

Welcome to E-XFL.COM

#### What is "Embedded - Microcontrollers"?

"Embedded - Microcontrollers" refer to small, integrated circuits designed to perform specific tasks within larger systems. These microcontrollers are essentially compact computers on a single chip, containing a processor core, memory, and programmable input/output peripherals. They are called "embedded" because they are embedded within electronic devices to control various functions, rather than serving as standalone computers. Microcontrollers are crucial in modern electronics, providing the intelligence and control needed for a wide range of applications.

#### Applications of "<u>Embedded -</u> <u>Microcontrollers</u>"

#### Details

E·XFl

Product Status	Active
Core Processor	HCS12
Core Size	16-Bit
Speed	32MHz
Connectivity	CANbus, SCI, SPI
Peripherals	LVD, POR, PWM, WDT
Number of I/O	64
Program Memory Size	64KB (64K x 8)
Program Memory Type	FLASH
EEPROM Size	4K x 8
RAM Size	4K x 8
Voltage - Supply (Vcc/Vdd)	1.72V ~ 5.5V
Data Converters	A/D 10x12b
Oscillator Type	Internal
Operating Temperature	-40°C ~ 105°C (TA)
Mounting Type	Surface Mount
Package / Case	80-QFP
Supplier Device Package	80-QFP (14x14)
Purchase URL	https://www.e-xfl.com/pro/item?MUrl=&PartUrl=mc9s12p64vqk

Email: info@E-XFL.COM

Address: Room A, 16/F, Full Win Commercial Centre, 573 Nathan Road, Mongkok, Hong Kong

#### Freescale Semiconductor Product Brief

#### Document Number: MC9S12P128PB Rev. 4, 4th July 2007

This document contains preview information on a new. product that may be in a design phase or under development. Freescale reserves the right to change or discontinue this product without notice.

# MC9S12P Family

Low-Cost 16-Bit Microcontroller Family Covers MC9S12P128, MC9S12P96, MC9S12P64, and MC9S12P32

The MC9S12P family is an optimized, automotive, 16-bit microcontroller product line focused on low-cost, high-performance, and low pin-count. This family is intended to bridge between high-end 8-bit microcontrollers and high-performance 16-bit microcontrollers, such as the MC9S12XS family. The MC9S12P family is targeted at generic automotive applications requiring CAN or LIN/J2602 communication. Typical examples of these applications include body controllers, occupant detection, door modules, seat controllers, RKE receivers, smart actuators, lighting modules, and smart junction boxes.

The MC9S12P family uses many of the same features found on the MC9S12XS family, including error correction code (ECC) on flash memory, a separate data-flash module for diagnostic or data storage, a fast analog-to-digital converter (ATD) and a frequency modulated phase locked loop (IPLL) that improves the EMC performance.

#### Contents

1	Appli	Application Example			
	1.1	Door Control			
2	Featu	eatures			
	2.1	MC9S12P Family Comparison			
	2.2	Block Diagram			
	2.3	Critical Performance Parameters			
	2.4	Chip-Level Features			
	2.5	Module Features 6			
3	Pino	uts			
4	Deve	loper Environment			
5	Docu	ment Revision History 15			



© Freescale Semiconductor, Inc., 2007. All rights reserved.

Freescale Confidential Proprietary, NDA Required Preliminary—Subject to Change Without Notice

#### **Application Example**

The MC9S12P family will deliver all the advantages and efficiencies of a 16-bit MCU while retaining the low cost, power consumption, EMC, and code-size efficiency advantages currently enjoyed by users of Freescale's existing 8-bit and 16-bit MCU families. Like the MC9S12XS family, the MC9S12P family will run 16-bit wide accesses without wait states for all peripherals and memories. The MC9S12P family will be available in 80-pin QFP, 64-pin LQFP, and 48-pin QFN package options and aims to maximize pin compatibility with the MC9S12XS family. In addition to the I/O ports available in each module, further I/O ports are available with interrupt capability allowing wake-up from stop or wait modes.

# 1 Application Example

The MC9S12P family MCUs are general-purpose devices suitable for a range of application, including:

- Body controllers
- Occupant detection
- Door modules
- Seat controllers
- RKE receivers
- Smart actuators
- Lighting modules
- Smart junction boxes
- Intelligent watchdog

### 1.1 Door Control

Figure 1 outlines a typical door application build around the MC9S12P128 microcontroller.





This section describes the key features of the MC9S12P family.

# 2.1 MC9S12P Family Comparison

Table 1 provides a summary of different members of the MC9S12P family and their proposed features. This information is intended to provide an understanding of the range of functionality offered by this microcontroller family.

Feature	MC9S12P32	MC9S12P64	MC9S12P96	MC9S12P128
CPU	HCS12			
Flash memory (ECC)	32 Kbytes	64 Kbytes	96 Kbytes	128 Kbytes
Data flash (ECC)	4 Kbytes			
RAM	2 Kbytes	4 Kbytes	6 K	bytes
MSCAN	1			
SCI	1			
SPI	1			
Timer	8 ch x 16-bit			
PWM	6 ch x 8-bit			
ADC	8 ch x 12-bit			
Frequency modulated PLL	Yes			
External oscillator (4 – 16 MHz Pierce with loop control)	Yes			
Internal 1 MHz RC oscillator	Yes			
Supply voltage	3.15 V – 5.5 V			
Execution speed	Static – 32 MHz			
Package 64 LQFP, 48 QFN		, 48 QFN	80 QFP, 64 L	_QFP, 48 QFN

Table	1.	MC9S12P	Family

# 2.2 Block Diagram

Figure 2 shows a high-level block diagram of the MC9S12P family.



#### MC9S12P Family

Figure 2. MC9S12P Family Block Diagram

# 2.3 Critical Performance Parameters

The critical performance parameters of the MC9S12P feature:

- Operating voltage of 3.15 V to 5.5 V
- Operating temperature (T<sub>A</sub>) of -40°C to 125°C
- Junction temperature (T<sub>J</sub>) of up to 150°C
- Bus frequency (f<sub>Bus</sub>) up to 32 MHz
- Packaging:
  - 80-pin QFP, 0.65 mm pitch, 14 mm x 14 mm outline
  - 64-pin LQFP, 0.5 mm pitch, 10 mm x 10 mm outline
  - 48-pin QFN, 0.65 mm pitch, 7 mm x 7 mm outline

Table 2 describes the MC9S12P family design targets for supply currents.

#### Table 2. Current Consumption Target<sup>1</sup>

Mode	Condition <sup>2</sup>	Typical <sup>3</sup>	Max <sup>4</sup>
<b>Run</b> $f_{osc} = 4$ MHz, $f_{Bus} = 32$ MHz, all modules enabled	25°C, 32 MHz	25 mA	TBD
Wait $f_{osc} = 4$ MHz, $f_{Bus} = 32$ MHz, all peripherals enabled	25°C	20 mA	TBD
<b>Wait</b> f <sub>osc</sub> = 4 MHz, f <sub>Bus</sub> = 8 MHz, all peripherals enabled	25°C	5 mA	TBD
<b>Wait</b> RTI enabled, all peripherals disabled, PLL off	25°C	3 mA	TBD
Stop	-40°C	20 μA	TBD
	25°C	25 μΑ	TBD
	85°C	150 μA	TBD
	105°C	300 μA	TBD
	125°C	450 μΑ	TBD

NOTES:

Values to be targeted by design, all values are currently estimates until silicon is available and characterization is performed

- <sup>2</sup> All temperatures are based on an ambient air temperature
- <sup>3</sup> Target typical current consumption for the mode observed on typical operating conditions and configuration for typical process devices
- <sup>4</sup> Target maximum current consumption for mode observed under typical operating conditions and configuration across full process variation of manufactured devices

## 2.3.1 Low Power Operation

The MC9S12P has two dynamic-power modes (run and wait) and one static low-power mode (stop).

- Dynamic power mode: run
  - Run mode is the main full performance operating mode with the entire device clocked. The user can configure the device operating speed through selection of the clock source and the phase locked loop (PLL) frequency. To save power, unused peripherals must not be enabled.
- Dynamic power mode: wait
  - This mode is entered when the CPU executes the WAI instruction. In this mode the CPU will not execute instructions. The internal CPU clock is switched off. All peripherals can be active in system wait mode. For further power consumption the peripherals can individually turn off their local clocks. Asserting RESET, XIRQ, IRQ, or any other interrupt that is not masked ends system wait mode.

- Static power mode: stop
  - The oscillator is stopped in this mode. By default, all clocks are switched off and all counters and dividers remain frozen. The autonomous periodic interrupt (API) and ATD modules may be enabled to self wake the device. A fast wakeup mode is available to allow the device to wake from full stop mode immediately on the internal RC oscillator without starting the oscillator clock.

## 2.4 Chip-Level Features

On-chip modules available within the family include the following features:

- HCS12 CPU core
- Up to 128 Kbyte on-chip flash with ECC
- 4 Kbyte data flash with ECC
- Up to 6 Kbyte on-chip SRAM
- Phase locked loop (IPLL) frequency multiplier with internal filter
- 4–16 MHz amplitude controlled Pierce oscillator
- 1 MHz internal RC oscillator
- Timer module (TIM) supporting input/output channels that provide a range of 16-bit input capture, output compare, counter, and pulse accumulator functions
- Pulse width modulation (PWM) module with 6 x 8-bit channels
- 8-channel, 12-bit resolution successive approximation analog-to-digital converter (ATD)
- One serial peripheral interface (SPI) module
- One serial communication interface (SCI) module supporting LIN communications
- One multi-scalable controller area network (MSCAN) module (supporting CAN protocol 2.0A/B)
- On-chip voltage regulator (VREG) for regulation of input supply and all internal voltages
- Autonomous periodic interrupt (API)

## 2.5 Module Features

The following sections provide more details of the modules implemented on the MC9S12P family.

## 2.5.1 HCS12 16-Bit Central Processor Unit (CPU)

The HCS12 CPU is a high-speed, 16-bit processing unit that has a programming model identical to that of the industry standard M68HC11 central processor unit (CPU).

- Full 16-bit data paths supports efficient arithmetic operation and high-speed math execution
- Supports instructions with odd byte counts, including many single-byte instructions. This allows much more efficient use of ROM space.
- Extensive set of indexed addressing capabilities, including:
  - Using the stack pointer as an indexing register in all indexed operations
  - Using the program counter as an indexing register in all but auto increment/decrement mode

- Accumulator offsets using A, B, or D accumulators
- Automatic index predecrement, preincrement, postdecrement, and postincrement (by -8 to +8)

## 2.5.2 On-Chip Flash with ECC

On-chip flash memory on the MC9S12P on the features the following:

- Up to 128 Kbyte of program flash memory
  - 32 data bits plus 7 syndrome ECC (error correction code) bits allow single bit fault correction and double fault detection
  - Erase sector size 512 bytes
  - Automated program and erase algorithm
  - User margin level setting for reads
  - Protection scheme to prevent accidental program or erase
- 4 Kbyte data flash space
  - 16 data bits plus 6 syndrome ECC (error correction code) bits allow single bit fault correction and double fault detection
  - Erase sector size 256 bytes
  - Automated program and erase algorithm
  - User margin level setting for reads

#### 2.5.3 On-Chip SRAM

• Up to 6 Kbytes of general-purpose RAM

### 2.5.4 Main External Oscillator (XOSC)

- Loop control Pierce oscillator using a 4 MHz to 16 MHz crystal
  - Current gain control on amplitude output
  - Signal with low harmonic distortion
  - Low power
  - Good noise immunity
  - Eliminates need for external current limiting resistor
  - Transconductance sized for optimum start-up margin for typical crystals

### 2.5.5 Internal RC Oscillator (IRC)

- Trimmable internal reference clock.
  - Frequency: 1 MHz
  - Untrimmed accuracy over full temperature range:  $\pm 14\%$

- Trimmed accuracy over -40°C to +125°C ambient temperature range: ±2.0%
- Trimmed accuracy over  $-40^{\circ}$ C to  $+85^{\circ}$ C ambient temperature range:  $\pm 1.5\%$

### 2.5.6 Internal Phase-Locked Loop (IPLL)

- Phase-locked-loop clock frequency multiplier
  - No external components required
  - Reference divider and multiplier allow large variety of clock rates
  - Automatic bandwidth control mode for low-jitter operation
  - Automatic frequency lock detector
  - Configurable option to spread spectrum for reduced EMC radiation (frequency modulation)
  - Reference clock sources:
    - External 4–16 MHz resonator/crystal (XOSC)
    - Internal 1 MHz RC oscillator (IRC)

### 2.5.7 Clocks and Reset Generator (CRG)

- COP (computer operating properly) watchdog
- Real time interrupt (RTI)
- Clock monitor (CM)
- · Fast wake from stop in self-clock mode for power saving and immediate program execution
- System reset generation

### 2.5.8 System Integrity Support

- Power-on reset (POR)
- Illegal address detection with reset
- Low-voltage detection with interrupt or reset
- Computer operating properly (COP) watchdog
  - Configurable as window COP for enhanced failure detection
  - Can be initialized out of reset using option bits located in flash memory
- Clock monitor supervising the correct function of the oscillator

### 2.5.9 Timer (TIM)

- 8 x 16-bit channels for input capture or output compare
- 16-bit free-running counter with 7-bit precision prescaler
- 1 x 16-bit pulse accumulator

#### 2.5.10 Pulse Width Modulation Module (PWM)

- Up to 6 channel x 8-bit or 3 channel x 16-bit pulse width modulator
  - Programmable period and duty cycle per channel
  - Center-aligned or left-aligned outputs
  - Programmable clock select logic with a wide range of frequencies

### 2.5.11 Controller Area Network Module (MSCAN)

- 1 Mbit per second, CAN 2.0 A, B software compatible
  - Standard and extended data frames
  - 0–8 bytes data length
  - Programmable bit rate up to 1 Mbps
- Five receive buffers with FIFO storage scheme
- Three transmit buffers with internal prioritization
- Flexible identifier acceptance filter programmable as:
  - 2 x 32-bit

•

- 4 x 16-bit
- 8 x 8-bit
- Wakeup with integrated low pass filter option
- Loop back for self test
- Listen-only mode to monitor CAN bus
- Bus-off recovery by software intervention or automatically
- 16-bit time stamp of transmitted/received messages

#### 2.5.12 Serial Communication Interface Module (SCI)

- Full-duplex or single-wire operation
- Standard mark/space non-return-to-zero (NRZ) format
- Selectable IrDA 1.4 return-to-zero-inverted (RZI) format with programmable pulse widths
- 13-bit baud rate selection
- Programmable character length
- Programmable polarity for transmitter and receiver
- Active edge receive wakeup
- Break detect and transmit collision detect supporting LIN

# 2.5.13 Serial Peripheral Interface Module (SPI)

- Configurable 8- or 16-bit data size
- Full-duplex or single-wire bidirectional
- Double-buffered transmit and receive
- Master or slave mode
- MSB-first or LSB-first shifting
- Serial clock phase and polarity options

## 2.5.14 Analog-to-Digital Converter Module (ATD)

- 8-channel, 12-bit analog-to-digital converter
  - 8-/10-/12-bit resolution
  - 3 µs, 10-bit single conversion time
  - Left or right justified result data
  - External and internal conversion trigger capability
  - Internal oscillator for conversion in stop modes
  - Wakeup from low power modes on analog comparison > or <= match
  - Continuous conversion mode
  - Multiple channel scans
- Pins can also be used as digital I/O

# 2.5.15 On-Chip Voltage Regulator (VREG)

- Linear voltage regulator with bandgap reference
- Low-voltage detect (LVD) with low-voltage interrupt (LVI)
- Power-on reset (POR) circuit
- Low-voltage reset (LVR)

## 2.5.16 Background Debug (BDM)

- Background debug module (BDM) with single-wire interface
  - Non-intrusive memory access commands
  - Supports in-circuit programming of on-chip nonvolatile memory

# 2.5.17 Debugger (DBG)

- Three comparators A, B, and C to monitor CPU buses
  - A compares full address bus and 16-bit data bus with mask register
  - B and C compare address bus only
  - Three modes: simple address/data match, inside address range, or outside address range

- 64 x 20-bit circular trace buffer to capture change-of-flow addresses or address and data of every access
- Tag-type or force-type hardware breakpoint requests

# 3 Pinouts



Figure 3. MC9S12P-Family Pin Assignment: 80 QFP Package



Figure 4. MC9S12P-Family Pin Assignment: 64 LQFP Package



Figure 5. MC9S12P-Family Pin Assignment: 48 QFN Package

#### **Developer Environment**

# 4 Developer Environment

The MC9S12P family of MCUs is supported by tools similar to those of other Freescale HCS12 products. The HCS12 MCU family offers a widespread and established network of tools and software vendors.

This development support will be available:

- Automotive evaluation boards (EVB) featuring CAN and LIN interfaces, and more
- Compilers
- Debuggers

This software support will be available:

• CAN and LIN drivers

# 5 Document Revision History

Identifies content changes compared to the previously released version.

#### Table 3. Revision History

Revision	Location(s)	Substantive Change(s)
0	D.Beattie - FSL EKB 12-Feb-07	1st draft for review
1	D.Beattie - FSL EKB 27-Feb-07	Corrected DBG module features Added Typical Idd estimations Updated RAM sizes Changed block diagram format.
2	D.Beattie - FSL EKB 02-Mar-07	Removed 80QFP option for P32 1.5% IRC trimmed accuracy (-40 to +85C)
3	D.Beattie - FSL EKB 05-Apr-07	Added Pinout diagrams for 80 QFP, 64 LQFP and 48 QFN package options Corrected DBG comparators from 4 to 3
4	D.Beattie - FSL EKB 05-Apr-07	Removed PIT from block diagram

#### How to Reach Us:

Home Page: www.freescale.com

E-mail: support@freescale.com

#### **USA/Europe or Locations Not Listed:**

Freescale Semiconductor Technical Information Center, CH370 1300 N. Alma School Road Chandler, Arizona 85224 +1-800-521-6274 or +1-480-768-2130 support@freescale.com

#### Europe, Middle East, and Africa: Freescale Halbleiter Deutschland GmbH

Freescale Halbleter Deutschland Gmb Technical Information Center Schatzbogen 7 81829 Muenchen, Germany +44 1296 380 456 (English) +46 8 52200080 (English) +49 89 92103 559 (German) +33 1 69 35 48 48 (French) support@freescale.com

#### Japan:

Freescale Semiconductor Japan Ltd. Headquarters ARCO Tower 15F 1-8-1, Shimo-Meguro, Meguro-ku, Tokyo 153-0064 Japan 0120 191014 or +81 3 5437 9125 support.japan@freescale.com

#### Asia/Pacific:

Freescale Semiconductor Hong Kong Ltd. Technical Information Center 2 Dai King Street Tai Po Industrial Estate Tai Po, N.T., Hong Kong +800 2666 8080 support.asia@freescale.com

#### For Literature Requests Only:

Freescale Semiconductor Literature Distribution Center P.O. Box 5405 Denver, Colorado 80217 1-800-441-2447 or 303-675-2140 Fax: 303-675-2150 LDCForFreescaleSemiconductor@hibbertgroup.com

Document Number: MC9S12P128PB Rev. 4 4th July 2007

Freescale Confidential Proprietary, NDA Required Preliminary—Subject to Change Without Notice Information in this document is provided solely to enable system and software implementers to use Freescale Semiconductor products. There are no express or implied copyright licenses granted hereunder to design or fabricate any integrated circuits or integrated circuits based on the information in this document.

Freescale Semiconductor reserves the right to make changes without further notice to any products herein. Freescale Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does Freescale Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation consequential or incidental damages. "Typical" parameters that may be provided in Freescale Semiconductor data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals", must be validated for each customer application by customer's technical experts. Freescale Semiconductor does not convey any license under its patent rights nor the rights of others. Freescale Semiconductor products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the Freescale Semiconductor product could create a situation where personal injury or death may occur. Should Buyer purchase or use Freescale Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold Freescale Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that Freescale Semiconductor was negligent regarding the design or manufacture of the part.

Freescale™ and the Freescale logo are trademarks of Freescale Semiconductor, Inc. All other product or service names are the property of their respective owners. © Freescale Semiconductor, Inc. 2007. All rights reserved.

