Operation of the Motorola 68HC11
A Typical MicroController System

Figure 1.3  Block Diagram of a Typical Microcontroller System
The Clock

- Clock pulses generated by an Oscillator (generally piezo-electric)
- It is literally a square wave (or very close to)
- The EVBPlus2 board uses an External Clock of $8 \text{ MHz}$
- Internally, the clock is divided by 4, resulting in an E-Clock of $2\text{MHz}$
- Therefore 1 Clock cycle takes $1/2 \text{ MHz} = 500 \text{ nSec}$
- Internal CPU operations are synchronised to the clock pulses
Memory

- Generally divided into two types, RAM and ROM
- For development, EPROM and EEPROM are very useful
- Accessed via a bus system
The MCU (MicroController Unit)
I/O Registers

• I/O registers are used for accessing the I/O ports

• Read from the registers to get data in

• Write to registers to configure or send data out
The CPU
Control Sequencer

• Used to coordinate data transfers to/from and within the CPU

• Logic governed by MicroPrograms – small sets of instructions designed into the CPU
Instruction Decoder

• Receives and Interprets Opcodes

• Depending on the opcode, tells the ALU what to do next

• Logic governed by MicroPrograms – small sets of instructions designed into the CPU
ALU

- An arithmetic-logic unit (ALU) is the part of a computer processor (CPU) that carries out arithmetic and logic operations on the operands in computer instructions (opcodes).

- 68HC11 has support for Add, Subtract, Multiply and Divide

- In some processors, the ALU is divided into two units, an arithmetic unit (AU) and a logic unit (LU). Some processors contain more than one AU - for example, one for fixed-point operations and another for floating-point operations. (In personal computers floating point operations are sometimes done by a floating point unit on a separate chip called a numeric coprocessor)
Address Bus

• “A bus is a network topology or circuit arrangement in which all devices are attached to a line directly and all signals pass through each of the devices. Each device has a unique identity and can recognize those signals intended for it.”

• Physically, the address bus of the 68HC11 is simply 16 parallel wires attached to a number of different devices (CPU, internal and external memory etc)

• \(2^{16} = 65536 = 64K\) Therefore no more than 64K of memory can be used.
Data Bus

• In the 68HC11, an 8 bit bus used to send or receive data.

• Used in conjunction with the address bus, specific data can be sent to or read from a specific memory location or device.
CPU registers

8-BIT ACCUMULATORS A & B OR 16-BIT DOUBLE ACCUMULATOR D

INDEX REGISTER X
INDEX REGISTER Y
STACK POINTER
PROGRAM COUNTER
CONDITION CODES

CARRY/BORROW FROM MSB
OVERFLOW
ZERO
NEGATIVE
1-INTERRUPT MASK
HALF CARRY (FROM BIT 3)
X-INTERRUPT MASK
STOP DISABLE
Accumulators

• Where the results from arithmetic operations are stored.

• Can also be used as ‘scratch pad’ data storage.

• In the 68HC11 there are two 8 bit accumulators (A and B)

• They can also be used together as a single 16 bit accumulator (D)

• But not both!
Index Registers

- Two 16 bit index registers (X and Y)

- Generally used like pointers in ‘C’ i.e. the value stored ‘points’ to a location in memory. Used in indexed addressing.

- Like the accumulators, X and Y can also be used for temporary data storage and arithmetic operations
Program Counter

- 16 bit register

- Stores the memory location of the next instruction to be executed

- This is how the CPU keeps track of what to do next
Stack Pointer

- 16 bit register – stores the location to the top of the ‘stack’

- “A stack is a data area or buffer used for storing requests that need to be handled. The *IBM Dictionary of Computing* says that a stack is always a push-down list, meaning that as new requests come in, they push down the old ones.”

- The stack is a LIFO (Last In First Out) buffer (area of memory)
Condition Code Register

- Used to record some results of an arithmetic operation

- For example if two numbers are compared (CMP) the CPU performs a subtraction. If the numbers are equal, bit Z will be set. If the result is negative, bit N will be set etc.

- Use table 10-1 in the data book to see which bits of the condition code register may be set by each operation