



*Instructor's Resource CD to Accompany*  
**The HCS12 / 9S12: An Introduction**  
Han-Way Huang

# ECE3120: Computer Systems Hardware & Software Development Tools

Manjeera Jeedigunta

<http://blogs.cae.tnitech.edu/msjeedigun21>

Email: [msjeedigun21@tnitech.edu](mailto:msjeedigun21@tnitech.edu)

Tel: 931-372-6181, Prescott Hall 120



## The HCS12 Members (1 of 2)

- Is a redesign of the 68HC12 family
- The 68HC12 family is an upgrade of the popular 68HC11 8-bit microcontroller family.
- The 68HC12 has a highest bus clock frequency of 8 MHz.
- The numbering system is shown in Figure 3.1.

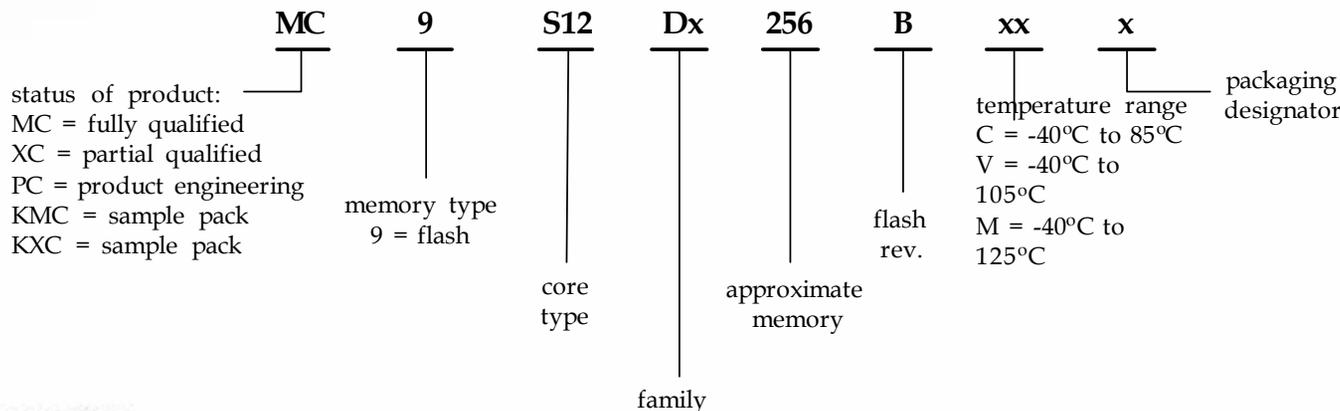
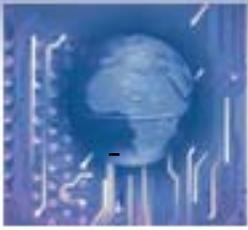


Figure 3.1 Motorola product numbering system for the HCS12



# The HCS12 / 9S12: An Introduction

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## The HCS12 Members (2 of 2)

- The HCS12 was initially designed for automotive and process control market.
- The HCS12 has many features designed for these target markets:
  - Parallel ports
  - Timer functions: input capture, output compare, pulse accumulation, real-time interrupt, pulse width modulation, modulus down counter
  - Serial communication interface (SCI)
  - Serial peripheral interface (SPI)
  - Inter-integrated circuit (I2C)
  - Byte data link control (BDLC)
  - Controller Area Network (CAN)
- Freescale also included the background debug mode (BDM) in each HCS12 member to facilitate the software debugging activities.
- Freescale also include special features to target other applications:
  - Ethernet controller: the MC9S12NE64 has an Ethernet controller to facilitate the access of the Internet.
  - USB controller: the MC9S12UF32 has an on-chip USB controller to facilitate the interfacing with USB bus.



## Development Tools

- Software development tools
  - Text editor, terminal program, cross assembler, cross compiler, simulator, source-level debugger, integrated development environment (IDE)
- Hardware development tools
  - Oscilloscope, function generator, in-circuit emulator, logic analyzer, demo board
    - Only demo boards and BDM kit will be discussed.



## Software Development Tools

- A text editor allows the user to enter and edit the program.
- A cross assembler allows the user to assemble their assembly programs.
- A cross compiler allows the user to compile their programs written in high-level languages.
- A simulator allows the user to run the application program without having the actual hardware.
- A terminal program allows the PC to communicate with the hardware demo board.
- A source-level debugger allows the user to set breakpoints in the program, trace program execution, watch program variable values after program execution, and so on.
- An IDE combines all of the above programs in one package so the user can perform all software debugging activities in one environment without quitting any program.
  - The freeware **miniIDE** and **asmIDE** are recommended for assembly program development.
  - The freeware **EmbeddedGNU IDE** and **GNU C** compiler are recommended for C program development.



## Demo Boards

- Many HCS12-based demo boards are available for learning the HCS12 and debugging the HCS12 application programs.
- A demo board has an HCS12 MCU and many peripheral chips to help test the HCS12 programs.
- A demo board often has an on-board monitor program to communicate with a PC or workstation on which the user develops the application program.
- The monitor program allows the user to display register and memory location contents, setting register and memory location contents, setting program breakpoints, tracing instruction execution, and download programs onto the demo board for execution.
- The PC or workstation communicates with the demo board using the terminal program.
- The **SSE256** from Shuan Shizu and the **Dragon12** from Wytec are recommended for learning the HCS12 microcontroller.



## The Dragon12 Demo Board (1 of 2)

- 24-MHz bus speed (generated from a 4-MHz crystal)
- D-Bug12 monitor
- 16 x 2 LCD kit (4-bit interface)
- Eight LEDs
- Four seven-segment displays
- Keypad connector
- Four buttons for input
- DIP switches for input
- Buzzer for playing siren and songs (wired to the PT5 pin)
- Potentiometer for testing A/D function (wired to PAD7 pin)
- Infrared transceiver
- CAN transceiver (Philips PCA82C250)
- A small breadboard
- BDM IN and BDM OUT connectors
- Two RS232 connectors
- LTC1661 10-bit D/A converter chip with SPI interface
- 24LC16 serial EEPROM with I2C interface
- Additional information is available at [www.evbplus.com](http://www.evbplus.com)



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# The Dragon12 Demo Board (2 of 2)

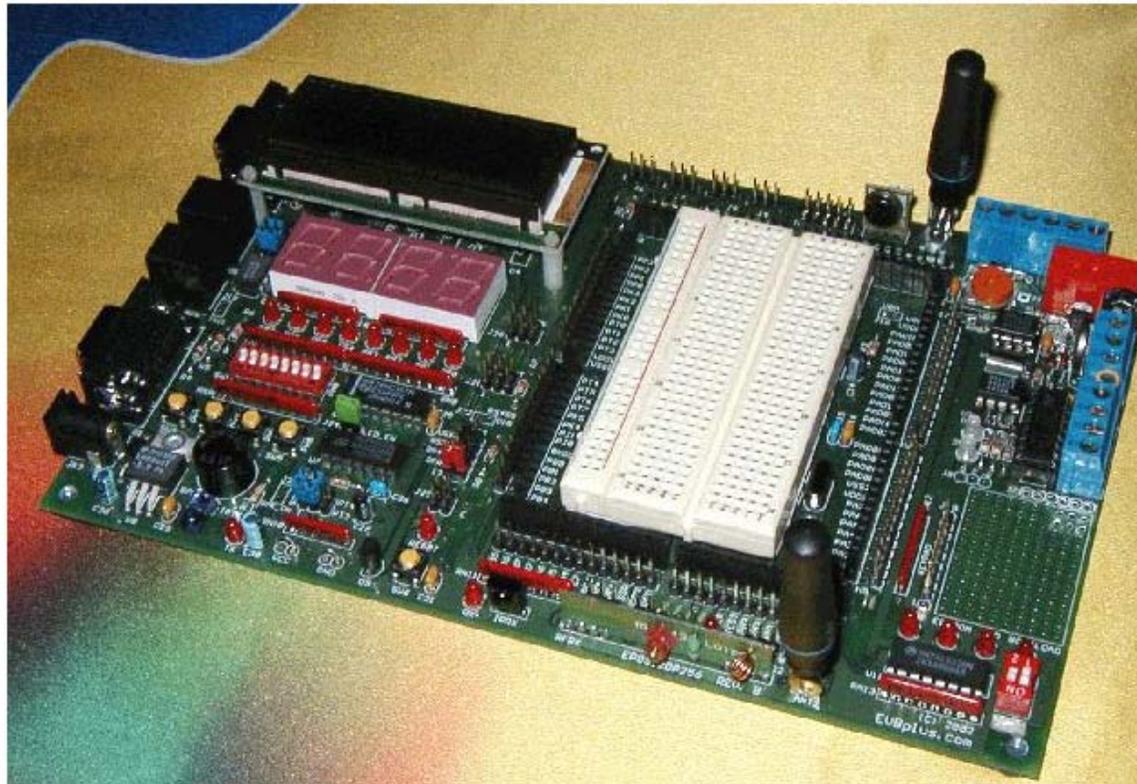


Figure 3.3 The Wytec Dragon12 demo board (courtesy of Wytec)



## The D-Bug12 Monitor

- Supports most HCS12 devices with 128KB and 256 KB flash memory
- Used in many demo boards
- Requires a host terminal program that supports the Xon/Xoff software handshake for proper operation
- The HyperTerminal bundled with Windows and the terminal program bundled with asmIDE, miniIDE, and EmbeddedGNU IDE can work with D-Bug12 monitor.
- Supports four operating modes: EVB mode, Jump to EEPROM mode, POD mode, and Serial Bootloader mode
- After reset, the D-Bug12 reads the logic levels on the PAD1 and PAD0 pins to decide which of the four D-Bug12 modes to enter.

Table 3.1 D-Bug12 operating modes

PAD1	PAD0	Operatingmode
0	0	D-Bug12;EVB
0	1	Jump to internal EEPROM
1	0	D-Bug12;POD
1	1	SerialBootloader



## EVB Mode

- The D-Bug12 monitor operates from the flash memory
- The users are restricted to use SRAM (from \$1000 to \$3BFF) or EEPROM to run application programs.
- The user runs a terminal program on the PC to communicate with the D-Bug12 monitor on the demo board.
- EVB operation model is shown below.

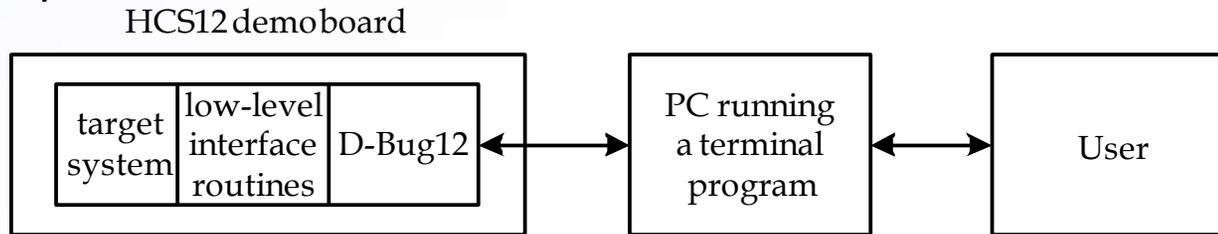


Figure 3.4 EVB model conceptual model

When the demo board is powered up and the baud rate is set properly, the message as shown to the right will appear on the terminal screen.

```

D-Bug12 4.0.0b24
Copyright 1996 - 2002 Motorola Semiconductor
For Commands type "Help"

>
  
```

Figure 3.5 D-Bug12 EVB mode sign on message



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- The D-Bug12 monitor displays the “>” character to indicate it is ready for operation.
- When a command issued to D-Bug12 is successfully executed, the monitor displays the execution result and a new > character on a new line.
- If a command is not successfully executed, press the reset button to get out.
- Dragon12 demo boards use the MC9S12DP256 as their MCU.
- The memory maps for Dragon12 is shown below.

Table 3.2 D-Bug12 memory map for HCS12Dx256

Address range	Description
\$0000-\$03FF	I/O registers
\$0400-\$0FFF	on-chip EEPROM
\$1000-\$3BFF	on-chip SRAM (available to user)
\$3C00-\$3FFF	on-chip SRAM (D-Bug12)
\$4000-\$EE7F	D-Bug12 code
\$EE80-\$EEBF	User accessible function table
\$EEC0-\$EEFF	Customization data
\$EF00-\$EF8B	D-Bug12 startup code
\$EF8C-\$EFFF	Secondary reset/interrupt table
\$F000-\$FFFF	Bootloader