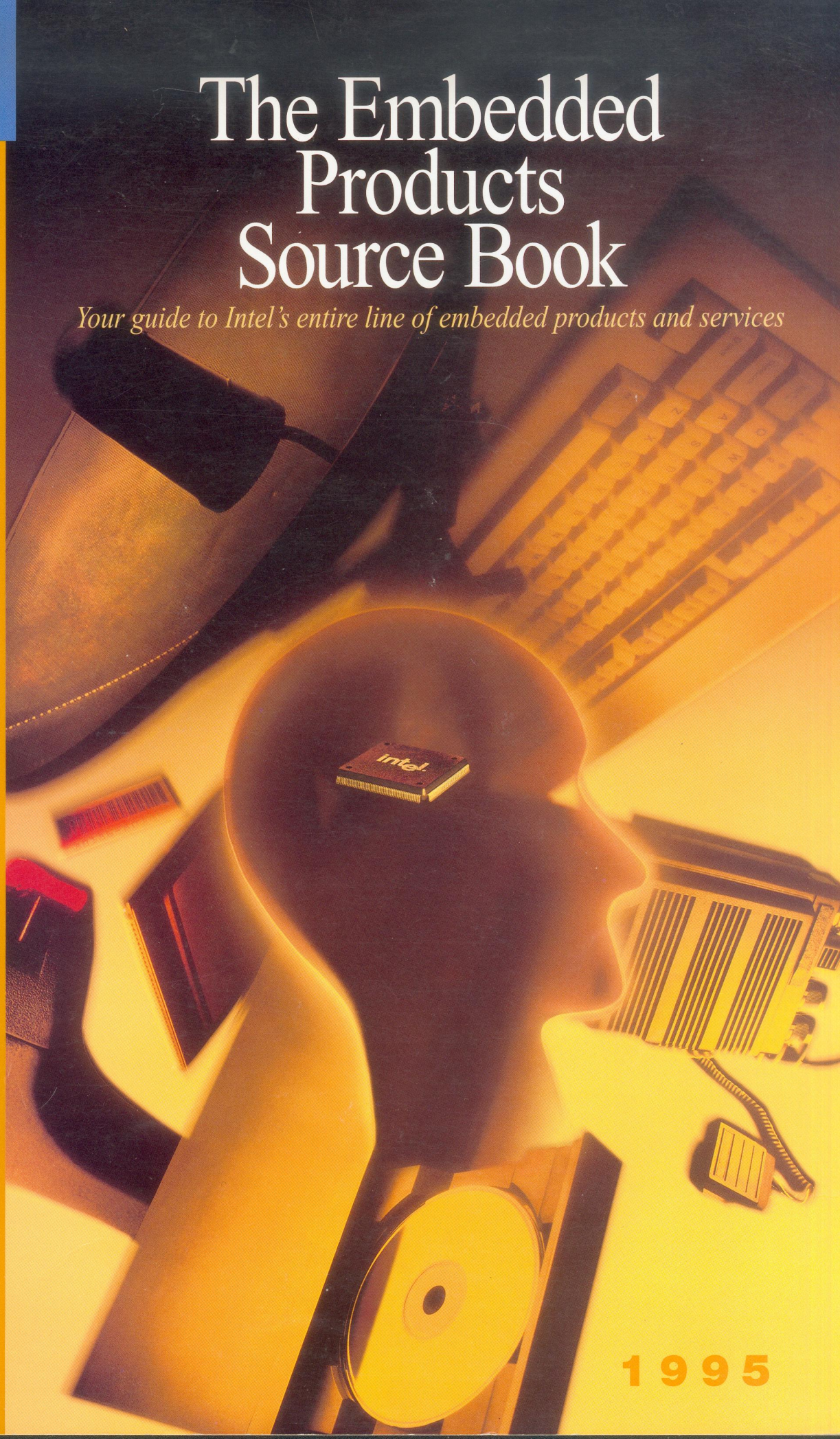
KEEPING
YOU ONE
DESIGN
AHEAD

The Embedded Products Source Book

Your guide to Intel's entire line of embedded products and services



intel®

1995

You'll find it all.

Right from the beginning we wanted this to be more than a marketing piece, more than something that's a quick skim and then forgotten on your bookshelf. Yes, it has the feel of a catalog. It has the product information and phone numbers you might expect. But in a day-in and day-out sense, it's far more useful.

It's a tool. A book designed with one specific intent: to help you evaluate and select Intel embedded products, with both ease and accuracy.

You'll see we've included overviews of every item offered by the Intel Semiconductor Products Group. You'll find linecards and other information to help you design faster and more efficiently. Details on Intel tools support are in these pages, too, along with information to help you contact the right sources to support and enhance your designs—worldwide. And to make sure you always find the sources you need, we'll be updating this guide twice a year.

A $1 billion commitment to R&D

Of course, we realize that all of the above would be meaningless without the product quality and leadership to keep you moving forward. That's why, year after year, Intel invests more money in future technology than any other chip maker. In recent years, our annual research and development budgets have topped $1 billion.

With more than 70 percent of the corporation's unit volume going into the embedded marketplace, it comes as no surprise that a significant portion of those budgets is dedicated to developing new technologies for our embedded products customers.

We continue to take advantage of breakthroughs made by other divisions of Intel, as well. By doing so, the Intel embedded products group has been able to introduce new features in our embedded products, keeping them at the forefront of the industry.

What have we done for you lately?

For examples of Intel leadership, consider Intel Flash memory and our new i960® Hx processors, MCS® 251 microcontrollers and SmartDie™ products.

Intel is the leader in Flash memory, and with innovations like SmartVoltage, it's easy to see why. You get the benefits of lower power demand, allowing you to give your customers more features and extended battery life.

The new i960 Hx superscalar processors continue Intel's leadership in 32-bit embedded RISC, with innovations such as clock-tripled processing. These cost-effective processors enable you to upgrade easily to the higher performance levels needed for today's most demanding embedded applications.

Our new MCS 251 architecture offers MCS® 51 microcontroller designers a high-performance upgrade path. The first product of this next-generation architecture is drop-in pin-compatible with existing MCS 51 microcontroller sockets, instantly producing as much as a 500 percent performance increase.

By eliminating chip packaging, SmartDie products give you a simple, cost-effective way to build smaller, lighter and smarter products, saving up to 75 percent of the board space consumed by traditional chips. But perhaps the real breakthrough is that even bare, these chips boast the same reliability and performance as our packaged processors.

In the future, look for Intel to continue to add new peripheral capabilities to existing architectures, as well as to expand signal processing capabilities.

Keeping us—and you—in the lead

As you might expect, our breakthroughs in technology have led to advances in manufacturing methods. They, in turn, have led to greater chip reliability and value to our customers.

The result? Intel has had increased wafer starts every year of the company's existence. To continue to ensure our worldwide leadership in manufacturing, quality and reliability, as well as to respond promptly to market demand, the company made $6 billion in capital improvements during the last three years.

We continue to enhance our support as well, with personnel who have completed extensive hands-on training at Intel factories. Then there are our technical hotlines, our FaxBack service and on-line support, including Intel's own bulletin board service, CompuServe* forums and our new Internet presence on the World Wide Web.

As you move through these pages, you'll get an overview of each of our architectures and product families. You'll be able to determine which products can best suit your needs. So please, make evaluations, formulate questions and feel free to contact us at any time.

It's all part of our effort to keep you one design ahead.

Flash Memory Components, Cards and Drives

INNOVATIVE TECHNOLOGY FOR COST-EFFECTIVE SOLUTIONS

Intel's Flash memory family features an extensive product line to match the right product to your specific needs. From high-integration SmartVoltage boot block to high-performance embedded Flash RAM and high-density FlashFile™ memory components, Intel has a Flash memory solution tuned for your embedded application. Intel's innovative Flash products give you cost-effective solutions by offering the lowest power and highest density available today.

Intel Flash Memory Cards and Drives

Intel's Flash memory cards and drives bring the mass storage advantages of Intel's FlashFile memory to mobile computers and embedded systems. These products provide the extended system battery life, high performance, ruggedness and reliability that are required for today's mobile computing systems. Both memory cards and drives comply with the PCMCIA 2.1/JEIDA 4.1, 68-pin standards.

COMPONENTS

FEATURES	BENEFITS
Broadest product line in industry (256K–32 MB)	**Speed.** There is an optimized Flash memory for your application
SmartVoltage technology ▪ low-voltage read ▪ high-voltage programming ▪ single-voltage operation	**Efficient.** Reduces system power **Manufacturable.** Fast programming **Flexible.** Easier board design
Multiple fab production	**Safety.** Assured supply of product

CARDS AND DRIVES

FEATURES	BENEFITS
PCMCIA form factor	**Portable.** Interface provides easy data transfer between systems
Solid-state reliability	**Rugged.** Withstands environments too harsh for rotating disks
Auto power management	**Efficient.** Extends system battery life

Flash Memory Components—High Integration

Intel's SmartVoltage boot block components offer a single-chip, asymmetrically blocked, highly integrated, high-performance solution for updatable firmware storage. These components come in 2-, 4- and 8-Mbit densities and provide an easy pin-out compatible upgrade path. These new Flash memory devices offer all the standard features of the 12V write Intel boot block architecture and add flexible voltage operation: low power, 3.3V or 5V read and 5V or fast 12V write. These products offer x8 and x8/x16 operation for CPU flexibility, and a hardware-lockable block to ensure security for critical code storage. A high-performance 60ns read access speed is also available.

Continued on next page

Flash Memory Components—High Integration continued

FEATURES	BENEFITS
3.3V low-power read option	**Efficient.** Reduces system power consumption; increases thermal reliability
5.5V single-voltage mode	**Flexible.** Easier board design
60% faster programming than restrictive 5V-only products	**Manufacturable.** Higher throughput equals lower programming and manufacturing costs
Single socket for 2-, 4- and 8-Mbit	**Upgradeable.** No board changes for code expansion
Widely sourced packaging and architecture	**Available.** Multiple supply sources and future protection from obsolescence
Backward compatibility	**Compatible.** Seamless transition from current 12V write/5V read Flash products
EEPROM emulation	**Fewer components.** Integrate EEPROM functionality on chip in selected applications
Automated algorithm for erase/write	**Simple.** Minimal software overhead

Flash Memory Components—High Performance

To meet high performance requirements, many embedded systems store code in nonvolatile memory (NVM) such as ROM, EPROM or Flash and shadow this code to DRAM for execution. Embedded Flash RAM memories, with their optimized system-read interfaces, have the performance, nonvolatility and updating capacity to replace redundant DRAM + NVM for code storage/execution and reduced system cost.

The synchronous, effective 0-wait-state, burst-read interface of the 28F016XS makes it ideal for residing on the local bus of burst-mode processors, such as the i960® and Intel486™ processors. The DRAM system read interface of the 28F016XD is optimized for designs such as embedded PC motherboards and anywhere a DRAM bus architecture is used.

All embedded Flash RAM devices feature SmartVoltage technology, providing the fastest available, 5V-only write performance and even higher performance 12V device writes. SmartVoltage technology also supports low-power 3.3V reads as well as high-performance 5V reads.

Because these devices feature the architecture of Intel's FlashFile™ memories, they are ideal for solid-state mass storage applications such as resident Flash disks (RFDs). Valuable mass storage features include an integrated Flash controller that supports SRAM-speed burst write performance and advanced command-set queuing to off-load system resources during Flash erase/write cycles.

FEATURES	BENEFITS
Optimized system interface	**Performance.** 28F016XS supports high-performance, burst-mode CPU local bus designs. The 28F016XD supports code execution via the system DRAM
Lower system cost than DRAM+NVM (NVM = ROM, EPROM, HDD, etc.)	**Lower power.** Higher integration and 3.3V capability coupled with cost savings
Nonvolatile, code storage/execution solution	**No refresh required.** No need for redundant memory (vs. DRAM + ROM). Lower device count
Lower power than DRAM + NVM	**Efficient.** Desirable for battery-powered portable applications
In-system updatable	**Faster time-to-market.** First systems can ship earlier and be updated in the field if necessary
SmartVoltage technology	**Low power.** 3.3V reads **Performance.** 12V writes, 5V reads **Integration.** 5V writes

Flash Memory Components—High Density

Intel's symmetrically blocked FlashFile™ memory family provides the widest range of high-density, mass storage Flash devices available today. Intel has manufactured more than 10 million devices to date using the highly successful ETOX™ IV wafer fab technology. Intel's strong track record and knowledge base positions the company as the leader on key fronts: price, features and performance.

The FlashFile memory architecture is partitioned into independently erasable 64K blocks, making it optimal for potential updates on file storage applications. On the 16-Mbit and higher density devices, these blocks are independently lockable to protect important firmware such as operating systems and application programs from being inadvertently erased.

The command set for the 8-Mbit 28F008SA is supported by all of the family members, which allows design migration up and down the device density range without system software changes. The 28F016SA, 28F016SV and 28F032SA devices also have an integrated Flash controller that supports 14.3 MB/sec burst write performance and advanced command-set queuing to off-load system resources during Flash erase/write cycles. These 16- and 32-Mbit devices are also configurable as x8 or x16, which is ideal for 16- and 32-bit applications.

The newest member of the FlashFile memory family, the 16-Mbit 28F016SV, premiered Intel's SmartVoltage technology. In addition to providing the fastest available 16-Mbit, 5V-only write performance, SmartVoltage supports even higher performance 12V device writes for applications that value optimum write speed. SmartVoltage also supports low-power 3.3V reads as well as high-performance 5V reads.

FEATURES	BENEFITS
Widest range of high-density devices	**Selection.** Choose from broadest offering of high-density Flash memory features and performance
3.3V device-read support	**Efficient.** Ideal for battery-powered, portable applications
Entire family compatible with 28F008SA	**Compatible.** Designs can easily migrate from 8- to 32-Mbit as command set and memory requirements change
Available in TSOP packages	**Saves space.** Minimizes board space requirements
Integrated Flash controller available on 28F016SV, 28F016SA and 28F032SA	**Fast.** Off-load system resources during Flash erase/write cycles. Independently lockable 64K blocks. High-speed, 14.3 MB/sec burst write support

Flash Memory Cards—Series 2

Intel's second-generation Flash memory cards feature block erasure, which offers data file and applications storage in removable nonvolatile memory. Intel's Series 2 Flash cards are ideal for a broad range of applications, from mobile PCs and personal digital assistants (PDAs) to embedded systems. The Flash cards are lightweight, extend system battery life and withstand rugged environments where small, form-factor rotating disks are not suitable.

The functionality of the Series 2 Flash memory cards is based on Intel's ETOX™ III 8-MB FlashFile™ memories. Each memory card consists of a PCMCIA connector, an array of 28F008SA Flash memories in TSOP packaging and two card-control logic devices. The control logic devices provide the system interface and control the internal Flash memories.

Intel Flash memory cards feature fast random access, byte-wide and word-wide operation, low power modes and a Card Information Structure (CIS) for easy identification of card characteristics. Combined with file management software, such as M-Systems' TrueFFS*, Intel's Flash cards provide removable, high-performance disk emulation in mobile personal computers.

FEATURES	BENEFITS
Flash block electrical erase	**Speed.** Fast read throughput of 10 MB/sec. 10 µs typical word write
Byte or word-wide operation	**Flexibility.** Flexibility in design and usage
Low-cost design	**Cost Effective.** Low-cost solution

Flash Memory Cards—Series 2+

The Intel Series 2+ Flash memory cards enable the design of next generation, 3.3V, 5V only and 5V/12V mobile PCs, PDAs and communicators. The cards are also an excellent solution for embedded systems. The lightweight Flash memory cards extend system battery life and withstand environments that are too harsh for small, form-factor rotating disks.

The functionality of the Series 2+ Flash memory cards is based on Intel's ETOX IV 16- and 32-Mbit FlashFile memories. Each memory card consists of a PCMCIA connector, an array of 28F016SA (4–20 MB) and 28F032SA (40 MB) Flash memories in TSOP packaging and two card-control logic devices. The control logic devices provide the system interface and control the internal Flash memories. In addition, the card features several enhancements to the Intel Series 2 Flash memory card, including:

- higher density
- faster random read access
- faster write performance
- individually lockable blocks
- write during suspended-erase
- flexible power supply operation

FEATURES	BENEFITS
Flash block electrical erase	**Speed.** 6 µs typical word write @ 5V, 9 µs typical word write @ 3.3V
SmartVoltage	**Flexibility.** Supply voltage flexibility (3.3V, 5V or 12V operation)
Byte or word-wide operation	**Options.** Flexibility in design and usage
Low-power sleep mode	**Efficient.** Extends system battery life
Independently lockable blocks	**Security.** Provides software code security

Flash Memory Drives

The Intel Flash drive delivers up to 10 MB of nonvolatile storage. This drive provides the battery life, performance, ruggedness, reliability and 100 percent silent operation needed for leading-edge, mobile computing applications. The drive extends system battery life up to 100 percent by eliminating continuously spinning disks and using power only when needed. Automatic, integrated power management reduces electrical current without special system BIOS support.

The Flash drive is interface compatible with PCMCIA-ATA magnetic drives, so using it only requires replacing the disk drive with a Flash drive. Additional system software drivers are typically not needed.

With its Type II 5mm form factor, which has only half the thickness of a 1.8 Type III hard disk drive, the Flash drive is very compact and allows two cards to occupy the space of one disk drive. Furthermore, the drive's solid-state construction yields high performance and a 1,000g shock specification.

FEATURES	BENEFITS
PCMCIA-ATA interface	**Speed.** Uses standard ATA host software driver
PCMCIA-IDE compatible	**Flexibility.** Direct replacement for hard disk drives
Auto power management	**Efficient.** Low battery drain, 10mW sleep mode
Seek time of < 1msec	**High performance.** Quick seek time
Solid-state reliability	**Reliable.** 250K power-on MTBF
Single +5V supply	**Ease of use.** Easy system design and integration

Flash Memory Development Tools

Intel offers a growing set of Flash memory evaluation, modeling and programming tools. The company is committed to providing the tools and support necessary to make our Flash memory products the easiest to use in the industry. Development tools include evaluation boards, programming and software support, FLASHBuilder software, prototyping sockets and VHDL modeling.

Intel's evaluation kits support the Flash card product line and PCMCIA Flash drive product line. Kits include a 4-MB Series 2+ Flash card or 5-MB Flash drive, an ISA-based PCMCIA reader/writer, SystemSoft's Cardsoft* software suite, Flash media managers, source code for low-level drivers and MTDs, and all the documentation needed to install, evaluate and create PCMCIA-based designs and applications. For more information about development tools support, refer to page 36 in this catalog or contact your Intel sales representative.

FLASH MEMORY LINECARD

DENSITY	PRODUCT	ORGANIZATION	@5.0VCC	@3.3VCC	VPP	#PINS	PACKAGE	TEMP
HIGH-INTEGRATION BOOT BLOCK FLASH MEMORY COMPONENTS—Asymmetrically blocked architecture								
▶ 8 Mbit	28F800BV	1M x 8/ 512K x 16	80, 120	150, 180	5V/12V	44	PA, X	C, E
▶	28F800CV	1M x 8/ 512K x 16	80	150	5V/12V	48	E	C, E
▶	28F008BV	1M x 8	80, 120	150, 180	5V/12V	40	E	C, E
4 Mbit	28F400BV	512K x 8/ 256K x 16	70, 90	110, 150	5V/12V	56	E, X	C, E
	28F400BV	512K x 8/ 256K x 16	70, 90, 120	110, 150, 180	5V/12V	44	PA, X	C, E
	28F400CV	512K x 8/ 256K x 16	70, 90	110, 150	5V/12V	48	E	C, E
	28F400BX	512K x 8/ 256K x 16	60, 80	N/A	12V	56	E, X	C, E, A
	28F400BX	512K x 8/ 256K x 16	60, 80, 120	N/A	12V	44	PA, X	C, E
	28F400BL	512K x 8/ 256K x 16	150	150	12V	56	E, X	C
	28F400BL	512K x 8/ 256K x 16	150	150	12V	44	PA, X	C
	28F004BV	512K x 8	70, 90, 120	110, 150, 180	5V/12V	40	E	C, E
	28F004BX	512K x 8	60, 80, 120	N/A	12V	40	E	C, E
	28F004BL	512K x 8	150	150	12V	40	E	C
▶ 2 Mbit	28F200BV	256K x 8/ 128K x 16	70, 90	110, 150	5V/12V	56	E, X	C, E
▶	28F200BV	256K x 8/ 128K x 16	70, 90, 120	110, 150, 180	5V/12V	44	PA, X	C, E
▶	28F200CV	256K x 8/ 128K x 16	70, 90	110, 150	5V/12V	48	E	C, E
	28F200BX	256K x 8/ 128K x 16	60, 80	N/A	12V	56	E	C, E
	28F200BX	256K x 8/ 128K x 16	60, 80, 120	N/A	12V	44	PA	C, E, A
	28F200BL	256K x 8/ 128K x 16	150	150	12V	56	E	C
	28F200BL	256K x 8/ 128K x 16	150	150	12V	44	PA	C
	28F002BV	256K x 8	70, 90, 120	110, 150, 180	5V/12V	40	E	C, E
	28F002BX	256K x 8	60, 80, 120	N/A	12V	40	E	C, E
	28F002BL	256K x 8	150	150	12V	40	E	C
1 Mbit	28F001BX	128K x 8	70, 90	N/A	12V	32	P, N, E, X	C, E
FIRST-GENERATION FLASH MEMORY COMPONENTS—Bulk Erase								
2 Mbit	28F020	256K x 8	70, 90, 120,150	N/A	12V	32	P, N, E, X	C, E, M
1 Mbit	28F010	128K x 8	65, 90, 120,150	N/A	12V	32	P, N, E, X	C, E, A, M
512 Kbit	28F512	64K x 8	120, 150, 200	N/A	12V	32	P, N	C, E, A
256 Kbit	28F256A	32K x 8	120, 150, 200	N/A	12V	32	P, N	C, A
HIGH-PERFORMANCE FLASH MEMORY COMPONENTS—Symmetrically blocked embedded Flash RAM architecture								
16 Mbit	28F016XS	2M x 8/ 1M x 16	0 WS 33 MHz	0 WS 25 MHz	5V/12V	56	E	C
			0 WS 25 MHz	0 WS 20 MHz				
▶	28F016XD	1M x 16	85 (random)	95 (random)	5V/12V	56	E	C
HIGH DENSITY FLASH MEMORY COMPONENTS—Symmetrically blocked FlashFile™ architecture								
32 Mbit	28F032SA	4M x 8/ 2M x 16	70, 100	150	12V	56	E	C
16 Mbit	28F016SV	2M x 8/ 1M x 16	65, 70	75, 120	5V/12V	56	E, DA, X	C, M
	28F016SA	2M x 8/ 1M x 16	70, 100	120, 150	12V	56	E, PA,	C, E
8 Mbit	28F008SA	1M x 8	85, 120	200	12V	40	E, X	C, E, M
	28F008SA	1M x 8	85, 120	200	12V	44	PA, X	C, E, M
PCMCIA FLASH MEMORY CARDS/DRIVES AT A GLANCE:								
SERIES 1 FLASH MEMORY CARDS								
4 MB	iMC004FLKA	4M x 8/ 2M x 16	200	N/A			Type 1	c
2 MB	iMC002FLKA	2M x 8/ 1M x 16	200	N/A			Type 1	c
1 MB	iMC001FLKA	1M x 8/ 512K x16	200	N/A			Type 1	c
SERIES 2 FLASH MEMORY CARDS								
20 MB	iMC020FLSAL	20M x 8/ 10M x 16	200	N/A			Type 1	C,E
10 MB	iMC010FLSA	10M x 8/ 5M x 16	200	N/A			Type 1	C,E
4 MB	iMC004FLSA	4M x 8/ 2M x 16	200	N/A			Type 1	C,E
2 MB	iMC002FLSA	2M x 8/ 1M x 16	200	N/A			Type 1	C,E
SERIES 2+ FLASH MEMORY CARDS								
40 MB	iMC040FLSP	40M x 8/ 20M x 16	150	250			Type 1	c
20 MB	iMC020FLSP	20M x 8/ 10M x16	150	250			Type 1	c
8 MB	iMC008FLSP	8M x 8/ 4M x 16	150	250			Type 1	c
4 MB	iMC004FLSP	4M x 8/ 2M x 16	150	250			Type 1	c
FLASH DRIVES: PCMCIA–ATA, IDE–ATA INTERFACE								
10 MB	iFD010P2SA	N/A	<1ms	N/A			Type 2	c
5 MB	iFD005P2SA	N/A	<1ms	N/A			Type 2	c

Check databook or FaxBack for extended temperature package and speed offerings

PACKAGE PREFIX CODES:
Components Commercial Temperature: **P** = Plastic DIP, **N** = PLCC, **PA** = PSOP, **E** = TSOP, **F** = TSOP, reverse pinout, **DA** = SSOP, **DD** = Dual Die

Components Extended Temperature: **TP** = Plastic DIP, **TN** = PLCC, **TB** = PSOP, **TE** = TSOP, **TF** = TSOP, reverse pinout, **DT** = SSOP, **X** = SmartDie™ product. For further information, please call **800-548-4725** and ask to receive the SmartDie Product Literature Kit No. G1B03. Intel SmartDie products are functionally equivalent die-level silicon versions of standard Intel products. All SmartDie products are tested to meet commercial specifications to ensure the same quality and reliability levels of packaged products. SmartDie products offer the user a cost-effective packaging alternative for those demanding small form-factor applications.

PCMCIA Memory Card/Drive: PCMCIA 2.1/JEIDA 4.1, 68-pin compatible, **Type 1** = 3.3mm thickness, **Type 2** = 5.0mm thickness

Other Codes: **N/A** = Not Available, **PA** = Package, **28F400BV** = Base Product, **80** = Speed

TEMPERATURE RANGES:
C = Commercial (0° to +70°C), **E** = Extended (-40° to +85°C), **A** = Automotive (-40° to +125°C). To receive more information on Intel's Automotive Products, call **800-548-4725** and ask for document #272452, "The Winning Formula Automotive Brochure." **M** = Military (-55° to +125°C) Intel's Military and Special Products offer industrial-strength semiconductors optimized for wide temperature ranges and tough applications and environments. For a list of these products, call **800-548-4725** and ask for document # 271153, "Military and Special Products Portfolio". **c** = Standard Version for PCMCIA cards (0° to +60°C)

▶= NEW PRODUCT

FLASH MEMORY LITERATURE

TITLE		ORDER #	FAXBACK #
PRODUCT INFORMATION			
Quick Reference Guide v6.0			2216
Technical Support Summary			2204
Intel Flash Memory Literature Documents			2268
Intel 8 Mbit FlashFile™ Memory 28F008SA		297107	
Intel 16Mbit FlashFile Memory Product Family 28F016SA and 28F016SV (SmartVoltage)		297349	
Intel FlashFile Memory DD28F032SA		297346	
Intel Blocked Flash Memory 28F001BX-B/28F001BX-T		296913	
2, 4, 8Mb Boot Block Product Brief		297570	
Intel 2 Megabit Boot Block Flash Memory for PC BIOS 28F200BX-T/B, 28F002BX-T/B		297184	
Intel Series 1 Flash Memory Card iMC001FLKA/ 002FLKA/004FLKA		296840	
Intel iFD005P2SA/iFD010P2SA Flash Drive Product Brief		297348	
Intel Series 2 and 2+ Flash Memory Cards Product Brief		297516	
DATA SHEETS			
28F016XS Data Sheet		290532	
28F016XD Data Sheet		290533	
28F008SA 8-Mbit (1-MBIT x 8) Flash Memory		290429	
28F008SA-L 8-Mbit (1 MBIT x 8) FlashFile Memory		290435	
28F016SA 16Mbit (1Mbit x 16, 2Mbit x 8) FlashFile Memory		290489	
28F016SV16Mbit (1Mbit x 16, 2 Mbit x 8) FlashFile Memory		290528	
DD28F032SA 32M (2Mbit x 16, 4Mbit x 8) FlashFile Memory		290490	
28F001BX-T/28F001BX-B B 1M (128K x 8) CMOS Flash Memory		290406	
2Mb Boot Block SmartVoltage Data Sheet		290531	
28F200BX-T/B, 28F002BX-T/B 2M (128Kx16, 256Kx8) Boot Block Flash Memory Family		290448	
28F200/002BX-TL/BL 2M (128K x 16, 256Kx8) Low Power Boot Block Flash Memory		290449	
4Mb Boot Block SmartVoltage Data Sheet		290530	
28F400BX-T/B, 28F004BX-T/B 4MBIT (256K x 16, 512K x 8) Boot Block Flash Memory		290451	
28F400/004BX-TL/BL 4M (256K x 16, 512K x 8) Boot Block Flash Memory Family		290450	
8Mb Boot Block SmartVoltage Data Sheet		290539	
28F256A 256K (32K x8) CMOS Flash Memory		290243	
28F512 512K (64K x 8) CMOS Flash Memory		290204	
28F010 1M 1024K (128K x 8) CMOS Flash Memory		290207	
28F020 2M 2048K (245K x 8) CMOS Flash Memory		290245	
APPLICATION NOTES/APPLICATION BRIEFS			
AP-384 Designing with the 28F016XD		292131	
AP-398 Designing with the 28F016XS		292147	
AP-343 Solutions for High Density Applications: Using Intel Flash Memory		292079	
AP-359 28F008SA Hardware Interfacing		292094	
AP-360 28F008SA Software Drivers		292095	
AP-362 Implementing Mobil PC Designs Using High Density FlashFile Components		292097	
AP-364 28F008SA Automation & Algorithms		292099	
AP-375 Upgrade Considerations form the 28F008SA to the 28F016SA		292124	
AP-378 System Optimization Using the Enhanced Features of the 28F016SA		292127	
AP-377 28F016SA Software Drivers		292126	
AP-380 Upgrading System Designs from Bulk Erase to Boot Block Flash Memories		292129	
AP-393 28F016SV Compatibility Erase with 28F016SA		292144	
AB-57 Intel's Flash Memory Boot Block Architecture for Safe Firmware Updates		292130	
AP-325 Guide to 1st Generation Flash Memory Programming		292059	
AP-371 Designing Flash Card Readiness into Today's Systems		292109	
AP-316 Using Flash Memory For In-System Reprogrammable Nonvolatile Storage		292046	
AP-341 Designing an Updatable BIOS Using Flash Memory		292077	
AP-357 Power Supply Solutions for Flash Memory		292092	
AP-363 Extended Flash BIOS Concepts for Portable Computers		292098	
AB-604 Flash Memory Parameter Blocks to Replace EEPROM		292148	
TOOLS			
Intel Flash Memory Tools and Support Information v1.2			2295
Programming Vendor Addresses and Phone Numbers			2203
FlashFile System Selection Guide v1.0			2258
PCMCIA: PCMCIA Flash Card and Drive Software Vendors			2255
Flash Memory Third Party Tool Vendors			2203
BBS File Listings for Flash			6005
FLASHBuilder	BBS:FBUILDER.ZIP	297508	
2Mb Boot Block Programming Support			2580
4Mb Boot Block Programming Support			2581
In-System Boot Block Programming Code	BBS:IBOOTLDR.EXE		
DD28F032SA Programming Support Tools			2222
Symmetrical Block File Manager Source Files	BBS:SBMBETA.EXE		
Linear File Manager Source Files	BBS:FM.EXE		
Intel 2/4 Mbit Boot Block Flash Memory Evaluation Module (D, FLASHEVAL5)		297152	
Intel 28F008SA FlashFile Memory Evaluation Module (D, FLASHEVAL4)		297117	
Intel Flash Memory Evaluation Kit II (D, FLASHEVAL2)		296997	
Flash Memory Card and Flash Drive Evaluation Kit Product Brief		297506	
MANUALS/DATABOOKS			
1995 Flash Memory Databook		210830	
Small Outline Package Guide		296514	
28F016SA User's Manual		297372	
Series 2+ Flash Memory CD User's Manual		297373	

Additional product information is always available via Intel's Bulletin Board System (BBS), CompuServe® and the World Wide Web. (refer to page 40)

i960® Processors

A LEADING PERFORMANCE CHOICE

The i960® processor family is a leading 32-bit embedded RISC architecture, with more than 15 million units shipped. The 14 processors in the family range in performance from 10 to 150 MIPS, with some priced as low as $1 per MIPS. Intel used its semiconductor technology and design skills to introduce eight i960 processors in 1994: five mid-range Jx series processors and three high-end Hx series processors. The i960 processor is the ideal choice for developing high-performance embedded control applications that have high software content and must move large amounts of data rapidly. All the processors are object-code compatible, from the entry-level 10-MIPS Sx parts to the high-end 150-MIPS Hx parts. When your first i960 processor-based product development is complete, you can move your application to other i960 processors, and offer your product at multiple price and performance levels while preserving your software engineering investment.

The excellent price/performance ratio, outstanding selection of development tools and wide selection of processors have made the i960 processor family the choice of many leading companies for local and wide area networking, intelligent I/O, imaging and telecommunications, as well as a variety of industrial embedded applications.

FEATURES	BENEFITS
32-bit register-based RISC architecture	**Efficiency.** Provides speed and simplicity of design at a low cost; processors available for less than $1/MIPS
Enhanced CISC-like instruction set optimized for embedded applications	**Simplicity.** Programming is easier; improves high code density and performance
Standard interrupt controller automatically resolves priorities; local registers are automatically saved when a subroutine is called	**Rapid response.** Ideal for applications requiring fast response times
On-chip instruction caches standard on all processors	**Speed.** Performance boosted by reducing external memory accesses to fetch instructions
On-chip data cache (Jx, Hx and CF processors)	**Performance.** Reduces external memory accesses to fetch frequently accessed data
Unaligned big endian data access support (Cx, Jx and Hx processors)	**Efficiency.** Handles a variety of data formats quickly and efficiently, eliminating the need for exception handling routines
High-performance data buses offer transfer rates of up to 160 MB per second	**Speed.** Supports demanding data-intense applications
Object-code compatibility across the family	**Selection.** Offers the ability to scale products across a wide range of price and performance levels while preserving existing software and minimizing development time
Processors provide up to 45 MIPS/Watt	**Energy efficiency.** Uses less power

The i960 Cx, Jx, Kx and Sx processors are all available now; the Hx processors are anticipated to sample in Q3 1995.

i960® Hx Superscalar Processor Family

The i960 HA, HD and HT processors will be Intel's newest superscalar RISC processors, with performance of up to 150 MIPS. These are the latest generation of the i960 processor architecture and will incorporate innovations such as the industry's first clock-tripled superscalar RISC processor core, providing maximum levels of performance while containing total embedded system cost. The HA is the base processor, while the HD is a clock-doubled version. The HT is a clock-tripled superscalar RISC processor running at up to 75 MHz with a 25-MHz external bus. The Hx processors are pin-for-pin compatible, so you can vary performance by simply switching which processor you use. They have large instruction and data caches, support 8-, 16- and 32-bit bus widths, and support both big endian as well as little endian unaligned data. They also incorporate a guarded memory unit for secure software development and execution.

FEATURES	BENEFITS
Superscalar RISC core executes multiple instructions	**Performance.** Increases execution speed without requiring complex per clock cycle hardware design
16K four-way set associative instruction cache and 8K four-way set associative data cache	**Cost reduction.** Enables low-speed memory coupled with a high-speed processor
Processors run at 1x, 2x or 3x external clock speed	**Ease of design.** Choose from multiple price/performance options
Two 32-bit timers	**Simplicity.** More functionality on a single component
Parity generation and checking	**Reliability.** Provides built-in data integrity
Guarded memory unit (GMU)	**Security.** Simplifies developing and evaluating application software
3.3V supply, 5V tolerant I/O	**Low power.** Ideal for energy-efficient applications
Power management features	**Less power consumption.** Higher performance
Design compatible with i960 CA/CF processors	**Expandable.** Easy to upgrade CA/CF-based designs to meet new market needs

i960® Jx Processor Family—The Cobra Series

The mid-range Jx processors offer twice the performance of the entry-level Kx parts, but at only a fraction of the price of most other high-performance RISC processors on the market. They offer higher integration, incorporate power-saving features, and provide up to 45 MIPS/Watt performance, making them ideal for cost-sensitive, data-intensive applications, such as inter-networking, imaging and high-performance I/O (RAID and SCSI). All the processors have on-chip instruction and data caches, a high-speed interrupt controller, and support for 8-, 16- and 32-bit wide buses. And most are available in 3.3V and 5V versions. They are ideal for networking applications because they support unaligned big endian and little endian data. The five pin-for-pin compatible processors are:

- 80960JF: The base processor has a 4K two-way set associative instruction cache and 2K direct-mapped data cache
- 80L960JF: 3.3V version of the 80960JF
- 80960JD: The first i960 processor to offer Intel clock-doubling technology—the processor runs at 50 MHz internally, with a 25-MHz external bus
- 80960JA: Low-cost version of the 80960JF, with a 2K instruction cache and a 1K data cache
- 80L960JA: 3.3V version of the 80960JA

FEATURES	BENEFITS
Enhanced i960 processor-compatible RISC core	**Higher performance.** Lower cost
Low-power operation, with 3.3V operation on selected processors	**Energy efficiency.** 45 MIPS/Watt performance
New instructions	**Code density.** Selected operations take a single instruction, which also enhances performance
Advanced cache architecture	**Increased performance.** Reduces access cycles to external memory and decreases bus traffic
Enhanced bus control unit, supporting 32-, 16- or 8-bit external memory	**Ease of design.** Simple interfacing to multiple device types
State-of-the-art testability ▪ built-in self-test (BIST) ▪ on-circuit emulation (ONCE) ▪ test access port (TAP) based on IEEE 1149.1 (JTAG) standard	**Simplified testing.** At chip and system level

i960® Cx Processor Family

The superscalar CA and CF processors are 66–80 MIPS processors that can execute up to three instructions in one clock cycle. They support 8-, 16- and 32-bit buses, and big endian and little endian data. The CF is a faster, pin-compatible version of the CA, with a 4K instruction cache in place of the 1K instruction cache on the CA, plus the addition of a 1K data cache. Both processors include a four-channel, on-chip DMA unit.

FEATURES	BENEFITS
World's first superscalar RISC core	**Higher performance.** Executes up to three instructions per clock cycle
On-chip 4-channel DMA controller	**Lower system cost.** Eliminates external logic
On-chip instruction cache CA-1K; CF-4K	**Higher performance.** Reduces time required to retrieve instructions from external memory
1K data cache (CF)	**Higher performance.** Reduces time required to access data from external memory
1K on-chip data RAM	**Higher performance.** No need for external access to frequently used data
Enhanced bus control unit, supporting 32-, 16- or 8-bit external memory	**Simplicity.** Easy to interface to different devices and memory types
Unaligned big endian and little endian support	**Ease of use.** Easy to process data, regardless of format

i960® Kx and Sx Processor Families

The entry-level SA and SB processors are ideal for upgrading 16-bit applications to higher levels of performance, and for taking advantage of the capabilities of the i960 architecture. These cost-effective, 32-bit RISC processors offer 10 MIPS performance and are priced as low as $10. The SA and SB are identical, except the SB includes an on-chip, IEEE-compliant, floating-point unit for compute-intensive applications. The KA and KB are the same as the SA and SB but have a 32-bit multiplexed external bus instead of a 16-bit bus.

FEATURES	BENEFITS
On-chip 512-byte instruction cache	**Speed.** Performance boosted by reducing external memory accesses to fetch instructions
On-chip IEEE 754 floating-point unit (SB, KB)	**High-speed arithmetic.** For compute-intensive applications
16-bit multiplexed burst bus (SA, SB)	**Economy.** Simple interface to low-cost, 16-bit memory and peripherals
32-bit multiplexed burst bus (KA, KB)	**Economy.** Low-cost external interface
Object code compatible with Jx, Cx and Hx processors	**Selection.** Ability to scale products across a wide range of price and performance levels

i960® Processor Development Tools

Fast, cost-effective processors are only part of what is needed to develop applications quickly and economically. It is just as important to have the right development tools available to bring products to market on time. Good tools are especially crucial when you're creating high-performance applications for which most of the engineering effort will go into writing and debugging application software.

The Intel Solutions960® tools program offers more than 200 of the best development tools in the industry, including in-circuit emulators, compilers, debuggers, operating systems, evaluation boards and much more. The tools in the program can speed time-to-market and, as an added bonus, you probably already know how to use them since many of them are used with other processors. For more information about development tools support, refer to page 34 in this catalog or contact your Intel sales representative.

i960® PROCESSOR LINECARD

	PRODUCT	SPEED (MHZ)	INSTRUCTION CACHE	FPU	PACKAGE	TEMP	KEY FEATURES
▶	80960HA	25, 33, 40	16K	No	A, FC	C	32-bit RISC superscalar CPU with two timers, flexible memory system, and 8K Data Cache
▶	80960HD	33/16, 50/25, 66/33	16K	No	A, FC	C	Clock-Doubled 32-bit RISC superscalar CPU with two-timers, flexible memory system, and 8K Data Cache
▶	80960HT	75/25	16K	No	A, FC	C	Clock-Tripled 32-bit RISC superscalar CPU with two-timers, flexible memory system, and 8K Data Cache
	80960CA	16, 25, 33	1K	No	A, KU	C, E, A, M	32-bit RISC superscalar CPU with on-chip DMA and programmable bus size
	80960CF	16, 25, 33, 40	4K	No	A, KU	C, E, A, M	32-bit RISC superscalar CPU with on-chip DMA, programmable bus size, and 1K data cache
▶	80L960JA	16, 25	2K	No	A, NG	C	32-bit RISC core that has very low power consumption with variable programmable bus at 8, 16, or 32-bit and 1K data cache, 3.3V
▶	80960JA	16, 25, 33	2K	No	A, NG	C	32-bit RISC core that has very low power consumption with variable programmable bus at 8, 16, or 32-bit and 1K data cache
▶	80L960JF	16, 25	4K	No	A, NG	C	32-bit RISC core that has very low power consumption with variable programmable bus at 8, 16, or 32-bit and 2K data cache, 3.3V
▶	80960JF	16, 25, 33	4K	No	A, NG	C	32-bit RISC core that has very low power consumption with variable programmable bus at 8, 16, or 32-bit and 2K data cache
▶	80960JD	33/16, 50/25	4K	No	A, NG	C	32-bit RISC core that utilizes speed doubler technology. Internal bus runs at twice the speed of external bus and 2K data cache
	80960KA	16, 20, 25	512 byte	No	A, NG	C	32-bit RISC CPU with multiplexed bus
	80960KB	16, 20, 25	512 byte	Yes	A, NG	C	32-bit RISC CPU with multiplexed bus and IEEE floating-point
	80960SA	10, 16, 20	512 byte	No	N, S	C	Low cost 32-bit RISC CPU with multiplexed 16-bit bus
	80960SB	10, 16	512 byte	Yes	N, S	C	Low cost 32-bit RISC CPU with multiplexed 16-bit bus and IEEE floating-point
	82961KD	16, 20	N/A	No	KU	C	Coprocessor that integrates banding technology along with bitmap image compression and 82961KA coprocessor integration

PACKAGES:
A = 168L PGA for i960 CA, CF, HA, HD, and HT processors, **A** = 132L PGA for i960 KA/KB processor, no 10 MHz, **FC** = 208L SQFP (also known as PQ2) for i960 HA/HD processors, **KU** = 196L PQFP for i960 CA/CF processor, no CA 33 MHz, no CF 40 MHz, **KU** = 132L and 164L PQFP for 82961KD processor, **NG** = 132L PQFP for i960 KA/KB processor, **N** = 84L PLCC for i960 SA/SB processor, **S** = 80L QFP (EIAJ) for i960 SA processor, no 20 MHz, for i960 SB processor, no 16 MHz

TEMPERATURE RANGES:
C = Commercial (0 to 70°C), **E** = Extended (-40 to 110°C) (Special Environments Grade 3), **A** = Automotive (-40 to 125°C). To receive more information on Intel's Automotive Products, call **800-548-4725** and ask for document #272452, "The Winning Formula Automotive Brochure." **M** = Military (-55 to 125°C). Intel's Military and Special Products offer industrial-strength semiconductors optimized for wide temperature ranges and tough applications and environments. For a list of these products, call **800-548-4725** and ask for document # 271153, "Military and Special Products Portfolio".

▶= NEW PRODUCT

i960® PROCESSOR LITERATURE

TITLE	ORDER #	FAXBACK #
PRODUCT INFORMATION		
i960 Processor Product Line Card		2033
i960 Processor Literature List		2115
FaxBack Document List		2068
i960 Microprocessor Family Brochure	272248	2064
i960 Processor for Networking Applications Brochure	272388	
i960CA/CF 32-Bit Superscalar Microprocessor InfoGuide		2705
i960KA/KB 32-Bit Embedded Microprocessor InfoGuide		2716
i960HA/HD/HT Superscalar Microprocessor InfoGuide		2730
i960JX Microprocessor/The Cobra Series InfoGuide		2731
QUICKval i960 Processor Starter Kit	272550	2189
i960 SA/SB 32-Bit Embedded Microprocessors with 16-Bit Burst Data Bus	272233	
82961KD Printer Coprocessor	272259	
80960CA Product Overview	270669	
DATA SHEETS		
80960 HA/HD/HT 32-Bit High-Performance Superscalar Processor	272495	
80960JA/JF Embedded 32-Bit Microprocessor	272504	
80960CA-33,-25,-16 32 Bit High Performance Superscalar Processor	270727	
80960CF-33,-25,-16 32 Bit High Performance Superscalar Processor	272187	
80960KA Embedded 32-Bit Microprocessor	270775	
80960KB Embedded 32-Bit Microprocessor with Integrated Floating-Point Unit	270565	
80960SA Embedded 32 Bit Microprocessor with 16-Bit Burst Data Bus	272206	
80960SB Embedded 32-Bit Microprocessor with 16-Bit Burst Data Bus	272207	
82961KD Printer Coprocessor	272221	
APPLICATION NOTES/APPLICATION BRIEFS		
i960 Microprocessor Competitive Benchmark Report	272392	2515
Solutions960® Catalog Application Article Reprint	272507	
Internetworking and the Intel i960 Microprocessor	272601	2359
Imaging and the Intel i960 Microprocessor	272602	2360
AB-42 80960Kx Self-Test	270703	
AR-540 80960 Reprints	270631	
AR-541 Intel 80960: An Architecture Optimized for Embedded Control	270671	
AR-551 Embedded Controllers Push Printer Performance	270766	
AP-506 Designing for 80960Cx and 80960Hx Compatibility	272556	
AP-703 DRAM Controller for the 33-MHz i960 CA/CF Microprocessor	272627	
AP-704 A Simple DRAM Controller for the i960 Cx Processor Using Flexlogic	272628	
AP-706 DRAM Controller for the 40-MHz i960 CA/CF Microprocessor	272655	
AP-712 DRAM Controller for the 33-MHz i960 JA/JF/JD Microprocessor	272674	
TOOLS		
Technical Assistance (tools)		2544
Order Info for Solutions960		2516
Solutions960 Catalog	270791	
i960 Processor Family Tools Brochure—Pushing Design to the Limits	272351	
C Programming Tools for the i960 Microprocessor Family Fact Sheet	281434	
GNU/960 Software Toolset Fact Sheet	272178	
IMPACT 960 Advance Customer Training Software	272327	
i960 Microprocessor Product Line and Support Tools Fact Sheet	272219	
EP80960CX Evaluation Platform	272505	
i960 Microprocessor Evaluation Platform/Cyclone EP	272508	
Cyclone Evaluation Platform User's Guide	272577	
i960 SA/SB Processor Evaluation Board Fact Sheet	272033	
QT 960 Evaluation and Prototyping Board Fact Sheet	270743	
EV80960SX Evaluation Board User's Manual	270853	
EP80960CX Evaluation Platform User's Guide	272456	
82596CA High-Performance 32-Bit Local Area Network Coprocessor	290218	
MANUALS/DATABOOKS		
i960 Jx Microprocessor User's Manual	272483	
i960 Cx Microprocessor User's Manual	270710	
i960 KB Microprocessor Programmer's Reference Manual	270567	
i960 SA/SB Microprocessor Reference Manual	270929	
82961KD Printer Coprocessor Reference Manual	272280	
i960 Extended Architecture Programmer's Reference Manual	271191	
i960 Processors and Related Products Databook	272084	

Additional product information is always available via Intel's Bulletin Board System (BBS), CompuServe® and the World Wide Web. (refer to page 40)

Intel386™ and 186 Processors

THE HIGH-PERFORMANCE CHOICE

The Intel architecture embedded 16- and 32-bit processors offer high performance and high integration, and they are well suited for the embedded market segment. In fact, the core architecture for these processors is the same as that developed for the PC industry and provides software compatibility and a huge support infrastructure. Tools suites, development platforms, compilers, debuggers, emulators, textbooks and training seminars from Intel and third-party suppliers greatly speed time-to-market.

The Intel architecture now powers a broad spectrum of communication information systems. These systems include digital cellular telephones, hand-held communicators and terminals, personal digital assistants, wired and wireless network interface cards, fax machines, modems and office automation peripherals.

You'll also find Intel architecture in many traditional, real-time applications, such as medical equipment, robotics, factory automation, measurement control systems, sensors and test equipment.

FEATURES	BENEFITS
Supported by more operating systems, software and hardware development tools, and application code than any other architecture	**Saves time and cuts costs.** Reduces start-up time for new projects, development time of prototypes and overall system cost
Provides the ability to develop embedded systems in a PC environment	**Easy to use.** Because of the availability of PC-compatible peripherals (either on-chip or within chipsets), you can easily port code developed on the PC to embedded applications **Allows easy integration.** Embedded versions of DOS and numerous windowing operating systems are available in ROM versions, allowing easy incorporation into embedded designs **Saves valuable development time.** Incorporation of off-the-shelf device drivers (required to interface between the hardware controller and the operating system into embedded systems) saves valuable development time and effort; the device drivers interface easily with Intel architecture
Well known and established in schools, and presented in numerous books, seminars and training sessions	**Reduces development cycle.** With a shortened learning curve, you'll be a step ahead on your next embedded design
Intel is committed to the architecture's longevity	**Provides security.** Assurance that the Intel processor you choose will be available for the life cycle of your embedded design

Intel386™ Processor Family

For 10 years, 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 new pin-for-pin compatible family enables higher performance and lower power and voltage capabilities for embedded systems than was previously possible.

FEATURES	BENEFITS
32-bit CPU	**Performance.** High-performance processing at 5 to 10 MIPS
80386 instruction set	**Compatibility.** Compatibility with all PC applications, development and operating system software
16 MB–4 GB addressability	**Expandable.** Headroom for software growth for future system product enhancements
Protected mode	**Security.** Ability to develop large, OS-based embedded system; provides restricted access privileges
SL enhanced SMM support	**Capabilities.** Application-independent power management
Single-copy incorporation license for real-time OS included (CX, EX)	**Low cost.** Real-time kernel embedded platform

Intel386™ Integrated Processor Family

The Intel386 EX processor is the first in a planned family of integrated processors for embedded applications. Intel based the EX on the same static Intel386 processor 32-bit core, and incorporated PC-compatible and traditional embedded peripherals to provide a high-performance, integrated embedded solution.

FEATURES	BENEFITS
PC-compatible peripherals (8254, 8259A, enhanced 8237A)	**Portability.** Easy portability of application software developed on a PC
16450-compatible serial ports	**Compatibility.** Standard protocol familiar and well supported within the industry
DMA-supported serial transfers	**Efficient.** Reduces CPU load
Dynamic bus sizing enables interface to 8- or 16-bit peripherals	**Reduces costs.** Lowers total system cost
Synchronous serial I/O	**Boosts rates.** Provides higher data transfer rates (baud rate generator on chip)
JTAG boundary scan	**Diagnostics.** Allows for in-system processor diagnostics

Intel386™ Processor Development Tools

Because the Intel386 processor is a member of the Intel architecture family, the leading architecture used in PCs, a broad range of familiar, low-cost development tools are readily available. *Ap*BUILDER, Intel's interactive programming software, is a powerful tool that generates peripheral initialization code in ASM and C for Intel's embedded devices, with a click of the mouse. This free software tool, along with Hypertext User's Manuals, speeds the learning curve and can reduce total design time. *Ap*BUILDER ordering information can be found on page 20, under Tools.

Growth and competition in the PC industry have produced tools that are time-proven and run on the PC, which eliminates the need for expensive workstation-based development tools. For example, the Microsoft* and Borland* development tools, used to create more than 50,000 PC applications, can now be used in an embedded environment. For more information about development tools support, refer to page 34 in this catalog or contact your Intel sales representative.

186 Standard Processor Family

For the 186 standard products family, the numbers tell the story: more than 10,000 design wins and 50 million units shipped in its 12 years of production. With the 186 family of products, you can determine the cost and performance requirements for your embedded design and then choose from a wide variety of options: CHMOS, HMOS, and 8- and 16-bit external bus versions.

The 80C186/188XL family is pin-for-pin compatible with the 80186/188 family and adds an enhanced feature set. The high-performance CHMOS process allows the 80C186/188XL to run at twice the clock rate of the HMOS 80186/188 while consuming less than one-fourth the power.

FEATURES	BENEFITS
16-bit CPU (XL operating at 25 MHz)	**Speed.** 1 MIPS performance
8086 instruction set, 1-MB addressing	**Easy debugging.** Use your PC for quick software development and debugging **Abundant storage.** Large address space for programs and data
On-chip peripherals	**High integration.** Enables low-cost and low-chip-count designs
8-bit external bus available	**Low cost.** Lower memory and system cost
Direct numerics interface (80C187)	**Power.** Increased computing power

186 Enhanced Processor Family

In 1990, Intel designed these processors to meet performance, integration and power consumption needs. Intel created a modular core architecture in order to easily proliferate the family. The 80C186Ex family 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 new features (serial channels, DRAM refresh control and power management) to provide more functionality. The Ex core has also been enhanced to run at 3 volts.

FEATURES	BENEFITS
3-stage power management unit	**Efficient.** Low power consumption
3V versions	**Mobile.** Enables portable, battery-powered designs
Watchdog timer (EC only)	**Durable.** Ensures system integrity in hostile environments
DMA channels (EA/EC only)	**Fast.** Allows high-speed data movement
Serial channels (EB/EC only)	**Interfacing.** Facilitates interprocessor communication and modem interface
CMOS inputs and outputs	**Less noise.** Improved noise margins
ONCE mode (system-level testing)	**Testing.** On-board device testing and inspection capabilities
I/O ports (EB/EC only)	**Communication.** Ability to communicate externally via standard operating systems

186 Processor Development Tools

There are many tools available for developing embedded systems with the 186 product family. In fact, 186 processors are compatible with Intel386 processor development tools and the PC architecture. This compatibility provides access to a wide array of familiar, low-cost development tools. *Ap*BUILDER, Intel's interactive programming software, is a powerful tool that generates peripheral initialization code in ASM and C for Intel's embedded devices, with a click of the mouse. This free software tool, along with Hypertext User's Manuals, speeds the learning curve and can reduce total design time. *Ap*BUILDER ordering information can be found on page 20, under Tools.

Growth and competition in the PC industry have produced tools that are time-proven and run on your PC, which eliminates the need for expensive workstation-based development tools. For example, the Microsoft* and Borland* development tools, used to create more than 50,000 PC applications, can now be used in an embedded environment. For more information about development tools support, refer to page 34 in this catalog or contact your Intel sales representative.

INTEL386™ & 186 PROCESSORS LINECARD

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	16, 20, 25, 33	0	NO	0	NO	NO	NO	16M	0	NO	NO	NO	0	NO	NO	TTL	5.0V	NG100, X	C, M
80386DX	16, 20, 25, 33	0	NO	0	NO	NO	NO	4G	0	NO	NO	NO	0	NO	NO	TTL	5.0V	A132, NG132	C, M
80386SXSA	25, 33, 40	0	NO	0	YES	NO	NO	16M	0	NO	NO	NO	0	NO	NO	TTL	5.0V	KD	C
80386CXSA	25, 33, 40	0	NO	0	YES	YES	YES	64M	0	NO	NO	NO	0	NO	NO	TTL	5.0V	KD, SB100	C, E
80386CXSB	25, 33	0	NO	0	YES	YES	YES	64M	0	NO	NO	NO	0	NO	NO	CMOS	3.3V	KD, SB100	C, E
80386CXSB	16																3.0V	KD, SB100	C
INTEL386 INTEGRATED PROCESSOR FAMILY																			
80386EXSA	25	24	3	3	YES	YES	YES	64M	2	YES	NO	PD, I	8	YES (8259A)	YES	CMOS	5.0V	KU132, FA	C, E
80386EXSA	20	24	3	3	YES	YES	YES	64M	2	YES	NO	PD, I	8	YES (8259A)	YES	CMOS	3.3V	KU132, FA	C
80386EXSA	16	24	3	3	YES	YES	YES	64M	2	YES	NO	PD, I	8	YES (8259A)	YES	CMOS	3.0V	KU132, FA	C
186 STANDARD PRODUCT FAMILY																			
80186/80188	8, 10	0	NO	3	NO	NO	NO	1M	2	NO	YES	NO	13	YES	NO	TTL	5.0V	A68, N68, R68	C, E, M
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, M
80C186XL/188XL	25	0	NO	3	YES	NO	NO	1M	2	NO	YES	PS	13	YES	YES	TTL	5.0V	A68, N68, R68, S80, SB80	C,
186 ENHANCED PRODUCT FAMILY																			
80C186EA/188EA	13, 20	0	NO	3	YES	NO	NO	1M	2	NO	YES	PS, PD, I	13	YES	YES	CMOS	5.0V	N68, S80, SB80	E
80C186EA/188EA	25	0	NO	3	YES	NO	NO	1M	2	NO	YES	PS, PD, I	13	YES	YES	CMOS	5.0V	N68, S80, SB80	C
80L186EA/188EA	8,13	0	NO	3	YES	NO	NO	1M	2	NO	YES	PS, PD, I	13	YES	YES	CMOS	3.0V	N68, S80, SB80	E
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, M
80C186EB/188EB	25	16	2	3	YES	NO	NO	1M	0	NO	YES	PD, I	10	YES	YES	CMOS	5.0V	N84, S80, SB80	C
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	8, 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	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
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
80L186EC/188EC	13	22	2	3	YES	NO	NO	1M	4	YES	YES	PS, PD, I	10	YES (8259A)	YES	CMOS	3.0V	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

PACKAGING:
A = 132ld, 68ld (186) Ceramic Pin-Grid Array (PGA), **FA** = 144ld Plastic Quad Flatpack (PQFP), **KD** = 100ld Plastic Quad Flatpack (PQFP), **KU** = 132ld, 100ld (186) Plastic Quad Flatpack (PQFP), **NG** = 100ld (SX), 132ld (DX), Plastic Quad Flatpack (PQFP), **R** = 68ld Ceramic Leadless Chip Carrier (LCC), **N** = 68ld, 84ld (EB) Plastic Leaded Chip Carrier (PLCC) **S** = 80ld, 100ld (EC) Quad Flatpack (QFP-EIAJ), **SB** = 80ld, 100ld (EC) Shrink Quad, Flatpack (SQFP-EIAJ), **X** = SmartDie™ products. For further information, please call **800-548-4725** and ask to receive the SmartDie Product Literature Kit No. G1B03. Intel SmartDie products are functionally equivalent die-level silicon versions of standard Intel products. All SmartDie products are tested to meet commercial specifications to ensure the same quality and reliability levels of packaged products. SmartDie products offer the user a cost effective packaging alternative for those demanding small, form-factor applications.

POWER OPTIONS:
PD = Power Down, **PS** = Power Save, **I** = Idle

TEMPERATURE RANGES:
C = Commercial (0 to 70°C), **E** = Extended (-40 to 85°C), **M** = Military (-55 to 125°C). Intel's Military and Special Products offer industrial-strength semiconductors optimized for wide temperature ranges and tough applications and environments. For a list of these products, call **800-548-4725** and ask for document # 271153, "Military and Special Products Portfolio".

▶= NEW PRODUCT

INTEL386™ & 186 PROCESSOR LITERATURE

TITLE		ORDER #	FAXBACK #
PRODUCT INFORMATION			
186 and Intel386 Embedded Processors Product Line Card			2777
186 and Intel386 Embedded Processor Literature List			2778
80C186XL/80C188XL Fact Sheet		272044	2090
80C186Ex Microprocessor Family InfoGuide			2712
80C186EA/80C188EA/80L186EA/80L188EA InfoGuide		272043	2713
80C186EB/80C188EB/80L186EB/80L188EB InfoGuide		272042	2714
80C186EC/80C188EC/80L186EC/80L188EC InfoGuide		272045	2704
AMD 80C18x to Intel 80CxXL Comparison			2540
Embedded Intel386 Microprocessor Family InfoGuide			2720
iRMX® EMB Operating System for Embedded Intel386 CPUs		272424	
80C186: Examples of Microprocessor Family Applications		272050	2087
DATA SHEETS			
80J86/80188 High Integration 16-Bit Microprocessors		272430	
80C186XL/80C188XL Embedded Processors		272431	
80C186EA/80C188EA/80L186EA/80L188EA Embedded Processors		272432	
80C186EB/80C188EB/80L186EB/80L188EB Embedded Processors		272433	
80C186EC/80C188EC/80L186EC/80L188EC Embedded Processors		272434	
Intel386 EX Embedded Microprocessor		272420	
Intel386 CXSA Embedded Microprocessor		272418	2753
Intel386 CXSB Embedded Microprocessor		272552	2763
Intel386 SXSA Embedded Microprocessor		272419	2754
Intel386 SX Microprocessor		240187	
Intel386 DX Microprocessor		231630	
APPLICATION NOTES/APPLICATION BRIEFS			
AP-286: 80186/188 Interface to Intel Microcontrollers		231784	
AP-468: Quick Upgrade from the 80C186 to the 80C186EA		272157	
AP-477: Low Voltage Embedded Design		272324	
AP-499: Intro to Family of Embedded Intel386 Processors		272425	
i386 EX CPU's Enhanced DMA and DOS Compatibility		272426	2755
High-Performance Serial Transfers Using the i386 EX CPU		272427	2756
80C186 3volt/5volt Mixed Voltage Design			2536
Increasing the Addressability of a 186 Based System			2386
80C186EX: 186EX to PCMCIA Interface, A Guide			2650
The 80C186/80C188 Integrated Refresh Control Unit		270520	
TOOLS			
186 Architecture Development Tools Line Card (tools/product/literature)			2624
Intel386 Embedded Microprocessor Family			2764
Hardware and Software Development Tools Line Card			2765
Intel386 EX and Intel386 CX Microprocessor Development Tools			2750
*Ap*BUILDER Fact Sheet		272198	2508
**Ap*BUILDER Interactive Programming Software	BBS:APBSETUP.EXE	272216	
*Ap*BUILDER 80C186EA Hypertext User's Manual (disk)	BBS:B186EA.EXE	272275	
*Ap*BUILDER 80C186EB Hypertext User's Manual (disk)	BBS:B186EB.EXE	272296	
*Ap*BUILDER 80C186EC Hypertext User's Manual (disk)	BBS:B186EC.EXE	272298	
POS Terminal Reference Design Kit (fact sheet, data sheet, apnote)		272586	
186 Development Tools Handbook		272326	
Embedded Intel386 Buyer's Guide		272474	
186 Architecture Development Tools Line Card		272344	2624
Intel386 Architecture Development Tools Line Card		272541	2765
Intel386 EX Microprocessor Evaluation Board Overview		272518	
Paradigm Design Kits, Microsoft/SSI Design Kits Fact Sheet		272077	2086
EV80C186EA/XL Evaluation Board Fact Sheet		272049	2084
EVAL186EB Evaluation Board Fact Sheet		270882	2085
EVAL186EC Evaluation Board Fact Sheet		272083	2143
MANUALS/DATABOOKS			
80C186EA/80C188EA User's Manual		270950	
80C186EB/80C188EB User's Manual		270830	
80C186EC/80C188EC User's Manual		272047	
80C186XL/80C188XL User's Manual		272164	
Intel386 EX Embedded Microprocessor Hardware Reference Manual		272485	
Intel386 SX Microprocessor Programmer's Reference Manual		240331	
Intel386 SX Microprocessor Hardware Reference Manual		240332	
Intel386 DX Microprocessor Programmer's Reference Manual		230985	
Intel386 DX Microprocessor Hardware Reference Manual		231732	
1995 Embedded Microprocessors Databook		272396	
Fuzzy Logic Applications Handbook		272589	

**Ap*BUILDER supports the Intel386™, 186, MCS® 96, MCS® 251 and MCS® 51 architectures. Be sure to order the appropriate Hypertext User's Manual (above, under Tools) to ensure maximum benefit.

Additional product information is always available via Intel's Bulletin Board System (BBS), CompuServe® and the World Wide Web. (refer to page 40)

MCS® 96 Microcontrollers

A POWERFUL FOUNDATION

Intel's MCS® 96 microcontroller product family fits a variety of embedded applications. The high-performance, register-to-register architecture is ideal for complex, real-time control applications. Intel designed its broad portfolio of 8XC196 microcontroller products to meet various levels of peripheral, memory size, addressability and performance requirements.

The 8XC196 family shares a common, register-based architecture core that eliminates the accumulator bottleneck and enables fast context switching. Although the 8XC196 is a 16-bit architecture, all devices have bit, byte, word and 32-bit operations.

The strong future of this architecture includes code-compatible devices with significantly higher performance and greater memory integration. Intel's commitment to providing a complete tools solution and continued enhancements in MCS 96 microcontrollers creates a strong foundation on which to build.

FEATURES	BENEFITS
16-bit CPU	**High performance.** Up to 50 MHz
On-chip memory	**Low cost.** Cost-effective solution
Register-to-register architecture	**Efficient.** More compact code than accumulator-based architecture, which allows more efficient use of memory **Unlimited usage.** Minimum of 232 registers can be directly addressed at any time
Three operand instructions	**Create efficient code.** Preserve the source data
Bus controller features programmable wait-state generation and 8- or 16-bit bus width	**Economical.** Efficient usage of wide variety of memory and peripheral devices
Flat addressability of large register files	**Fewer barriers.** Avoids artificial limitation and barriers of segmented files
Three distinct product lines: ·event processor array ·high-speed input/output ·motion control	**Advanced.** Peripherals include configurable input/output ports and modular event processor array structure **Speed.** Devices with high-speed input FIFO and output system **Waveform.** Uses waveform generator and event processor array system for input/output

MCS® 96 Microcontroller Family—High-Speed Input/Output

Intel designed the HSIO family for applications that require high-speed input and output and closed-loop event control. These devices can lock events in the high-speed output unit (CAM), which allows you to repeat events with no software overhead. The family consists of the 8X9X, 8XC196KB, 8XC196KC and 8XC196KD.

The CHMOS version is code- and peripheral-compatible with NMOS devices. HSIO allows interrupt servicing in the background with minimal CPU overhead and reduces external components for temperature control, strain gauge and motion detection. It's an ideal solution for applications that need accurate timing of multiple events.

FEATURES	BENEFITS
Register-to-register architecture; up to 1000-byte register RAM and up to 32K internal OTPROM	**Efficient.** No accumulator bottleneck, fast context switching
1.4uSec 16X16 multiply, 2.4uSec 32/16 divide	**Speed.** Good math performance for fast and compact calculation loops
8-channel, 8- or 10-bit A/D converter	**Fewer components.** Reduces external components requirement by integrating A/D functionality on chip
8- or 16-bit external bus	**Performance.** Optimal memory interfacing
Full-duplex serial port	**Interfaces.** Communicates with standard devices
Two 16-bit timers	**Tracking.** Versatile event tracking
Pulse-width-modulated output	**Less overhead.** Reduces processor overhead
High-speed I/O subsystem	**Timing.** For accurate timing of multiple events
Peripheral transition server on KC and KD	**Less overhead.** Reduces CPU overhead during interrupt servicing

MCS® 96 Microcontroller Family—Motor Control

Intel's Motor Control family provides efficient three-phase AC induction motors, DC brushless motors and inverter applications. The product line features the 8XC196MC, 8XC196MD and 8XC196MH. The 8XC196MC/MD/MH have a unique three-phase waveform generator that enables precise and efficient motor control. All include standard microcontroller peripherals so the same chip can also handle additional functions such as front panel control. These products are ideal single-chip solutions for reducing system cost.

FEATURES	BENEFITS
Three-phase PWM waveform generator	**Ease of operation.** Simplifies software and hardware requirements
Up to 12-channel EPA	**Timing.** High-resolution timing of multiple events
Peripheral transition server (PTS)	**Less overhead.** Reduces CPU overhead required to service interrupts
Up to 14-channel A/D converter	**Efficiency.** Monitors multiple analog signals
16-bit watchdog timer	**Reliability.** Increases reliability of system
488 MC/MD and 744 MH byte register file, high-performance CPU	**Speed.** Provides fast context switching, fast instruction execution
On-chip ROM/OTPROM 16K MC/MD and 32K MH	**Storage.** Available for code and data storage
Frequency generator (MD only)	**Applications.** For infrared (remote) functionality
Two serial ports (MH only)	**Applications.** For increased communication capability

MCS® 96 Microcontroller Family—Event Processor Array (EPA)

The EPA family of devices is ideal for complex, real-time control applications that require a flexible input/output system. They yield a finer granularity in timing measurement. Products include the 8XC196KR, 8XC196KT, 8XC196NT, 8XC196NP and 80C196NU. The 80C196NU is the newest addition to this family to bring enhanced performance. The next generation of devices will be code- and pin-compatible, which provides an easy upgrade path.

FEATURES	BENEFITS
Register-to-register architecture	**Speed.** Fast context switching and compact calculation loops
High-speed capture/compare EPA channels	**Precision.** Precision event capture, output compare
Peripheral transaction server	**Less overhead.** Reduces system overhead to service interrupts
Pulse width modulator unit on the NP/NU	**Less overhead.** Reduces system overhead
Optional ROM on chip when codes are stable; NP is ROM or CPU-only, NU is CPU-only	**Solutions.** Provides single-chip solutions
Up to 1000-byte register RAM	**Performance.** Fast data manipulation with register space
Up to 31 prioritized interrupt sources	**Flexibility.** Handles a variety of commands
NP/NU feature dynamic demux/mux address/data bus and chip select unit with six chip select pins; NP supports 3V operation	**Performance.** Fast external memory access using commodity or low-cost memory devices; allows for glueless memory interface; NU provides a clock-doubled performance increase over all MCS 96 microcontroller devices and approximately twice the performance of the C196NP

MCS® 96 Microcontroller Development Tools

The MCS 96 microcontroller product family is supported by a variety of development tools, including *Ap*BUILDER and evaluation boards. *Ap*BUILDER, Intel's interactive programming software, is a powerful tool that generates peripheral initialization code in ASM and C for Intel's embedded devices, with a click of the mouse. This free software tool, along with Hypertext User's Manuals, speeds the learning curve and can reduce total design time. *Ap*BUILDER ordering information can be found on page 25, under Tools.

Project Builder Kits are low-cost (below US $200) development platforms that give design engineers all the hardware and software tools needed to fully evaluate device features and performance. These turn-key kits provide tools for every stage of the project design cycle. The MCS 96 microcontroller version can be ordered through your Intel sales representative using order # PROJBLD196KBCD.

Complete sets of development tools and C compilers are available from third-party vendors. Third-party vendors also support development tools for in-circuit emulation. For more information about development tools support, refer to page 34 in this catalog or contact your Intel sales representative.

MCS® 96 MICROCONTROLLER LINECARD

PRODUCT	SPEED (MHZ)	ROM/ OTPROM	REGISTER RAM	CODE RAM	I/O PINS	I/O TYPE	SERIAL PORTS	TIMER COUNTERS	ANALOG INPUT CHANNELS	ONCE TEST MODE	ADDRESS SPACE	PROCESS	PKG.	TEMP	KEY FEATURES
HSIO															
8X9XBH	12	8K	232	NO	48	HSIO	1	2	8	NO	64K	HMOS	N, R, U, P, C	C, A	Low Cost, 8/16-bit Bus, Register-to-Register Architecture
8X9XJF	12	16K	232	256	48	HSIO	1	2	8	NO	64K	HMOS	N, U	C	16K OTPROM, Internal (Code) RAM Version of BH
8XC196KB/ 8XC196KB16	12,16	8K	232	NO	48	HSIO	1	2	8	YES	64K	CMOS	N-68, N, S, S-80	C, E, A, M	Low-Power, High-Performance CMOS
8XC198	16	8K	232	NO	48	HSIO	1	2	4	YES	64K	CMOS	N-52,	C S-80	Lower cost, 8-bit Bus, 4 Channel A/D Version of KB
8XC196KC20	20	16K	488	NO	48	HSIO	1	2	8	YES	64K	CMOS	N-68, S-80	C, E, A, M	16K OTPROM, 488-Byte RAM 3-PWM, PTS
8XC196KD/ 8XC196KD20	16,20	32K	1000	NO	48	HSIO	1	2	8	YES	64K	CMOS	N-68, S-80	C, E, A	32K OTPROM, 1000-byte RAM Version of KC
MOTOR CONTROL															
8XC196MC	16	16K	488	NO	53	8 EPA	PTS Mode	2	13	YES	64K	CMOS	N-84, S-80, U-64	A*	PTS, PWM, 3-Phase Waveform Generator
8XC196MD	16	16K	488	NO	64	12 EPA	PTS Mode	2	14	YES	64K	CMOS	N-84, S-80, U-64	A*	MC Enhancement with Frequency Generator
▶ 8XC196MH	16	32K	744	NO	50	6 EPA	2	2	8	YES	64K	CMOS	N-84, S-80, U-64	A*	Enhanced 3-Phase Waveform Generator with 32K EPROM
EPA															
8XC196JQ	16	12K	360	128	41	6 EPA	2	2	8	YES	64K	CMOS	N-52	C, E, A	6 EPA, 6 A/D, 52L Package for Cost-Sensitive Applications
8XC196JR	16	16K	488	256	56	10 EPA	2	2	8	YES	64K	CMOS	N-52	C, E, A	6 EPA, 6 A/D, 52L Package, More Memory than JQ
8XC196KQ	16	12K	360	128	41	6 EPA	2	2	8	YES	64K	CMOS	N-68	C, E, A	10 EPA, 8 A/D, 56 I/O Lines, 12K OTPROM
8XC196KR	16	16K	488	256	56	10 EPA	2	2	8	YES	64K	CMOS	N-68	C, E, A	Memory Scaler Version of KQ
8XC196KT	16	32K	1000	512	56	10 EPA	2	2	8	YES	64K	CMOS	N-68	C, A	Memory Scaler Version of KR with Enhanced Bus Controller
▶ 8XC196NP	25	4K	1000	NO	33,32	4 EPA	1	2	0	YES	1MB	CMOS	S-100, SB-100	C	1 MB Linear Address Range, Low Power, 6 Chip Selects, 3 PWM's, Demux Bus
8XC196NT	20	32K	1000	512	56	10 EPA	2	2	4	YES	1MB	CMOS	N-68	C	1 MB Linear Address Range
▶ 80C196NU	40, 50	0	1000	NO	33,32	4 EPA	1	2	0	YES	1MB	CMOS	S-100, SB-100	C	1 MB Linear Address Range, 6 Chip Selects, 3 PWMs, Demux Bus

PACKAGE OPTIONS:
N = 68L (PLCC), **N-52** = 52L (PLCC), **N-68** = 68L (PLCC), **N-84** = 84L (PLCC), **S** = 80L (EIAJ) (QFP), **S-100** = 100L (QFP), **C** = 48L (Ceramic Dip), **R** = 68L (Ceramic LCC), **P** = 48L (Plastic Dip), **U** = 64L (Shrink Dip), **SB-100** = 100L (SQFP)

TEMPERATURE RANGES:
C = Commercial (0 to 70°C), **E** = Extended (-40 to 85°C), **A** = Automotive (-40 to 125°C), To receive more information on Intel's Automotive Products, call **800-548-4725** and ask for document #272452, "The Winning Formula Automotive Brochure." **M** = Military (-55 to 125°C). Intel's Military and Special Products offer industrial-strength semiconductors optimized for wide temperature ranges and tough applications and environments. For a list of these products, call **800-548-4725** and ask for document # 271153, "Military and Special Products Portfolio".

NOTES:
EPA = Event Processor Array; **PTS** = Peripheral Transaction Server

▶= NEW PRODUCT

MCS® 96 MICROCONTROLLER LITERATURE

TITLE		ORDER #	FAXBACK #
PRODUCT INFORMATION			
MCS 96 Family Product Information Line Card		272246	2591
MCS 96 Microcontroller Family Fact Sheet		272223	2305
8097BH/8098/8097JF/8095BH/8096BH Fact Sheet		270858	
8XC196KB/KC/KD InfoGuide			2702
8XC196KR/KQ/JR/JQ Fact Sheet (InfoGuide on FaxBack)		270861	2701
8XC196MC/MD/MH Fact Sheet (InfoGuide on FaxBack)		272316	2703
8XC196NT InfoGuide Fact Sheet (InfoGuide on FaxBack)		272284	2710
8XC196NP InfoGuide Fact Sheet (InfoGuide on FaxBack)		272469	2724
80C196NU Microcontroller Fact Sheet (InfoGuide on FaxBack)		272654	2732
QUICK REFERENCE DATA SHEETS			
8X9X Quick Reference		272110	
8XC196KB Quick Reference		272111	
8XC196KC Quick Reference		272112	
8XC196KD Quick Reference		272265	
8XC196KR Quick Reference		272113	
8XC196KT Quick Reference		272269	
8XC196MC Quick Reference		272114	
8XC196NP Quick Reference		272466	
8XC196NT Quick Reference		272270	
DATA SHEETS			
MCS 96 Architectural Overview Data Sheet		272109	
8098/8398/8798 Commercial/Express Data Sheet		270532	
809XBH/839XBH/879XBH Commercial/Express Data Sheet		270090	
809XJF/839XJF/879XJF Commercial/Express Data Sheet		270795	
8XC196KB16 CHMOS Microcontroller Commercial/Express Data Sheet		270909	
8XC196KC/KC20 CHMOS Microcontroller Commercial/Express Data Sheet		270942	
8XC196KD/KD20 CHMOS Microcontroller Commercial/Express Data Sheet		272145	
8XC196KR/KQ/JR/JQ CHMOS Microcontroller Data Sheet		270912	
8XC196KT CHMOS Microcontroller Data Sheet		272266	
8XC196MC Industrial Motor Control Microcontroller Data Sheet		270946	
8XC196MD Industrial Motor Control Microcontroller Data Sheet		272323	
8XC196MH Industrial Motor Control Microcontroller Data Sheet (Preliminary)		272543	
8XC196NT CHMOS Microcontroller Data Sheet		272267	
8XC196NP CHMOS Microcontroller Data Sheet		272459	
80C196NU CHMOS Microcontroller Data Sheet		272644	
TOOLS			
MCS 96 Architecture Development Tools Line Card		272343	2623
Embedded Development Tools Handbook		272326	
*Ap*BUILDER Fact Sheet		272198	
**Ap*BUILDER Interactive Programming Software		272216	
*Ap*BUILDER 8XC196KC/KD Hypertext User's Manual	BBS:B196KC.EXE	272274	
*Ap*BUILDER 8XC196KX Hypertext User's Manual	BBS:B196KR.EXE	272349	
*Ap*BUILDER 8XC196NP Hypertext User's Manual	BBS:B196NP.EXE	272497	
Project Builder 196 App. Proj. Kit & Mod. S/W for 8XC196KC/KD Fact Sheet		272334	2643
BSO/TASKING Software Development Tools Information			2183
Nohau Emulator Fact Sheet			2191
MCS 96 Fuzzy Logic Development Tools			2174
EV8097BH Evaluation Board Fact Sheet		270739	2036
EV80C196KB Evaluation Board Fact Sheet		270729	2039
EV80C196KC Evaluation Board Fact Sheet		270802	2034
EV80C196MC Evaluation Board Fact Sheet		272215	2551
EV80C196KR Evaluation Board Fact Sheet		272078	2040
MANUALS/DATABOOKS			
1995 Embedded Microcontrollers Databook		270646	
8X9X User's Manual		272457	
80C196KB User's Guide		270651	
8XC196KC/8XC196KD User's Manual		272238	
Hypertext Disk for 8XC196KC/KD User's Manual		272274	
8XC196KX User's Manual		272258	
Hypertext Disk for 8XC196KX User's Manual		272349	
8XC196MC User's Manual		272181	
8XC196MD User's Manual Supplement to 8XC196MC		272330	
8XC196MH User's Manual Supplement to 8XC196MC		272642	
Application Examples Using the 8XC196MC/MD (AP-483)		272282	
Using the SIO on the 8XC196MH (AB-71)		272594	
8XC196NT User's Manual		272317	
8XC196NP User's Manual		272479	
Hypertext Disk for 8XC196NP User's Manual		272497	
80C196NU User's Manual Supplement to 8XC196NP		272669	
Fuzzy Logic Applications Handbook		272589	
Comparison of EPA and HSIO (AP-449)		270968	
87C196NT Sample Pack		272350	
Using the 8XC196NT (AP-475)		272315	

**Ap*BUILDER supports the Intel386™, 186, MCS® 96, MCS® 251 and MCS® 51 architectures. Be sure to order the appropriate Hypertext User's Manual (above, under Tools) to ensure maximum benefit.

Additional product information is always available via Intel's Bulletin Board System (BBS), CompuServe® and the World Wide Web. (refer to page 40)

MCS® 251 Microcontrollers

THE NEXT GENERATION OF PERFORMANCE

Using advanced modular design techniques, Intel launched the next generation of its 8-bit (8051) architecture: the MCS® 251 architecture. By modifying code using the MCS 251 architecture instructions, performance can be increased up to 15 times. Even with existing MCS® 51 microcontroller code, system performance can be boosted up to five times.

The MCS 251 architecture delivers higher performance and a host of other enhanced features, including an increased memory mix and addressing, low power, low noise, efficient high-level language support, an enhanced instruction set, and integrated features and functions. All of the products in the family are based on the new MCS 251 architecture core.

Most importantly, the new architecture maintains binary code and pin compatibility with existing MCS 51 controllers. That means you can drop in the 8XC251SB microcontroller, as well as future products based on the MCS 251 architecture core, into existing sockets with little or no development effort and still get increased performance.

FEATURES	BENEFITS
Three-stage pipeline CPU architecture 1 state (2 clocks) per machine cycle vs. 6 states (12 clocks) per machine cycle for MCS 51 microcontrollers	**High performance.** Five to 15 times increase in performance compared to MCS 51 microcontroller at the same clock speed
16-bit internal code bus	**High-instruction throughput.** Reduces power consumption and RFI at low clock speed
Enhanced MCS 51 instruction set with: ▪16-bit and limited 32-bit data transfer, arithmetic and logic instructions ▪register-to-register operations ▪extended addressing modes ▪improved control instructions ▪bigger bit addressable space	**Flexibility.** Increased performance and programming flexibility **Optimized code.** Reduced code size
Binary code-compatible with MCS 51 microcontroller	**Cost savings.** Protects your software investment **Easy to upgrade.** Simple performance upgrade from MCS 51 microcontroller applications
Register-based machine with 40 register bytes accessible as 16 8-bit registers, 16 16-bit registers, 10 32-bit registers or a combination of all. All registers are general-purpose with accumulator functionality and data indexing capability, 64K extended stack space and additional stack instructions	**Performance.** Increased programming flexibility **Efficiency.** Increased efficiency for C code
24-bit linear addressing for up to 16-MB memory space	**Capabilities.** Supports bigger code and data memory requirements
Supports 64 interrupt sources	**Flexibility.** Increased flexibility for event control applications

8XC251SB Microcontroller—"Drop-In" Compatibility

The 8XC251SB microcontroller, the first product based on the powerful new MCS® 251 high-performance architecture core, delivers the performance increases needed for today's applications: up to 15 times faster at the same clock speed. Intel achieved this using advanced controller/processor design techniques such as three-stage pipeline and register-based CPU architecture, and by enhancing and expanding the instruction set.

The true beauty of the 8XC251SB controller, however, is that it's binary code- and pin-compatible with existing MCS® 51 microcontroller products. It provides an easy upgrade path: a direct "drop-in" replacement. Now you can get improved performance with little to no additional costs. Because the 8XC251SB controller will boost performance in all existing MCS 51 microcontroller applications, it saves development time and costs, as well as reducing time-to-market.

FEATURES	BENEFITS
MCS 251 architecture core	**Performance.** Five to 15 times performance increase compared to MCS 51 microcontrollers at the same clock speed; reduced power consumption and RFI; increased efficiency and support for C language programming
Binary code- and pin-compatible with MCS 51 microcontroller	**Easy to upgrade.** Direct "drop-in" replacement in MCS 51 applications to achieve performance boost; software investment protected; minimal development cost and effort required; quick time-to-market and time-to-money
1K on-chip data RAM	**Memory capacity.** Increased internal memory capacity for data manipulation and C language support
16K on-chip OTP, ROM or ROMless versions supported	**Flexibility.** Reduces need for additional external memory chips
Programmable Counter Array (PCA) supports ▪real-time capture and compare ▪high-speed output ▪PWM	**Real-time control applications.** Flexibility and performance enhancement in real-time control applications such as: ▪measurement of duty cycle, phase difference and frequency ▪real-time interrupt generation and output toggling ▪adjustable duty cycle generation
Hardware watchdog timer	**Reliability.** Increased system reliability
Page mode configuration	**Performance.** Increases performance for external instruction fetch by two times
0 or 1 wait-state configuration for external memory access	**Fast or slow memory.** Flexibility in external memory and peripheral interface
Support seven interrupt sources, each with four interrupt priority levels	**Event control applications.** Increased flexibility for event control applications

MCS® 251 Microcontroller Development Tools

Intel offers a variety of hardware and software development tools from some of the industry's leading tools suppliers to support the new MCS 251 architecture. These suppliers provide integrated device programming support that features high-performance, Windows* based software and full-featured, real-time emulators.

*Ap*BUILDER, Intel's interactive programming software, scheduled to include the MCS 251 architecture, is a powerful tool that generates peripheral initialization code in ASM and C for Intel's embedded devices, with a click of the mouse. This free software tool, along with Hypertext User's Manuals, speeds the learning curve and can reduce total design time. *Ap*BUILDER ordering information can be found on page 33, under Tools.

Project Builder Kits are low-cost (below US $200) development platforms that give design engineers all the hardware and software tools needed to fully evaluate device features and performance. These turn-key kits provide tools for every stage of the project design cycle. The MCS 251 microcontroller version will be available in May 1995 and can be ordered through your Intel sales representative using order # PROJBLD251BP12.

Fuzzy logic tools offer the leading edge in development efforts, with a full line of highly optimized software. The Project Builder 251 Evaluation Kit brings all the hardware and software together in a low-cost, turn-key kit. For more information about development tools support, refer to page 34 in this catalog or contact your Intel sales representative.

MCS® 51 Microcontrollers

THE ORIGINAL 8-BIT MICROCONTROLLERS

Intel's 8-bit MCS® 51 microcontroller family consists of CHMOS versions of the original 8-bit microcontrollers. The MCS 51 architecture is optimized for control-oriented applications. A variety of fast addressing modes for accessing the internal RAM facilitates byte processing and numerical operations on small data structures. The instruction set provides a convenient menu of 8-bit arithmetic instructions, including multiply and divide instructions. Extensive on-chip support is provided for 1-bit variables as a separate data type, allowing direct bit manipulation and testing in control and logic systems that require Boolean processing.

Intel offers a wide variety of MCS 51 controllers with different levels of on-chip peripherals and memory. The MCS 51 microcontroller family includes versions with on-chip EPROM, One-Time Programmable (OTP) and ROM memory, as well as CPU-only microcontrollers. Intel's proven CHMOS technology provides lower power, higher integration and higher performance in this line of controllers.

FEATURES	BENEFITS
8-bit CPU optimized for event control	**Efficient.** Event control design
Boolean processing	**Ease.** Simple bit manipulation **Flexibility.** Enables single-chip designs
On-chip peripherals (timer/counters, serial ports, I/O ports, PCA, etc.)	**Integration.** High integration enables low-cost and low-chip-count designs
Extensive software and hardware programming support	**Easy to use.** Simplifies your design cycle

MCS® 51 Microcontroller Family—Classic

Intel's 8-bit MCS 51 family of microcontrollers is a leading choice for embedded control. This Classic family consists of CHMOS versions of all the original 8-bit microcontrollers that introduced the MCS 51 family. Intel offers a wide variety of on-board memory in EPROM and ROM, as well as CPU-only microcontrollers. Intel's proven CHMOS technology provides lower power, higher integration and higher performance.

FEATURES	BENEFITS
8-bit CPU optimized for event control	**Efficient.** Event control design
Boolean processing	**Ease.** Simple bit manipulation
On-chip memory (up to 32K)	**Solutions.** Enables single-chip designs
On-chip peripherals (timer/counters, serial ports, PCA, etc.)	**High integration.** Enables low-cost and I/O ports, low-chip-count designs

MCS® 51 Microcontroller Family—Low Voltage

The 8XL5X and 8XL51FX are redesigned 3V versions of the MCS 51 microcontroller family. Operating Vcc ranges from 2.7V to 3.6V, and maximum frequency of 20 MHz, provide both low-voltage and high-performance benefits. They provide a compatible and ideal low-voltage migration path for customers who want to design low-power versions of their embedded designs.

FEATURES	BENEFITS
Redesigned true 3V operation	**Performance.** High performance and low noise
Optimized for high performance (max frequency of 20 MHz)	**No sacrifice.** No performance loss at low voltage
Functionally compatible with other MCS 51 microcontrollers	**Easy migration.** From 5V to 3V designs
Power-saving modes (idle and power down)	**Power control.** Improved power management control
On-chip peripherals (timer/counters, serial ports, PCA, etc.)	**Integration.** High integration enables low-cost and low-chip-count designs

MCS® 51 Microcontrollers—Expanded RAM

The 8XC51RA/RB/RC is the random access memory (RAM) expansion of the 80C52/C54/C58 part from 256 to 512 bytes with the watchdog timer added. Intel designed this microcontroller for 5V operation and functional compatibility with the Intel 8051 instruction set. It's ideal if your systems and applications require large on-chip data storage.

FEATURES	BENEFITS
Expanded internal RAM (512 byte) size	**Synergy.** More working space on chip, breaks the 256-byte limitation
Dedicated hardware watchdog timer	**Control.** Improved system integrity control
Functionally compatible with other MCS 51 microcontrollers	**Compatibility.** Easy migration of existing designs
On-chip peripherals (timer/counters, serial ports, I/O ports, etc.)	**High integration.** Enables low-cost and low-chip-count designs

8XC51GB Microcontroller—Application Specific

The 8XC51GB is an enhanced version of the 8XC51FA. Added features make it an even more powerful microcontroller for applications that require on-chip A/D, pulse width modulation, high-speed I/O, up/down counting capabilities and memory protection features. It also has a more versatile serial channel that facilitates multiprocessor communications.

FEATURES	BENEFITS
Same instruction set as MCS 51 microcontrollers and is software compatible with 80C51	**Synergy.** Preserves design team knowledge/investment; no training required
Enhanced interrupt structure with: ▪15 vectors (7 external, 8 internal) ▪4 programmable priority-level applications	**Flexibility.** Flexible and comprehensive interrupt handling capacity for interrupt-intensive applications; reduces CPU overhead to define proper interrupt routing for heavy interrupt-driven applications
8-channel, 8-bit A/D converter: ▪eight 8-bit result registers ▪four programmable modes ▪automatic comparator reference ▪trigger input pin	**A/D conversions.** Intelligent, accurate A/D conversions allow: ▪sequential A/D (one per channel) ▪two start and sequencing modes to address any application need ▪more precise A/D conversions ▪minimal CPU overhead, simple interface
Two programmable counter arrays	**Precision.** Precise event timing measurement and control capabilities
Half-duplex synchronous serial port	**Peripherals.** More I/O peripherals expansion, such as off-chip (EEPROM)

8XC152JX Microcontroller Family—Application Specific

The 8XC152JA/JB/JC/JD, based on the MCS® 51 architecture core, is a highly integrated, single-chip, 8-bit microcontroller designed for cost-sensitive, high-speed, multi-protocol serial communications. It is ideal for implementing ISDN, LAN and user-defined serial backplane applications.

FEATURES	BENEFITS
Same instruction set as MCS 51 microcontrollers; software-compatible with 80C51	**Synergy.** Preserves design team knowledge/investment; no training required
Fast data transfer with global serial channel	**Effective.** High effective data-rate throughput
Serial protocol	**Cost effective.** Cheaper and can be more reliable than parallel communications; easy to add and subtract nodes
Dual DMA channels	**Efficient.** Frees CPU for other tasks; on-chip DMA controller simplifies system design and reduces board space
SDLC and other HDLC subsets	**Compatible.** Supports proprietary and emerging ISDN applications such as PABX linecards and terminal adapters, and other proprietary networks as in programmable logic controllers
Carrier sense multiple-access/collision detect	**Compatible.** Supports IEEE 8023 defined access and other proprietary access methods
Deterministic collision resolution scheme	**Unique.** Determines worst-case access time; allows CSMA/CD to be used in real-time control environments; combines some of the best features of traditional methods—deterministic protocol with no polling overhead

8XC51SL Microcontroller—Application Specific

The 8XC51SL is an integrated keyboard controller designed for power-sensitive, portable PCs. It offers functions such as a UPI host interface, keyboard scanning, power management, temperature/battery monitoring and external keyboard/mouse interface. Package option includes PQFP 100ld and SQFP 100ld, with 5V and 3.3V operations.

FEATURES	BENEFITS
Same instruction set as MCS 51 controllers; software compatible with 80C51	**Synergy.** Preserves design team knowledge and investment; no training required
Integration of 80C42-type host interface and keyboard scan	**Single-chip solution.** Saves board space and lowers system cost, especially in small notebook environment
Four channels, 8-bit A/D	**Monitoring.** Battery/CPU temperature and voltage monitoring
Interface for up to 32K of external memory	**Flexibility.** Accommodates larger code; flexibility in manufacturing flow
Five LED drivers	**Reduces parts.** Eliminates external discrete components
Two serial interfaces	**Support.** Provides external serial keyboard and mouse support
Additional power management register set, 3.3V operation	**Efficiency.** Enhanced power management function; provides greater power savings
100LD PQFP and SQFP packages	**Saves space.** Small package size for board space savings

MCS® 51 Microcontroller Development Tools

The MCS 51 microcontroller product family is supported by a variety of development tools, including *Ap*BUILDER and evaluation boards. *Ap*BUILDER, Intel's interactive programming software, is a powerful tool that generates peripheral initialization code in ASM and C for Intel's embedded devices, with a click of the mouse. This free software tool, along with Hypertext User's Manuals, speeds the learning curve and can reduce total design time. *Ap*BUILDER ordering information can be found on page 33, under Tools.

Project Builder Kits are low-cost (below US $200) development platforms that give design engineers all the hardware and software tools needed to fully evaluate device features and performance. These turn-key kits provide tools for every stage of the project design cycle. The MCS 51 microcontroller version will be available in May 1995 and can be ordered through your Intel sales representative using order # PROJBLD51FX12.

Complete sets of development utilities and C compilers are available through third-party vendors. Many third-party vendors also provide in-circuit emulator development tools. For more information about development tools support, refer to page 34 in this catalog or contact your Intel sales representative.

MCS® 251 & MCS® 51 MICROCONTROLLER LINECARD

PRODUCT	ROM EPROM (BYTES)	REGISTER RAM (BYTES)	TIMER/ COUNTERS	SERIAL	ANALOG INPUT CHANNELS	I/O PINS	SPEED (MHZ)	PROCESS	PACKAGE	SECURITY	TEMP	KEY FEATURES
MCS 251 NEW ARCHITECTURE												
▶ 80C251SB	ROMless	1K	3	1	0	32	12,16	CHMOS	N	L3	C, E	High-Performance MCS 251 Architecture, PCA, H/W WDT
▶ 83C251SB	16K ROM	1K	3	1	0	32	12,16	CHMOS	N	L3	C, E	High-Performance MCS 251 Architecture, PCA, H/W WDT
▶ 87C251SB	16K OTP	1K	3	1	0	32	12,16	CHMOS	N	L3	C, E	High-Performance MCS 251 Architecture, PCA, H/W WDT
MCS 51 CLASSIC												
80C31BH	ROMless	128	2	1	0	32	12,16,20,24†,33†	CHMOS	N, P, S	N/A	C, E, A, M	Power Save Modes
80C51BH	4K ROM	128	2	1	0	32	12,16,20,24†,33†	CHMOS	N, P, S	P	C, E, A, M	Power Save Modes
87C51	4K EPROM	128	2	1	0	32	12,16,20,24†,33†	CHMOS	D, N, P, S	L3	C, E, A, M	Three-Level Memory Lock
80C32	ROMless	256	3	1	0	32	12,16,20,24†,33†	CHMOS	N, P, S	N/A	C, E, A	Up-Down Timer/Counter
80C52	8K ROM	256	3	1	0	32	12,16,20,24†,33†	CHMOS	N, P, S	L1	C, E, A	Up-Down Timer/Counter
87C52	8K EPROM	256	3	1	0	32	12,16,20,24†,33†	CHMOS	D, N, P, S	L3	C, E, A	Up-Down Timer/Counter
80C54	16K ROM	256	3	1	0	32	12,16,20,24†,33†	CHMOS	N, P, S	L1	C, E, A	Up-Down Timer/Counter
87C54	16K EPROM	256	3	1	0	32	12,16,20,24†,33†	CHMOS	D, N, P, S	L3	C, E, A	Up-Down Timer/Counter
80C58	32K ROM	256	3	1	0	32	12,16,20,24†,33†	CHMOS	N, P, S	L1	C, E	Up-Down Timer/Counter
87C58	32K EPROM	256	3	1	0	32	12,16,20,24†,33†	CHMOS	D, N, P, S	L3	C, E	Up-Down Timer/Counter
80C51FA	ROMless	256	3	1	0	32	12,16,20,24†,33†	CHMOS	N, P, S	N/A	C, E, A	Programmable Counter Array (PCA), Prog. Clock out
83C51FA	8K ROM	256	3	1	0	32	12,16,20,24†,33†	CHMOS	N, P, S	L1	C, E, A	Programmable Counter Array (PCA), Prog. Clock out
87C51FA	8K EPROM	256	3	1	0	32	12,16,20,24†,33†	CHMOS	D, N, P, S	L3	C, E, A	Programmable Counter Array (PCA), Prog. Clock out
83C51FB	16K ROM	256	3	1	0	32	12,16,20,24†,33†	CHMOS	N, P, S	L1	C, E, A	Programmable Counter Array (PCA), Prog. Clock out
87C51FB	16K EPROM	256	3	1	0	32	12,16,20,24†,33†	CHMOS	D, N, P, S	L3	C, E, A, M	Programmable Counter Array (PCA), Prog. Clock out
83C51FC	32K ROM	256	3	1	0	32	12,16,20,24†,33†	CHMOS	N, P, S	L1	C, E, A, M	Programmable Counter Array (PCA), Prog. Clock out
87C51FC	32K EPROM	256	3	1	0	32	12,16,20,24†,33†	CHMOS	D, N, P, S	L3	C, E, A, M	Programmable Counter Array (PCA), Prog. Clock out
MCS 51 LOW VOLTAGE												
▶ 80L52	8K ROM	256	3	1	0	32	12,16,20*	CHMOS	N, S	L1	C, E	Low-Voltage, Up-Down Timer/Counter
▶ 87L52	8K OTP	256	3	1	0	32	12,16,20*	CHMOS	N, S	L3	C, E	Low-Voltage, Up-Down Timer/Counter
▶ 80L54	16K ROM	256	3	1	0	32	12,16,20*	CHMOS	N, S	L1	C, E	Low-Voltage, Up-Down Timer/Counter
▶ 87L54	16K OTP	256	3	1	0	32	12,16,20*	CHMOS	N, S	L3	C, E	Low-Voltage, Up-Down Timer/Counter
▶ 80L58	32K ROM	256	3	1	0	32	12,16,20*	CHMOS	N, S	L1	C, E	Low-Voltage, Up-Down Timer/Counter
▶ 87L58	32K OTP	256	3	1	0	32	12,16,20*	CHMOS	N, S	L3	C, E	Low-Voltage, Up-Down Timer/Counter
▶ 80L51FA	ROMless	256	3	1	0	32	12,16,20*	CHMOS	N, S	L1	C, E	Low-Voltage, PCA, Prog. Clock out
▶ 83L51FA	8K ROM	256	3	1	0	32	12,16,20*	CHMOS	N, S	L1	C, E	Low-Voltage, PCA, Prog. Clock out
▶ 87L51FA	8K OTP	256	3	1	0	32	12,16,20*	CHMOS	N, S	L3	C, E	Low-Voltage, PCA, Prog. Clock out
▶ 83L51FB	16K ROM	256	3	1	0	32	12,16,20*	CHMOS	N, S	L1	C, E	Low-Voltage, PCA, Prog. Clock out
▶ 87L51FB	16K OTP	256	3	1	0	32	12,16,20*	CHMOS	N, S	L3	C, E	Low-Voltage, PCA, Prog. Clock out
▶ 83L51FC	32K ROM	256	3	1	0	32	12,16,20*	CHMOS	N, S	L1	C, E	Low-Voltage, PCA, Prog. Clock out
▶ 87L51FC	32K OTP	256	3	1	0	32	12,16,20*	CHMOS	N, S	L3	C, E	Low-Voltage, PCA, Prog. Clock out
MCS 51 EXPANDED RAM												
▶ 80C51RA	ROMless	512	3	1	0	32	12,16,20,24†	CHMOS	N, P	N/A	C, E	Expanded RAM, Prog. Clock Out, H/W WDT
▶ 83C51RA	8K ROM	512	3	1	0	32	12,16,20,24†	CHMOS	N, P	L1	C, E	Expanded RAM, Prog. Clock Out, H/W WDT
▶ 87C51RA	8K OTP	512	3	1	0	32	12,16,20,24†	CHMOS	N, P	L3	C, E	Expanded RAM, Prog. Clock Out, H/W WDT
▶ 83C51RB	16K ROM	512	3	1	0	32	12,16,20,24†	CHMOS	N, P	L1	C, E	Expanded RAM, Prog. Clock Out, H/W WDT
▶ 87C51RB	16K OTP	512	3	1	0	32	12,16,20,24†	CHMOS	N, P	L3	C, E	Expanded RAM, Prog. Clock Out, H/W WDT
▶ 83C51RC	32K ROM	512	3	1	0	32	12,16,20,24†	CHMOS	N, P	L1	C, E	Expanded RAM, Prog. Clock Out, H/W WDT
▶ 87C51RC	32K OTP	512	3	1	0	32	12,16,20,24†	CHMOS	N, P	L3	C, E	Expanded RAM, Prog. Clock Out, H/W WDT
MCS 51 APPLICATION SPECIFIC												
80C51GB	ROMless	256	3	1+SEP	8	48	12,16	CHMOS	N1	N/A	C, E	8-Channel 8-bit A/D, 2 PCA, 6 I/O Ports
83C51GB	8K ROM	256	3	1+SEP	8	48	12,16	CHMOS	N1	L1	C, E	8-Channel 8-bit A/D, 2 PCA, 6 I/O Ports
87C51GB	8K OTP	256	3	1+SEP	8	48	12,16	CHMOS	N1	L3	C, E	8-Channel 8-bit A/D, 2 PCA, 6 I/O Ports
80C152JA	ROMless	256	2	1	0	40	12,16.5	CHMOS	P1, N1	N/A	C, E	Multi-Protocol Serial Communication, Power Save Modes
83C152JA	8K ROM	256	2	1	0	40	12,16.5	CHMOS	P1, N1	No	C, E	Multi-Protocol Serial Communication, Power Save Modes
80C152JB	ROMless	256	2	1	0	56	12,16.5	CHMOS	N1	N/A	C, E	Multi-Protocol Serial Communication, Power Save Modes
80C152JC	ROMless	256	2	1	0	40	12,16.5	CHMOS	P1,N1	N/A	C, E	Multi-Protocol Serial Communication, Power Save Modes
83C152JC	8K ROM	256	2	1	0	40	12,16.5	CHMOS	P1,N1	N/A	C, E	Multi-Protocol Serial Communication, Power Save Modes
80C152JD	ROMless	256	2	1	0	56	12,16.5	CHMOS	N1	N/A	C, E	Multi-Protocol Serial Communication, Power Save Modes
80C51SLAH	ROMless	256	2	1	4	24	16	CHMOS	Ku,Sb	N/A	C	Keyboard Controller, Power Save Modes
81C51SLAH	16K *ROM	256	2	1	4	24	16	CHMOS	Ku,Sb, X	No	C	Keyboard Controller, Power Save Modes
83C51SLAH	16K ROM	256	2	1	4	24	16	CHMOS	Ku,Sb	No	C	Keyboard Controller, Power Save Modes
87C51SLAH	16K OTP	256	2	1	4	24	16	CHMOS	Ku,Sb	No	C	Keyboard Controller, Power Save Modes
80C51SLAL	ROMless	256	2	1	4	24	16	CHMOS	Sb	N/A	C	Low-Voltage, 4-Channel 8-bit A/D, Power Save Modes
81C51SLAL	16K *ROM	256	2	1	4	24	16	CHMOS	Sb, X	No	C	Low-Voltage, 4-Channel 8-bit A/D, Power Save Modes
83C51SLAL	16K ROM	256	2	1	4	24	16	CHMOS	Sb	No	C	Low-Voltage, 4-Channel 8-bit A/D, Power Save Modes
87C51SLAL	16K OTP	256	2	1	4	24	16	CHMOS	Sb	No	C	Low-Voltage, 4-Channel 8-bit A/D, Power Save Modes

PACKAGE OPTIONS:
D = 40LD CerDIP, **Ku** = 100LD QFP (Quad Flat Pack), **N** = 44L PLCC , **N1** = 68LD PLCC, **P** = 40LD PDIP, **P1** = 48LD PDIP, **S** = 44LD QFP (Quad Flat Pack), **Sb** = 100LD SQFP, **X** = SmartDie™ Product. For further information, please call **800-548-4725** and ask to receive the SmartDie Product Literature Kit No. G1B03. Intel SmartDie products are functionally equivalent die-level silicon versions of standard Intel products. All SmartDie products are tested to meet commercial specifications to ensure the same quality and reliability levels of packaged products. SmartDie products offer the user a cost-effective packaging alternative for those demanding small, form-factor applications. **ROM/EPROM** (bytes): *ROM = SystemSoft Standard BIOS

TEMPERATURE RANGES:
C = Commercial (0 to 70°C), **E** = Extended (-40 to 85°C), **A** = Automotive (-40 to 125°C). To receive more information on Intel's Automotive Products, call **800-548-4725** and ask for document #272452, "The Winning Formula Automotive Brochure." **M** = Military (-55 to 125°C). Intel's Military and Special Products offer industrial-strength semiconductors optimized for wide temperature range and tough applications and environments. For a list of these products, call **800-548-4725** and ask for document # 271153, "Military and Special Products Portfolio". **Speed** (Mhz): * = commercial temperature range only, † = internal execution. **Security: L1** = 1 Lock Bits, **L2** = 2 Lock Bits, **L3** = 3 Lock Bits, **P** = Protection

▶ = NEW PRODUCT

MCS® 251 & MCS® 51 MICROCONTROLLER LITERATURE

TITLE		ORDER #	FAXBACK #
PRODUCT INFORMATION			
MCS 51 Product Line Card			2373
MCS 251 Architecture Fact Sheet		272605	2369
MCS 251 SB Microcontroller Fact Sheet		272641	
MCS 51 Family Architecture Fact Sheet		272008	2155
MCS 51 Family Line Card		272273	2373
Info Guide: 8XC251SB			2398
Info Guide: 8XC51FX Family (8C51FA/FB/FC)			2700
Info Guide: 87C51SL Low-Power Keyboard Controller			2711
Info Guide: 3 Volt MCS 51 Family			2723
DATA SHEETS			
8XC251SB High-Performance CHMOS Single-Chip Microcontroller Datasheet		272616	
MCS 51 Programmer's Guide and Instruction Set		270249	
8051, 8052 and 80C51 Hardware Description		270252	
8XC51FX Hardware Description		270653	
8XC51SL/Low Voltage 8XC51SL Hardware Description		272268	
8XC52/54/58 Hardware Description		270783	
83C152 Hardware Description		270427	
MCS 51 80-Bit Control-Oriented Microcontroller		272318	
8XC52/54/58 CHMOS Single-Chip 8-Bit Microcontroller		272336	
8XL52/54/58 Commercial/Express Low Voltage CHMOS Single-Chip 8-Bit Microcontrollers		272468	
87C51/80C51BH/80C31BH CHMOS Single-Chip 8-Bit Microcontroller		272335	
8XC51FX CHMOS Single-Chip 8-Bit Microcontrollers		272322	
8XL51FA/FB/FC Commercial/Express Low Voltage CHMOS Single-Chip 8-Bit Microcontrollers		272356	
8XC51GB CHMOS Single-Chip 8-Bit Microcontroller		272337	
8XC51SL/Low Voltage 8XC51SL Keyboard Controller		272271	
8XC152JA/JB/JC/JD Universal Communication Controller 8-Bit Microcontroller		270431	
8XC52/54/58 24 MHz Data Sheet		272643	
8XC51FX 24 MHz Data Sheet		272656	
APPLICATION NOTES/APPLICATION BRIEFS			
AP-708 Introducing the MCS 251 Microcontroller—8XC251SB		272670	
AP-709 Maximizing Performance Using MCS 251 Microcontroller—Programming 8XC251SB		272671	
AP-710 Migrating MCS 51 Microcontroller to MCS 251 Microcontroller—W/W and H/W Considerations		272672	
AB-41 Software Serial Port Implemented with the PCA		270531	
AB-44 Using the 87C51GB		270957	
AP-476 How to Implement 12C Serial Communication Using Intel MCS 51 Microcontrollers		272319	
AP-70 Using the Intel MCS 51 Boolean Processing Capabilities		203830	
AP-223 8051 Based CRT Terminal Controller		270032	
AP-252 Designing With The 80C51BH		270068	
AP-410 Enhanced Serial Port on the 83C51FA		270490	
AP-415 83C51FA/FB PCA Cookbook		270609	
AP-425 Small DC Motor Control		270622	
AP-429 83C152 Global Serial Channel in CSMA/CD Mode		270720	
Low Voltage Embedded Design		272324	
TOOLS			
MCS 251 Architecture Development Tools Line Card		272635	2187
MCS 51 Architecture Development Tools Line Card		272342	2622
Development Tools Handbook		272326	
*ApBUILDER Interactive Programming Software	BBS:APSETUP.EXE	272216	
ApBUILDER 8XC51FX Hypertext User's Manual	BBS:B51FX.EXE	272576	
EV80C51FX & EV80C51GX: Evaluation Board Fact Sheet			2041
87C51, 87C51FX, 87C54, 87C58: 8-Bit Microcontroller Programming Support			2587
8751BH, 8752BH: 8-Bit Microcontroller Programming Support			2586
MANUALS/DATABOOKS			
8XC251SB User's Manual		272617	
MCS 51 Microcontroller Family User's Manual		272383	
1995 Embedded Microcontrollers Databook		270646	
Fuzzy Logic Applications Handbook		272589	

*ApBUILDER supports the Intel386™, 186, MCS® 96, MCS® 251 and MCS® 51 architectures. Be sure to order the appropriate Hypertext User's Manual (above, under Tools) to ensure maximum benefit.

Additional product information is always available via Intel's Bulletin Board System (BBS), CompuServe® and the World Wide Web. (refer to page 40)

DEVELOPMENT TOOLS

Intel is proud of the wide variety of hardware and software development tools available to support you in all phases of the development cycle. Some of the industry's leading tools suppliers are providing high-performance Windows* based software, full-featured, real-time emulators along with flexible, fully integrated device programming support for Intel's embedded products. We are committed to providing the tools and support needed to speed the learning curve and reduce design time. The pages that follow list our tool vendors and phone numbers. Feel free to contact them directly. It's all part of our effort to keep you one design ahead.

PROCESSORS AND MICROCONTROLLERS—Hardware Support

i960® PROCESSORS	INTEL386™ PROCESSORS	186 PROCESSORS	MCS® 96 MICROCONTROLLERS	MCS® 251 MICROCONTROLLERS	MCS® 51 MICROCONTROLLERS
EMULATORS					
Applied Microsystems Corp. Genesis Microsystems, Corp. Hewlett-Packard Company STEP Engineering Topmax/TDS XLNT Designs, Inc.	Kontron Elektronik Microtek International Yokogawa Digital Computer Corp.	Applied Microsystems Corp. Bitran Emulation Technology Hewlett-Packard Company Microtek International Sophia Systems & Technology Systems & Software, Inc. Tektronix, Inc. Yokogawa Digital Computer Corp.	American Arium BSO/Tasking Dr. Krohn & Stiller GmbH MicroTime Nohau Corporation Orion Instruments Signum Systems Yokagawa Digital Computer	Nohau Corporation Metalink Corporation	Advanced Microcomputer Systems American Arium Ashling Mircrosystems, Ltd. BSO/Tasking Cactus Logic Ceibo, Ltd. Deemax Dr. Krohn & Stiller Hewlett-Packard Company HI-LO Systems Research Co., Ltd. Hitex Systementwicklung GmbH Huntsville Microsystems, Inc. Iwasaki Electronics Co., Ltd. MetaLink Corporation MicroComputer Control Microtek International MicroTime Nohau Corporation Orion Instruments Siemens SME Sophia Systems & Technology Sun-Shine Electronics Tribal Microsystems, Inc Vail Silicon Tools
EVALUATION BOARDS/KITS					
Array Microsystems Cyclone Microsystems, Inc. Heurikon Corporation Jupiter Systems Micro Industries PLX Technology RPM Systems Corporation SKY Computers Tadpole Technology V3 Corporation Vigra	Intel Corporation	Intel Corporation	Intel Corporation Dearborn Group	Intel Corporation	Binary Technology Ceibo Ltd. Intel Corporation Iota Systems Micro/sys New Micros, Inc.
HARDWARE DEBUG TOOLS/ACCESSORIES					
3M Industrial Chemical Prod. Div. AMCC AMP Incorporated Concept Manufacturing, Inc. Emulation Technology Interconnect Systems Inc. ITT Pomona Electronics	Emulation Technology ITT Pomona Electronics	Emulation Technology ITT Pomona Electronics		Emulation Technology ITT Pomona Electronics	Emulation Technology ITT Pomona Electronics
LOGIC ANALYZERS					
American Arium Corporation Biomation Corporation Fluke Hewlett-Packard Company Tektronix, Inc.	Emulation Technology Hewlett-Packard Company Tektronix, Inc.	Emulation Technology Hewlett-Packard Company Tektronix, Inc.	American Arium Lauterbach GmbH Orion Instruments Tektronix, Inc.		Orion Instruments Tektronix, Inc.
PROGRAMMING ADAPTERS					
N/A				Emulation Technology ITT Pomona Electronics	Emulation Technology ITT Pomona Electronics
SUPPORT COMPONENTS					
AMCC Intel Corporation LSI Logic Corporation National Semiconductor PLX Technology RouterWare, Inc. V3 Corporation					

PROCESSORS AND MICROCONTROLLERS—Software Support

i960® PROCESSORS	INTEL386™ PROCESSORS	186 PROCESSORS	MCS® 96 MICROCONTROLLERS	MCS® 251 MICROCONTROLLERS	MCS® 51 MICROCONTROLLERS
ASSEMBLERS & COMPILERS					
Applied Microsystems Corp. Archelon, Inc Cygnus Support Green Hills Software, Inc. Intel Corporation Irvine Compiler Corp. Microtec Research Inc. STEP Engineering TLD Systems, Ltd. U.S. Software Corp.	Borland International Microsoft Corporation PharLap Software Microtec Research, Inc. Paradigm Systems Systems & Software, Inc. Watcom International Corp.	Applied Microsystems Corp. Borland International Hewlett-Packard Microsoft Corporation Microtec Research, Inc. Paradigm Systems PharLap Software Systems & Software, Inc U.S. Software Watcom International Corp.	Avocet Systems, Inc. BSO/Tasking IAR Systems	BSO/Tasking Franklin Software/Keil Electronik Production Languages Corp.	2500 A.D. Software, Inc. Avocet Systems, Inc. Binary Technology BSO/Tasking Franklin Software/Keil Electronik IAR Systems Iota Systems Intermetrics Microsystems Software MicroComputer Control Production Languages Corp. Universal Cross Assemblers
BIOS					
N/A	Digital Research General Software, Inc. Intel Corporation Microsoft Corporation Microware Ready Systems		N/A	N/A	N/A
DEBUGGERS					
Applied Microsystems Corp. CaseTools, Inc. Genesis Microsystems Corp. Integrated Systems Inc. Intel Corporation Microtec Research, Inc. Quad Design Technology Inc. Real-Time Innovations, Inc. STEP Engineering Topmax/TDS	Applied Microsystems Corp. Concurrent Sciences Systems & Software, Inc.	Applied Microsystems Corp. Concurrent Sciences Datalight Emulation Technology Hewlett-Packard Microsoft Corporation Microtec Research, Inc. Microtek International Paradigm Systems Sophia Systems & Technology Systems & Software, Inc.	BSO/Tasking ChipTools, Inc.	BSO/Tasking Franklin Software/Keil Electronik Production Languages Corp.	BSO/Tasking ChipTools, Inc. Franklin Software/Keil Electronik IAR Systems Production Languages Corp.
FUZZY/NEURAL NETS					
N/A			Byte Craft Limited Inform Software Corporation Intel Corporation	Intel Corporation Inform Software Corporation	Inform Software Corporation
OPERATING SYSTEMS & REAL-TIME KERNELS					
Accelerated Technology, Inc. Integrated Systems, Inc. Intel Corporation JMI Software Systems, Inc. KADAK Products, Ltd. STEP Engineering U.S. Software Corp. Wind River Systems	Annabooks Accelerated Technology Datalight	Accelerated Technology Datalight Embedded Systems Products Ready Systems	Accelerated Technology, Inc. BSO/Tasking CMX Company Embedded Systems Products Forth, Inc. U.S. Software	N/A	Byte-BOS Integrated Systems CMX Company Embedded Systems Products Forth, Inc. Franklin Software/Keil Electronik U.S. Software
PROGRAMMING					
N/A	N/A	N/A	Advin Systems B&C Microsystems BP Microsystems Data I/O Corporation Elan Digital Systems Ertec GmbH Link Computer Graphics Logical Devices, Inc Minato Electronics SMS Mikrocomputer-Systems GmbH Stag Microsystems, Inc System General Corporation Tribal Microsystems, Inc	BP Microsystems Data I/O Corporation Needham's SMS Mikrocomputer-Systems GmbH System General Corporation	Advin Systems B&C Microsystems BP Microsystems Ceibo, Ltd Data I/O Corporation Elan Digital Systems, Ltd. Link Computer Graphics Logical Devices, Inc. Minato Electronics SMS Microcomputer-Systems GmbH Stag Microsystems, Inc. System General Corporation
SIMULATORS					
Integrated Systems, Inc. Logic Modeling, Inc. Quickturn Design Systems, Inc. RAVIcad, Inc. Synopsis	Logic Modeling, Inc. Systems & Software, Inc.	Logic Modeling, Inc.	BSO/Tasking Lear Com Company Logic Modeling, Inc.	BSO/Tasking Franklin Software/Keil Electronik Production Languages Corp.	2500 A.D. Software, Inc. Avocet Systems, Inc. BSO/TaskingChipTools, Inc. Franklin Software/Keil Electronik IAR Systems Intermetrics Microsystems Software Logic Modeling, Inc. MicroComputer Control Production Languages Corp.
SPECIALTY TOOLS					
U.S. Software Corporation	Intel Corporation	Datalight Drumlin Embedded Systems Products Hewlett-Packard Paradigm Systems Systems & Software, Inc.	Intel Corporation	Intel Corporation	Intel Corporation

PROCESSORS AND MICROCONTROLLERS—Other Products & Services

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APPLICATION SPECIFIC TOOLS/SERVICES—Software (SW) Hardware (HW)

AGE Logic (SW)
Brooktree (SW) (HW)
Cyclone Microsystems, Inc. (HW)
Destiny Technology Corp. (SW) (HW)
Intel Corporation (HW)
Integrated Systems, Inc. (SW)
Microsoft Corporation (SW)
Peerless Systems Inc. (SW)
Phoenix Technologies Ltd. (SW)
Pipeline (SW)
PLX Technology (HW)
RouterWare, Inc. (SW) (HW)
STAC Electronics (SW)
Topmax/TDS (SW) (HW)
UFO Systems (HW)
U.S. Software (SW)

CONSULTING SERVICES—Software (SW) Hardware (HW)

Ace Computer Engineering (SW)
Computervision (SW) (HW)
COMSYS Technical Services (SW)
Cruz Digital (SW)
Cyclone Microsystems, Inc. (HW)
Intel Corporation (SW) (HW)
Logic Solutions, Inc. (SW)
Microtec Research Inc. (SW)
Peerless Systems Inc. (SW) (HW)
Performance Computing, Inc. (SW)
PLX Technology (HW)
RouterWare, Inc. (SW) (HW)
Venture Technologies, Inc. (SW) (HW)

FLASH MEMORY COMPONENTS, CARDS/DRIVES—Hardware Support

	HIGH-PERFORMANCE FLASH	HIGH-DENSITY FLASH	HIGH-INTEGRATION FLASH	FLASH MEMORY CARDS	PCMCIA-ATA FLASH DRIVES
EVALUATION KITS	N/A	Intel FaxBack/Lit	Intel FaxBack/Lit	Intel FaxBack/Lit	Intel FaxBack/Lit
PCMCIA READER/WRITERS	N/A	N/A	N/A	Adtron Cardwell International Chase Advanced Databook Data I/O Elan Digital Systems Omega Micro Quatech SCM Microsystems Stag Programmers	Adtron Cardwell International Chase Advanced Databook Data I/O Elan Digital Systems Omega Micro Quatech SCM Microsystems Stag Programmers
PROGRAMMER SUPPORT	Advantest Advin Systems Aval Data B&C Microsystems BP Microsystems Bytek Data I/O Elan Digital Systems Logical Devices Minato Electronics Needham's Electronics SMS MikrocomputerSystems GmbH Stag Programmers System General	Advantest Advin Systems Aval Data B&C Microsystems BP Microsystems Bytek Data I/O Elan Digital Systems Logical Devices Minato Electronics Needham's Electronics SMS MikrocomputerSystems GmbH Stag Programmers System General	Advantest Advin Systems Aval Data B&C Microsystems BP Microsystems Bytek Data I/O Elan Digital Systems Logical Devices Minato Electronics Needham's Electronics SMS MikrocomputerSystems GmbH Stag Programmers System General	Aval Data B&C Microsystems Bytek Data I/O Elan Digital Systems Epro Logical Devices SMS MikrocomputerSystems GmbH Stag Programmers System General	B&C Microsystems Data I/O Elan Digital Systems Stag Programmers
PROGRAMMING ADAPTERS	CA Integration Coordinators Emulation Technology	CA Integration Coordinators Emulation Technology	CA Integration Coordinators Emulation Technology	N/A	N/A
AUTOMATION EQUIPMENT	Data I/O Unmanned Solutions	Data I/O Exatron (PSOP) Unmanned Solutions	Data I/O Exatron (PSOP, PLCC) Unmanned Solutions	N/A	N/A

FLASH MEMORY COMPONENTS, CARDS/DRIVES—Hardware Support

HIGH-PERFORMANCE FLASH	HIGH-DENSITY FLASH	HIGH-INTEGRATION FLASH	FLASH MEMORY CARDS	PCMCIA-ATA FLASH DRIVES
MANUAL PROGRAMMING AIDS				
Vacuum-Powered Precising Wand				
Intel designed	Intel designed	Intel designed	N/A	N/A
Hand-Actuated Vacuum Pen				
Enplas	Enplas	Enplas	N/A	N/A
SOCKETS				
Prototyping				
Meritec	Meritec	Meritec		
Production				
N/A	Yamaichi (44PSOP)	AMP (32PLCC) Burndy (32PLCC) Socket Express (32PLCC) Yamaichi (44PSOP, 32TSOP)	Fujitsu Microelectronics	Fujitsu Microelectronics
BURN-IN				
Yamaichi	Yamaichi (56TSOP) TI (56SSOP,44PSOP)	Enplas (32/40TSOP) TI (44PSOP) Wells (48TSOP) Yamaichi (TSOP)		

FLASH MEMORY COMPONENTS, CARDS/DRIVES—Hardware Support

HIGH-PERFORMANCE FLASH	HIGH-DENSITY FLASH	HIGH-INTEGRATION FLASH	FLASH MEMORY CARDS	PCMCIA-ATA FLASH DRIVES
FLASH MEDIA MANAGERS				
Datalight Intel BBS M-Systems SCM	Datalight Intel BBS M-Systems SCM	Datalight Intel BBS M-Systems SCM	Datalight Intel BBS M-Systems Microsoft Saville & Associates (Consulting) SCM SystemSoft	Datalight Intel BBS M-Systems Microsoft Saville & Associates (Consulting) SCM SystemSoft
O/S AND REAL TIME				
N/A	N/A	N/A	GeoWorks Microsoft	GeoWorks Microsoft
DESIGN TOOLS				
Schematic Symbol Files				
Intel BBS	Intel BBS	N/A	N/A	N/A
Schematic Reference Designs				
Intel BBS	Intel BBS	N/A	N/A	N/A
VHDL/Verilog Models				
Intel BBS	Intel BBS	N/A	N/A	N/A
iBIS Models				
Intel BBS	Intel BBS	Intel BBS	N/A	N/A
Timing Designer Models				
Intel BBS	Intel BBS	N/A	N/A	N/A
IDE-ATA Adapter CAD Files				
N/A	N/A	N/A	N/A	Intel BBS
PCB Flexible Layout Files				
Intel BBS/Lit	Intel BBS/Lit	Intel BBS/Lit	N/A	N/A
REFERENCE CODE				
Program/Erase Drivers				
Intel BBS	Intel BBS	Intel BBS	Intel BBS	Intel BBS
EEPROM Emulation				
N/A	N/A	Intel BBS	N/A	N/A
Boot Loader				
N/A	N/A	Cyber Quest (Consulting) Intel BBS	N/A	N/A
PRODUCT EVALUATION UTILITIES				
FLASHBuilder				
Intel BBS	Intel BBS	N/A	Planned Q2 '95	Planned Q2 '95
Cycling Utilities				
Intel BBS/FLASHBuilder 2.0	Intel BBS/FLASHBuilder 2.0	N/A	Intel BBS	Intel BBS
Benchmarking Utilities				
Intel BBS/FLASHBuilder 2.0	Intel BBS/FLASHBuilder 2.0	N/A	Intel BBS	N/A
BIOS				
AMI Award Software Intel Phoenix Technologies SystemSoft	AMI Award Software Intel Phoenix Technologies SystemSoft	AMI Award Software Intel Phoenix Technologies SystemSoft	AMI Award Software Intel Phoenix Technologies SystemSoft	AMI Award Software Intel Phoenix Technologies SystemSoft

TOOL VENDOR CONTACT INFORMATION

VENDOR	U.S.	EUROPE	JAPAN/APac
2500 A.D. Software	800-843-8144	49-2411-54071	886-3577-2155
3M Company	800-364-3577		
Accelerated Technology, Inc.	800-468-NUKE	205-661-5770	205-661-5770
Ace Computer Engineering	407-332-1518		
Adtron	602-926-9324		
Advantest			81(0)49-356-4433
Advanced Microcomputer Systems	305-784-0900		
Advin Systems, Inc.		49-7459-1271	852-883-5188
AGE Logic, Inc.	619-455-8600		
American Arium Corp.	714-731-1661		
AMCC		44-272-237594	
AMI	404-246-8625		
AMP Inc.	800-522-6752	44-753-676800	81-44-813-8502 (Japan)
Annabooks	619-673-0870	619-673-0870	619-673-0870
Applied Micro Circuits Corporation	800-450-9333	619-450-9333	619-450-9333
Applied Microsystems Corp.	800-426-3925	44-296-625462	81-3-3493-0770 (Japan)
Archelon, Inc.	800-357-5670	519-746-7925	519-746-7925
Archimedes	800-338-1453		
Array Microsystems, Inc.	719-540-7900		
Ashling Microsystems, Ltd.		353-61-33-44-66	
AT&T Capital	800-874-7123		
Aval Data			81(0)44-952-1322 (Japan)
Avocet Systems	800-448-8500	44-93-282-9460	81-45-661-7362 (Japan)
Award Software	415-968-4433		
B&C Microsystems	408-730-5511		
Binary Technology	508-369-9556		
Biomation Corporation	800-934-2466	408-435-7800	408-435-7800
Bitran			81-485-56-9881
Bitstream	617-497-6222	31-20-575-3021	
Borland International	800-682-9299 800-331-0877	408-431-1000 33-1-4629-3640	81-3-5350-9370 (Japan)
BP Microsystems	800-225-2102	49-89-857-6667	81-45-4592406 (Japan)
Brooktree	800-2-BT-APPS		
Burndy	203-852-6042		
BSO/Tasking	617-320-9400	31-33-55-85-84	81-3-3405-0511 (Japan)
Bytek	800-523-1565		
Byte Craft, Ltd.	519-888-6911	519-888-6911	519-888-6911
Byte-BOS Integrated Systems	800-788-7288		
Cactus Logic	800-847-1998		
California Integration Coordinators		916-626-6168	
Cardwell International	916-985-1880		
CaseTools, Inc.	408-685-0336		
Ceibo Limited	617-863-9927	61- 51-27-505	972-9-555387
Chase Advanced		44-274 -841-316	
CheckMate Systems	206-869-7211	33-1-3054-2222	802-2-785-3753
ChipTools, Inc.	905-274-6244		
CMX Company	508-872-7675	508-872-7675	508-872-7675

VENDOR	U.S.	EUROPE	JAPAN/APac
Computervision	800-234-8806	617-275-1800	617-275-1800
COMSYS Technical Services, Inc.	800-926-6797	301-921-3600	301-921-3600
Concept Manufacturing, Inc.	415-365-2256		
Concurrent Sciences, Inc.	208-882-0445	208-882-0445	208-882-0445
Cruz Digital	408-458-0515		
Cyber Quest	703-631-8323		
Cyclone Microsystems, Inc.	203-786-5536		
Cygnus Support	800-CYGNUS-1	415-903-1400	415-903-1400
Data I/O Corporation	206-881-6444	44-0734-440-011	206-881-6444
Databook	716-292-5725		
Datalight, Inc.	800-221-6630	44-0285-658-122	206-435-8086
Deemax	886-35-723-311		
Destiny Technology Corp.	408-562-1000		
Digital Research	800-274-4374	49-2112-577-744	81-3-548-1161 (Japan)
Dr. Krohn & Stiller		49-89-61-00-0012	
Drumlin	818-244-4600		
Elan Digital Systems, Ltd.		44-489-579-799	
Electro Rent	818-787-2100		
Embedded Systems Products	713-728-9688	713-728-9688	713-728-9688
Emulation Technology	408-982-0660		
Enplas	415-572-1683		
Epro	408-982-9707		
Ertec GmbH		49-9131-7700-0	
Exatron	800-EXATRON		
Fluke	800-44-FLUKE	206-347-1600	206-347-1600
Forth, Inc.	800-55-FORTH	44-932-829-460	
Franklin Software	408-296-8051	49-089-46-50-57	49-089-46-50-57
Fujitisu Microelectronics Inc.	408-922-8900		
G.E. Rental/Lease	404-248-6292		
General Software, Inc.	206-454-5755	206-391-4285	206-391-4285
Genesis Microsystems, Corp.	707-542-5000		
Genstar Rentals	800-323-8964		
GeoWorks	510-814-5867		
Green Hills Software	805-965-6044		
Heurikon Corporation	800-356-9602	608-831-5500	
Hewlett-Packard Company	800-447-3282	31-20-547-9999 31-20-547-9869	852-848-7070 852-848-7018
HI-LO Systems Research Co., Ltd.	886-27-640-125		
HiTech Equipment Corp.	619-566-1892		
Hitex Systementwicklung GmbH	408-451-3986	49-721-96280	
Huntsville Microsystems, Inc.	205-881-6005		
IAR Systems	415-765-5500	46-18-16-78-00	
Inform Software Corporation	708-866-1838	49-24-089-456-83	03-56-886-800
Integrated Systems, Inc.	800-543-PSOS	44-707-331199	81-3-5721-0101 (Japan)
Intel Corporation	800-628-8686	44-793-696-522	503-696-5025
Intermetrics Microsystems Software	617-661-0072		
Interconnect Systems Inc.	805-581-5626		
Iota Systems	702-831-6302		
Irvine Compiler Corp.	714-250-1366		

TOOL VENDOR CONTACT INFORMATION

VENDOR	U.S.	EUROPE	JAPAN/APac
ITCN	800-439-4039	513-439-2648	
ITT Pomona Electronics	909-469-2900		
Iwasaki Electronics Co., Ltd.	803-863-3025		
JMI Software Systems, Inc.	215-628-0840		
Jupiter Systems	510-523-9000		
KADAK Products, Ltd.	604-734-2796		
Keil Electronik	214-735-8052	49-89-46-50-57	
Kontron Elektronik	800-KONTRON	49-816-577-177	800-KONTRON
Lauterbach GmbH	49-81-04-89430	49-81-04-89430	
Lear Com Company	303-232-2226		
Link Computer Graphics	201-808-8990		
Logic Modeling, Inc.	800-34MODEL	503-690-4900	
Logic Solutions, Inc.	617-441-3797		
Logical Devices, Inc.	800-331-7766	49-89-834-3047	33-764-5350
LSI Logic Corp.	408-433-4288	49-89-99-313100	81-33-589-2711 (Japan)
MDS Aero Support Corporation	613-744-7257		
MERITEC	800-628-2283	44-793-496646	
MetaLink Corporation	602-926-0797	49-80-912046	602- 926-0797
MicroComputer Control	609-466-1751		
Microsoft Corporation	206-882-8080	206-882-8080	206-882-8080
Micro Industries	614-584-7878		
Microsys	818-244-4600		
Microtec Research, Inc.	800-950-5554	44-256-57551	81-3-5210-3050 (Japan)
Microtek International, Inc.	800-886-7333	49-89-893-1390	886-35-772-155
MicroTime		88-62-881-1791	88-62-881-1791
MicroView	408-356-4421	408-356-4421	408-356-4421
Microware	515-224-1929	515-224-1929	515-224-1929
Minato Electronics, Inc.	800-576-6068		81-45-591-5611 (Japan)
M-Systems	408-654-5820		
National Semiconductor	408-721-3046	49-0-81-411030	03-3299-7001 (Japan)
Needham	916-924-8037		
New Micros, Inc.	614-431-2675		
Nohau Corporation	408-866-1820	46-40-922-425	81-33-405-0511 (Japan)
Omega Micro	408-554-8660		
Orion Instruments	408-747-0440	408-747-0440	408-747-0440
Paradigm Systems	800-537-5043 607-748-5966	607-748-5966	607-748-5966
Peerless Systems Corp.	310-297-3278	310-297-3278	81-33-446-0392
Performance Computing, Inc.	503-641-1221		
PharLap Software, Inc.	617-661-1510	617-661-1510	617-661-1510
Phoenix Technologies Ltd.	617-551-8030	33-93-65-4600	408-452-6524
Pipeline	201-267-3840		
Production Languages Corporation	800-525-6289	817-599-8363	
PLX Technology	415-694-2800		
Quad Design Technology	805-988-8250	44-344-306166	
Quatech	800-553-1170		

VENDOR	U.S.	EUROPE	JAPAN/APac
Quickturn Design Systems, Inc.	415-967-3300	44-494-670-267	81-33-292-2821 (Japan)
RAVIcad, Inc.	800-RAVICAD	408-720-6123	
Ready Systems	800-321-2636 408-736-2600	33-139-468-986	81-337-951-811 (Japan)
Real-Time Innovations, Inc.	408-720-8312	408-720-8312	
RouterWare, Inc.	714-442-0770	714-442-0770	
RPM Systems Corp.	206-869-3901		
Saville & Associates	408-479-7199		
SCM	408-370-4888	49-361-664-870	
Siemens SME	49-8-941-440		
Signum Systems	805-371-4608	44-254-682-092	866-2-501-6699
SKY Computers, Inc.	508-250-1920	508-250-1920	
SMS Mikrocomputer Systems GmbH	800-722-4122	49-7-522-97280	
Socket Express	908-247-9500		
Sophia Systems & Technology	415-493-6700	415-493-6700	
STAC Electronics	619-431-7474		
Stag Microsystems, Inc.	408-988-1118		
STEP Engineering	800-538-1750	33-139-611414	81-44-812-7430 (Japan)
Sun-Shine Electronics			886-2-766-0206
Synopsis	415-962-5000		
System General Corporation	408-263-6667	41-1-945-0300	886-2-917-3005
Systems & Software, Inc.	800-788-4386 714-833-1700	49-1-816-577-177	714-833-1700
Systemsoft	508-651-0088		
Tadpole Technology Inc.	512-219-2200	33-1-60-725060	
Tartan, Inc.	412-856-3600		
Tektronix, Inc.	800-426-2200	44-662-848-6000	
Teledyne Electronic Systems	818-886-2211		
Telogy, Inc.	800-835-6494		
TLD Systems, Ltd.	310-542-5433		
Tribal Microsystems, Inc.	510-623-8859	510-623-8859	886-2-764-0215
Tronix Product Development	602-220-0011		
Topmax/TDS	602-730-2530		
UFO Systems, Inc.	716-248-3372		
U.S. Software	503-641-8446	503-641-8446	503-641-8446
Universal Cross Assemblers	506-849-8952	44-703-631-441	506-849-8952
Unmanned Solutions	510-656-4300		
V3 Corporation	408-988-1050	416-285-9188	
Vail Silicon Tools	305-570-5580		
Venture Technologies Inc.	508-667-9890		
Watcom International Corporation	800-265-4555	44-506-460-112	519-886-3700
Wells	219-287-5941		
Wind River Systems	800-545-WIND 510-784-4100	33-1-69-077878	813-3432-4000 (Japan)
XLNT Designs, Inc.	619-487-9320		
Yamaichi Yokagawa Digital Computer	408-456-0797 81-422-569-101		81-422-569-101 (Japan)

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