# MC9S08AC16

## Overview

Freescale Semiconductor's HCS08AC family of microcontrollers (MCUs) is part of the popular and rapidly growing HCS08 product family, featuring advanced on-chip development support, enhanced peripherals, increased memory options and improved system security.

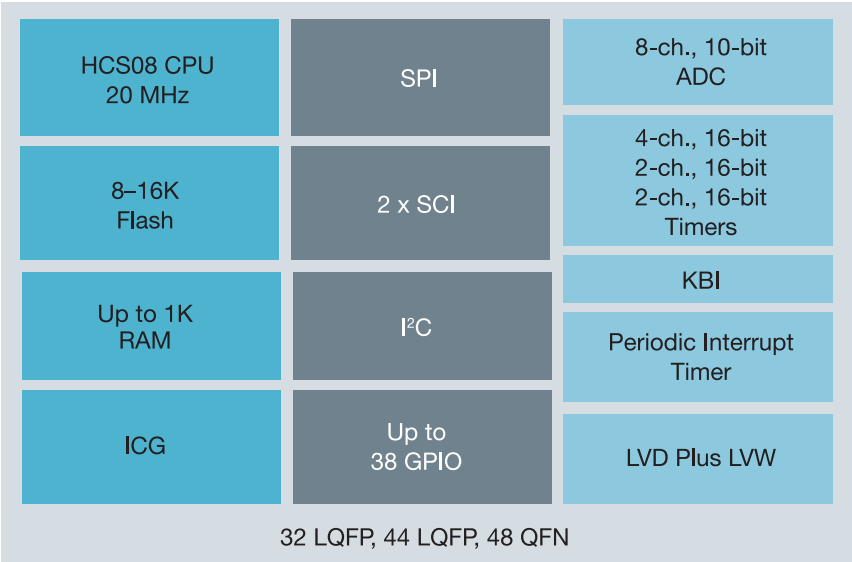
Using Freescale's industry-leading 0.25 µm flash, the MC9S08AC16 offers a migration path from Freescale's MC9S08AW products for applications that need enhanced peripherals, increased performance and improved system security. Other features include enhanced low-voltage warning, two serial communications interfaces (SCIs), a serial peripheral interface (SPI), an Inter-Integrated Circuit ($I^2C$), a 10-bit analog-to-digital converter (ADC) and eight programmable 16-bit timer channels with center-aligned pulse-width modulation (PWM) capability.

This combination of performance and on-chip integration makes the MC9S08AC16 a perfect fit for many general embedded industrial control applications, specifically motor control applications.

## Target Applications

- General Industrial Applications
  - Motor control
  - Building control
  - HVAC
- Appliance Applications
  - Dishwashers
  - Washing machines
  - Dryers
  - Refrigerators

## AC16 Block Diagram




| Features | Benefits |
|---|---|
| **8-bit HCS08 Central Processing Unit (CPU)** | |
| • High-performance 20 MHz CPU<br>  ◦ 50 ns minimum instruction cycle time down to 2.7V at 20 MHz bus<br>• C-optimized architecture<br>• Multiply and divide instructions<br>• Optional reduced power modes<br>  ◦ Support for up to 32 interrupt reset sources<br>• Auto wake-up with internal timer requires only 300 nA of additional current | • Provides the performance needed in many high-performance 8-bit applications<br>• Produces extremely compact code with full 16-bit stack pointer and stack relative addressing<br>• Allows for greater software flexibility and optimizations in addition to saving power |
| **Integrated Third-Generation Flash Memory** | |
| • In-application programming<br>• Self-timed fast programming<br>  ◦ Program 8-bits in 20 us<br>  ◦ Fast flash page erase, 20 ms<br>• 10K write erase cycles minimum, 100IK typical<br>• 15 year minimum data retention, 100 years typical<br>• Internal program/erase voltage generation<br>• Fine flash granularity—512B flash erase/ 1B flash program<br>• Flexible block protection and enhanced security<br>• Single power supply program/erase<br>• Read/program/erase over full operation voltage and temperature | • Ultra-fast programming reduces system cost<br>• Command program interface eliminates complex programming algorithms<br>• Flexibility—flash-based systems can be reprogrammed during the development cycle or late in the manufacturing cycle<br>• Flash is easily used for data EEPROM |

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| Features | Benefits |
|---|---|
| **Internal Clock Generator** | |
| • Programmable frequency-locked loop (FLL) generates 8 MHz to 40 MHz<br>• Provides multiple options for clock source and in-application clock switching<br>  ○ 32 KHz to 16 MHz reference external crystal<br>  ○ External clock<br>• Trimmable with temperature and voltage compensation<br>• Post FLL divider gives one of eight bus rate dividers | • Designed to reduce board space and system cost by eliminating the need for external components<br>• Accuracy across temperature and voltage allows reliable serial communications without external clocks<br>• The lack of external components decreases noise |
| **10-bit ADC** | |
| • 8-channel ADC<br>• 2.5 us, 10-bit single conversion time | • Fast, easy conversion from analog inputs such as temperature, pressure and fluid levels, to digital values<br>• Robust specified operation |
| **Timer with Ten Programmable Channels** | |
| • Two 2-channel 16-bit timer systems<br>• One 4-channel 16-bit timer systems<br>• Programmable for input, capture, output compare or buffered PWM<br>  ○ PWM can be edge or center aligned | • Flexible, programmable timer system.<br>• Center aligned PWM's are designed to allow noise minimization by distributing the edges of the PWM. |
| **Extensive Serial Communications** | |
| • Dual asynchronous SCIs<br>  ○ Flexible 13-bit module-based baud rate generators<br>  ○ Active edge on receive pin detection<br>  ○ Selectable receiver input polarity<br>  ○ LIN compatible<br>• Inter IC-bus ($I^2C$)<br>  ○ Up to bus speed/20 Mbps throughput with minimal loading<br>  ○ Supports broadcasting mode and 10-bit addressing<br>• Synchronous SPI<br>  ○ Multi-master operation<br>  ○ 256 clock options | • Asynchronous communication between the MCU and a terminal, computer or a network with accurate buad rate matching<br>• SCI interrupts and flags can be set when an active edge occurs on RxD pin<br>• SCI can correctly receive data whose polarity was inverted during transmission<br>• High-speed synchronous communication between multiple MCUs or between MCU and serial peripherals<br>• Provides a simple, efficient method of data exchange between devices<br>• Serial peripherals are available for use in parallel |
| **System Protection** | |
| • Selectable low-voltage detect/reset<br>• Enhanced low-voltage warning<br>• COP watchdog timer<br>  ○ Option to run COP off independent clock source or bus | • Provides additional system security<br>• The addition of a 1 kHz independent oscillator provides two additional timeout options |
| **Input/Output** | |
| • Up to 38 GPIO pins<br>  ○ Programmable pull ups<br>  ○ High-current drivers<br>  ○ Eight keyboard interrupts<br>  ○ Controlled rise/fall times minimize noise | • Results in a large number of flexible I/O pins that allow vendors to easily interface the device into their own designs as every peripheral pin is GPIO capable<br>• Reduces system cost |
| **On-Chip Debug Interface** | |
| • Single-wire background debug mode<br>• On-chip trace buffer with nine flexible trigger modes and multiple hardware breakpoints.<br>• Non-intrusive emulation | • Real-time emulation of MCU functions at full operating voltage and frequency range with no limitations<br>• On-chip trigger and buffer hardware replaces emulator's expensive bus state analyzer<br>• Non-intrusive debugging through a single dedicated pin helps eliminate the need of cost emulator cables<br>• View and change internal registers and memory while running an application |

## Product Selector Guide

| Part Number | Temp. Range | Package |
|---|---|---|
| MC9S08AC16CFDE | -40°C to +85°C | 48-pin QFN |
| MC9S08AC16MFDE | -40°C to +125°C | 48-pin QFN |
| MC9S08AC16CFGE | -40°C to +85°C | 44-pin LQFP |
| MC9S08AC16MFGE | -40°C to +125°C | 44-pin LQFP |
| MC9S08AC16CFJE | -40°C to +85°C | 32-pin LQFP |
| MC9S08AC16MFJE | -40°C to +125°C | 32-pin LQFP |
| MC9S08AC8CFDE | -40°C to +85°C | 48-pin QFN |
| MC9S08AC8MFDE | -40°C to +125°C | 48-pin QFN |
| MC9S08AC8CFGE | -40°C to +85°C | 44-pin LQFP |
| MC9S08AC8MFGE | -40°C to +125°C | 44-pin LQFP |
| MC9S08AC8CFJE | -40°C to +85°C | 32-pin LQFP |
| MC9S08AC8MFJE | -40°C to +125°C | 32-pin LQFP |

All parts are available in tape & reel packages. They are also available in extended temperature ranges. See datasheet for details.

### Cost Effective Development Tools

For more information, please refer to the Freescale Development Tool Selector Guide (SG1011).

**DEMO9S08AC60**
$85*

Full-featured evaluation system for the AC16/8 device family. The DEMO9S08AC60 is powered by the MC9S08AC60 processor and features an ZIF Socket, a built-in USB BDM, LEDs, a serial port, an acceleration sensor and an I/O header. This kit comes complete with everything you need to get your board up and running quickly and easily.

**USBMULTILINKBDM**
$99*

A universal in-circuit emulator and debugger, capable of flash programming that can also be used on HCS08 and HCS12 products. Comes standard with USB-PC interface.

**M68CYCLONEPRO**
$499*

A stand-alone flash programmer that can also be used as an in-circuit emulator and debugger on HC08, HCS08, HC12 and HCS12 products. Comes standard with USB, serial and Ethernet interface options.

**CodeWarrior® Development Studio for HC(S)08 Architectures, V6.1**
**Complimentary**

CodeWarrior Development Studio for HC(S)08 architectures is a single tool suite that supports software development for Freescale's HC(S)08 family of 8-bit products. Support for all Freescale HC(S)08 devices coupled with the cross-platform capabilities of the award-winning CodeWarrior Integrated Development Environment (IDE) simplifies code migration and reuse for faster product development. CodeWarrior® Development Studio for HC(S)08 Architectures, version 6.1 is a complete integrated development environment for ColdFire® hardware bring-up through embedded applications.

*Prices indicated are MSRP

**Learn More:** For current information about Freescale products and documentation, please visit **www.freescale.com/8bit**.



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