BR1168/D
Rev. 1

THE M68HC11 FAMILY OF 8-BIT MICROCONTROLLERS

the Family

ADVANCED MICROCONTROLLER

MOTOROLA
Semiconductor Products Sector

THE PRIDE OF THE FAMILY THE M68HC11

Our family of microcontrollers includes a true standout. It offers a wide range of devices, each versatile in operation and covering a broad range of cost and performance combinations: The high-performing 8-bit M68HC11 Family.

The M68HC11 Family is a product of Motorola's industry-leading CSIC design methodology. Motorola's constant quest for improved quality and cycle time is why the M68HC11 holds, and will maintain, its preeminent position with more than 400,000,000 units sold.

Our family was the first microcontroller to include on-chip EEPROM; setting the standard for its inclusion on most M68HC11 derivatives. The M68HC11 Family offers architectural compatibility with the M68HC05 Family of 8-bit microcontrollers. It is also code compatible with the M68HC16 Family of microcontrollers, which means you can upgrade a system – without having to start over again with completely new software.

With Motorola, you can choose from a diverse selection of devices with on-chip peripherals and memories to meet your specific design requirements.

FOR MOBILE TELECOMMUNICATIONS PRODUCTS, SUCH AS THIS ASCOM CORDLESS TELEPHONE, THE VERSATILE LOW VOLTAGE 68HC11E9 IS IDEAL.

THE M68HC11 S TRADITION OF QUALITY TO THE CORE

Motorola products carry a strong tradition of quality, outstanding features and unmatched performance. An enhanced version of the original M6801 core, the M68HC11 is no exception.

Leading features of the M68HC11 Family include:

- Optimized for low power consumption and high performance operation at bus frequencies up to 4 MHz
- Seven CPU registers
- A fully featured interrupt system
- EEPROM on most derivatives
- A math coprocessor embodied in recent M68HC11 devices includes a separate Arithmetic Logic Unit (ALU) performing fast 16-bit integer multiplication and division, increasing throughput
- Operating ranges between -40°C and +125°C

CENTRAL PROCESSING UNIT

The M68HC11 CPU is optimized for low power consumption and high-performance operation at bus frequencies up to 4 MHz. Features include:

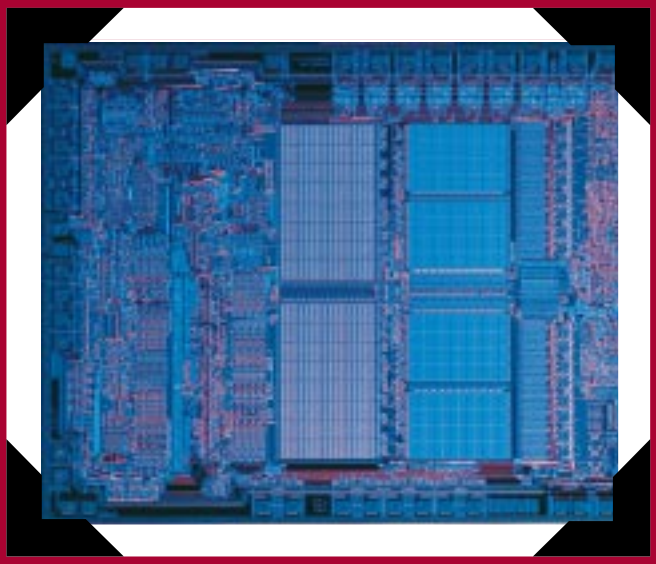
- Two 8-bit or one 16-bit accumulator
- Two 16-bit index registers
- Powerful bit-manipulation instructions
- Six powerful addressing modes (Immediate, Extended, Indexed, Inherent, and Relative)
- Power saving STOP and WAIT modes
- Memory mapped I/O and special functions
- 16x16 integer and fractional divides
- 8x8 multiply

MEMORY

The M68HC11 Family leads in microcontroller memory technology. In fact, the 68HC711E9 was the first device to integrate EPROM and EEPROM technologies on the same chip.

The M68HC11 Family on-chip memory technology offers:

- Fully static designed RAM



The 68HC11E9 has 12 Kbytes ROM, 512 bytes EEPROM, 512 bytes RAM, SPI, SCI, A/D converter, and 38 I/O pins. The timer system allows 3 or 4 input captures, 4 or 5 output compares, and real-time interrupt.

- One time programmable and windowed EPROM
- Secure storage EEPROM
- Expanded bus memory interfaces
- 4-channel direct memory access

In many applications, the M68HC11 provides a single-chip solution with mask programmed ROM or user-programmable EPROM. All family derivatives are also expandable for the incorporation of external memory in the design. In addition to the standard 64 Kbytes of address space, many devices offer up to six additional memory expansion to access more than 1 Mbyte.

The M68HC11 Family's RAM uses a fully static design, and the contents can be preserved during periods of processor inactivity.

One Time Programmable (OTP) and windowed EPROM versions of M68HC11 devices are offered across the family providing a cost-effective, user-programmable ROM facility for small volume prototypes and development runs. Secure EPROM devices are also available for applications where code is at risk of being compromised.

The M68HC11's EEPROM is ideal for the secure storage of essential calibration, diagnostic and security information.

THE INTEGRATION OF THE 68HC11 INTO SONY S HANDYCAM CAMCORDER HELPED PUT 8MM COLOR VIDEO INTO THE HANDS OF CUSTOMERS WORLDWIDE.

A 4-channel Direct Memory Access (DMA) unit on some devices permits fast data transfer between two blocks of memory (including externally mapped memory in expanded mode), between registers or between registers and memory.

SERIAL COMMUNICATIONS

The M68HC11 Family provides on-chip serial communication interfaces supporting a broad range of applications, and data transfer to both local and remote peripherals. Both the synchronous Serial Peripheral Interface (SPI) and asynchronous Serial Communications Interface (SCI) have a wide range of software-selectable baud rates and are optimized to minimize CPU overhead.

The SCI features a full duplex Universal Asynchronous Receiver/Transmitter system, using the non-return-to-zero (NRZ) format for microcontroller-to-PC connections, or to form a serial communications network connecting several widely distributed microcontrollers. Through the SCI, the built-in bootstrap interface allows in-circuit programming, and facilitates diagnostic and test operation of your application.

The SPI is capable of inter-processor communication in a multiple-master system. The SPI also enables synchronous communication between the microcontroller and peripheral devices such as:

- Shift registers
- Liquid Crystal Display (LCD) drivers
- Analog-to-Digital Converters
- Other microprocessors

LOW POWER OPERATION

The M68HC11 provides high performance at low power. Further power reductions can be achieved by some devices which have a Phase-Locked Loop (PLL) clock synthesizer circuit.

The PLL allows clock speed reduction by switching the internal clock to a lower, power saving frequency.

SCIENTIFIC ATLANTA CHOSE THE 68HC11D3 TO POWER THEIR 8600X HOME COMMUNICATIONS TERMINAL.

Additional low power features include:

- More than 25 derivatives that operate in applications with supply voltages ranging from 3.0-5.5V
- Extended voltage versions operate identically to standard devices, and are ideal for battery powered, hand-held applications, remote sensors and actuators
- The core supports two software selectable low power modes, STOP and WAIT
- Some derivatives operate as low as 2.7V

HIGH PERFORMANCE TIMER

The industry standard M68HC11 timer provides flexibility, performance and ease of use. The system is based on a free-running 16-bit counter with a programmable prescaler, overflow interrupt, and separate function interrupts.

Additional M68HC11 timer features include:

- Fixed periodic rate interrupts
- Computer Operating Properly (COP) protection against software failures
- Pulse accumulator for external event counting or gated time accumulation
- An optional PWM offering up to six channels and up to 16-bit PWM outputs
- Optional event counter system for advanced timing operations
- Multiple input capture functions and multiple output compares

It also provides a selection of timer sub-systems geared towards timing-intensive applications; each supported by additional features associated with specific family members, including:

- Input Captures
- Output Compares
- Real-Time Interrupt
- Pulse Accumulator
- Watchdog function

A/D SYSTEM

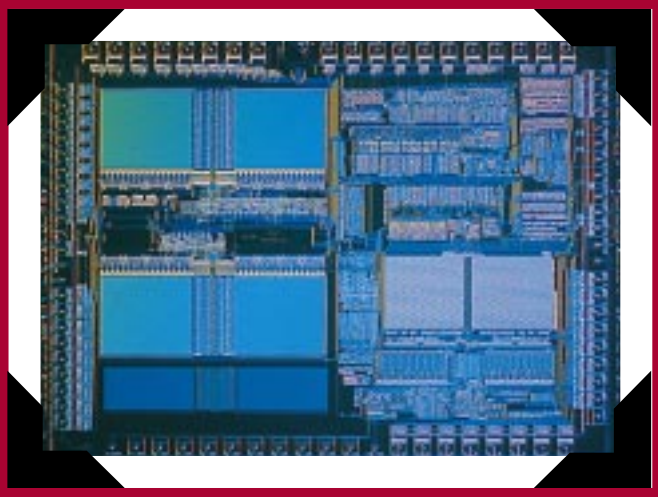
A/D systems are available with 8 to 12 channels and 8- and 10-bit resolution. The A/D is software programmable to provide single or continuous conversion modes. The M68HC11 Family now also offers D/A conversion for added versatility.

PULSE WIDTH MODULATION

The M68HC11 Family offers a selection of Pulse Width Modulation (PWM) options to support a variety of applications. Up to six PWM channels can be selected to create continuous waveforms with programmable rates and software selectable duty cycles from 0 to 100%.

MEMORY MANAGEMENT AND CHIP SELECTS

The 68HC11K4 and 68HC11C0 are two devices in the family that offer memory expansion logic. The Memory Management Units (MMU) implement additional address lines that are active only when required by the CPU; the Chip Select block provides signals to simplify the interface to external devices.



The 68HC711K4 is a high speed, large memory microcontroller with plenty of I/O. It offers 24 Kbytes of EPROM, 640 bytes of EEPROM, 768 bytes of RAM, A/D converter, SPI, SCI and 62 I/O pins. This K-series member offers an address space greater than 1 Mbyte with address expansion lines.

MORE THAN 60 MEMBERS MAKE UP THE M68HC11 FAMILY

Within the M68HC11 Family, there are ten major series of microcontroller units; each is composed of many related devices. The following are examples of the features the M68HC11 can offer as shown through specific devices within each series:

A-series — The 68HC11A8 is an advanced 8-bit MCU featuring 8 Kbytes ROM, 256 bytes of RAM, 512 bytes of EEPROM, sophisticated on-chip peripheral capabilities, and a nominal bus speed of 3 MHz. Included is an eight-channel A/D converter with eight bits of resolution.

C-series — The 68HC11C0 provides chip selects and memory expansion to 256 Kbytes, 2PWM channels and 4 A/D channels. The multiplexed bus reduces pin count and improves control signals and reduces chip count.

D-series — The 68HC11D3 chip with 4 Kbytes ROM offers an economical alternative for applications when advanced 8-bit performance is required with fewer peripherals and less memory.

E-series — In this series, the 68HC11E9's extremely flexible I/O capability allows facilities to be configured to best match the application. It was the first in the family to combine EEPROM and EPROM on a single chip. The E-series offers multiple memory sizes in a pin-compatible package.

F-series — High-speed expanded systems required the development of the 68HC11F1. This particular chip series stands out with its extra I/O ports, an increase in static RAM (1 Kbyte), chip-selects, and a 4 MHz non-multiplexed bus.

G-series — The 68HC11G5 is the first family member to offer 10-bit A/D resolution. This series also includes the most sophisticated timer systems in the family.

K-series — Of these very high performance devices, the 68HC11K4 offers high speed, large memories, an MMU, PWMs, and plenty of I/O.

KA-series — Similar to the K-series, these devices offer high performance, high integration, and large on-chip memories in lower pin-count packages.

L-series — The 68HC11L6 is a high-speed, low-power chip with a multiplexed bus capable of operation up to 3 MHz. The L6's high performance design is based on the 68HC11E9. It includes 16 Kbytes of ROM, plus an additional bi-directional port. Its fully static design allows operation at frequencies down to dc.

M-series — These enhanced, high-performance microcontrollers are derived from the 68HC11K4 and include large memory modules, a 16-bit math coprocessor, and 4 channels of DMA.

P-series — The 68HC11P2 offers a power saving programmable PLL-based clock circuit along with many I/O pins, large memory and 3 SCI ports.

All M68HC11 Family members have on-chip SCI and SPI, and most have EEPROM and an A/D converter.

DEVELOPMENT SUPPORT

The M68HC11 Family is supported by dozens of independent development tool suppliers with a variety of hardware and software development tools including: emulators, logic analyzers, programmers, evaluation boards, simulators, C compilers, real-time operating systems, assemblers, and debuggers – all allowing you to efficiently develop, monitor, test and debug your code to get your applications up and running fast.

Hardware tools from Motorola include:

THE MMDS11 MOTOROLA MODULAR DEVELOPMENT SYSTEM

This real-time emulator system for developing embedded systems is based on 68HC11 microcontrollers, and provides a bus state analyzer, 4 hardware breakpoints, 64 Kbytes fast emulation SRAM, and real-time memory windows. The unit's integrated development environment includes an editor, assembler, user interface, and source-level debug. These and many other features significantly reduce the time necessary to develop and debug hardware or software for 68HC11-based systems.

EVALUATION SYSTEMS (EVS)

The EVS is a two-board system consisting of a 68HC11 Platform Board (PFB) and an Emulator Module (EM) which contains the control circuits and a 68HC11 MCU for the part or series of parts being emulated. The EMs can be used with both the MMDS11 and the HC11EVS. EVSs provide expanded-mode, special test, and single-chip mode emulation; a dual 64 Kbyte memory map with 64 Kbytes of emulation, and an RS-232 port.

THE SPGMR11 SERIAL PROGRAMMER

Program your own code into 68HC11 microcontrollers with on-chip EPROM and EEPROM. Programming software is included. A variety of easily interchangeable programming adapters for use with different microcontrollers and packages are available.

EVALUATION BOARDS (EVB)

Our low-cost EVBs debug code under the Bit User Fast Friendly Aid to Logical Operations (BUFFALO) monitor/debugging program contained in the microcontroller ROM. The EVB has no EPROM programmer. The EVBU, a condensed "universal" version of the EVB, emulates only single-chip mode operations and includes a wire-wrap area for custom interfacing.

THE M68HC11 FAMILY

Motorola backs you with the high quality you find in the M68HC11 Family, and many other products. Find out more about how the M68HC11 Family can work for your next application. For additional information or more literature, call your local Motorola sales office or call (800)765-7795, ext. 906; or fax (800)765-9753; or write us at P.O. Box 13026, Austin, Texas 78711-3026.

THE 68HC11KA4 HELPED SCHLUMBERGER SET A NEW STANDARD IN SOLID-STATE METERING WITH THE VECTRON" ELECTRONIC POLYPHASE METER.

WWW: http://www.mcu.motsps.com

Additional literature may be ordered by calling 1-800-765-7795 extension 900.

For a complete listing of Advanced MCU literature, order document BR1116/D.

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