# 16-bit Microcontrollers

MC9S12DG128

Target Applications
> Automotive applications

> Industrial control

Overview

Freescale Semiconductor's HCS12 Family of microcontrollers (MCUs) is the next generation of the highly successful 68HC12 architecture. Using Freescale's industry-leading 0.25 µs Flash, the MC9S12DG128 is part of a pin-compatible family that scales from 32 KB to 512 KB of Flash memory. The MC9S12DG128 provides an upward migration path from Freescale's 68HC08, 68HC11 and 68HC12 architectures for applications that need larger memory, more peripherals and higher performance. Also, with the increasing number of CAN-based electronic control units (ECUs), its multiple network modules support this environment by enabling highly efficient communications between different network buses.
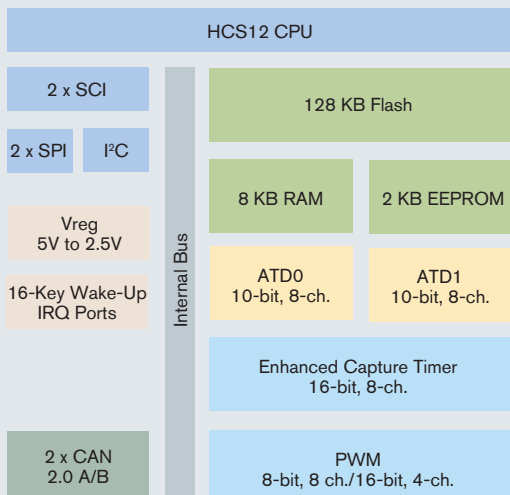
Features		Benefits	
High-Performance 16-bit HCS12 CPU Core			
> 25 MHz bus operation at 5V for 40 ns minimum instruction cycle time		> Opcode compatible with the 68HC11 and 68HC12	
		> C-optimized architecture produces extremely compact code	
On-Chip Debug Interface			
> Dedicated serial debug interface		> Real-time in-circuit emulation and debug without expensive and cumbersome box emulators	
> On-chip breakpoints		> Read/write memory and registers while running at full speed	
Network Modules			
> Two msCAN modules implementing the CAN 2.0 A/B protocol		> Ability to link modules for higher buffer count	
▪ Five receive buffers per module with FIFO storage scheme		> Programmable bit rate up to 1 Mbps	
▪ Three transmit buffers per module with internal prioritization		> FIFO receive approach superior for event-driven networks	
Integrated Third-Generation Flash Memory			
> In-application reprogrammable		> Flexibility to change code in the field	
> Self-timed, fast programming		> Efficient end-of-line programming	
▪ Fast Flash page erase—20 ms (512 bytes)		> Total program time for 128 KB code is less than five seconds	
▪ Can program 16 bits in 20 µs while in burst mode		> Reduces production programming cost through ultra-fast programming	
> 5V Flash program/erase/read		> No external high voltage or charge pump required	
> Flash granularity—512 byte Flash erase/ 2 byte Flash program		> Virtual EEPROM implementation, Flash array usable for EE extension	
> Two independently programmable Flash arrays		> Can erase one array while executing code from another	
> Flexible block protection and security			
2 KB Integrated EEPROM			
> Flexible protection scheme for protection against accidental program or erase		> Can erase 4 bytes at a time and program 2 bytes at a time for calibration, security, personality and diagnostic information	
> EEPROM can be programmed in 46 µs			

Block Diagram

HCS12 CPU		
2 x SCI		128 KB Flash
2 x SPI / I²C	Internal Bus	
Vreg 5V to 2.5V		8 KB RAM / 2 KB EEPROM
16-Key Wake-Up IRQ Ports		ATD0 10-bit, 8-ch. / ATD1 10-bit, 8-ch.
		Enhanced Capture Timer 16-bit, 8-ch.
2 x CAN 2.0 A/B		PWM 8-bit, 8 ch./16-bit, 4-ch.

freescale™
semiconductor

Features	Benefits
10-bit Analog-to-Digital Converter (ADC)	
> Two 8-channel ADC > 7 µs, 10-bit single conversion time, scan mode available	> Fast, easy conversion from analog inputs like temperature, pressure and fluid levels to digital values for CPU processing > Can effectively have 3.5 µs conversion time by sampling same signal with both ADC
Clock Generation Module with Phase-Lock Loop (PLL)	
> Clock monitor with self clock mode in case of no external clock > Programmable clock frequency with 1024 options ranging from divide by 16 to multiply by 64 from base oscillator > Real-time interrupt > Watchdog	> Reliable, robust operation > Provides high performance using low-cost reference crystals > Reduces generated noise > Reduces power consumption > Easily able to implement real-time clock
Enhanced Capture Timer	
> 8-channel, 16-bit with input capture, output compare and pulse accumulator > 16-bit modulus down counter	> Flexible, programmable timer system
8-bit or 16-bit Pulse-Wide Modulation (PWM)	
> 8-channel, 8-bit or 4-channel, 16-bit PWM > PWM supports center aligned operation	> Efficiently implement motor control, battery charging or digital-to-analog (DAC) functions
Two Serial Communications Interfaces	
> 8192 prescaler option	> Asynchronous communication between the MCU and a terminal, computer or a network of MCUs > Exact baud rate matching
Two Serial Peripheral Interfaces	
> Up to 6.25 Mbps	> High-speed synchronous between multiple MCUs or between MCU and serial peripherals
Inter IC (I²C) Bus	
> 256 clock rate options	> Provides a simple, efficient method of data exchange between devices > Minimizes the need for large numbers of connections between devices and eliminates the need for an address decoder
Up to 91 Input/Output (I/O) Lines	
> Programmable pull-ups/pull-downs > Dual drive capability	> Reduce system cost > Able to tailor application for minimum EMC or high current loads

Data Sheets

9S12DT128BDGV1	MC9S12DB128, MC9S12DT128B, MC9S12DG128 & MC9S12DJ128 Device Guide
S12DT128PIMV1	MC9S12DT128 Port Integration Module Block Guide
S12BDMV4	HCS12 Background Debug (BDM) Block Guide
S12BKVD1	HCS12 Breakpoint (BKP) Block Guide
S12CPUV2	HCS12 CPU Reference Manual
S12ATD10B8CV2	HCS12 10-bit 8-channel Analog to Digital Block Guide
S12CRGV3	HCS12 Clock Reset Generator Block Guide
S12ECT16B8CV1	HCS12 16-bit 8-channel Enhanced Capture Timer Block Guide
S12EETS2KV1	HCS12 2K EEPROM Block Guide
S12FTS128KV1	HCS12 128K Flash Block Guide
S12IICV2	HCS12 I²C Bock Guide
S12INTV1	HCS12 Interrupt (INT) Block Guide
S12MEBIV3	HCS12 Multiplexed External Bus Interface (MEBI) Block Guide
S12MMCV4	HCS12 Module Mapping Control (MMC) Block Guide
S12MSCANV2	HCS12 Motorola Scalable Controller Area Network Block Guide
S12PWM8B8CV1	HCS12 8-bit 8-channel Pulse-Width Modulator Block Guide
S12SCIV2	HCS12 Serial Communications Interface Block Guide
S12SPIV2	HCS12 Serial Peripheral Interface Block Guide
S12VREGV1	HCS12 Voltage Regulator Block Guide

Cost-Effective Development Tools

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

M68KIT912DP256 *$495**	Evaluation kit for development and evaluation of HCS12 application code that includes the M68EVB912DP256 and USBMULTILINKBDM
M68CYCLONEPRO *$499**	HC08/HCS08/HC12/HCS12 stand-alone Flash programmer or in-circuit emulator, debugger, Flash programmer; USB, serial or Ethernet interface options
USBMULTILINKBDM *$99**	Universal HCS08/HCS12 in-circuit emulator, debugger, and Flash programmer; USB PC interface
CWX-H12-SE *Free**	CodeWarrior™ Special Edition for HCS12 MCUs; includes integrated development environment (IDE), linker, debugger, unlimited assembler, Processor Expert™ auto-code generator, full-chip simulation and limited C compiler

Package Options

Part Number	Package	Temp. Range
MC9S12DG128BCFU	80 QFP	-40°C to +85°C
MC9S12DG128BVFU	80 QFP	-40°C to +105°C
MC9S12DG128BMFU	80 QFP	-40°C to +125°C
MC9S12DG128BCPV	112 LQFP	-40°C to +85°C
MC9S12DG128BVPV	112 LQFP	-40°C to +105°C
MC9S12DG128BMPV	112 LQFP	-40°C to +125°C

80-Lead QFP — FU

112-Lead LQFP — PV

Application Notes and Engineering Bulletins

AN2206	Security and Protection on the HCS12 Family
AN2213	Using Cosmic Software's M68HC12 Compiler for MC9S12DP256
AN2216	MC9S12DP256 Software Development Using Metrowerks CodeWarrior™
AN2250	Audio Reproduction on HCS12 Microcontrollers
BCANPSV2.0	Bosch Controller Area Network (CAN) Version 2.0 Protocol Standard
BDLCRM	Byte Data Link Controller Reference Manual
EB386	HCS12 D-Family Compatibility

Learn More: For more information about Freescale products, please visit **www.freescale.com**.

freescale™
semiconductor