

# 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.

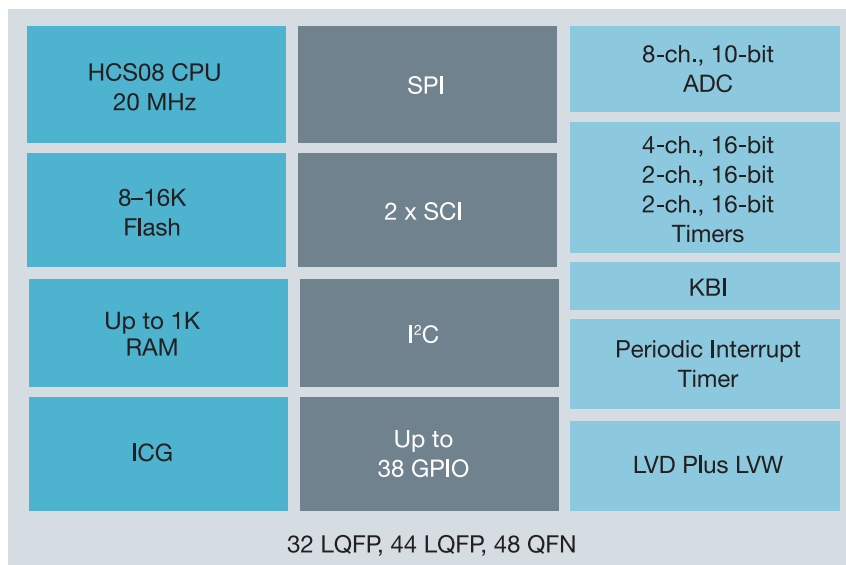
Using Freescale's industry-leading 0.25  $\mu$ m flash, the MC9S08AC16 offers a migration path from Freescale's MC9S08AW products for applications that need enhanced peripherals, increased performance and improved system security. Other features include enhanced low-voltage warning, two serial communications interfaces (SCIs), a serial peripheral interface (SPI), an Inter-Integrated Circuit (I<sup>2</sup>C), 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

### 8-bit HCS08 Central Processing Unit (CPU)

- High-performance 20 MHz CPU
  - 50 ns minimum instruction cycle time down to 2.7V at 20 MHz bus
- C-optimized architecture
- Multiply and divide instructions
- Optional reduced power modes
  - Support for up to 32 interrupt reset sources
- Auto wake-up with internal timer requires only 300 nA of additional current

## Benefits

- Provides the performance needed in many high-performance 8-bit applications
- Produces extremely compact code with full 16-bit stack pointer and stack relative addressing
- Allows for greater software flexibility and optimizations in addition to saving power

### Integrated Third-Generation Flash Memory

- In-application programming
- Self-timed fast programming
  - Program 8-bits in 20 us
  - Fast flash page erase, 20 ms
- 10K write erase cycles minimum, 100K typical
- 15 year minimum data retention, 100 years typical
- Internal program/erase voltage generation
- Fine flash granularity—512B flash erase/1B flash program
- Flexible block protection and enhanced security
- Single power supply program/erase
- Read/program/erase over full operation voltage and temperature

- Ultra-fast programming reduces system cost
- Command program interface eliminates complex programming algorithms
- Flexibility—flash-based systems can be reprogrammed during the development cycle or late in the manufacturing cycle
- Flash is easily used for data EEPROM

## Features

### Internal Clock Generator

- Programmable frequency-locked loop (FLL) generates 8 MHz to 40 MHz
- Provides multiple options for clock source and in-application clock switching
  - 32 KHz to 16 MHz reference external crystal
  - External clock
- Trimmable with temperature and voltage compensation
- Post FLL divider gives one of eight bus rate dividers

### 10-bit ADC

- 8-channel ADC
- 2.5 us, 10-bit single conversion time

### Timer with Ten Programmable Channels

- Two 2-channel 16-bit timer systems
- One 4-channel 16-bit timer systems
- Programmable for input, capture, output compare or buffered PWM
  - PWM can be edge or center aligned

### Extensive Serial Communications

- Dual asynchronous SCIs
  - Flexible 13-bit module-based baud rate generators
  - Active edge on receive pin detection
  - Selectable receiver input polarity
  - LIN compatible
- Inter IC-bus (I<sup>2</sup>C)
  - Up to bus speed/20 Mbps throughput with minimal loading
  - Supports broadcasting mode and 10-bit addressing
- Synchronous SPI
  - Multi-master operation
  - 256 clock options

### System Protection

- Selectable low-voltage detect/reset
- Enhanced low-voltage warning
- COP watchdog timer
  - Option to run COP off independent clock source or bus

### Input/Output

- Up to 38 GPIO pins
  - Programmable pull ups
  - High-current drivers
  - Eight keyboard interrupts
  - 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
- Reduces system cost

### On-Chip Debug Interface

- Single-wire background debug mode
- On-chip trace buffer with nine flexible trigger modes and multiple hardware breakpoints.
- Non-intrusive emulation
- Real-time emulation of MCU functions at full operating voltage and frequency range with no limitations
- On-chip trigger and buffer hardware replaces emulator's expensive bus state analyzer
- Non-intrusive debugging through a single dedicated pin helps eliminate the need of cost emulator cables
- View and change internal registers and memory while running an application

## Benefits

- Designed to reduce board space and system cost by eliminating the need for external components
- Accuracy across temperature and voltage allows reliable serial communications without external clocks
- The lack of external components decreases noise

- Fast, easy conversion from analog inputs such as temperature, pressure and fluid levels, to digital values
- Robust specified operation

- Flexible, programmable timer system.
- Center aligned PWM's are designed to allow noise minimization by distributing the edges of the PWM.

- Asynchronous communication between the MCU and a terminal, computer or a network with accurate baud rate matching
- SCI interrupts and flags can be set when an active edge occurs on RxD pin
- SCI can correctly receive data whose polarity was inverted during transmission
- High-speed synchronous communication between multiple MCUs or between MCU and serial peripherals
- Provides a simple, efficient method of data exchange between devices
- Serial peripherals are available for use in parallel

- Provides additional system security
- The addition of a 1 kHz independent oscillator provides two additional timeout options

## 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](http://www.freescale.com/8bit).