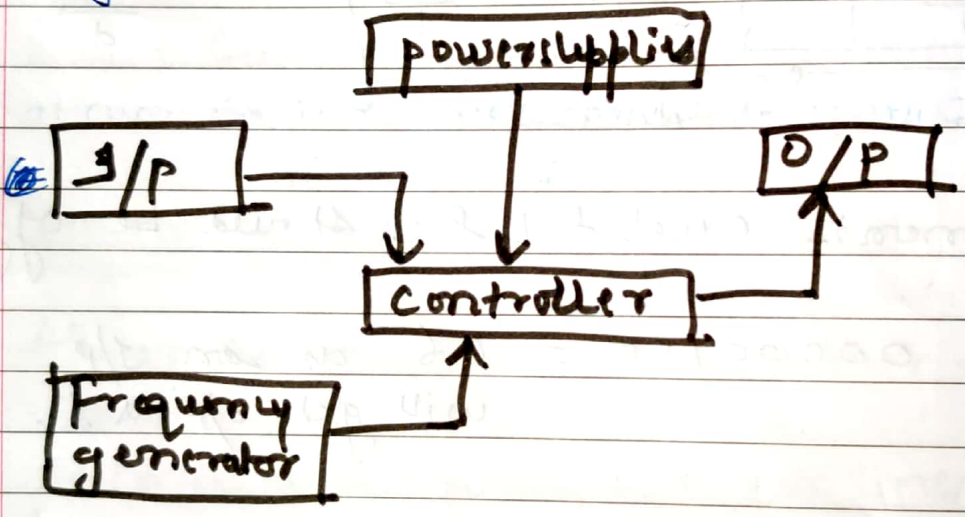
EMBEDDED SYSTEM

→ It is an arrangement in which all its units, assemble work together according to set of rules.
Eg :- Watch is a time display system.

→ It is a combination of S/w & H/w
→ It is designed to perform a particular task
→ The task has to be completed in a given time.
Eg :- Microoven, washing m/c etc.



Building blocks of Embedded System

I/P → Sensors, buttons, touch pannels, bluetooth, IR

O/P – LED's, LCD's, bluetooth, IR

Controller – ROM, RAM, ALU, CU
ROM → code memory
RAM → runtime data mem
ALU → Arithmetic Logic unit
CU → control unit

Freq generator – Crystall oscillator

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Characteristics of Embedded System

- Real time operation ⇒ oper has to be completed by deadline
- sophisticated functionality
- low manufacturing cost – designed to perform specific task
- low power consumption
- Application dependent processor & not general purpose processor which we find in computers.
- Restricted memory

Applications of Embedded system

1. Medical System – pacemaker, patient monitoring System, ICU etc.
2. Office equipment – printer, copier, fax etc.
3. Tools – Multimeter, oscilloscope, GPS system etc.
4. Banking – ATM, statement printers etc.
5. Transportation → planes, trains, boats, Automobiles etc.
6. Radar, traffic lights, signaling system etc.
7. Automobiles – Engine management, car alarms Airbags etc.
8. Building system – Elevators, Heater, Air conditioner lightning etc.
9. Agriculture → feeding system & milking system
10. Space → satellite system etc.

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ROBOTICS

→ A reprogrammable, multifunctional manipulator or designed to move material, parts, tools or specialized devices through various programmed motions for performance of a variety of tasks is called Robot.

→ Robotics is the study of the design, construction & use of robots.

→ Robot has three essential characteristics
a) Sensing 2) Movement 3) Intelligence

Types of Robots

1) Pre-programmed Robots

It operates in a controlled environment where they do simple monotonous task.

2) Humanoid Robots

These robots usually performs human like activities like running, jumping, carrying objects etc.

3) Autonomous Robots

These robots are usually designed to carry out tasks in open environments that do not require human supervision.

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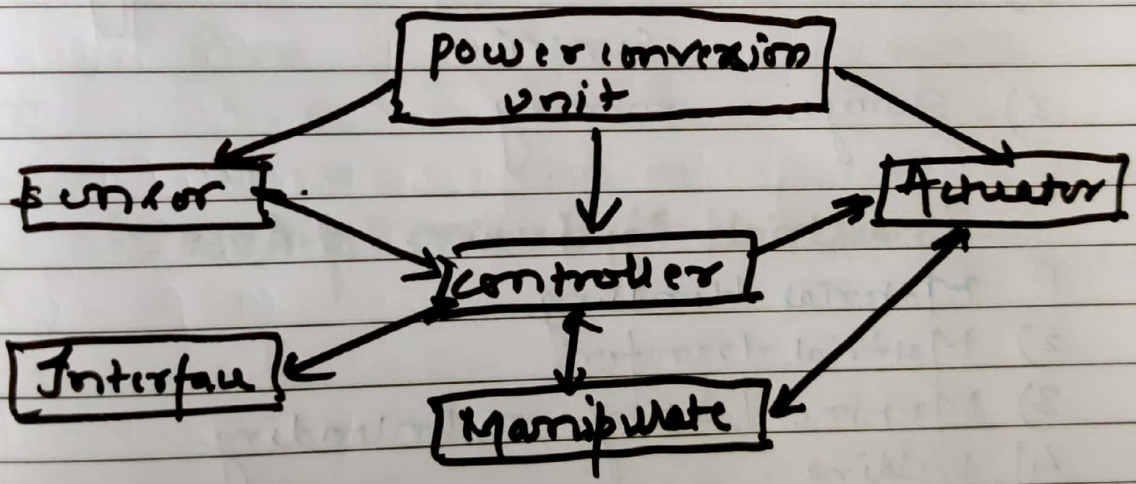
Teleoperated Robots → These robots usually work in extreme geographical conditions, weather circumstances etc.

Augmenting Robots – Augmenting robots either enhance current human capabilities or replace the capabilities a human may have lost.

other types are manipulator, legged Robot or wheeled Robot, Unmanned Aerial vehicle or Autonomous under water vehicle etc.



Design & operation of Robotic System

Working principle of Robotics

based on laws of Robotics called Asimov's laws

First law – A robot may not injure a human or through inaction, allow a human to come to harm.

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Second Law – A robot must obey the orders given it by human beings, unless such orders would conflict with first law.

Third Law – A robot must protect its own existence as long as such protection does not conflict with the first or second law.

Robot mechanism

Robots may have following elements :-

1) Mechanical element – Eg :- piston etc.
2) Electrical element - eg :- D.C Motor, A.C motor etc.
3) sensors - movements of hands, legs etc.
4) Actuators – A.C servo motor, servo motor etc.
5) Controller – To manipulate all information of sensors.
6) Storage - memory

Industrial Application of Robots

1) Material Handling
2) Material transfer
3) Machine loading or Unloading
4) Welding
5) Spray Coating.
6) Assembly
7) Inspection.

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AVR MICROCONTROLLER

AVR → Advanced virtual RISC → Reduced instruction set computing
Alf - vegard RISC

AVR is a family of μc developed since 1996 by Atmel, acquired by Microchip Technology in 2016. AVR was one of the first μc families to use on-chip flash memory for program storage, as opposed to one-time programmable ROM, EPROM or EEPROM used by other μc

AVR μc classified into three parts :-
Tiny AVR
Mega AVR
x Mega AVR

	Pins	Memory	Feature
Tiny AVR	6-32	0.5-8KB	Small in size
Mega AVR	28-100	4-256KB	extended peripheral
x Mega AVR	44-100	16-384KB	DMA, event system included

AVR μc can be 8 bit, 16 bit & 32 bit

32-bit AVR → 16-512 KB flash memory
48-144 pin
1.5 MIPS/MHz

AVR x Mega → 16-384 KB flash
32-100 pins
1.0 MIPS/MHz

8-bit tiny AVR → 0.5-8 KB flash
6-32 pin
1.0 MIPS/MHz

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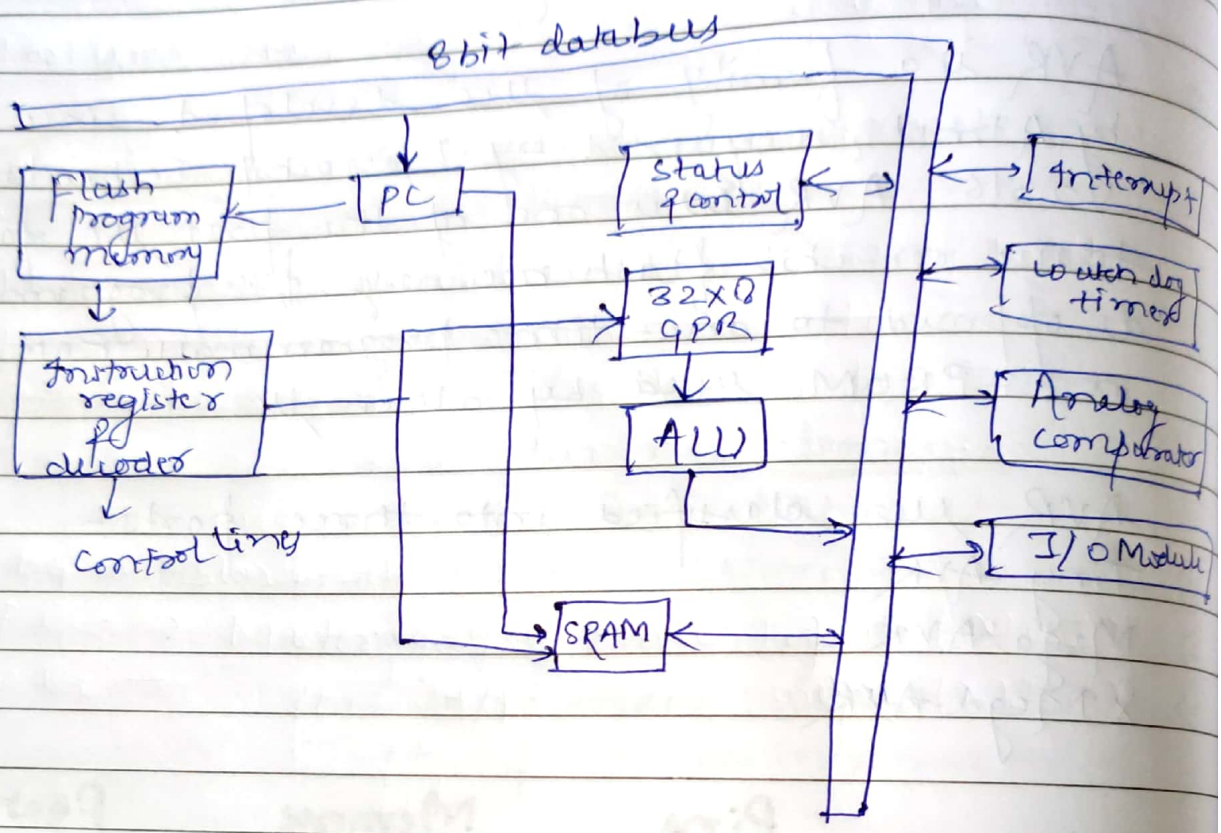
Block Diagram of AVR Architecture



Main parts of AVR architecture :-

1) GPR general purpose Register
2) SPR Special purpose Register
3) ALU
4) SRAM
5) Interrupt & watching timer.

GPR → It has capability to access ~~1 clock cycle~~ 32x8 GPR in 1 clock cycle

SPR – It works with extended data of µC.

ALU – performs all arithmetic & logical operation

SRAM – It can access data very easily through five different addressing modes which supported by AVR architecture.

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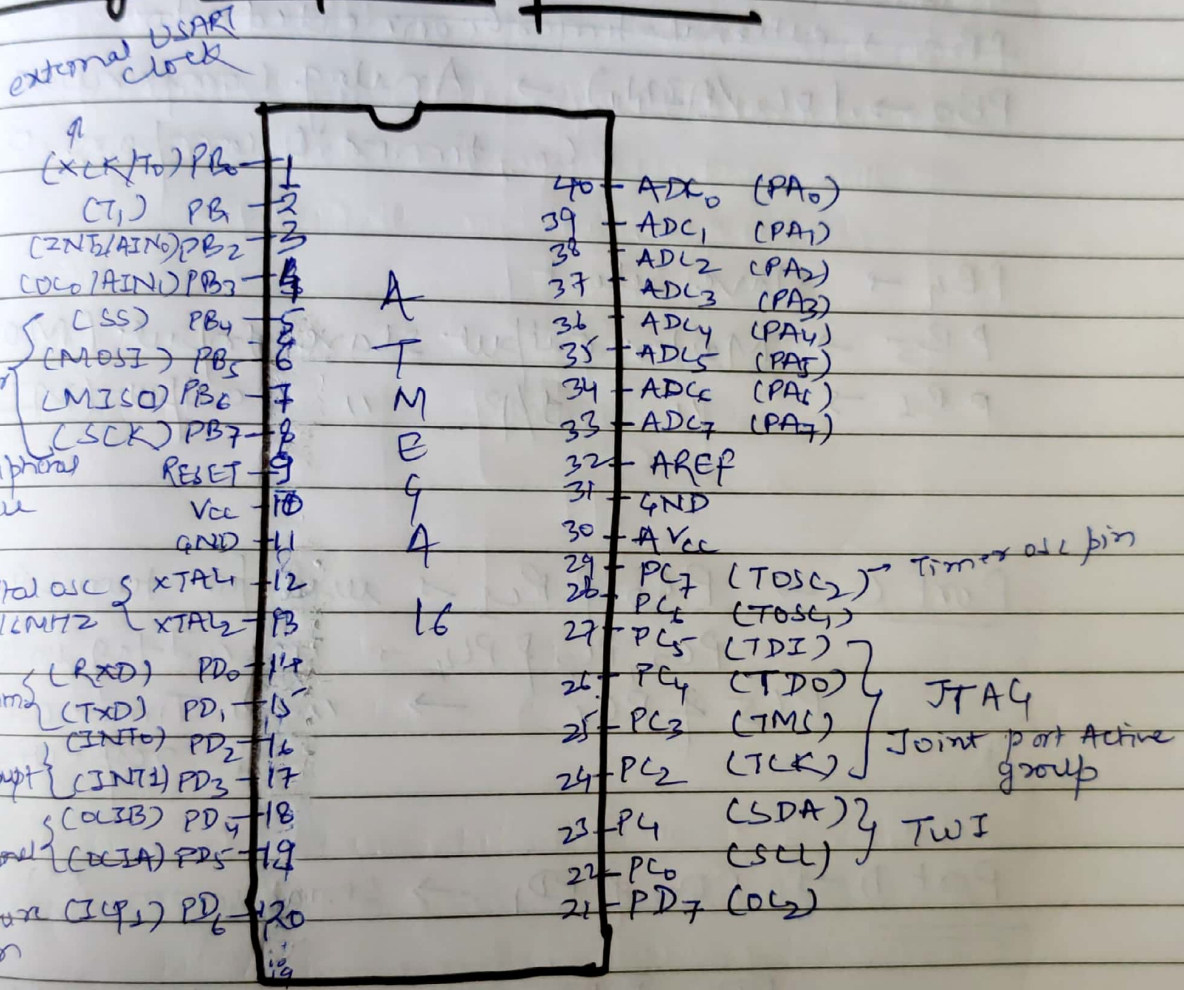
Interrupt & watch dog timer

It is used to overcome software failures in real time applications & to wake up the MC from sleep mode.

pin Diagram of Atmega 16



40 pin IC, 4 ports A, B, C, D as an I/O

I/O pins = 32 pins

AREF → Analog Refrence voltage

AVCC → ~~Analog~~ Vcc (ADC power supply)

RESET - Active low pin XTAL1 & XTAL2 → external crystal osc. do inc. speed & noise level is low.

GND

Vcc - +5V

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Port A →
ADC → Analog to Digital converter (ADC0 - ADC7)

Port B → PB_0 → XCK / T_0 → external timer counter connected to zero i/p

PB_1 → external timer counter connected to i/p one.

PB_2 → external interrupt connected to i/p 2.

~~PB_3 → external timer 0 connected to~~

PB_3 → [OC_0 / AIN_1) → Analog comparator i/p (-ve) / OC_0, timer 0 compare o/p

PB_4 → Slave Select

PB_5 → Master output slave input (MOSI)

PB_6 → " i/p " output (MISO)

Port C → PC_0 & PC_1 → used for two wire interface

PC_2, PC_3 & PC_4 → " " JTag interface

PC_5 & PC_6 → " " Timer OSC. pin i/p respectively.

Port D → PD_0 & PD_1 → Serial comm. RXD TXD

PD_2 & PD_3 → external interrupt

PD_4 & PD_5 → PWM channels

PD_6 & PD_7 → Timer counter 1 i/p & Timer counter 2 o/p

ICP → ~~interrupt~~ i/p capture pin.

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XCK → external clock USART clock
T_0 → Timer 0, T_1 → Timer 1
INT2 → ext. interrupt 2
AIN0 → Analog comparator positive
AIN1 → " " -ve
OC0 → O/p compare
pin 5, 6, 7, 8 pins are used to burn program in µC.
OC1B & OC1A used for PWM channel
output compare of counter 1
OC_2 → o/p compare of counter 2
SCL → Serial clock line
SDA → " data "
JTAG is used for testing, designing, debugging.

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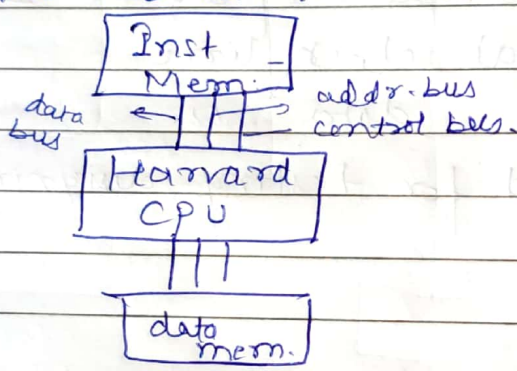
PIC Microcontroller

Peripheral interface controller.

PICs are Harvard architecture based.

Harvard Architecture → when data & code bus is on different memory block.

→ separate bus for both instruction & data.
→ this architecture has data storage entirely contained within the CPU.



Architecture of PIC μC

Pipelining is a technique used to overlap two or more instructions as they are being executed, thus reduce execution time.

CPU - includes ALU, receiving, processing & storing data to & from various registers.

ALU → perform arithmetic & logical oper^n available in instruction set.
→ shows the status of result.

W (working Register) → associated with ALU that temporarily stores data.

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Data Memory (RAM) → It is 8 bit wide & used to store all of program variables (Operands) & that's why the PIC µC are called 8-bit µC.

program memory → where program resides. 0.5 to 16K

Stack – Size of stack depends on each PIC model.

I/o Devices – 8 bit I/I ports, Timers, sync. & async. serial ports, A/D & D/A converters etc.
→ I/o devices generat interrupt request from the µC

Interrupts – provide variety of interrupt sources. interrupt priority available in advanced 18-series PIC.

OSC → crystal osc, RC osc are used.

System Timer – 8-bit or 16-bit counters with pre-scalers & post scalers, which divide down the I/P or O/P of counter to extend its range.

Watchdog timer – It allows the chip to reset itself automatically.

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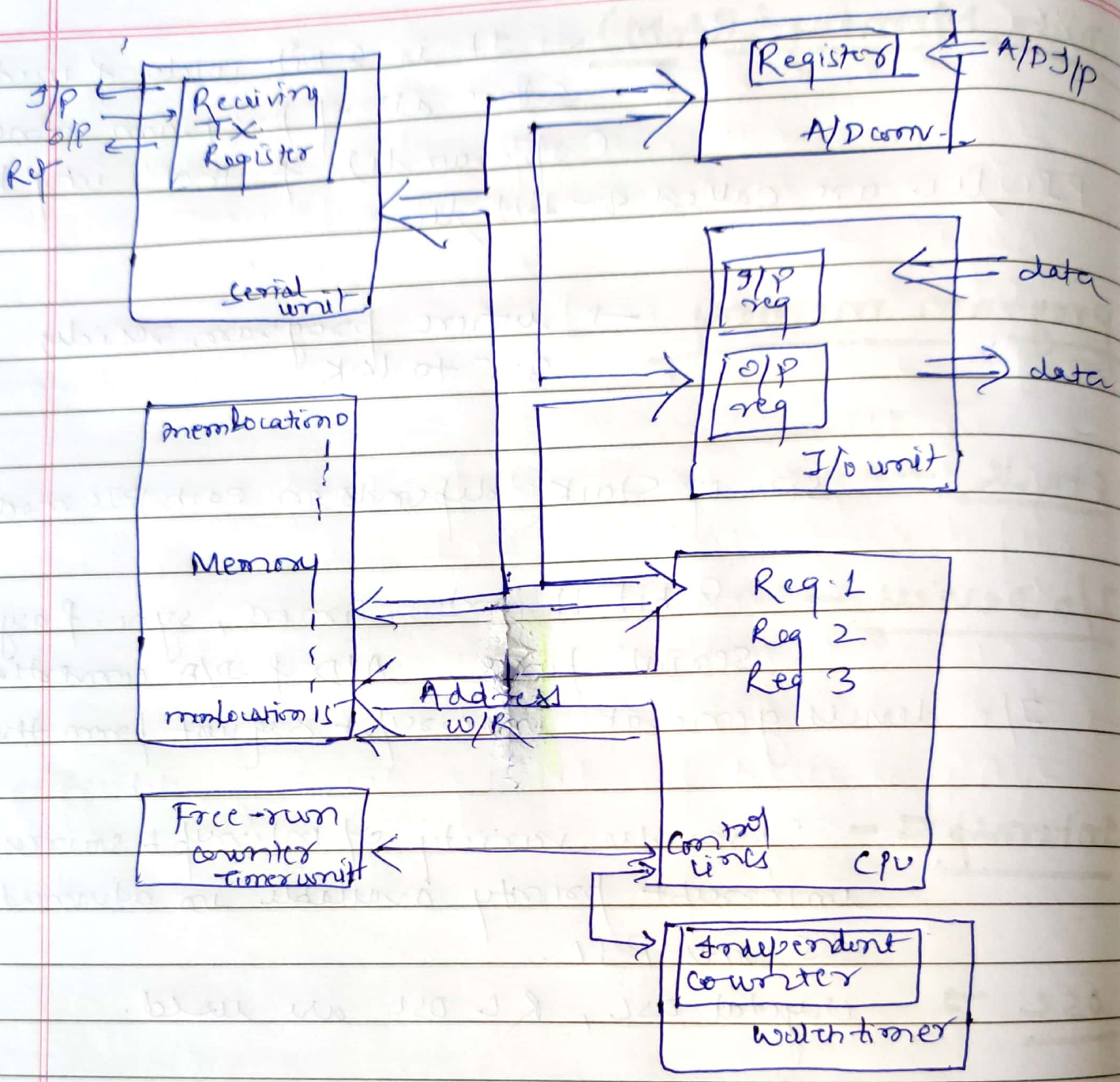

Architecture of PIC

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