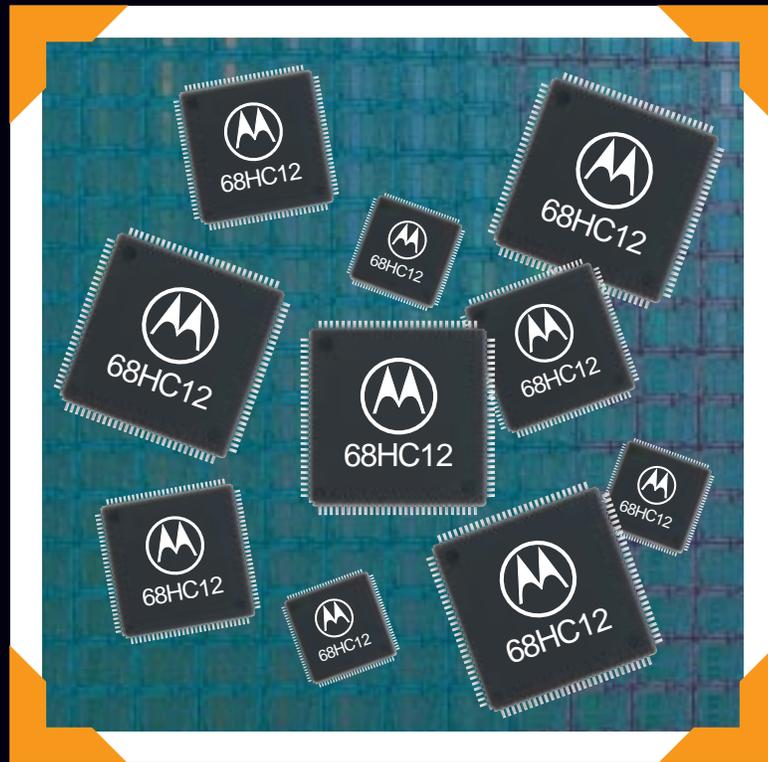


# THE M68HC12 FAMILY OF 16-BIT MICROCONTROLLERS



*the*  
ADVANCED MICROCONTROLLER  
*Family*



**MOTOROLA**

Semiconductor Products Sector



**A LOW POWER, COST-EFFECTIVE 16-BIT ARCHITECTURE WITH STRONG FAMILY TIES: THE 68HC12.**

Motorola has added yet another family to our ever-expanding lineup of advanced microcontrollers: The new 68HC12. This highly integrated, general-purpose family is our new 16-bit microcontroller architecture specifically designed for low power consumption. And it is completely source code compatible with Motorola's popular 68HC11 8-bit microcontroller family.

With a direct migration path, current 68HC11 users can now easily step up to 16-bit performance and increased functionality without sacrificing software engineering investments. And, new 16-bit applications benefit equally from this cost-effective solution.

68HC12 strong points include:

- Low power consumption and low voltage operation at full bus speed
- Single wire Background Debug™ Mode for non-intrusive in-circuit programming and debugging
- High-level language optimization
- Flash EEPROM and byte-erasable EEPROM integrated on a single device
- Fuzzy logic instructions
- Modular design enabling the central processing unit to connect to existing, proven Motorola peripheral modules

Combining all the characteristics of the industry-leading 8-bit 68HC11 Family with powerhouse 16-bit performance and an unparalleled array of enhanced features, the 68HC12 is an exciting new option for Motorola customers. It's the ideal solution for power-thrifty applications that range from wireless communications and automotive to industrial control and smaller-than-ever consumer electronic products.

The 68HC12. It's a new dimension in 16-bit performance, yet steeped in the heritage of the microcontroller families that have made Motorola number one worldwide. Considering the 68HC12? We have only one thing to say.

Welcome to the family.

**68HC12**

## THE 68HC12 ARCHITECTURE: THE BEST OF THE 68HC11. AND MORE.

The 68HC12 incorporates an unparalleled technology and feature set, along with a superset of popular 68HC11 instructions. Key elements of the 68HC12 architecture include:

- 16-bit core (CPU12)
- 16-bit data bus
- Lite Integration Module (LIM)
- Low power consumption design, low voltage operation, low noise
- Modular design methodology allows integration of on-chip peripherals from 68HC08, 68HC16, and 68300 families
- World-class sub-micron process technology

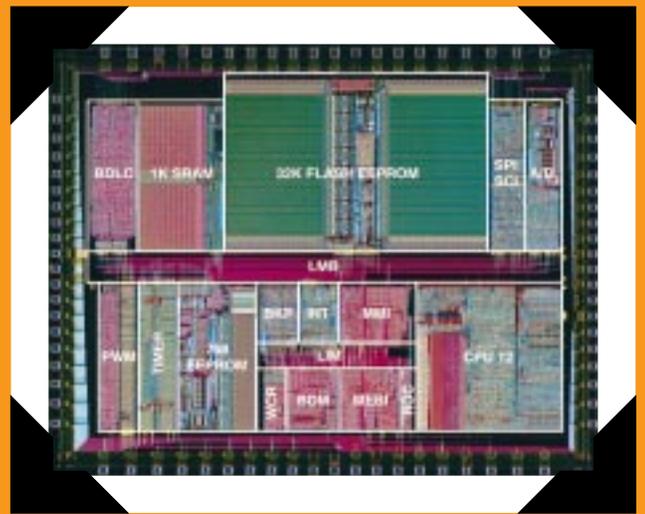
### ENHANCED CENTRAL PROCESSING UNIT

At the core of the 68HC12 is CPU12, a high-speed 16-bit evolution of the 68HC11 architecture that is designed to maintain complete source-code compatibility with the 68HC11 core. The 68HC12 fully supports all internal registers, instructions, addressing modes, and operating modes of the 68HC11. Additional features and benefits include:

- 64 new instructions, 20-bit Arithmetic Logic Unit (ALU), instruction queue, and 7 new indexed addressing modes
- 64 Kbytes linear and paged memory addressing capability, enabling access to more than 4 megabytes of program space and 1 megabyte of data space
- Call and Return from Call (RTC) instructions for efficient paged addressing
- High-level language (HLL) optimization
- Fast math capabilities (16x16 MUL, 32÷16 DIV, EMACS)
- Fuzzy logic instructions for simplified programming, reduced code size, and faster code execution

### FLEXIBLE MODULAR DESIGN

A standard bus interface—the Lite Module Bus (LMB) designed for low power—is used to connect the CPU12 to specialized peripheral modules. The LMB is similar to the Intermodule Bus (IMB) found on the M68HC16, M68300, and MPC500 families, allowing Motorola to leverage existing, proven peripheral modules to develop new 68HC12 derivatives.



The 68HC912B32 is the first 16-bit microcontroller to integrate both Flash EEPROM and Byte-erasable EEPROM with a complete set of on-chip peripheral modules.

### LOW POWER, LOW VOLTAGE, LOW NOISE

The 68HC12 runs at 8 MHz and was designed for extended voltage range operation as well as low power consumption. Devices operate from 2.7 V to 5.5 V, with a roadmap to 1.8 V. Low power operation is achieved through:

- Stop and Wait modes
- Ability to shut down peripherals
- Phase-Locked Loop (PLL) system clock on some derivatives
- Transistor sizes that are optimized for low power
- Fewer bus interface and address lines
- Signals propagated on the bus only as needed
- Programmable output drivers on most I/O ports reduce noise and power consumption



THE 68HC12 FAMILY HAS BEEN OPTIMIZED FOR A RANGE OF COMMUNICATIONS APPLICATIONS.

## LITE INTEGRATION MODULE (LIM)

The 68HC12's LIM offers the option of either a multiplexed or non-multiplexed bus, runtime monitors, and Motorola's Background Debug Mode (BDM) in-circuit debug feature. This enhanced, patented version of the BDM found on our 68HC16 and 68300 microcontrollers replaces conventional debug modes. It allows non-intrusive, real-time read/write capability to the memory and registers for faster code debugging. It also allows for field diagnostics and upgrades of customer end products. BDM features/benefits include:

- Simple commands used to debug while in-circuit
- Single-wire communication protocol
- In-circuit programming of Flash EEPROM and byte-erasable EEPROM

## FLASH EEPROM MEMORY

Some derivatives of the 68HC12 Family feature on-chip non-volatile Flash EEPROM memory that is bulk-erasable and supports byte or aligned word operations. In addition, fast termination is assured with single-cycle access speed and an optional 1 Kbyte of protected boot block is available. This innovative 16-bit wide memory subsystem offers many benefits, including:

- Fast programming and erase times
- Reduced circuit board complexity/size
- Increased reliability through fewer interconnections
- Fast memory access
- Prototypes can be reprogrammed over and over
- Faster time to market
- Production units that can be customized at end of process
- In-circuit programming through Background Debug Mode
- Field reprogrammability

## BYTE-ERASABLE EEPROM MEMORY

The 68HC12 Family also features on-chip byte-erasable EEPROM for enhanced programming flexibility. This integrated memory solution enables:

- Programming and erasing in all modes of operation
- 16-bit configuration array management
  - Read as bytes or words
  - Programming by bytes or aligned words
- Supports byte, aligned word, row (32 bytes) or bulk erase
- Programming voltage is derived from  $V_{DD}$  with an internal charge pump

## STATIC RAM (SRAM) MEMORY

To support byte and word operations, Static Random Access Memory (SRAM) will be available in 1, 1.5, 2, 3.5, and 4 Kbyte blocks that provide fast single cycle access speeds.

## WORLD-CLASS MANUFACTURING PROCESS

The 68HC12 Family was designed using Motorola's Unified Design Rules (UDR), a high-density, double-layer metal, HCMOS wafer fabrication technology. The UDR process supports a high level of integration on very small die sizes, enabling even lower costs and increased speeds on future devices.



## INITIAL FAMILY MEMBERS

The first members in the 68HC12 Family are the 68HC812A4 (A4) and the 68HC912B32 (B32). Both the A4 and the B32 are composed of the CPU12 and Lite Integration Module, plus a set of enhanced on-chip peripheral modules. The B32 is the world's first 16-bit microcontroller with Flash EEPROM memory and byte-erasable EEPROM integrated on-chip.

Initial family members will be followed by other cost-effective derivatives based on Motorola's Customer Specified Integrated Circuit (CSIC) design methodology. Like the A4 and the B32, each upcoming derivative will feature the CPU12 core and Lite Integration Module (LIM) surrounded by integrated features such as on-chip memory, serial communications interfaces, timers, analog-to-digital converters, PWM, display drivers, custom logic, and other tried and true Motorola on-chip peripherals.



**A COST-EFFECTIVE DESIGN AND MOTOROLA'S WORLD-WIDE MANUFACTURING CAPABILITY MAKE THE 68HC12 FAMILY IDEAL FOR CONSUMER APPLICATIONS.**

## INITIAL 68HC12 FAMILY MEMBERS

FEATURES	68HC812A4	68HC912B32
Byte-erasable EEPROM	4 Kbytes	768 bytes
Flash EEPROM	—	32 Kbytes with 1 Kbyte block protected
SRAM	1 Kbyte	1 Kbyte
8-channel, 8-bit A/D converter	✓	✓
8-channel, 16-bit timer	✓	✓
8-bit, 4-channel Pulse Width Modulator with center-aligned options	—	✓
Asynchronous Serial Communication Interface (SCI)	2	1
Synchronous Serial Peripheral Interface (SPI)	1	1
Byte Data Link Controller for J1850 multiplexing	—	✓
LIM Features		
Background Debug Mode	✓	✓
Two hardware breakpoints	—	✓
Non-multiplexed expanded mode or single-chip mode	✓	—
Single-chip mode or multiplexed data and address buses for single-chip or expanded mode	—	✓
16 data lines	✓	muxed
16 address lines	✓	muxed
Memory expansion logic with chip selects	✓	—
Key wake-up lines with interrupt capability	24	—
Phase-Locked Loop	✓	—
Real-time (periodic) interrupt circuit	✓	✓
Watchdog timer (COP)	✓	✓
Clock monitor	✓	✓
On-chip mapping/expansion	64K linear; 4 Mbyte program; 1 Mbyte data, paged	64 Kbytes linear
Wait and stop modes	✓	✓
Programmable chip selections	7	—
I/O pins	up to 94	up to 64
Package	112 TQFP	80 QFP



**H**ardware and software designs based on the 68HC12 architecture can be evaluated and debugged quickly and efficiently with Motorola's full-featured evaluation board.

## DEVELOPMENT SUPPORT

Motorola and several independent development tool suppliers offer both hardware and software development tools for the 68HC12 Family. Motorola's offering includes the M68HC12A4EVB Evaluation Board, the SDI™ Serial Debug Interface, MCUasm™ assembly language toolset, and MCUdebug™ source-level debugger. A Modular Development System (in-circuit emulator) and a 68HC12 version of the RTEK™ Real-Time Kernel are also planned.

### M68HC12A4EVB EVALUATION BOARD

The Evaluation Board (EVB) for applications based on the 68HC812A4 microcontroller offers design, debugging and code development support. By providing essential timing plus I/O and debugging circuitry, the M68HC12A4EVB enables users to easily evaluate prototype hardware and software designs. It includes the MCUasm toolset.

This flexible EVB provides all necessary interface and power connections for the 68HC812A4 microcontroller, which is installed in a production socket. Features include:

- 68HC12 MCU-based debugging circuitry
- Background mode operation
- Single power supply (+3 to +5 Vdc)
- Support for up to 1 Mbyte of program space and 512 Kbytes of data storage using optional memory configurations
- One RS-232 termination interface
- Two memory sockets with 32K x 8 EPROMs installed
- D-bug 12 monitor/debugger program
- Two socketed 8K x 8 SRAMs
- Built-in 16 MHz crystal-controlled clock oscillator
- Headers for access and jumper selection of hardware options
- File transfer capability from host computer
- Wire wrap area for custom interfacing



**WITH LOW POWER CONSUMPTION AND LOW VOLTAGE, THE 68HC12 FAMILY IS IDEAL FOR WIRELESS COMMUNICATIONS SYSTEMS.**

## **SDI SERIAL DEBUG INTERFACE**

The SDI Serial Debug Interface is a serial in-circuit debugging tool that utilizes the Background Debug Mode on 68HC12 microcontrollers to quickly update and verify application code. When used with compatible debug software such as MCUdebug, developers can view and modify their application real time. The SDI is available in 5V only and low voltage (2.7 - 5.5V) versions.

## **MCUASM ASSEMBLY LANGUAGE TOOLSET**

The MCUasm assembler is a full-featured toolset with nearly a dozen different code-building tools, including a project manager, linker, S-record generator, assembler, disassembler and assembly language converter. This integrated toolset gives users the flexibility to control assembly listings, select case-sensitive labels, and alter symbol tables to shorten download times. Its syntax and language extensions are common to most Motorola microcontroller families, making it easy for users to migrate upward without sacrificing speed or efficiency. MCUasm is optimized to handle large and complex input, allows nested include files, and supports the Common Object File Format (COFF) and P&E Microcomputer's Map files.

## **MCUDEBUG SOURCE-LEVEL DEBUGGER**

The MCUdebug tool supports assembly source-level debugging. It features a user-defined graphical interface and provides a choice between entering commands directly or using a flexible windowing environment for debugging sessions. The MCUdebug tool allows users to set their own debugging variables and breakpoints, and customize and recreate debugging sessions.

In addition, it can be used with the SDI Interface to read and write to memory non-intrusively through BDM. Other features include real-time memory, user configurable memory mapping, and the ability to modify EEPROM and RAM.

The 68HC12 Family has extensive support from third-party development tool suppliers. Companies already supporting or planning to support the M68HC12 architecture include Ashling Microsystems, BYTEcraft, COSMIC Software, Emulation Technology, Hitex, HIWARE, IAR Systems, Inform, Introl, Lauterbach, Nohau, Noral Micrologics, P&E Microcomputer, Pentica Systems, and U.S. Software.



## **READY TO MEET THE FAMILY?**

Designers who need a cost-effective microcontroller that delivers 16-bit performance will find the 68HC12 a welcome addition to Motorola's encompassing family of microcontrollers. For more information or to evaluate the 68HC12 for your next application, please call your local Motorola sales office or authorized distributor. Or call (800) 765-7795, ext. 906 (outside the U.S., call 1-512-328-2268); Fax: (800) 765-9753; or write us at P.O. Box 13026, Austin, Texas 78711-3026. Additional information can be found on our WWW site at: <http://www.mot.com/m68hc12>



**AUTOMOTIVE APPLICATIONS  
BENEFIT FROM THE 68HC12  
FAMILY'S ON-CHIP FLASH  
MEMORY, WIDE TEMPERATURE  
RANGE AND LOW  
POWER CAPABILITIES.**

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www: <http://www.mot.com/m68hc12>

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