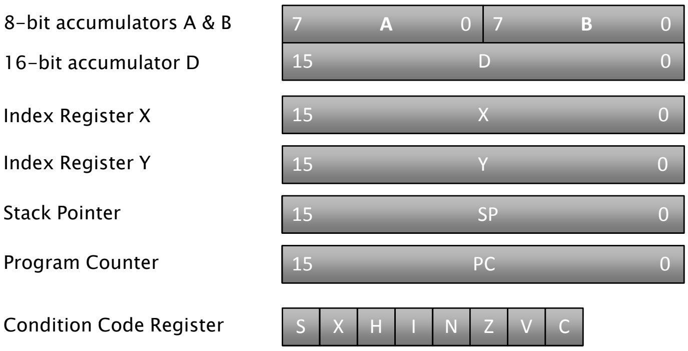
Lecture 3:
Introduction to HCS12/9S12

Today's Topics

- Major pieces of information about the processor
- Specific information on MC9212DG256 microcontroller

Register Set

Programming Model



8-bit accumulators A & B — 7 A 0 | 7 B 0

16-bit accumulator D — 15 D 0

Index Register X — 15 X 0

Index Register Y — 15 Y 0

Stack Pointer — 15 SP 0

Program Counter — 15 PC 0

Condition Code Register — S X H I N Z V C

- The register set is also called the <u>programming model</u> of the computer.
- Programming Model
  - An abstract model of the microprocessor registers
  - This provides enough detail to understand the fundamentals of programming.
- In many processors, data may only be operated on if it is in a register.

Registers

General Purpose Registers

- A
  - A one-byte (8-bit) general purpose register.
  - Since many mathematical operations can be performed using A, it is also referred to as the <u>A accumulator</u>.
- B
  - A one-byte (8-bit) general purpose register.
  - Since many mathematical operations can be performed using B, it is also referred to as the <u>B accumulator</u>.
- D
  - A two-byte (16-bit) general purpose register.
  - The D register is actually the concatenation of the A and B registers.
  - A is used as the more significant byte with B as the less significant byte.
  - Note, the two bytes worth of registers may be used as either A and B or as D, but not both at the same time.

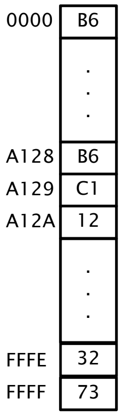
Registers

Index Registers and Others

- X
  - A two-byte (16-bit) register primarily used to hold addresses. Very few mathematical operations can.
- Y
  - A two-byte (16-bit) register primarily used to hold addresses. Very few mathematical operations can.
- SP
  - A two-byte (16-bit) register used to manipulate the stack data structure.
- PC
  - Called the **program counter**, this is a two-byte (16-bit) register that holds the address of the next instruction to be executed.
- CCR
  - The **condition code register** maintains general operating status of the processor and some information used for branching. This one-byte register is the concatenation of eight 1-bit signals.

Memory Model

The way in which the microcomputer stores data

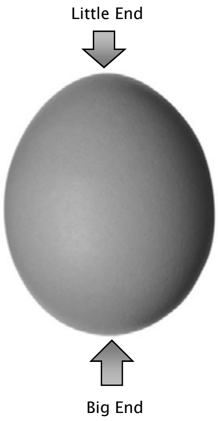


0000	B6
	. . .
A128	B6
A129	C1
A12A	12
	. . .
FFFE	32
FFFF	73

- Programmers usually visualize memory as a bunch of sequential spaces.
- Each space has a unique address that is used to refer the location.
- Number of memory units
  - Remember the two different architectures: Princeton* and Harvard
- Bit size of each location:
  - The number of bits stored in each location
- Bit size of the address
  - The number of bits used for the address limits the number of memory location

Endianness

Gulliver's Travels

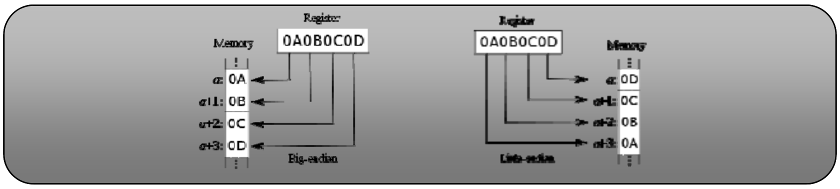


Big-endians crack soft-boiled eggs at the big end, and little-endians crack them at the other end in the story.

Endianness

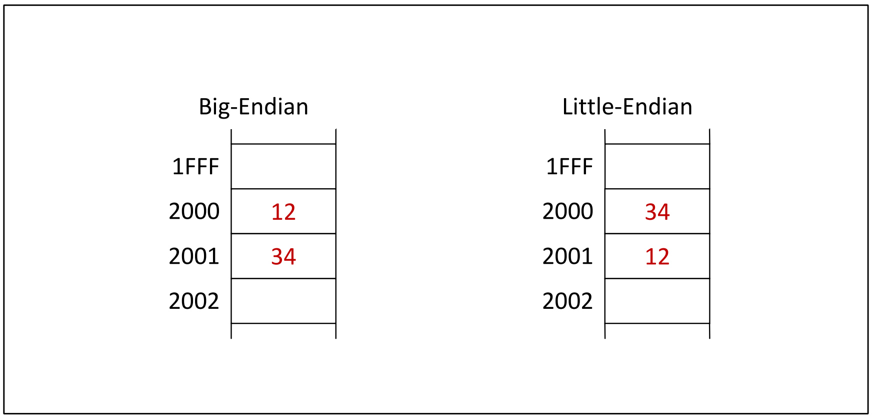
Big and Little-endian

- A microprocessor may need to store a number that is larger than a single memory location (in the HCS12, the size of memory location is 1 byte).
- How to store 16-, 32- or 64-bit word to 8-bit address space.
- Endianness means which byte is put first into the memory!
  - Big-endian: put the big number portion of the large number first into the memory.
  - Little-endian: put the little number portion of it first into the memory.



Endianness

Example

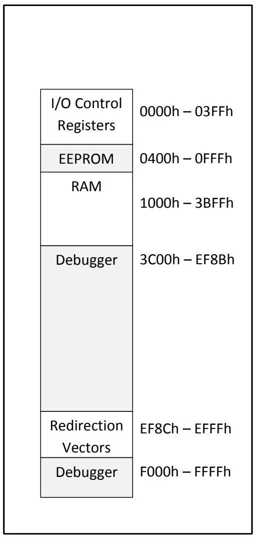


Big-Endian	
1FFF	
2000	12
2001	34
2002	

Little-Endian	
1FFF	
2000	34
2001	12
2002	

- The number 1234h stored at address 2000h

Type of Memory



I/O Control Registers	0000h – 03FFh
EEPROM	0400h – 0FFFh
RAM	1000h – 3BFFh
Debugger	3C00h – EF8Bh
Redirection Vectors	EF8Ch – EFFFh
Debugger	F000h – FFFFh

- The memory map for the S12 which has <u>16-bit addresses</u> and <u>8-bit locations</u>.
- Different ranges of addresses are mapped to different types of storage.

Instruction Set

- A list of all the operations that a processor can perform.
- A small section of the HCS12 instruction set.

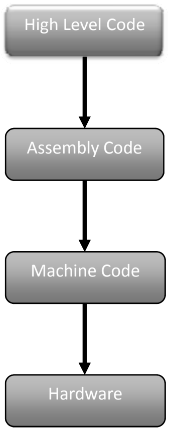
- Source Form:
  - Assembly code for the instruction
- Operation
  - A brief description that explains what the instruction does.
- Addressing mode
  - It tells how the instruction uses the operand(s), if any.

Instruction Set

- Machine Coding
  - The hexadecimal value that represents the instruction in memory.
  - Also called the instruction format since it shows how to convey the operation and its operands to the processor.
- Access Detail
  - Each letter stands for the internal operation performed during each clock cycle required by the operation.
  - The number of letters = the number of clock cycles taken.
- SXHINZVC: Condition Code Register
  - Δ: affected by operation, 1: set 1, and 0: set 0 after the instruction.

Programming Flow

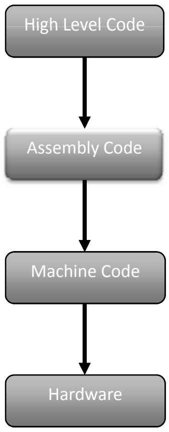
High Level Code



- C, C++, Basic, Pascal, Fortran, and others
- Usually exist as a text file.
- A portion of high level may be written without regard to the specific processor that will eventually run the program
- A compiler converts high level code to assembly code that runs on the same processor as the compiler runs
- A cross-compiler runs on one type of processor and converts high level code to assembly for a different type of processor.
- High level languages do not have instructions that can access all of a microcomputer's instructions. Many programs written mainly in a high level language have sections of assembly code.
- One line in a high level language may compile into several, possibly hundreds, of lines of assembly.

Programming Flow

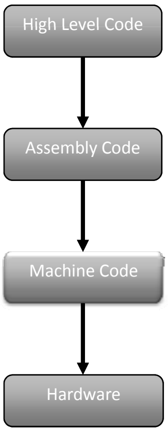
Assembly Code



- A somewhat "human readable" form of the exact code that will be executed on the processor
- Usually exists as a text file
- An assembler converts assembly code to machine code that runs on the same processor as the assembler runs
- A cross-assembler runs on one type of processor and converts assembly code to machine code for a different type of processor.
- Assembly code itself is not executed
- Assembly code is specific to a given type, or family, of processors.
- Each line of assembly code uniquely corresponds to one instruction in machine code.

Programming Flow

Machine Code



- The string of 1's and 0's representing the operations.
- The exact values that are loaded by the microprocessor from memory to execute the program.
- On PCs, these are executable (often .EXE) files.
- May not be executed on other types of microprocessors

Questions?

Wrap-up

What we've learned

- Registers – Programming Model
- Memory Model – Endianness
- Programming flow

What to Come

- Addressing Mode!