Microcontroller Minimum System

Course Number : TTH2D3

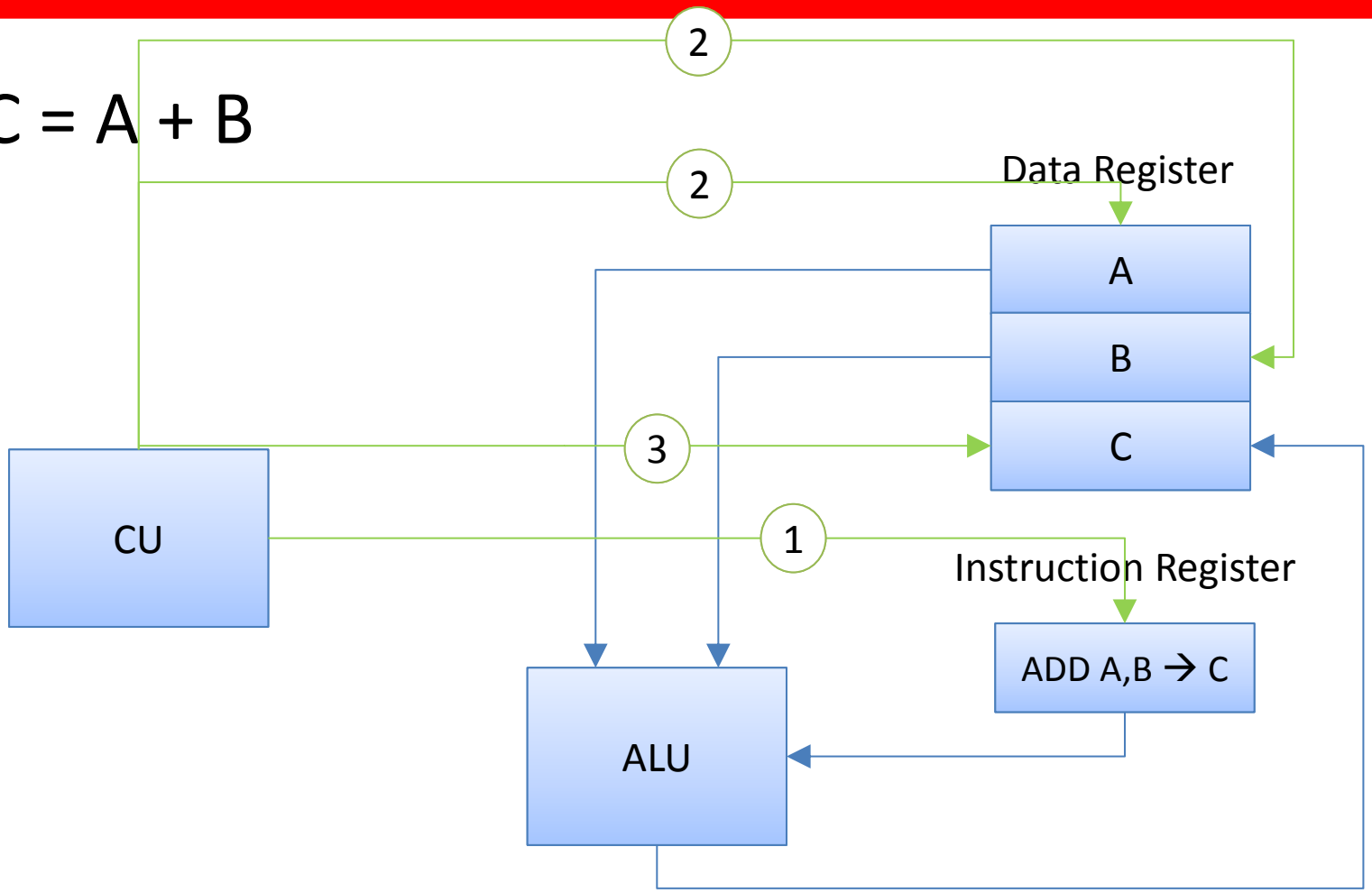
CLO : 1

Week : 5-7

CLO#1 Student have the knowledge to explain microprocessor system
[C2] Understand the history of microprocessor and microcontroller
[C2] Understand the architecture of computer system
[C2] Understand the design of minimum system for microcontroller

How it Works?

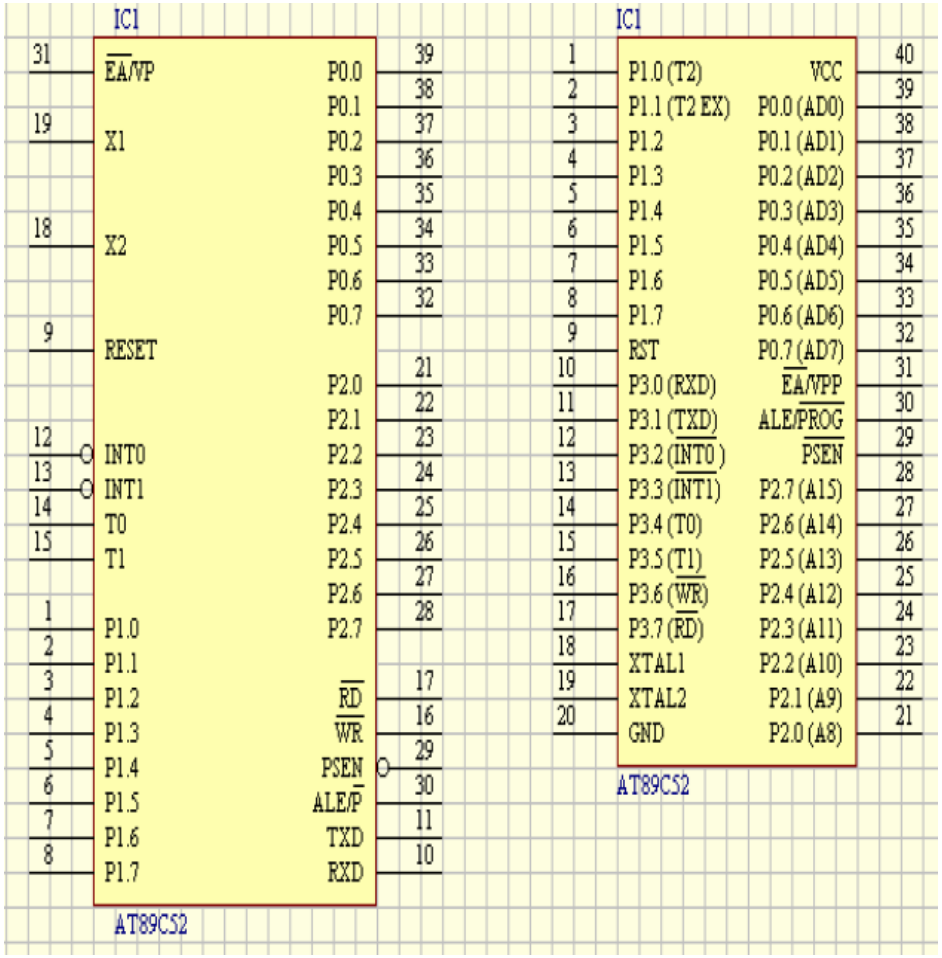
- C = A + B



What is the difference between Microprocessor and Microcontroller?

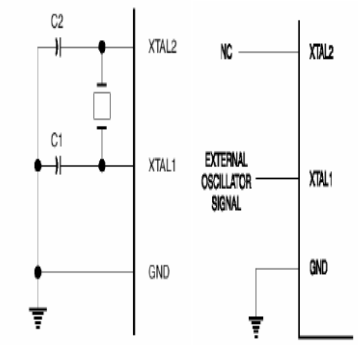
- Microcontroller is a single chip CPU that already consists of:
  - Processor (ALU + Unit Control)
  - Internal Memory RAM
  - Input / Output
  - Timer
  - Interrupt Control
- Microcontroller is designed for a specific purpose, which makes it only applicable for 1 domain

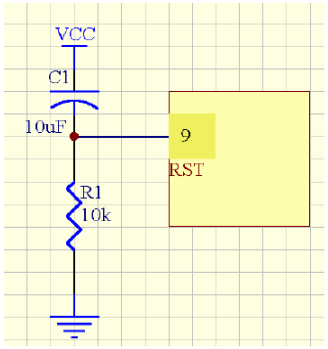
Atmel Microcontroller



To be fully functional, a microcontroller needs:

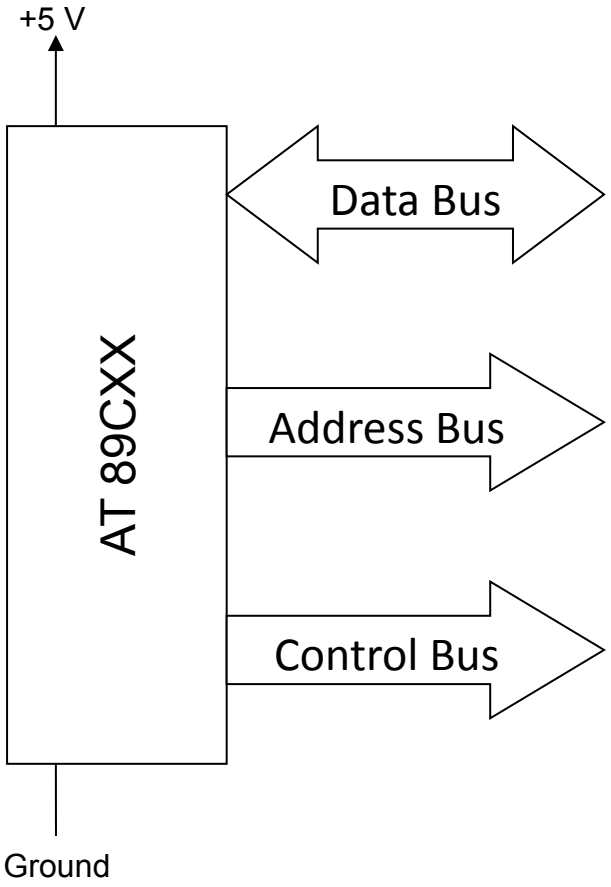
- Power suply
- Clock generator
- Power Reset





AT89CXX

- Data Bus (8 bit) for transferring data from or to AT89CXX
- Address Bus (16 bit) for:
  - indicating the address of data in memory
  - indicating which I/O that want to be connected
- Control Bus for delivering signal to other peripherals, such as memory and I/O



Microcontroller

Minimum System

AVR Microcontroller

- Designed and fabricated by Atmel
- Simple, low-cost, high-performance and full features

Seri	Flash (KBytes)	RAM (Bytes)	EEPROM (KBytes)	Pin I/O	Timer 16-bit	Timer 8-bit	UART	PWM	ADC 10-bit	SPI	ISP
ATmega8	8	1024	0.5	23	1	1	1	3	6/8	1	Ya
ATmega8535	8	512	0.5	32	2	2	1	4	8	1	Ya
ATmega16	16	1024	0.5	32	1	2	1	4	8	1	Ya
ATmega162	16	1024	0.5	35	2	2	2	6	8	1	Ya
ATmega32	32	2048	1	32	1	2	1	4	8	1	Ya
ATmega128	128	4096	4	53	2	2	2	8	8	1	Ya
ATtiny12	1	-	0.0625	6	-	1	-	-	-	-	Ya
ATtiny2313	2	128	0.125	18	1	1	1	4	-	1	Ya
ATtiny44	4	256	0.25	12	1	1	-	4	8	1	Ya
ATtiny84	8	512	0.5	12	1	1	-	4	8	1	Ya

References 1

- Flash is a ROM, used for storing user-defined program that need to be run by the microcontroller
- RAM (Random Acces Memory), used for storing data temporarily while program runs
- EEPROM (Electrically Erasable Programmable Read Only Memory), used for store data permanently (as a result of a program)
- I/O port, is a pin for communication purposes with other devices

References 2

- Timer is a hardware module to count time (pulse)
- UART (Universal Asynchronous Receive Transmit), used for asynchronous data communication
- PWM (Pulse Width Modulation), used for creating pulse modulation
- ADC (Analog to Digital Converter), used for converting analog signal into digital representation

References 3

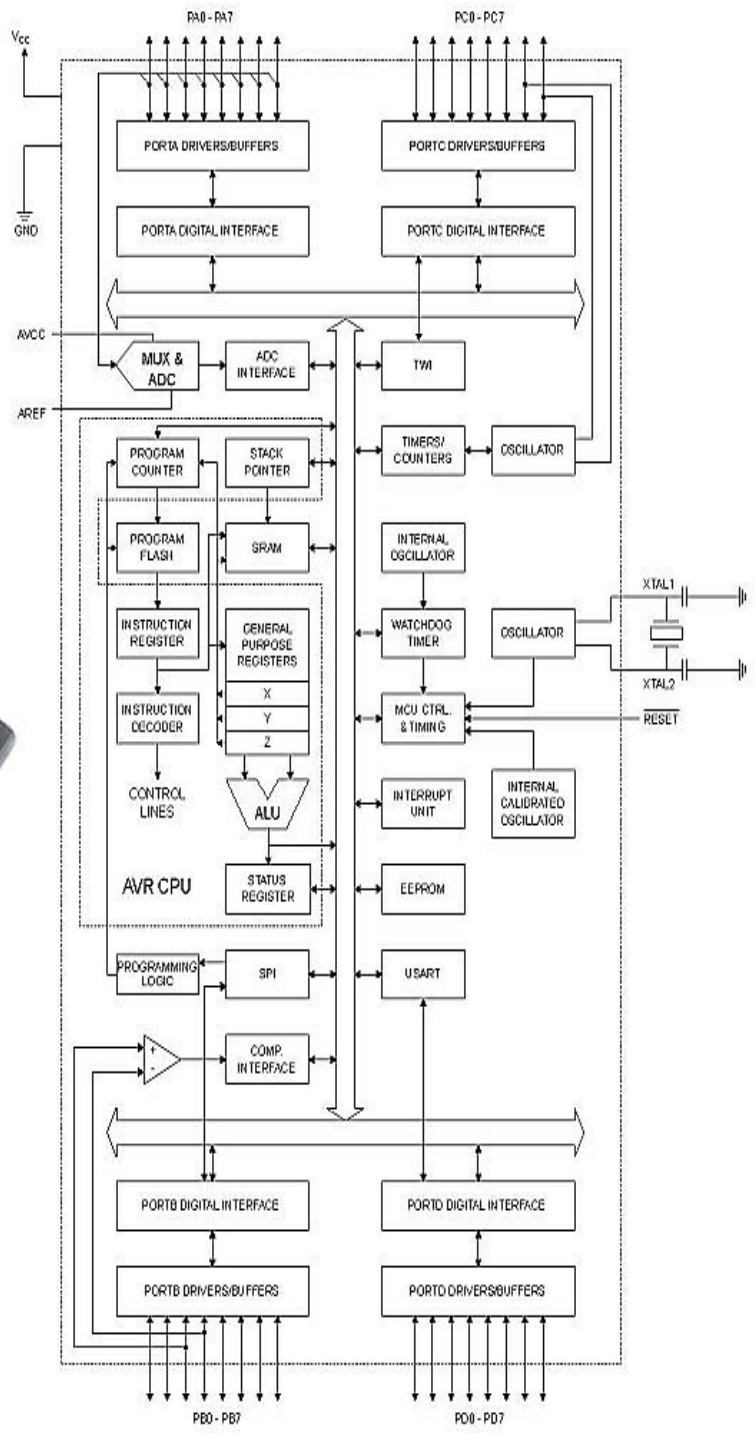
- SPI (Serial Peripheral Interface), used for synchronous serial data communication
- ISP (In System Programming), used for direct programming into the system

About ATMega 8535

- ATMega8535 is a 8-bit CMOS RISC architecture
- Most instruction are executed in 1 clock cycle, which makes a 1 MIPS per MHz
- 4 I/O programmable port for many applications

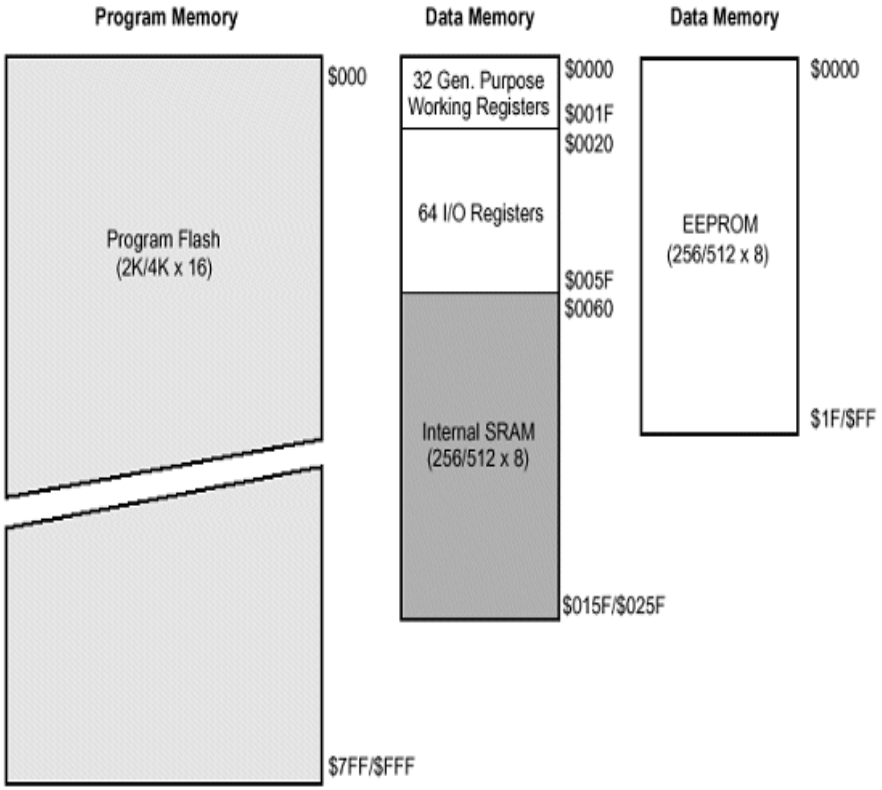
ATMega 8535 Architecture

- 4 I/O port (4x8) Port A, B, C and D
- ADC (Analog to Digital Converter)
- 3 Timer/Counter
- 32 register
- 512 byte SRAM
- 8kb Flash memory
- Internal and external interrupt
- SPI interface port to download program into flash
- 512 byte EEPROM
- Analog comparator interface
- USART port for serial communication



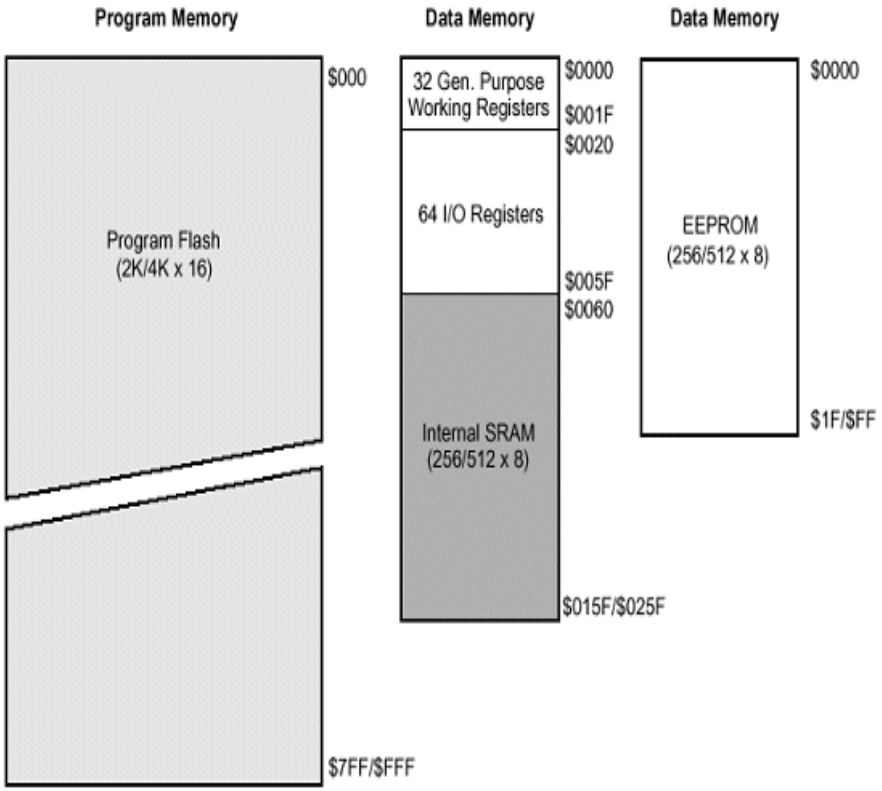
See you on next class

ATMega 8535: Memory Map



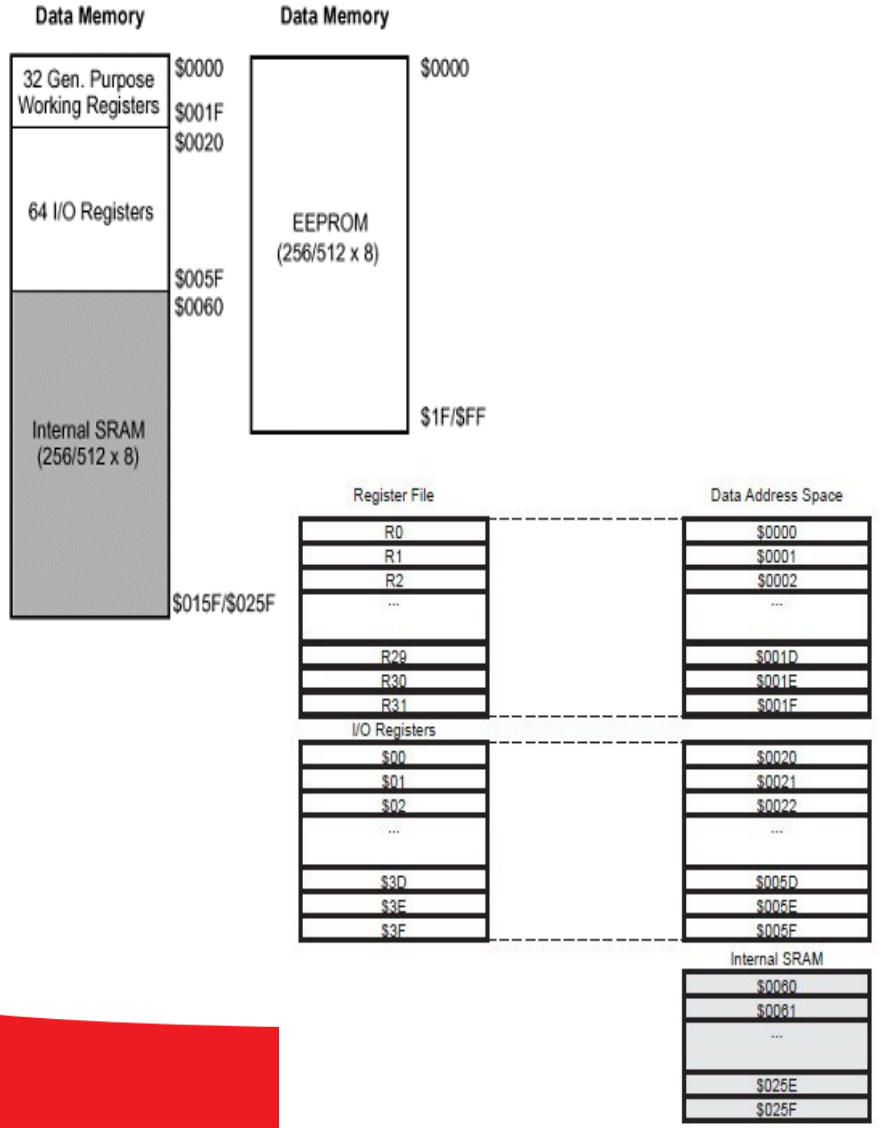
- Flash stores user-defined program
- RAM stores temporary data
- EEPROM stores permanent data

ATMega 8535: Memory Map



- Flash memory (non-volatile) has 4k word (1 word = 2 byte) 0x000 - 0xFFF
- Use Program counter (PC) to address flash

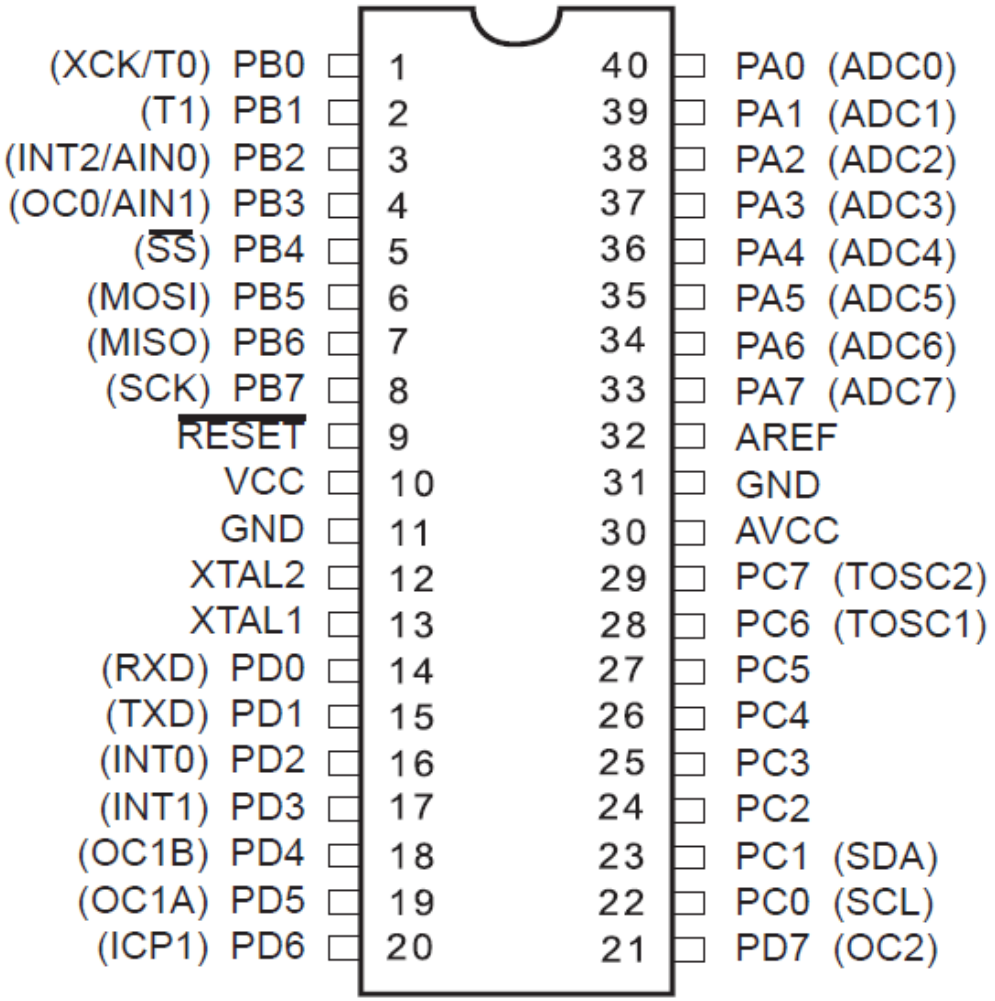
ATMega 8535: Memory Map



Static RAM (volatile):

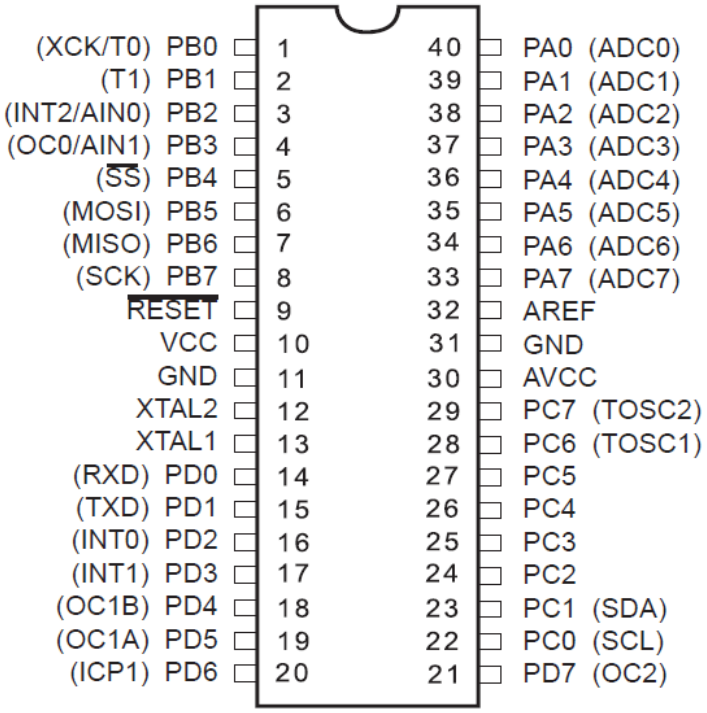
- 32 general purpose register (0x00 - 0x1F)
- 64 I/O register (0x20 - 0x5F) → control μC peripheral functionality
- SRAM internal (0x60 - 0x25F)

MICROCONTROLLER (μC) AVR ATMEGA 8535



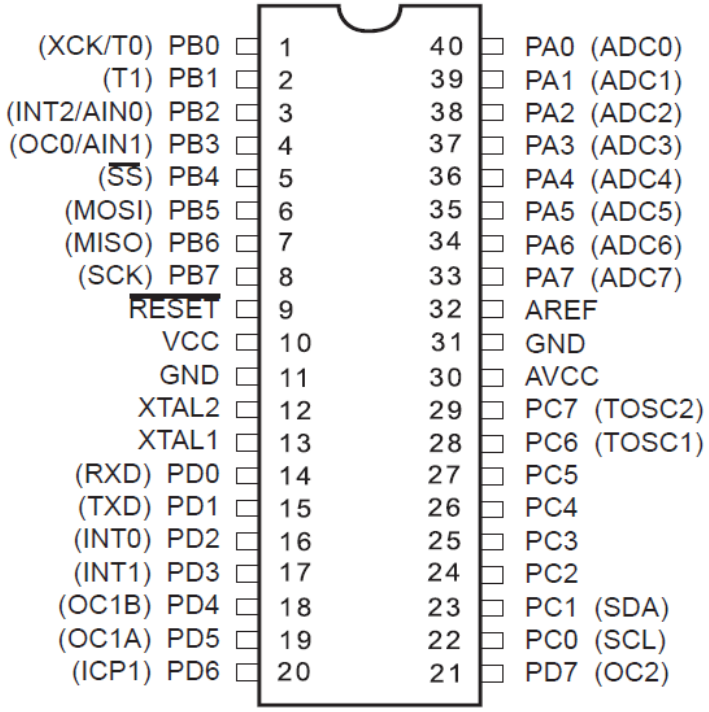
μC ATMega 8535: Features

- μC AVR ATMega 8535 has 40 pins where 32 pins used for parallel port.
- Each parallel port has 8 pins, so μC AVR ATMega 8535 has 4 parallel ports, port A, B, C, and D.
- Each pin in parallel port has designated name, like portA.0 to portD.7



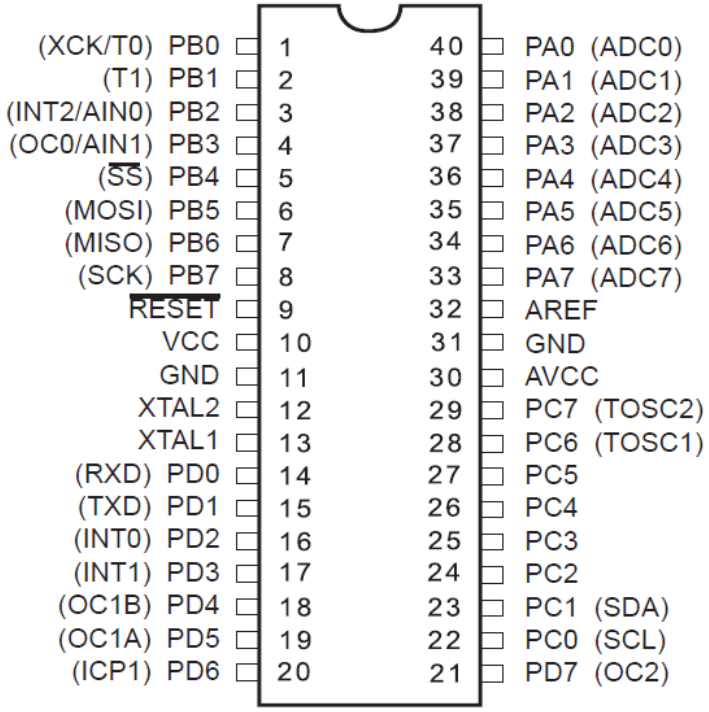
PORT A

- Pin 33 to 40 are for parallel port A (8 bit directional I/O)
- Each pin has internal pull-up resistor to provide electric current up to 20 mA to charge LED display directly
- To enable port A we have to set Data Direction Register port A (DDRA). Bit DDRA = 0 means that specific pin become input (1 for output)
- Special functionality: each pin in port A can also be used for analog input (ADC)



PORT B

- Pin 1 to 8 are for parallel port B (8 bit directional I/O)
- Each pin has internal pull-up resistor to provide electric current up to 20 mA to charge LED display directly
- To enable port B we have to set Data Direction Register port B (DDRB). Bit DDRB = 0 means that specific pin become input (1 for output)

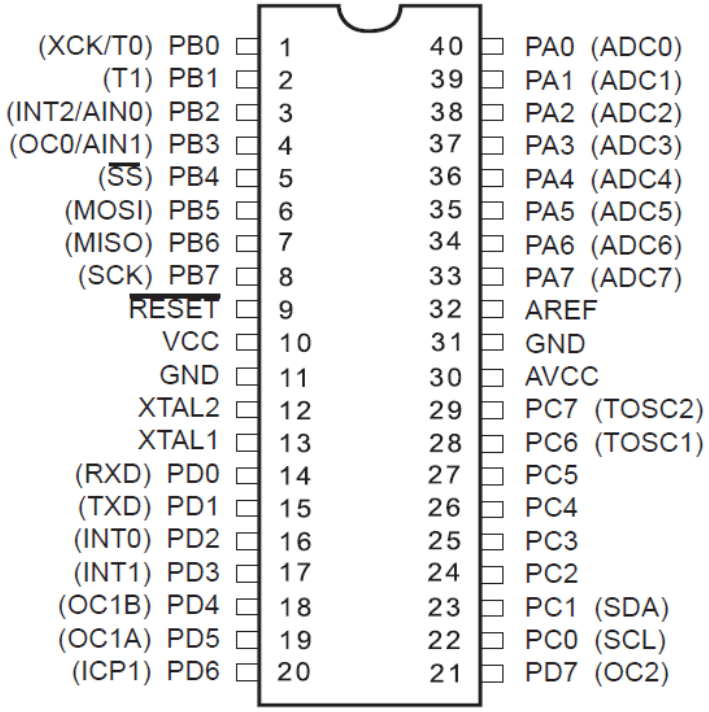


Port Pin	Special Functionality
PB0	T0 = timer/counter 0 external counter input
PB1	T1 = timer/counter 0 external counter input
PB2	AIN0 = analog comparator positive input
PB3	AIN1 = analog comparator negative input
PB4	SS = SPI slave select input
PB5	MOSI = SPI bus master output / slave input
PB6	MISO = SPI bus master input / slave output
PB7	SCK = SPI bus serial clock

PORT C

- Pin 22 to 29 are for parallel port C (either input or output)
- Each pin has internal pull-up resistor to provide electric current up to 20 mA to charge LED display directly
- To enable port C we have to set Data Direction Register port C (DDRC). Bit DDRC = 0 means that specific pin become input (1 for output)

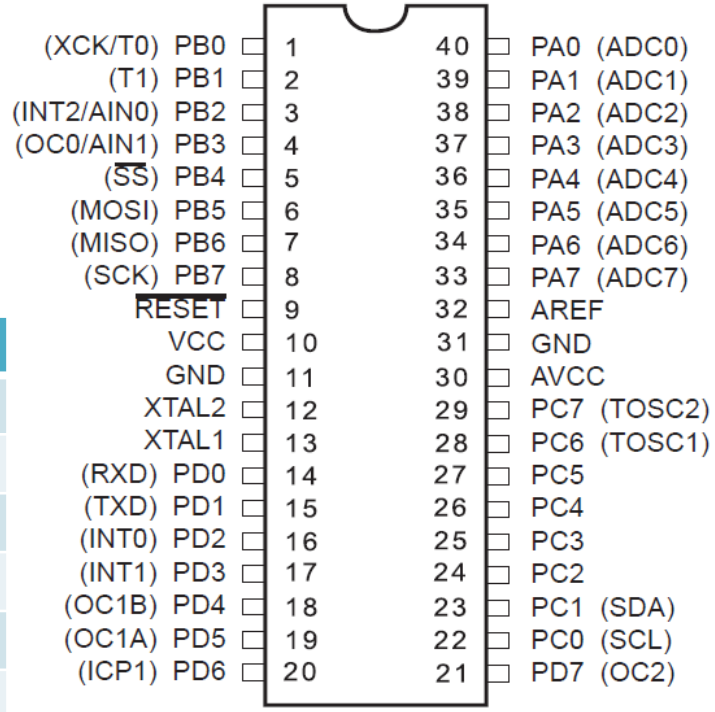
Pin	**Special Functionality**
PC.7	TOSC2 (*Timer Oscillator Pin 2*)
PC.6	TOSC1 (*Timer Oscillator Pin 1*)
PC.1	SDA (*Two-Wire Serial Bus Data Input/Output Line*)
PC.0	SCL (*Two-Wire Serial Bus Clock Line*)



PORT D

- Pin 14 to 20 are for parallel port D (8 bit directional I/O)
- Each pin has internal pull-up resistor to provide electric current up to 20 mA to charge LED display directly
- To enable port D we have to set Data Direction Register port D (DDRD). Bit DDRD = 0 means that specific pin become input (1 for output)

Port Pin	Special Functionality
PD0	RDX (UART input line)
PD1	TDX (UART output line)
PD2	INT0 (external interrupt 0 input)
PD3	INT1 (external interrupt 1 input)
PD4	OC1B (Timer/Counter1 output compareB match output)
PD5	OC1A (Timer/Counter1 output compareA match output)
PD6	ICP (Timer/Counter1 input capture pin)
PD7	OC2 (Timer/Counter2 output compare match output)



Other Pins

RESET

RST on pin 9 is a reset for AVR, activated with low voltage in at least 2 machine cycle

XTAL1 and XTAL2

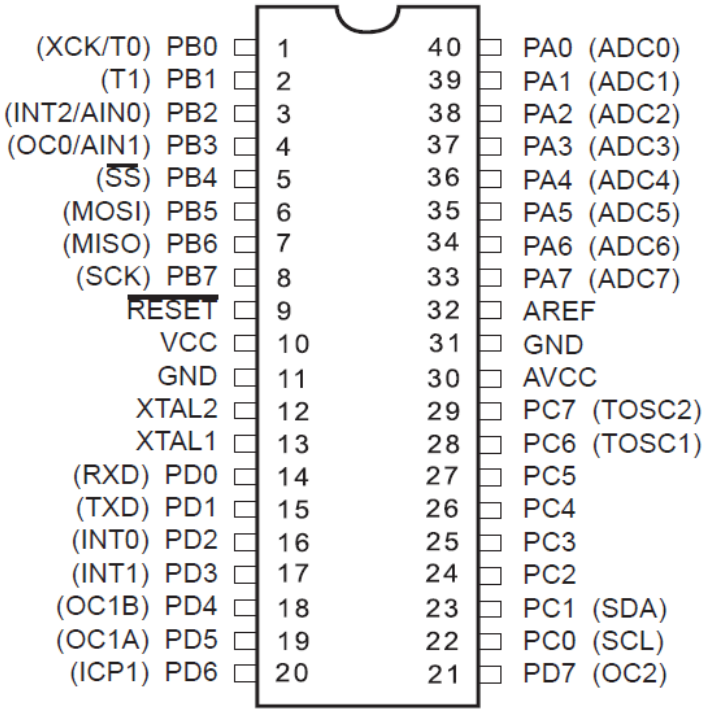
XTAL1 on pin 13 and XTAL2 on pin 12 is an input for oscillator crystal

AVcc

AVcc on pin 10 is an input for ADC externally connected to Vcc via LPF

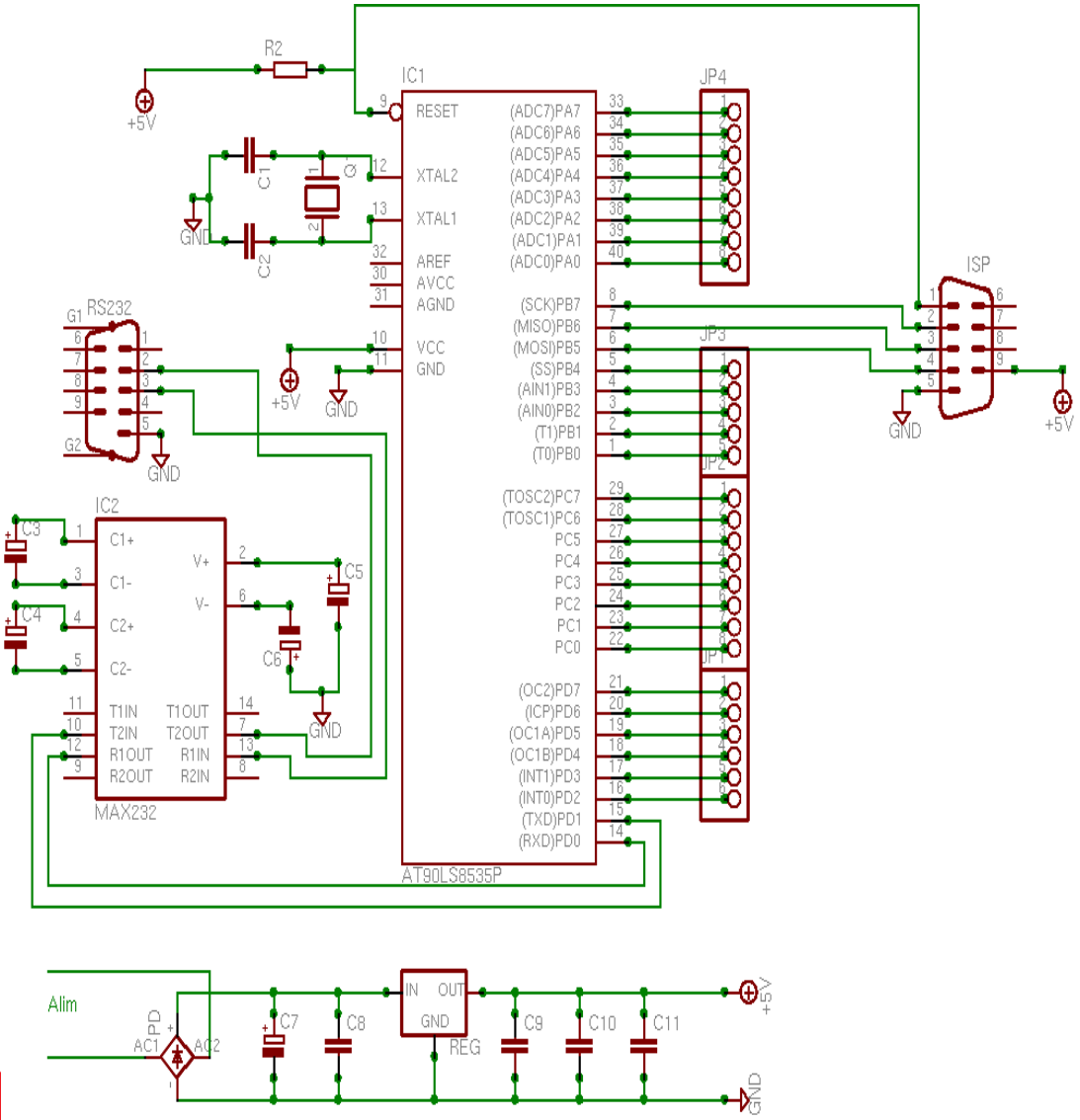
AREF

AREF on pin 32 is a reference input voltage for ADC



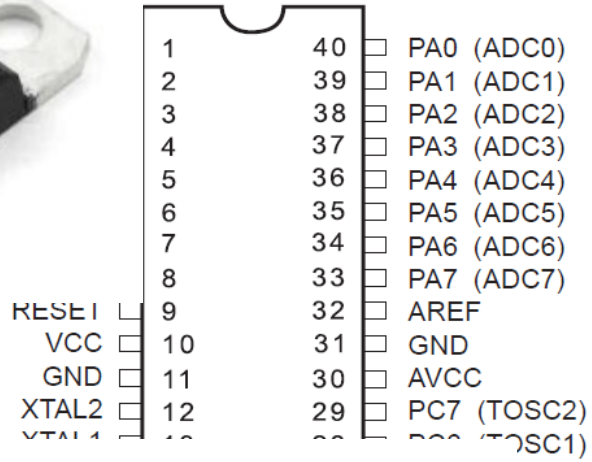
ATMega 8535: Minimum System

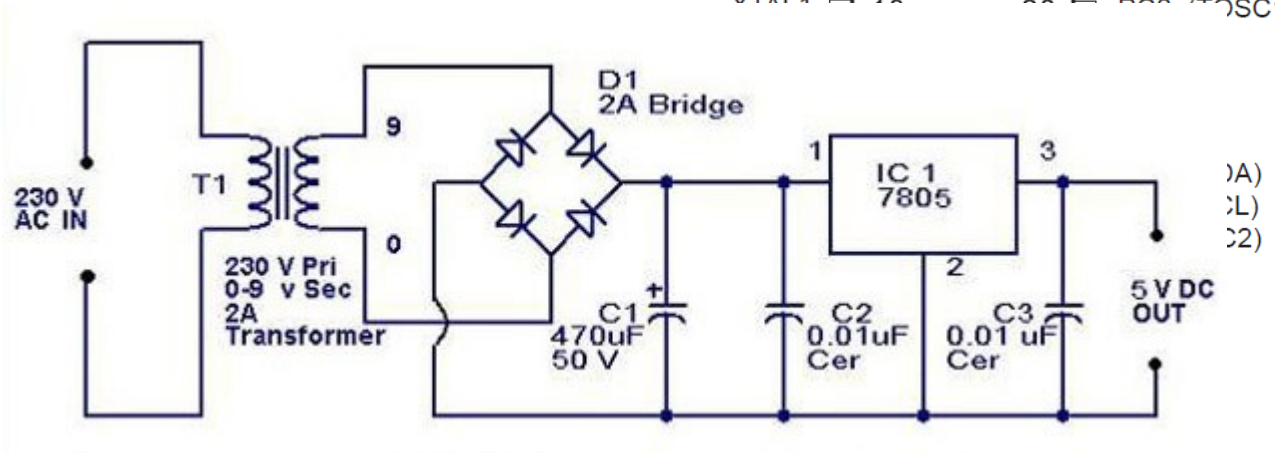
Minimum System of a μC is the most simplest circuit to make it works



ATMega 8535: Minimum System: Power Supply

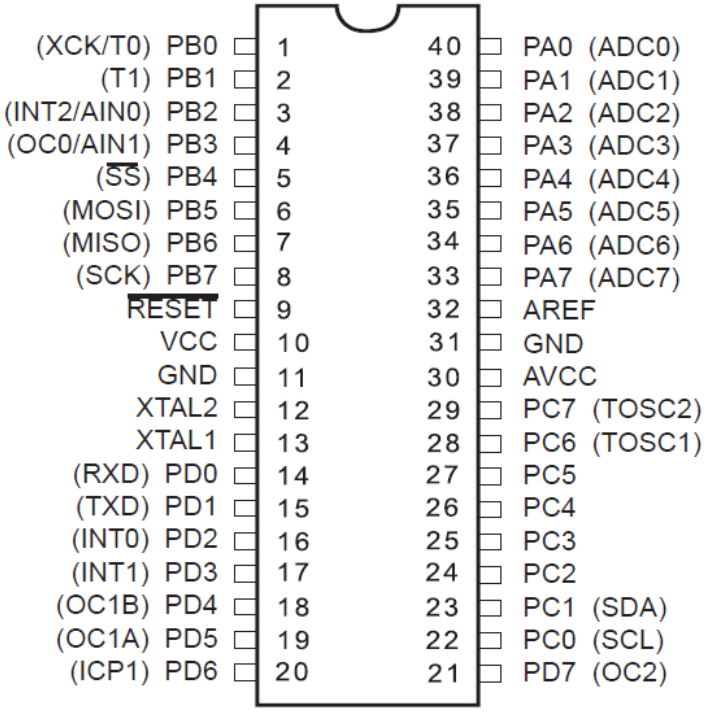
- Most μC use +5 VDC for power supply, it could be either uses 3x1,5VDC batteries or 220VAC power outlet
- 7805 is a +5VDC power regulator





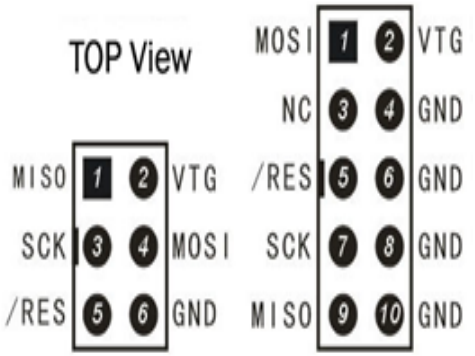
ATMega 8535: Minimum System: Oscillator

- Oscillator = pulse generator
- µC ATMega 8535 has an internal 8 MHz oscillator, but sometimes we need faster or slower system
- µC ATMega 8535 can works as fast as 16 Mhz



ATMega 8535: Minimum System: ISP

- ISP = In-System Programming
- μC ATMega 8535 can be programmed via parallel or serial



ATMega 8535: Minimum System: Reset

Reset button

- Similar with reset button in PC/laptop (using power button)
- When reset is activated, μC will restart from the beginning

See you on next class