

# i960<sup>®</sup> CA/i960 CF 32-Bit Superscalar Embedded Microprocessor

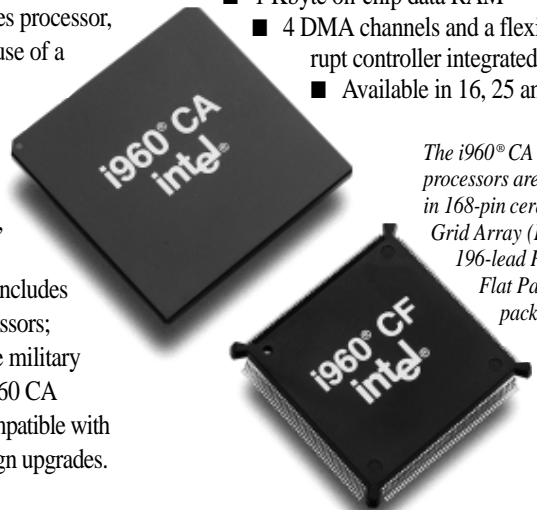
## Product Overview

The i960<sup>®</sup> CA embedded RISC processor was introduced in September, 1989 as the world's first superscalar 32-bit processor developed for embedded applications. It delivers multiple instructions per clock cycle for throughput of 66 native MIPS (Millions of Instructions Per Second), doubling the performance goal of RISC (Reduced Instruction Set Computing) techniques.

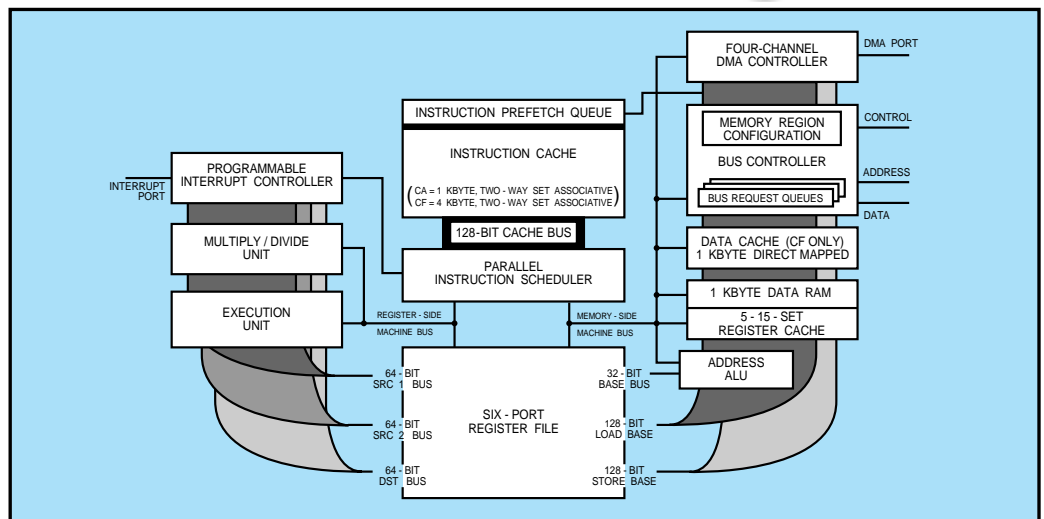
Intel also offers the second i960 C-series processor, the i960 CF microprocessor. Through the use of a superscalar CPU core and advanced cache memory design, the i960 CF processor is capable of double the performance of the i960 CA processor in many applications. The ninth member of the i960 architecture, the i960 CF processor is object code-compatible with all family members. This includes the entry-level, low-cost i960 SA/SB processors; the mid-range i960 KA/KB processors; the military i960 MC processor; and the superscalar i960 CA processor. The i960 CF device is socket-compatible with the i960 CA processor, allowing quick design upgrades.

## Product Highlights

- Superscalar RISC core
- 1 Kbyte two-way set associative instruction cache (i960 CA processor only)
- 4 Kbyte two-way set associative instruction cache (i960 CF processor only)
- 1 Kbyte direct mapped data cache (i960 CF processor only)
- 1 Kbyte on-chip data RAM
- 4 DMA channels and a flexible interrupt controller integrated on-chip
- Available in 16, 25 and 33 MHz



*The i960<sup>®</sup> CA and i960 CF processors are available in 168-pin ceramic Pin Grid Array (PGA) and 196-lead Plastic Quad Flat Pack (PQFP) packages.*



**i960<sup>®</sup> CA/i960 CF Microprocessor Block Diagram**

# i960<sup>®</sup> CA/i960 CF Microprocessor Product

*The integration of key performance system functions in the i960<sup>®</sup> CA and CF superscalar microprocessors brings parallel computing performance to cost- and space-sensitive applications. With nearly twice the performance of the i960 CA CPU, the i960 CF CPU brings a new level of performance to embedded RISC computing.*

## Features

- i960 CA and i960 CF processors socket and object code-compatible
- Two instructions per clock sustained execution
- Demultiplexed 32-bit burst bus with pipelining
- 32-bit parallel architecture
  - Two instructions/clock execution
  - Load/store architecture
  - Sixteen, 32-bit global registers
  - Sixteen, 32-bit local registers
  - Manipulate 64-bit bit fields
  - 11 addressing modes
  - Full parallel fault model
  - Supervisor protection model
- Fast processor call/return model
  - Full procedure call in four clocks
  - RISC call in two clocks (BAL)
- On-chip register cache
  - Caches the registers on call/return
  - Minimum of six frames provided
  - Up to 15 frames programmable
- On-chip instruction cache
  - 1 Kbyte two-way set associative (CA only)
  - 4 Kbyte two-way set associative (CF only)
  - 128-bit path to instruction sequencer
  - Cache-lock, cache-off mode
- On-chip data cache (CF only)
  - 1 Kbyte direct-mapped, write through
  - 128 bits per clock access on cache hit
- 1 Kbyte high bandwidth on-chip data RAM
- Four on-chip DMA channels
  - 59 Mbytes/sec fly-by transfers
  - 32 Mbytes/sec two-cycle transfers
  - Data chaining, packing/unpacking
  - Programmable priority method
- High-speed interrupt controller
  - Up to 248 external interrupts
  - 32 fully programmable priorities
  - Multi-mode 8-bit interrupt port
  - Four internal DMA interrupts
  - Separate, non-maskable interrupt pin
  - Context switch in 759 ns typical

## Benefits

- Quick, easy design upgrades.
- Superscalar performance doubles performance goals of RISC techniques.
- Enables sustained execution of multiple instructions per clock from a sequential instruction stream.
- High-performance and reduced code size maintain assembly-level compatibility.
- Greatly reduces the external bus traffic associated with procedure context saving and restoring.
- Accelerates execution of standard software and time-critical interrupt routines.
- Enhances performance.
- Eliminates bottlenecks; data is available when it is needed.
- High-speed DMA data transfers to/from internal or external locations.
- Eases control. Prioritization of software interrupts, hardware interrupts and the process priority.

# Features and Benefits

## INTERNETWORKING

### Features

- Superscalar architecture with instruction set that supports data agility
- Integrated DMA, caches, interrupt controller
- Integrated SRAM and hardware multiply
- Broad and mature tool support including optimizing compiler
- Pipelined burst-bus
- 32-level priority-based interrupt structure

### Benefits

- Maximum amount of processing per packet without clogging data flow (i.e., forwarding decisions, encapsulating, translating, routing).
- Maximizes performance of critical routines with cleaner programming and quick interrupt response.
- Quicker address table access for swift forwarding/routing decisions.
- Ease of re-use for larger programs (i.e., network management, statistics) with easy optimization of critical path.
- Provides maximum memory bandwidth.
- Provides hardware support for interrupt management.

## IMAGING

### Features

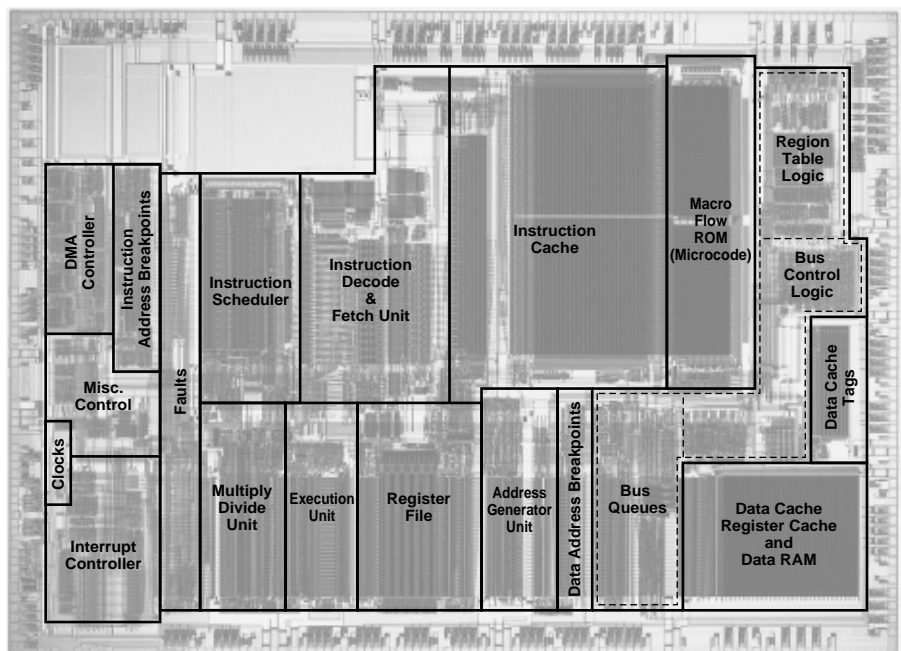
- Software-configurable bus controller compensates for external memory subsystems that contain a combination of bus widths (8-, 16- or 32-bit), access times, burst-mode capabilities and data-ordering conventions
- Integrated DMA

### Benefits

- Easy to configure, lower cost memory subsystems for 32-bit performance levels. Easy to deal with varying I/O (8-, 16- or 32-bit).
- Provides high-speed DMA data transfers for character input and video output.

The i960<sup>®</sup> CA and i960 CF microprocessors incorporate the right mix of peripheral integration: a 4-channel DMA controller and an 8-channel interrupt control unit. Pictured is the i960CF superscalar microprocessor.

 BUS CONTROLLER



## i960® CA/i960 CF MICROPROCESSOR APPLICATION AREAS

### Office Automation

Image scanners, page-printer controllers  
X terminal applications  
Document teleprocessing  
Local-area network (LAN) controllers and communications bridges (FDDI, TI)  
Database engines, department filing systems, process servers  
Telecommunications and data communications equipment  
I/O processing for graphics workstations

### Industrial Robotics

Automated vision systems  
Robotics  
Image recognition  
Production line coordination, communications  
Factory process control, monitoring instruments  
Transport system control

### Medical Instrumentation

Real-time data collection and analysis instruments  
Monitoring systems  
Ultrasound imaging displays

### Avionics and Aerospace

Flight-control equipment  
Ground-to-air communications systems  
Satellite navigation computers  
Celestial telescope systems

### i960® CA/i960 CF Microprocessor Development Support

To help minimize development costs, Intel has developed the Solutions960™ program. Currently, we have assembled over 200 tools from more than 70 companies. Included in the program are the following:

- Optimized support components
- Full suite of software development tools, including optimizing C compiler
- Operating systems
- Debug tools – in-circuit emulators, debugger/simulators, logic analyzers
- Evaluation boards
- Specific support products for networking and laser printer application support

### Support Information

<b>Product and Sales Information</b>	Intel product information, sales office and distributor phone numbers.	<b>800-628-8686</b>
<b>Literature Department</b>	To order Intel product literature.	<b>800-548-4725</b>
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<b>Applications Bulletin Board Service</b>	24-hour access via modem to publicly available technical information. For a complete listing of all files available on BBS, call the FaxBack service and request catalog #6 (BBS Master File Listing).	<b>916-356-3600</b>

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