



Embedded Systems Concepts

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Memory used to store data.

There are **two** types of memory:

Volatile:

The memory will **lose** its data when the applied voltage **removed** “**power off**”.

Non-Volatile:

The memory will **never lose** its data when the applied voltage **removed** “**power off**”.

Memory

Volatile

RAM

DRAM

SRAM

Non-Volatile

NVRAM

-Hardware NVRAM

-Software NVRAM

ROM

-Masked ROM

-OTP ROM

-EPROM

-EEPROM

-Flash ROM

RAM “Random Access Memory”:

It called random access because the time which it takes to reach any address in the memory is constant. (no difference in access time between address 0x0000 and 0xFFFF).

SRAM “Static Random Access Memory”:

Based on Transistors.

DRAM “Dynamic Random Access Memory”:

Based on Capacitors.

SRAM VS DRAM

	SRAM	DRAM
Cost		<i>Lower</i>
Size	<i>Lower</i>	
Performance	<i>Higher</i>	
Power Consumption	<i>Lower</i>	Needs a refresh circuit to recharge capacitors.

So, DRAM is **not applicable** in embedded application because of high **power consumption**.

- **Masked ROM**: Designed and programmed by manufacturer.
- **OTP ROM** “One Time Programmable ROM”: Can be programmed only one time.
- **EPROM** “Erasable Programmable ROM”: Programmed many times and erased by **UV** “Ultra Violet”.
- **EEPROM** “Electrically Erasable Programmable ROM”: Programmed and erased by electrical signals.
- **Flash ROM**

FLASH VS EEPROM

	FLASH	EEPROM
Access	Block of bytes access	Byte access
Cost	✓	
Size	✓	
Performance	Good for Block	Good for Byte
Power Consumption	—	—
Endurance	10,000 times to die	100,000 to 11000,000 times to die

Memory Conclusion

RAM :

for “Run Time” because it is faster than ROM.

ROM :

for “Code” because it doesn’t lose its data after power off.

Note:

Every Embedded system must have FLASH and **SRAM** and may have EEPROM.

Input Output Peripherals

Input and output peripherals as a channel between the user and the processor.

Examples

1- Digital Input Output (DIO)

2- Analog to Digital Converter (ADC)

3- Digital to Analog Converter (DAC)

4- Timers and Pulse Width Modulators (PWM)

5- Universal Asynchronous Receiver Transmitter (UART)

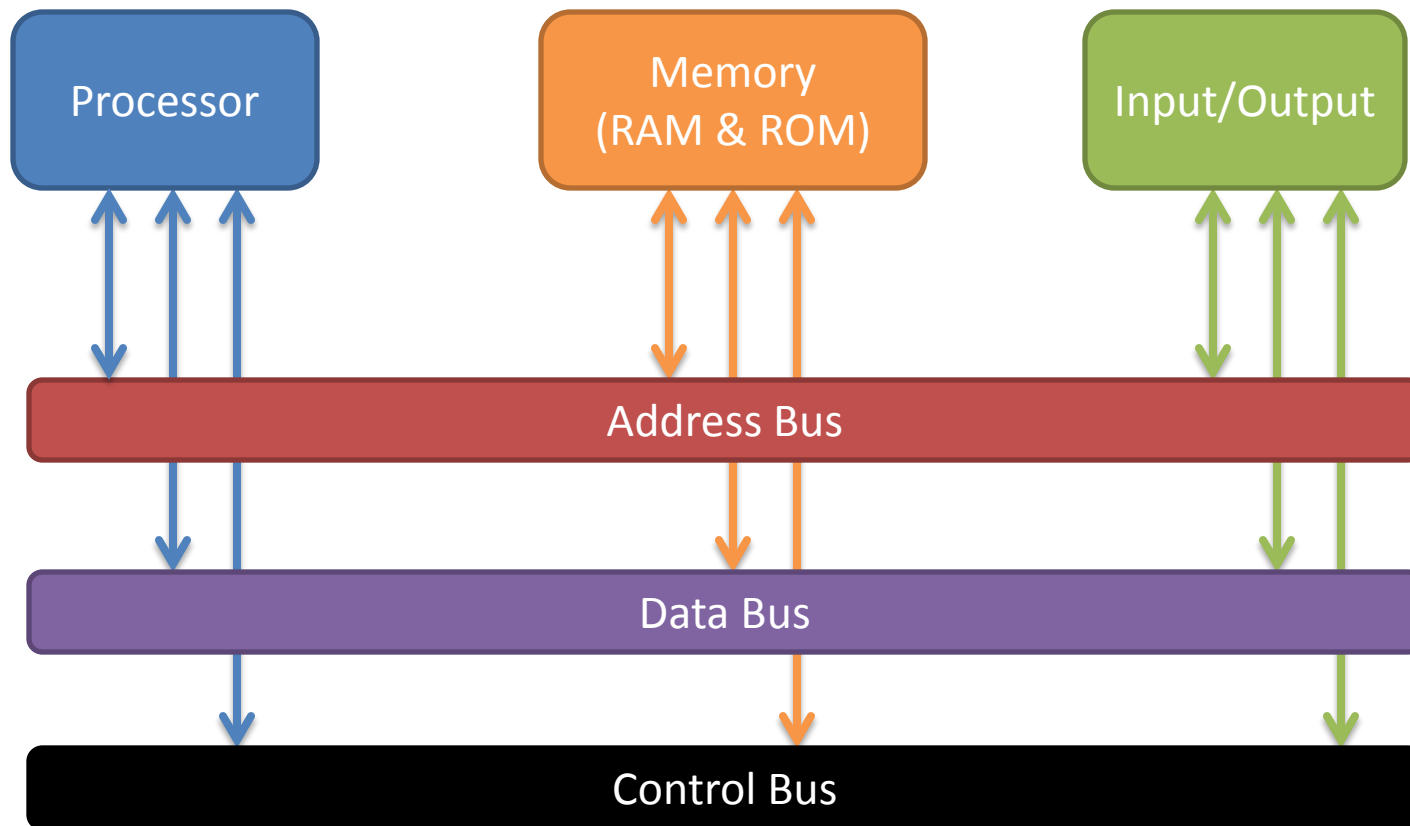
6- Serial Peripheral Interface (SPI)

7- Inter Integrated Circuit (I2C)

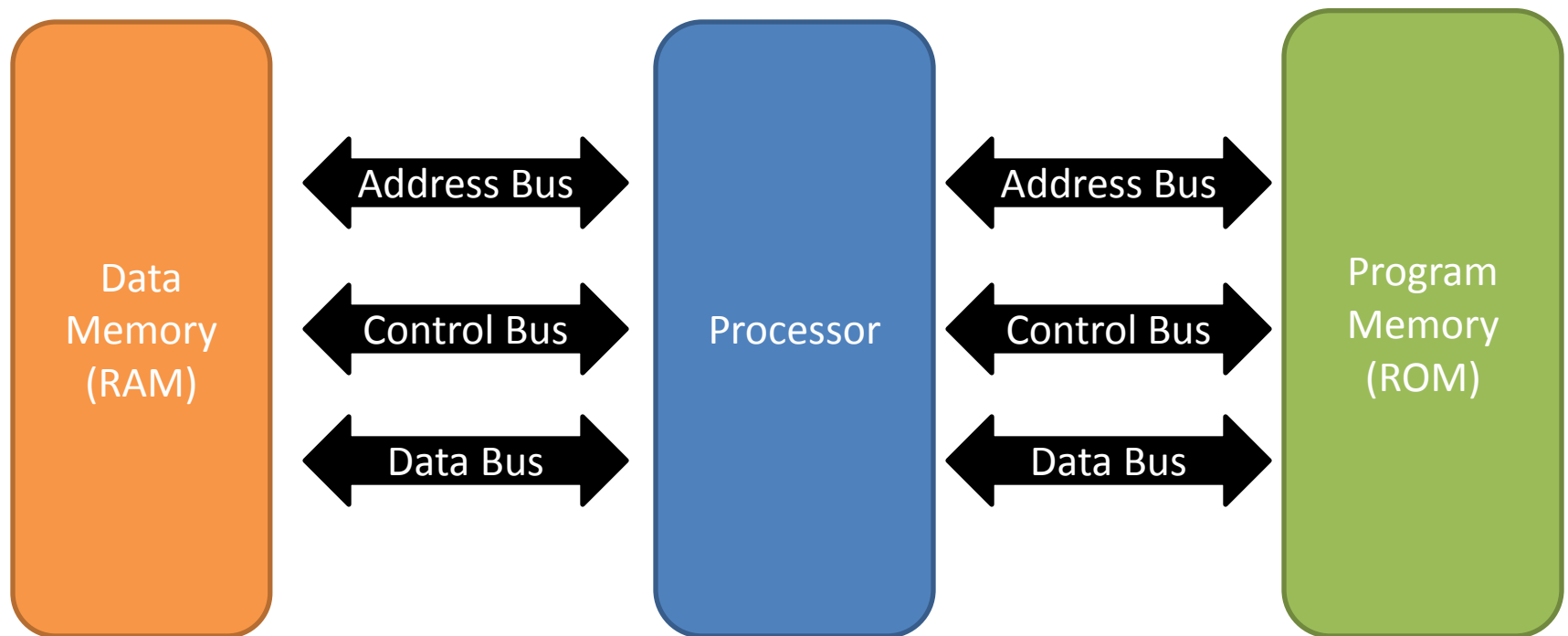


Serial
Communication
Protocols

2- Von Numann Architecture



2- Harvard Architecture



Open the datasheet of the microcontroller **Atmel AVR Atmega32** and read the first page "Specifications".

Could you understand the mentioned specifications ... ?



The End ...





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