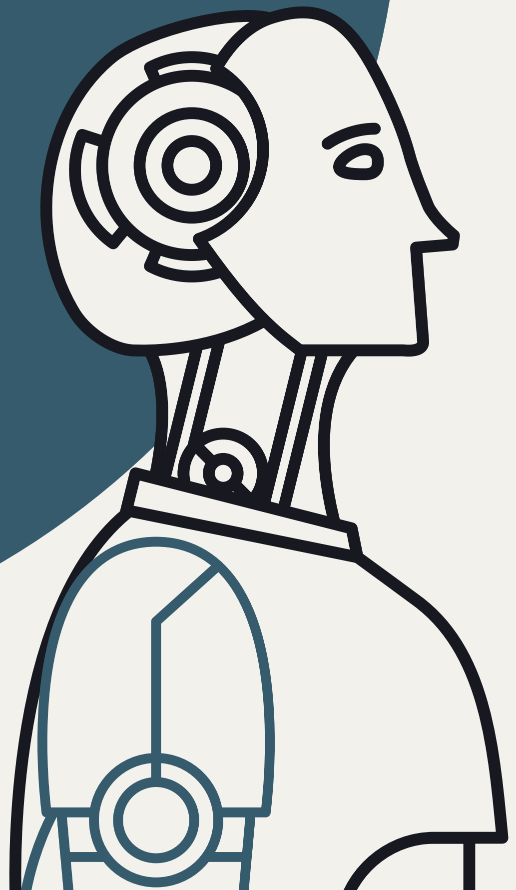
Shoubra Faculty of Engineering
Communications and Computer Engineering Department

PIC16F877A

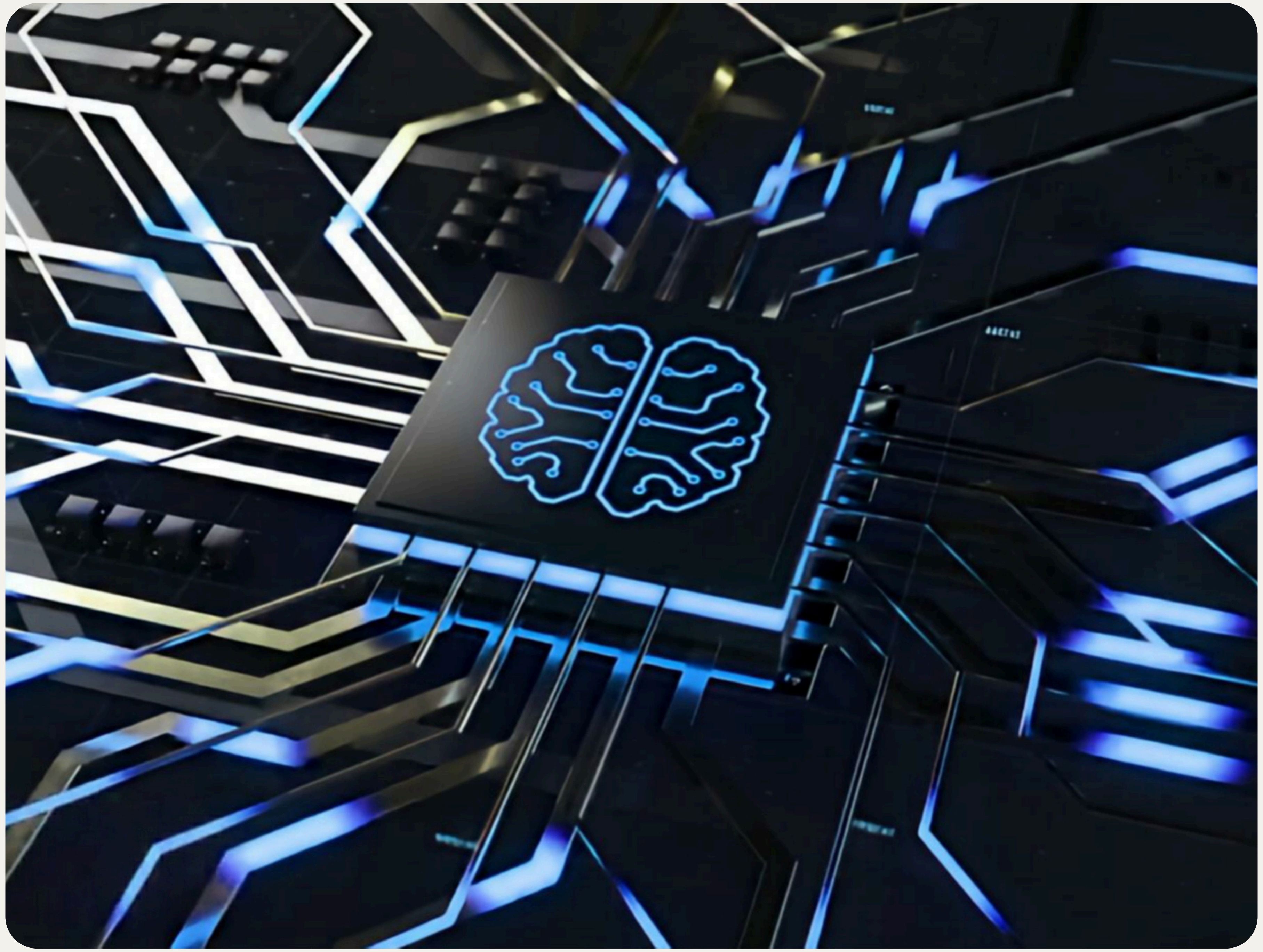
Presentation



Presented By : Ahmed Hamdy

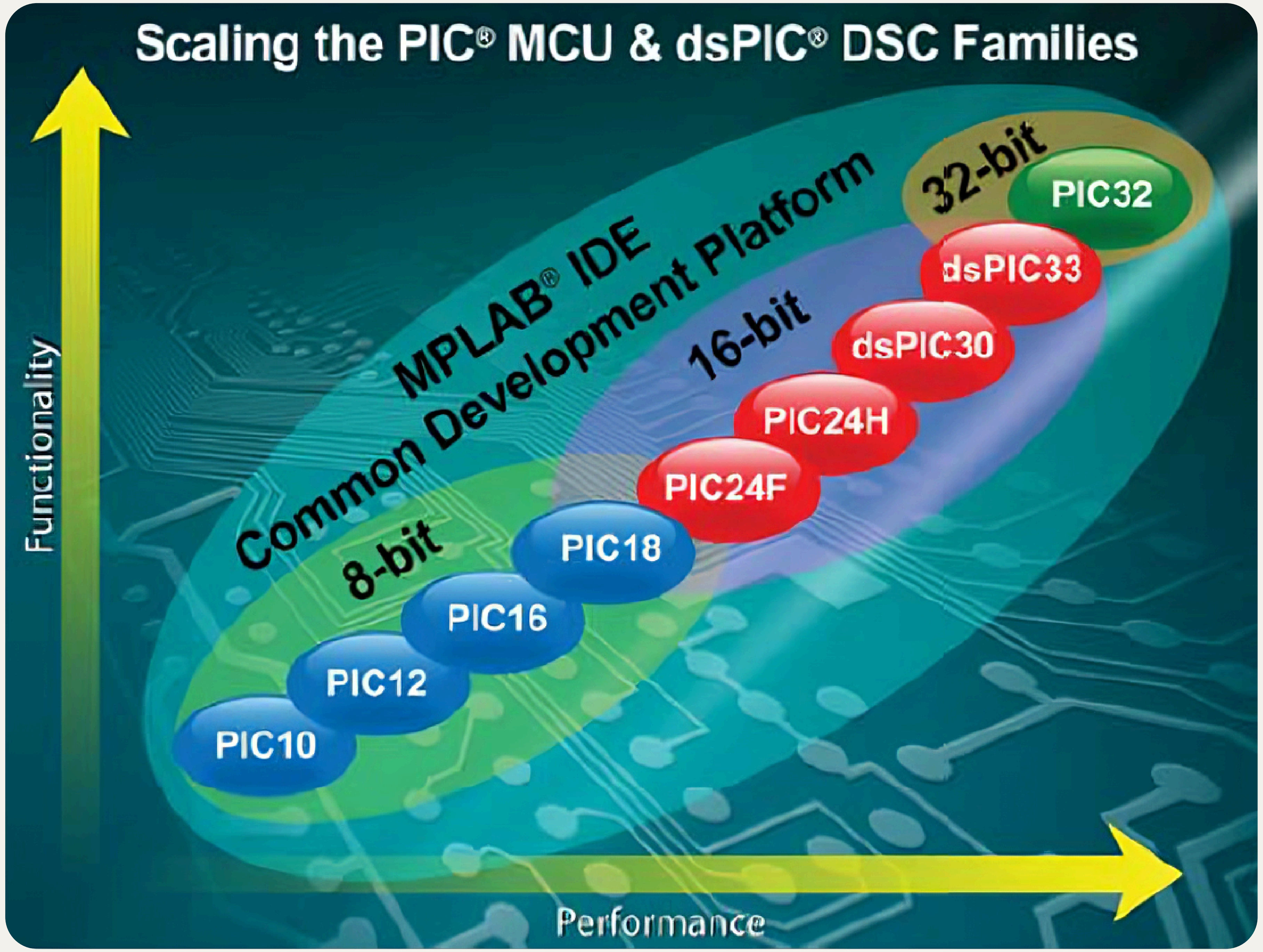
Peripheral Interface Controller (PIC)

The PIC microcontroller is a family of microcontrollers developed by Microchip Technology. Known for their efficiency and low cost. PIC microcontrollers are widely used in embedded systems, automation, robotics, and consumer electronics.



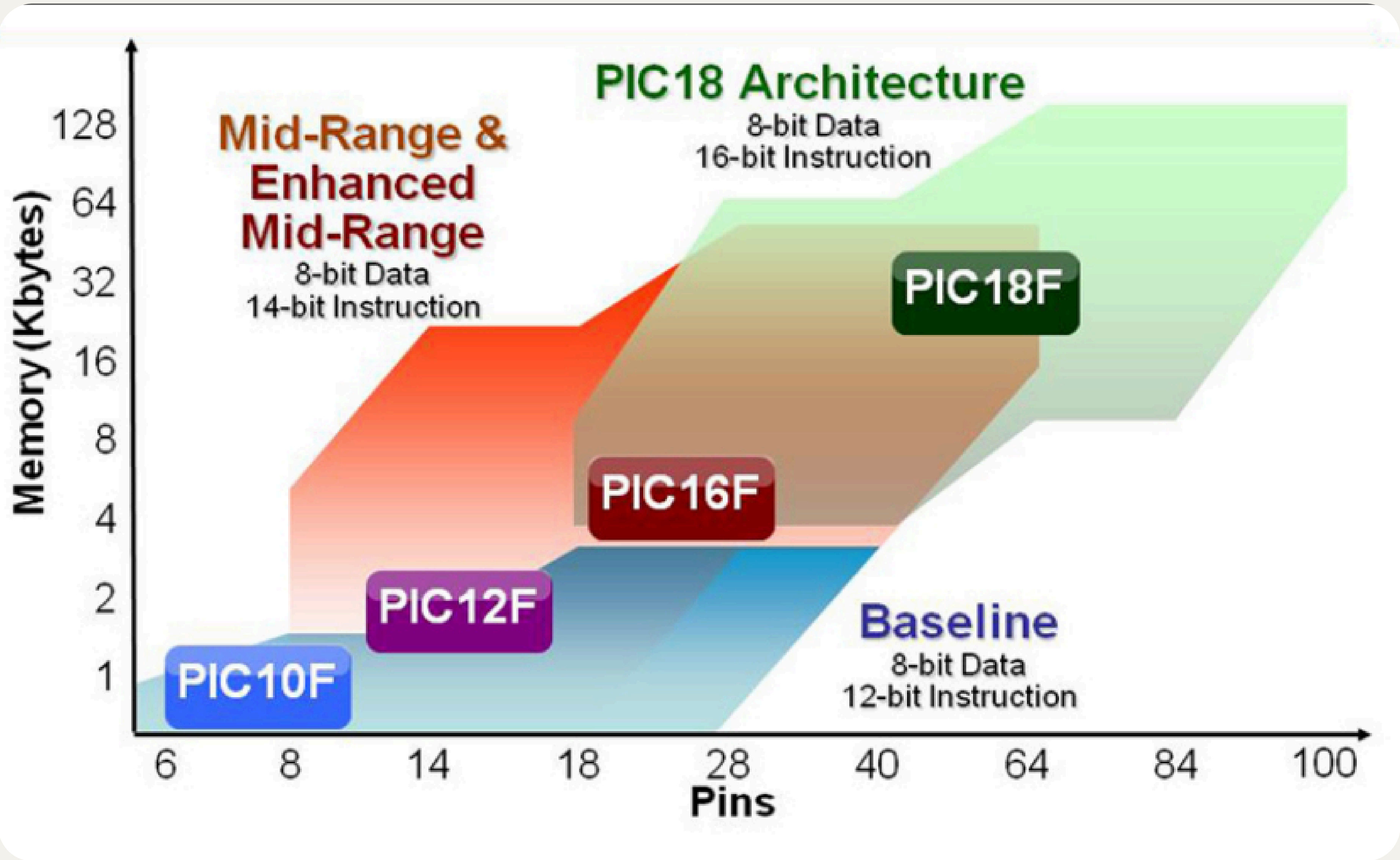
PIC Microcontroller Families

- 8-bit Microcontroller
- 16-bit Microcontroller
- 32-bit Microcontroller



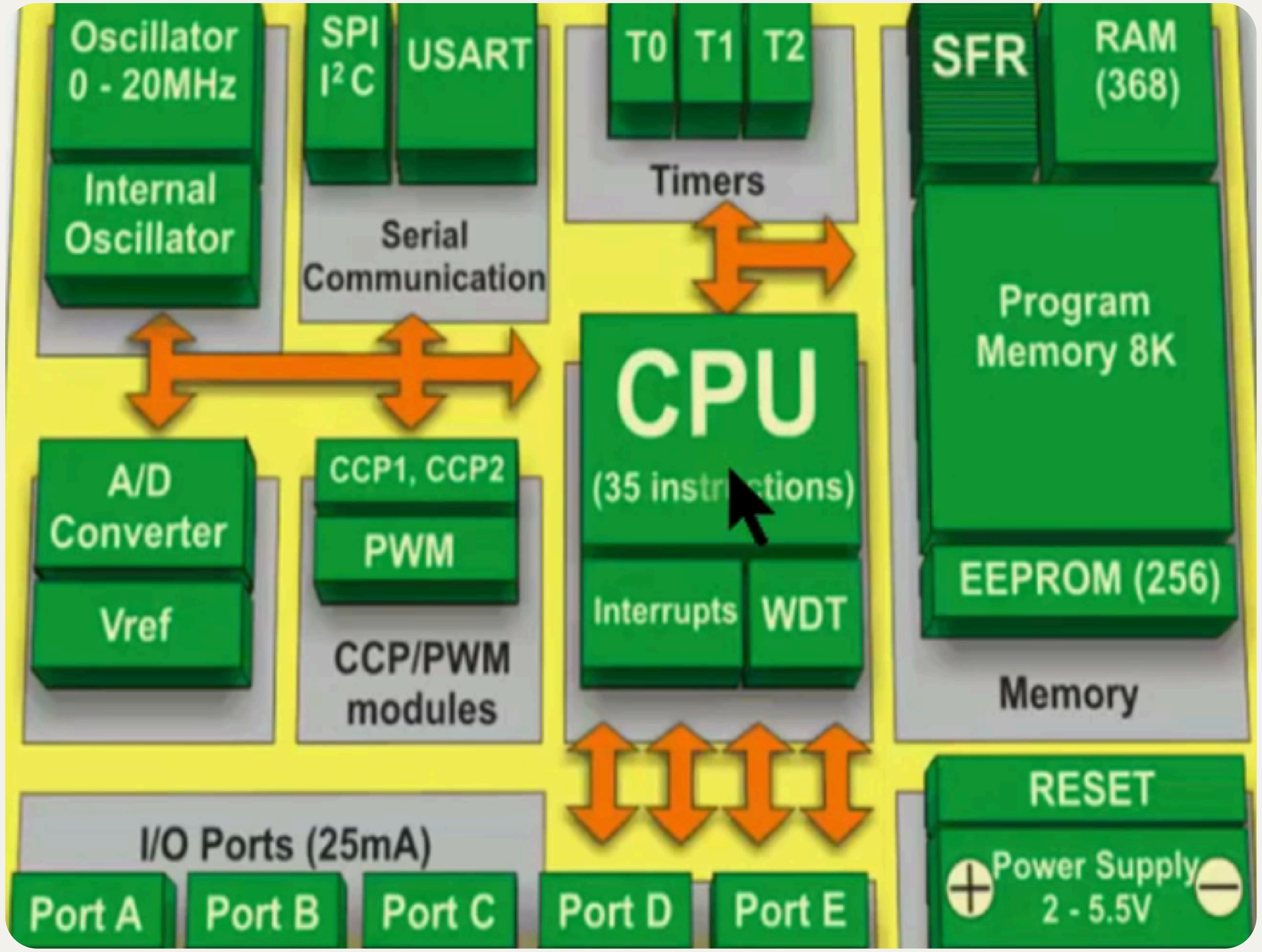
8-Bit Microcontroller

- Baseline (PIC10F)
- Mid-Range (PIC16F877A)
- High-Performance (PIC18F)



Main Blocks of PIC16F877A

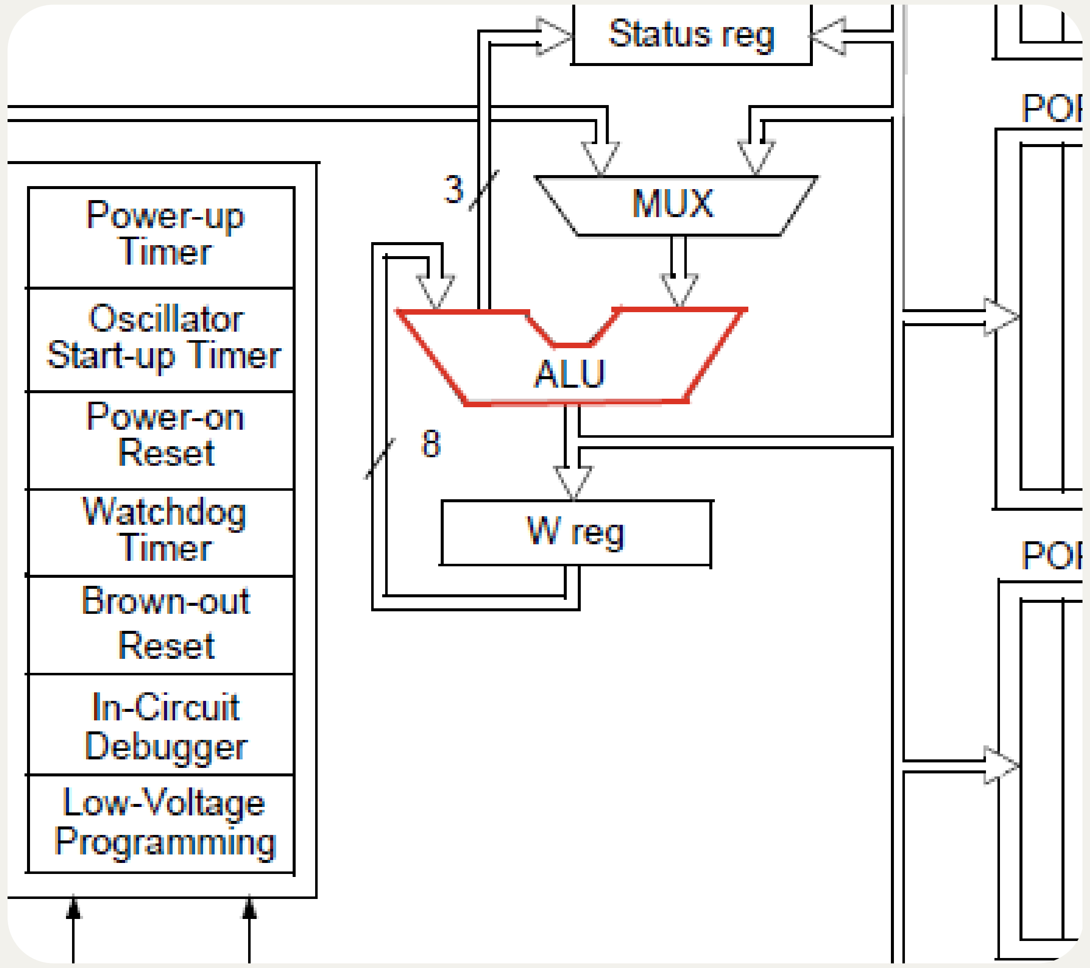
- ALU
- Status and Control
- Program Counter
- Flash Program Memory
- Instruction Register
- Instruction Decoder



ALU

The ALU is the core computation unit. It performs:

- Arithmetic operations: addition, subtraction, increment, etc
- Logic operations: AND, OR, NOT, XOR
- The ALU works with the W register (working register) and data from RAM or program memory



Page 7 (Figure 1-2) in the datasheet

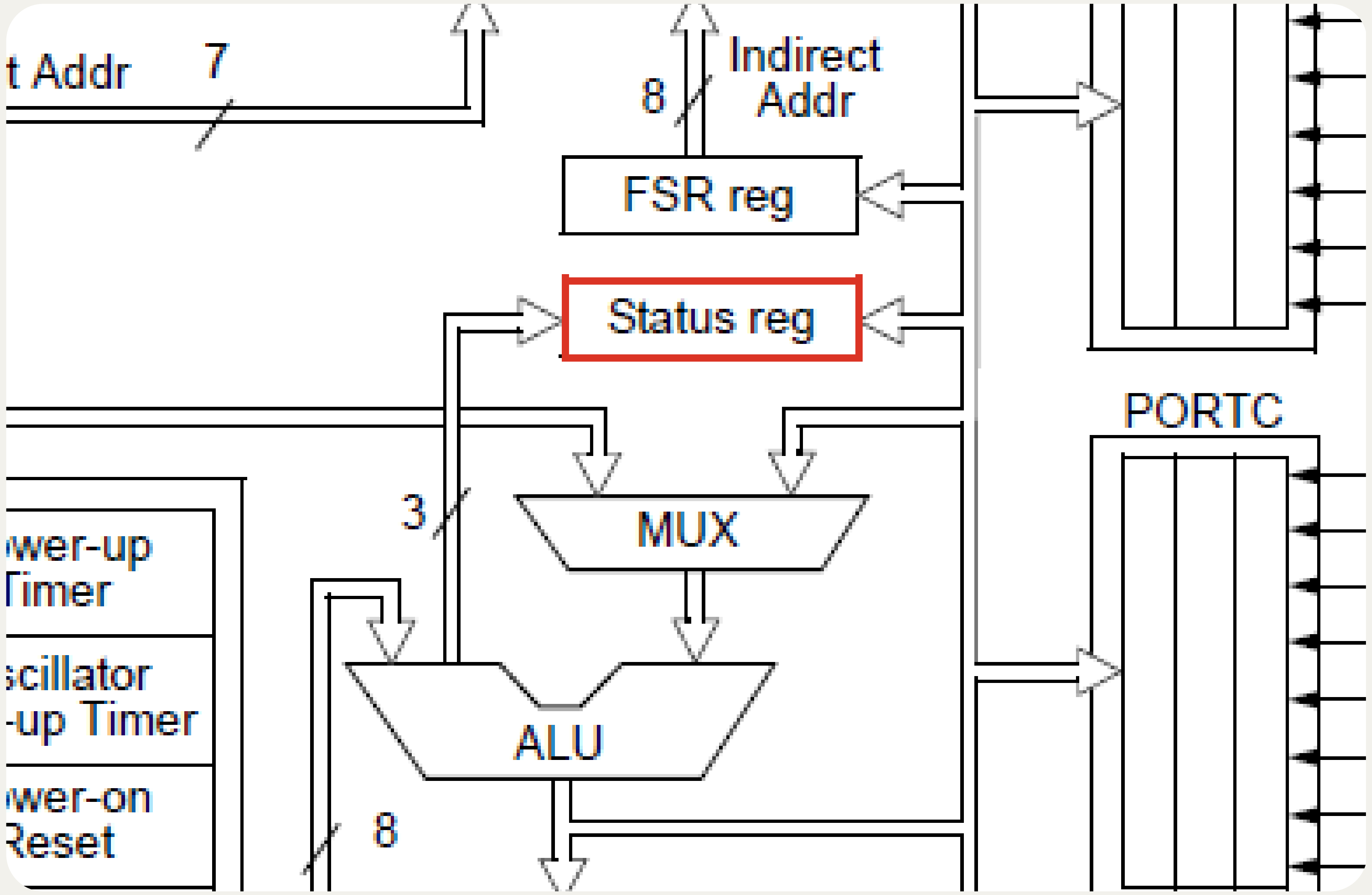
STATUS Register

The STATUS register is a special function register (SFR).
Holds flags that reflect the outcome of ALU operations

2.2.2.1 Status Register

The Status register contains the arithmetic status of the ALU, the Reset status and the bank select bits for data memory.

The Status register can be the destination for any instruction, as with any other register. If the Status register is the destination for an instruction that affects the Z, DC or C bits, then the write to these three bits is disabled. These bits are set or cleared according to the device logic. Furthermore, the $\overline{\text{TO}}$ and $\overline{\text{PD}}$ bits are not writable, therefore, the result of an instruction with the Status register as destination may be different than intended.



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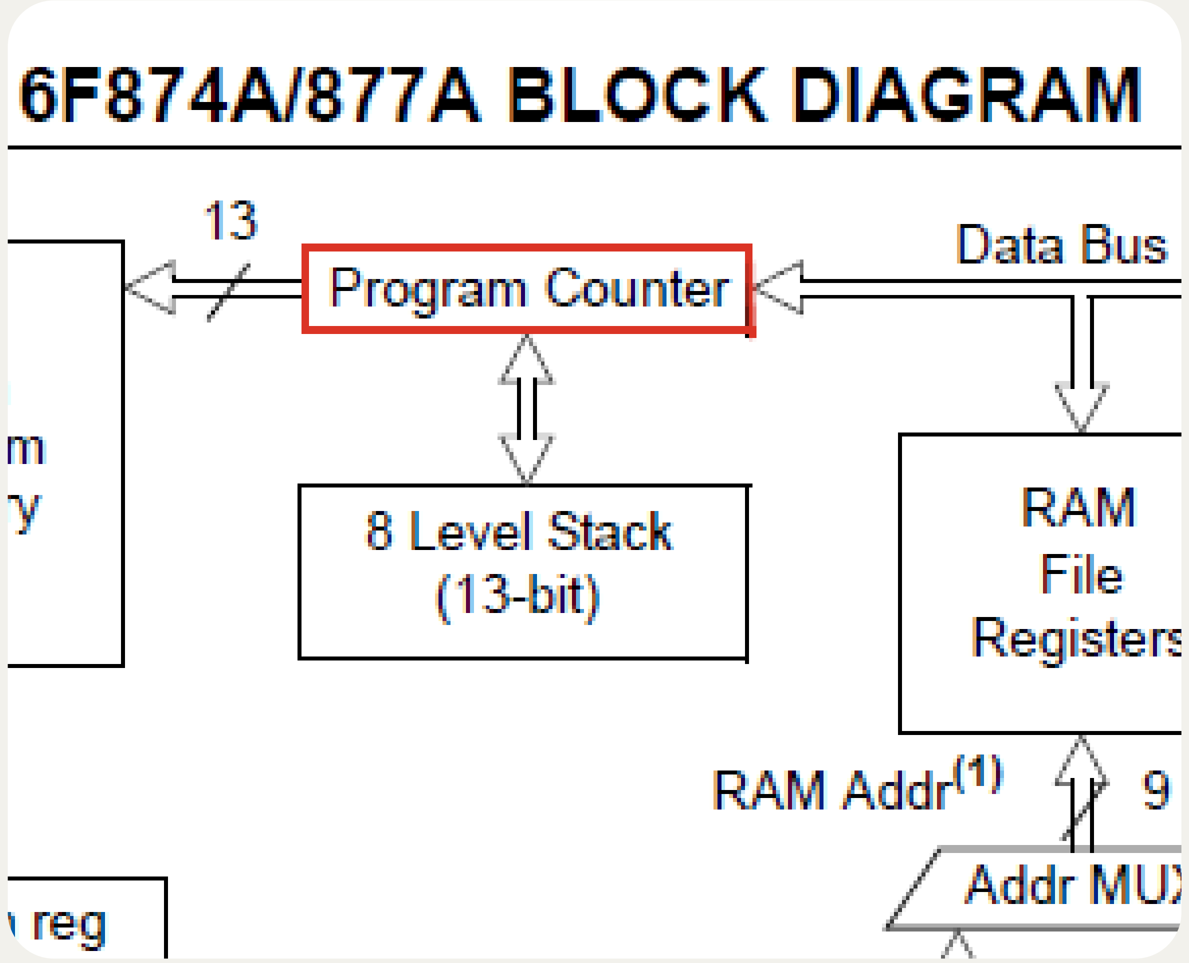
Program Counter (PC)

- Holds the address of the next instruction to execute
- It's a 13-bit register in PIC16F877A, allowing access to 8K words of program memory.
- Automatically increments after each instruction



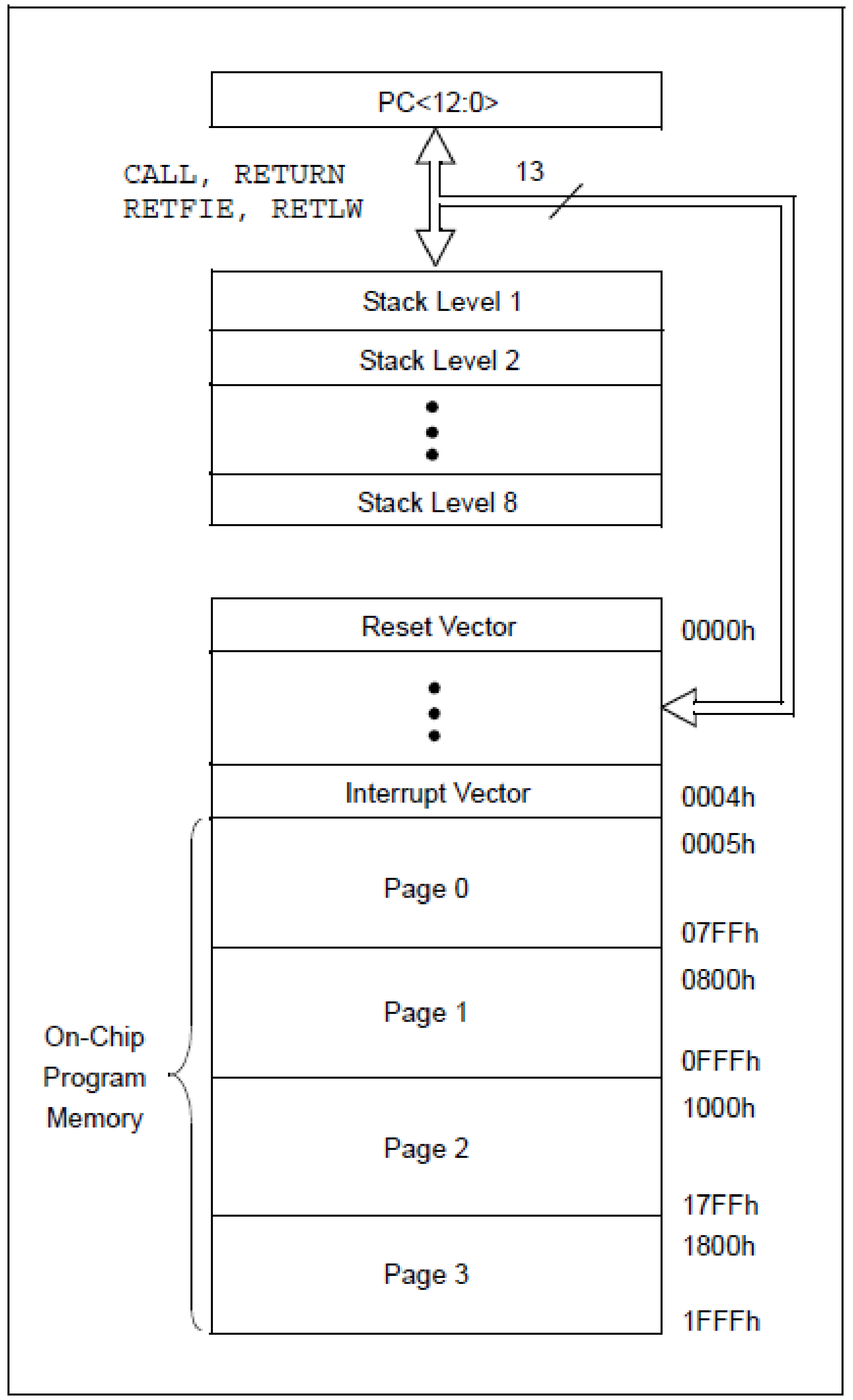
Page 7 (Figure 1-2) in the datasheet

Flash Program Memory

Stores user program (instructions)

- Stores the actual instructions to be executed
- It's a non-volatile memory, so contents persist even when power is off.
- PIC16F877A has 8K x 14-bit words of program memory

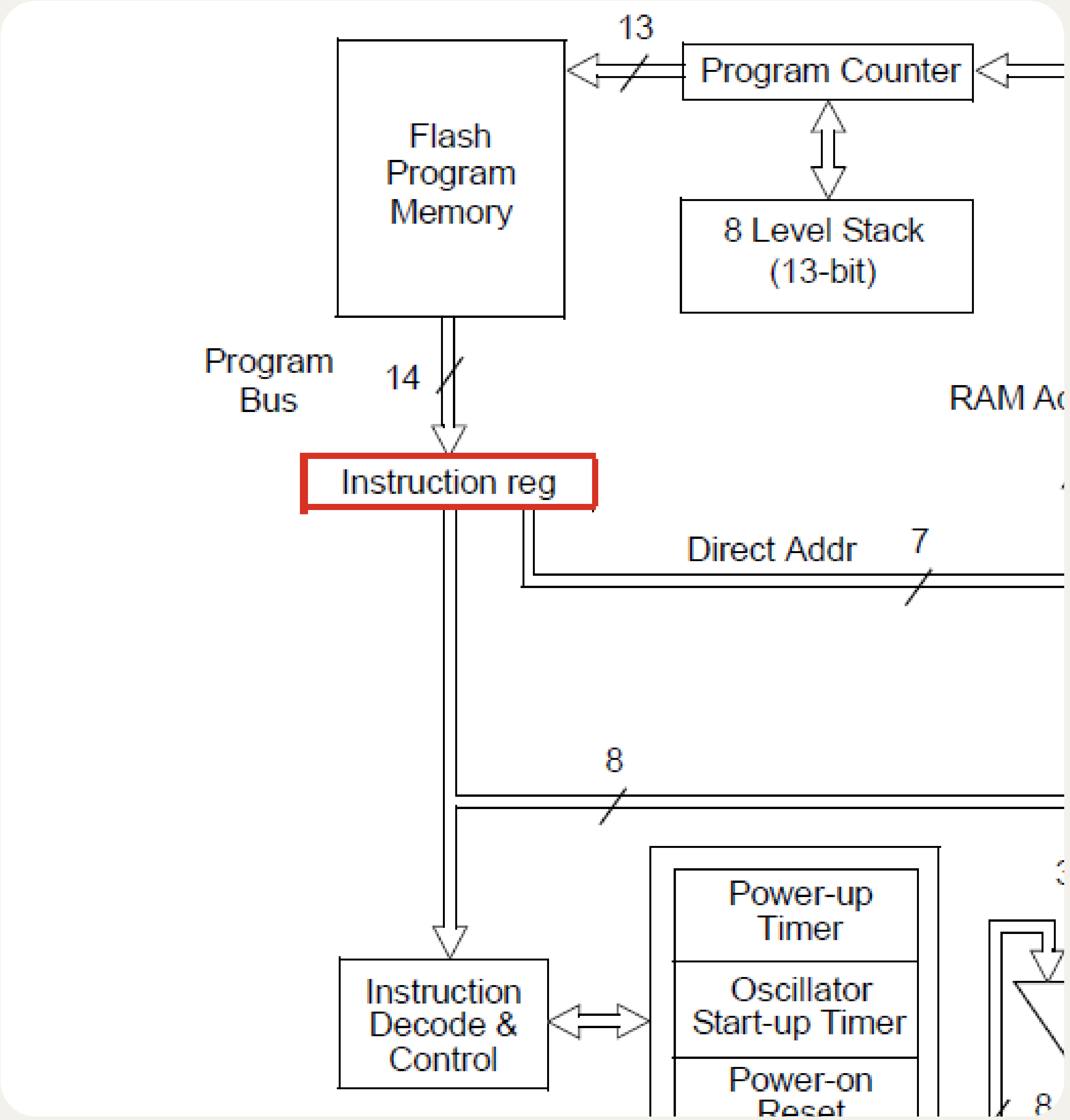
FIGURE 2-1: PIC16F876A/877A PROGRAM MEMORY MAP AND STACK



Page 15 (Figure 2-1) in the datasheet

Instruction Register

- Temporarily holds the current instruction fetched from program memory.
- Acts as a buffer between Flash and the Instruction Decoder
- It's not directly accessible by the user

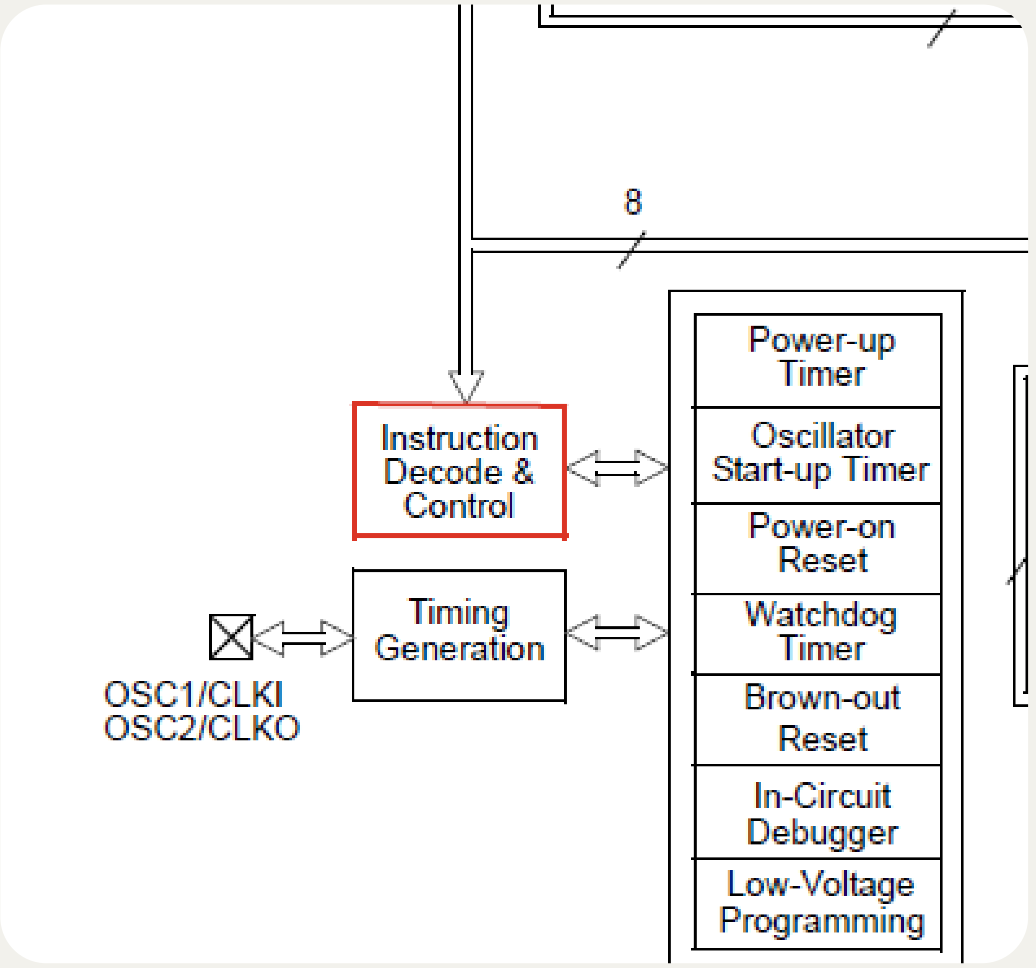


Page 7 (Figure 1-2) in the datasheet

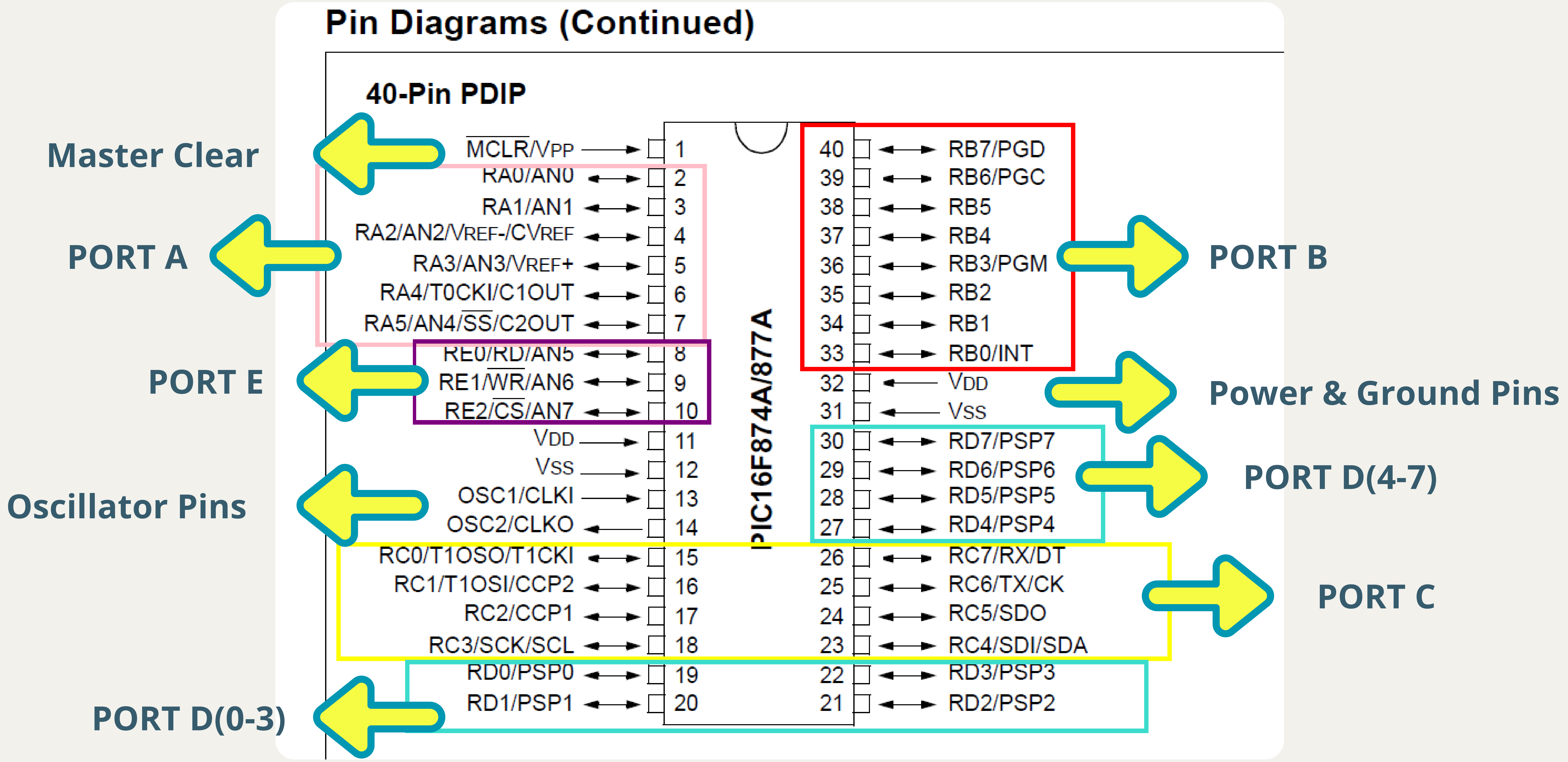
Instruction Decoder

Converts instruction into control signals

- Decodes the binary instruction held in the Instruction Register
- Determines what action the CPU must perform.
- Controls internal control signals, execution units, memory access, and ALU operation



Page 7 (Figure 1-2) in the datasheet


Pin Diagrams (Continued)
40-Pin PDIP
PIC16F874A/877A
Master Clear
PORT A
PORT E
Oscillator Pins
PORT D(0-3)
PORT B
Power & Ground Pins
PORT D(4-7)
PORT C
MCLR/VPP 1
RA0/AN0 2
RA1/AN1 3
RA2/AN2/VREF-/CVREF 4
RA3/AN3/VREF+ 5
RA4/T0CKI/C1OUT 6
RA5/AN4/SS/C2OUT 7
RE0/RD/AN5 8
RE1/WR/AN6 9
RE2/CS/AN7 10
VDD 11
VSS 12
OSC1/CLKI 13
OSC2/CLKO 14
RC0/T1OSO/T1CKI 15
RC1/T1OSI/CCP2 16
RC2/CCP1 17
RC3/SCK/SCL 18
RD0/PSP0 19
RD1/PSP1 20
40 RB7/PGD
39 RB6/PGC
38 RB5
37 RB4
36 RB3/PGM
35 RB2
34 RB1
33 RB0/INT
32 VDD
31 VSS
30 RD7/PSP7
29 RD6/PSP6
28 RD5/PSP5
27 RD4/PSP4
26 RC7/RX/DT
25 RC6/TX/CK
24 RC5/SDO
23 RC4/SDI/SDA
22 RD3/PSP3
21 RD2/PSP2

REGISTER 11-2: ADCON1 REGISTER (ADDRESS 9Fh)

R/W-0	R/W-0	U-0	U-0	R/W-0	R/W-0	R/W-0	R/W-0
ADFM	ADCS2	—	—	PCFG3	PCFG2	PCFG1	PCFG0
bit 7							bit 0

Pins A0, A1, A2, A3, A5 & E0, E1, E2 read analog signal by default, So if we need them to read digital signal, We can use ADCON1 Register (Analog to Digital Converter Register)

According to the figure shown :

ADCON1 value must be 0b011x to make all the pins above read digital signal

ADCON1 = 7; OR ADCON1 = 6;

PCFG <3:0>	AN7	AN6	AN5	AN4	AN3	AN2	AN1	AN0	VREF+	VREF-	C/R
0000	A	A	A	A	A	A	A	A	VDD	VSS	8/0
0001	A	A	A	A	VREF+	A	A	A	AN3	VSS	7/1
0010	D	D	D	A	A	A	A	A	VDD	VSS	5/0
0011	D	D	D	A	VREF+	A	A	A	AN3	VSS	4/1
0100	D	D	D	D	A	D	A	A	VDD	VSS	3/0
0101	D	D	D	D	VREF+	D	A	A	AN3	VSS	2/1
011x	D	D	D	D	D	D	D	D	—	—	0/0
1000	A	A	A	A	VREF+	VREF-	A	A	AN3	AN2	6/2
1001	D	D	A	A	A	A	A	A	VDD	VSS	6/0
1010	D	D	A	A	VREF+	A	A	A	AN3	VSS	5/1
1011	D	D	A	A	VREF+	VREF-	A	A	AN3	AN2	4/2
1100	D	D	D	A	VREF+	VREF-	A	A	AN3	AN2	3/2
1101	D	D	D	D	VREF+	VREF-	A	A	AN3	AN2	2/2
1110	D	D	D	D	D	D	D	A	VDD	VSS	1/0
1111	D	D	D	D	VREF+	VREF-	D	A	AN3	AN2	1/2

A = Analog input D = Digital I/O

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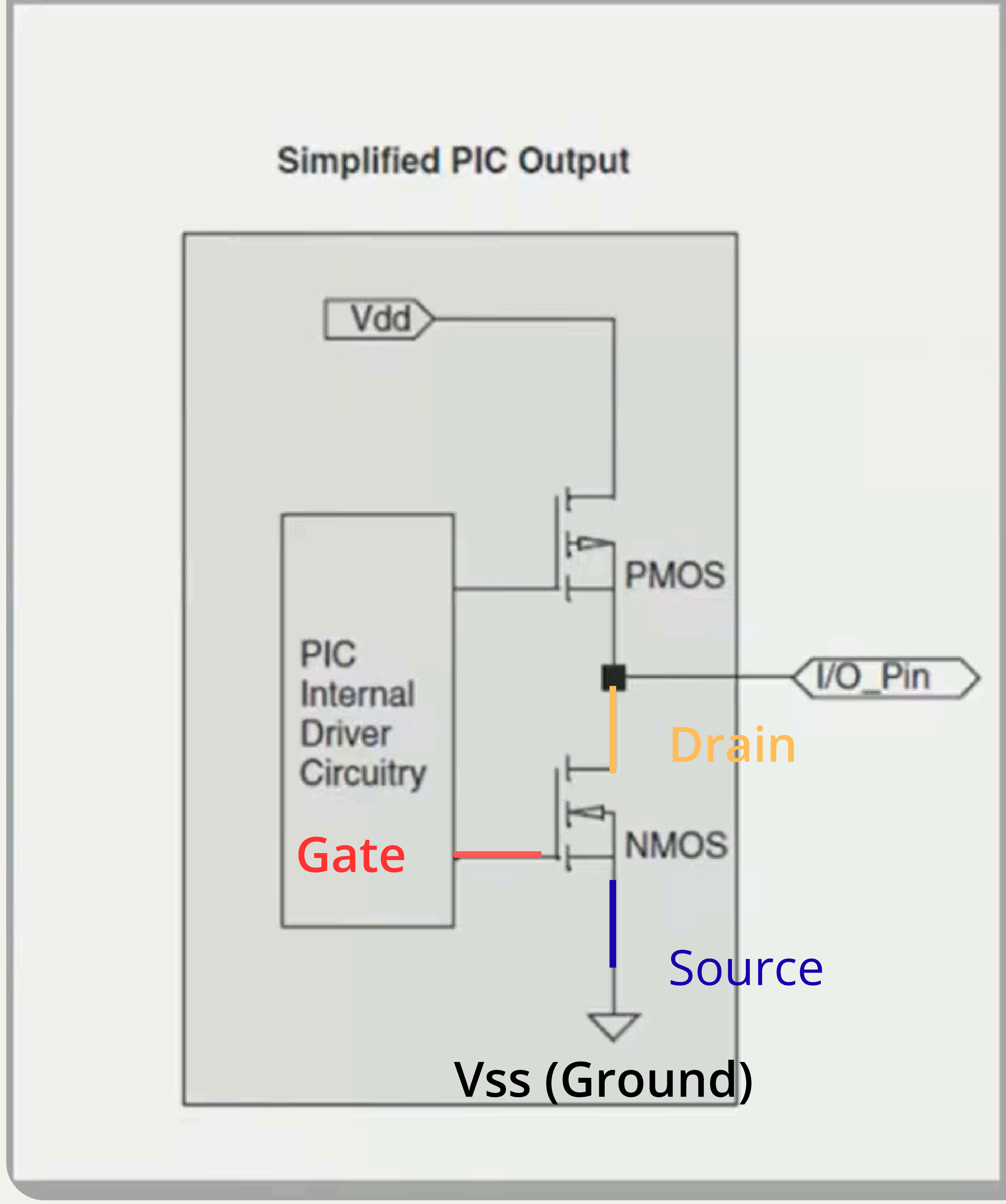
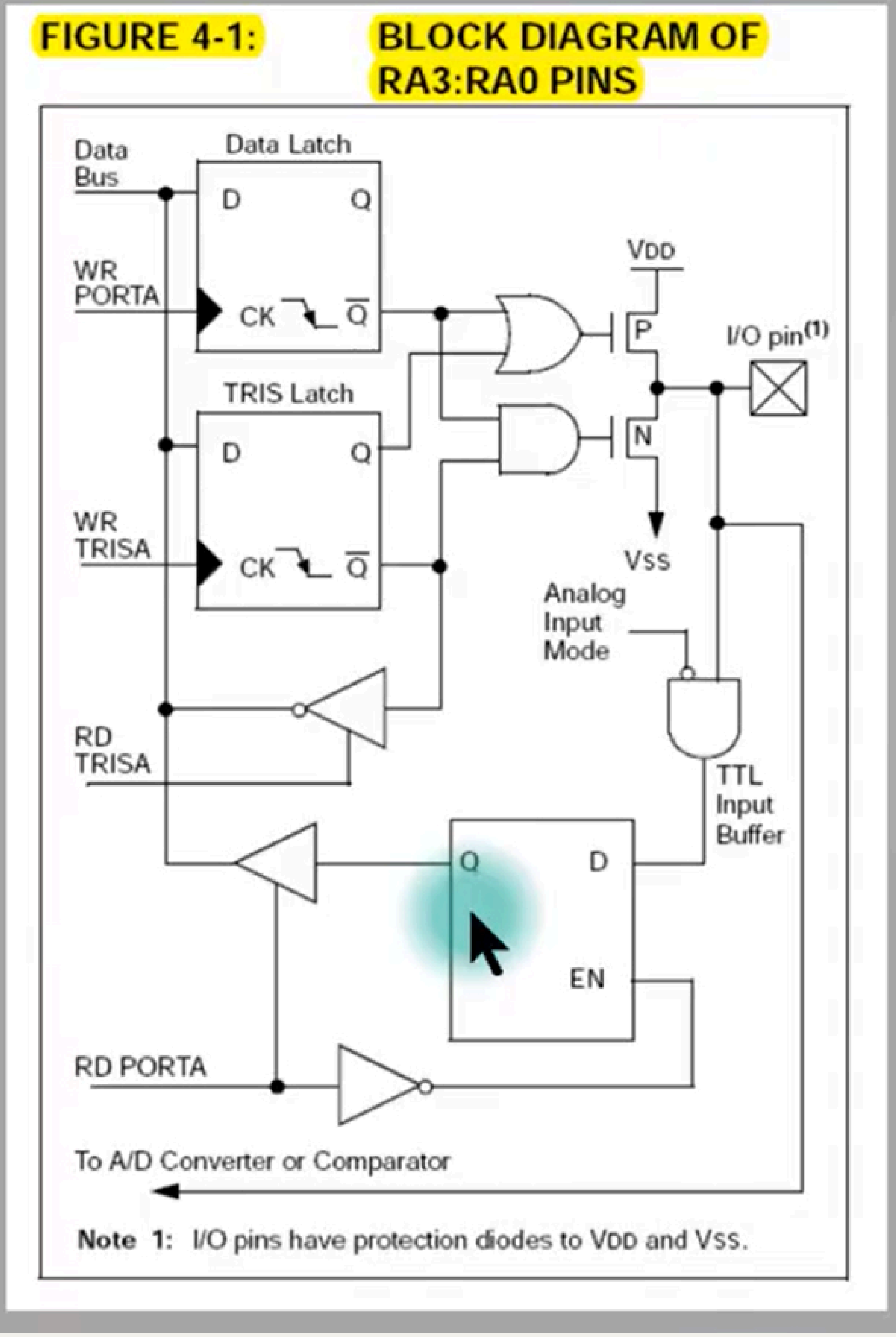




Case 5V (Logic 1) :

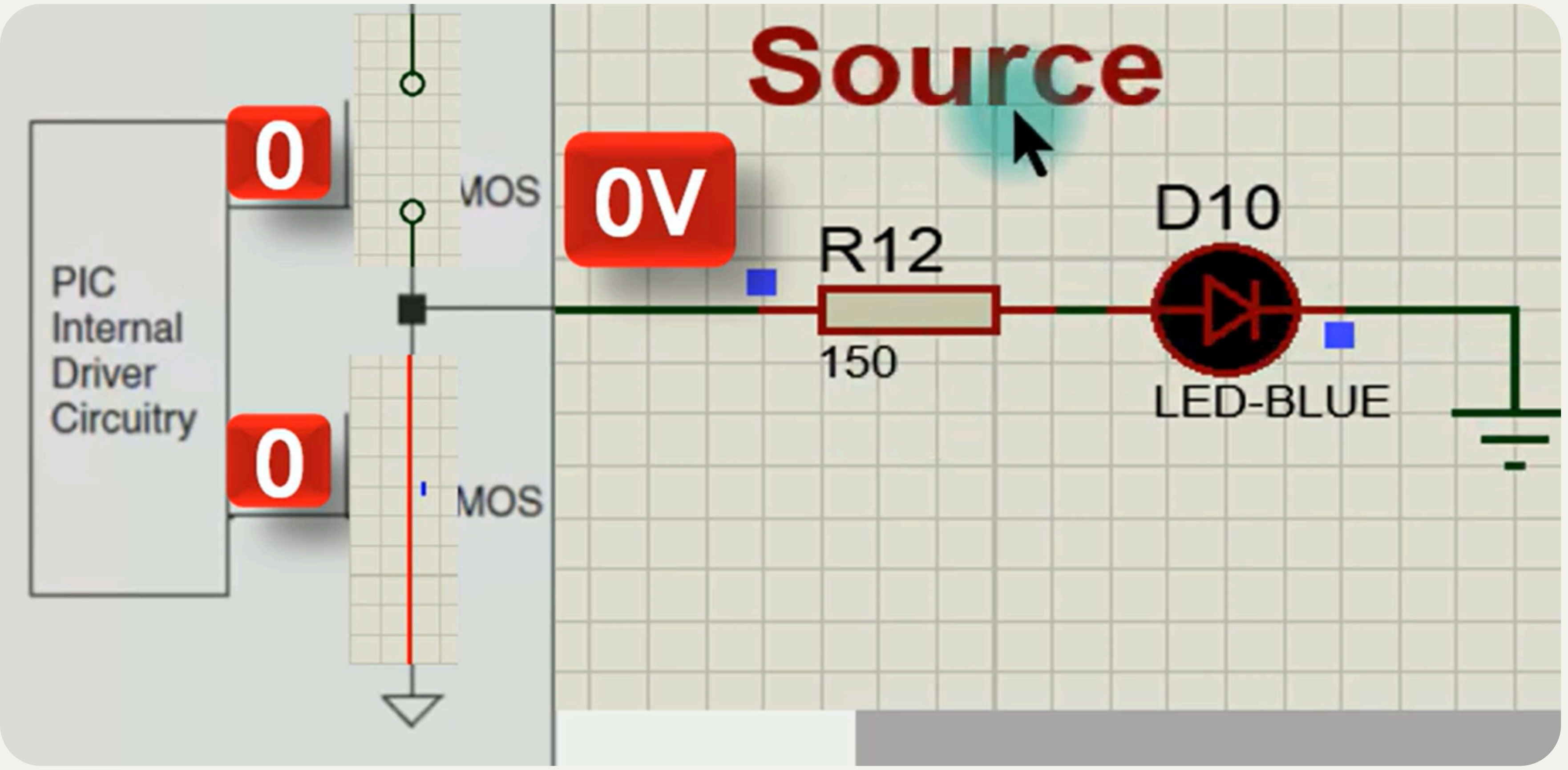
PMOS is ON (Short-Circuit)

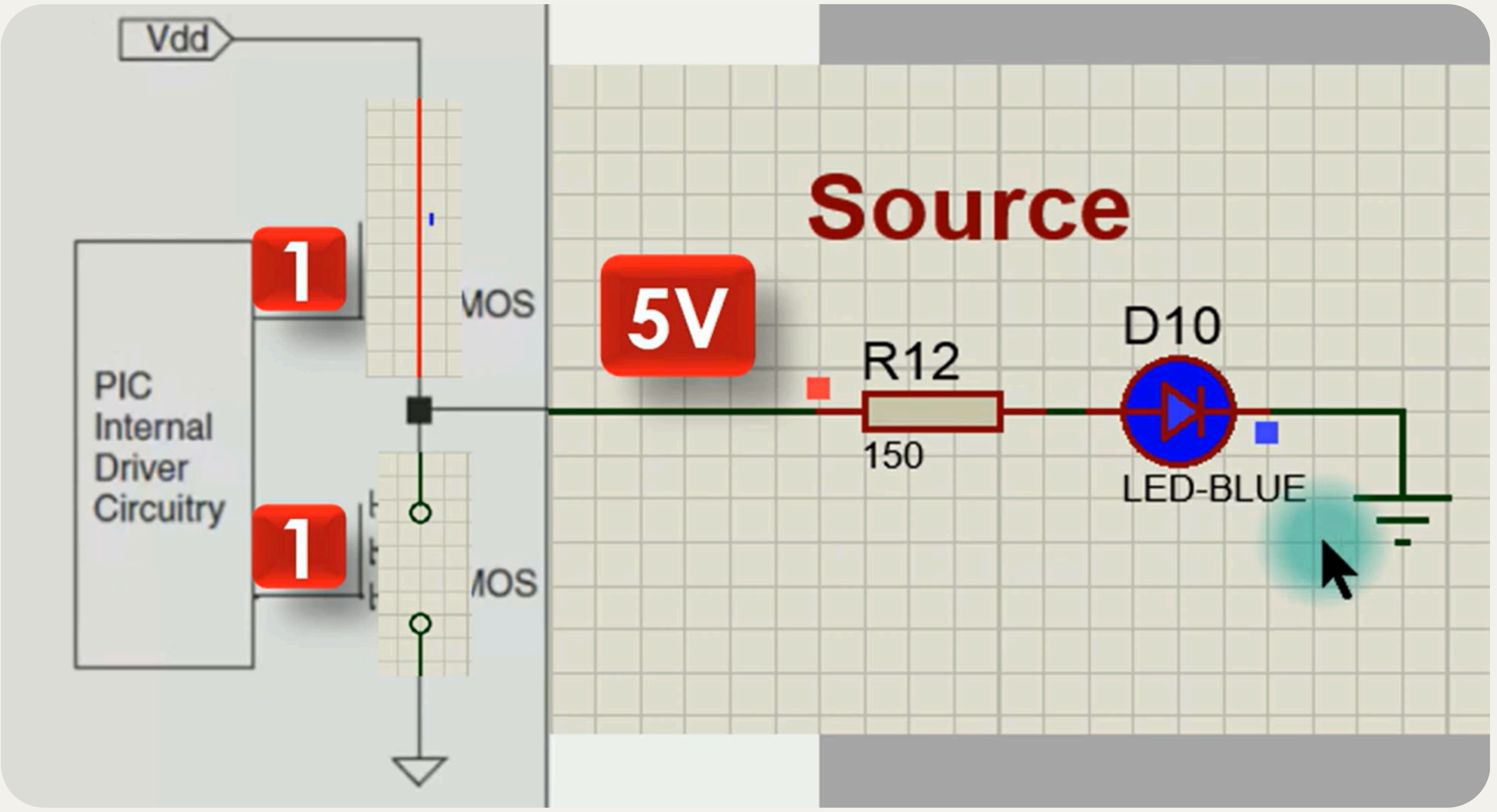
NMOS is OFF (Open-Circuit)

Case 0V (Logic 0) :

PMOS is OFF (Open-Circuit)

NMOS is ON (Short-Circuit)



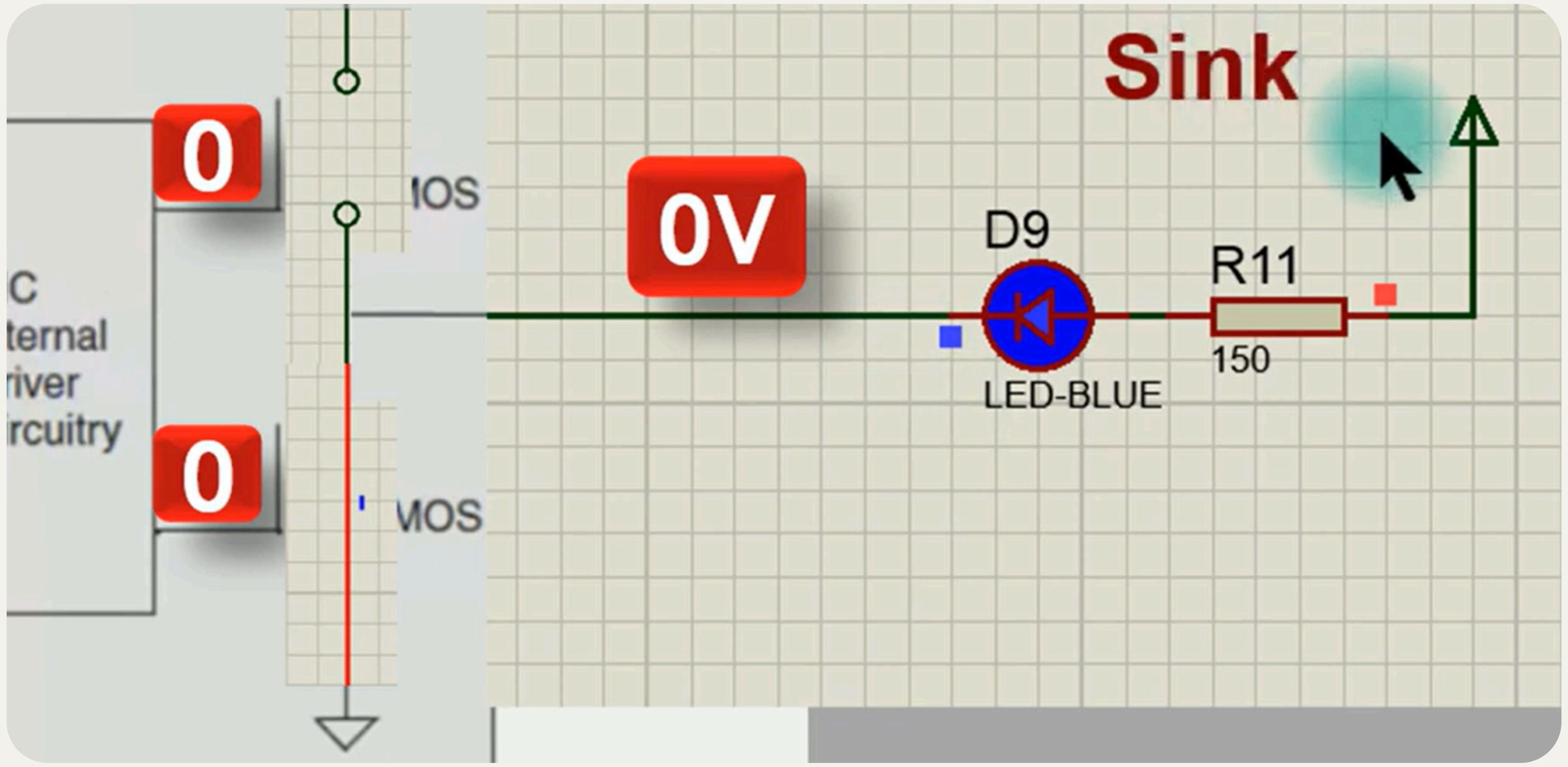


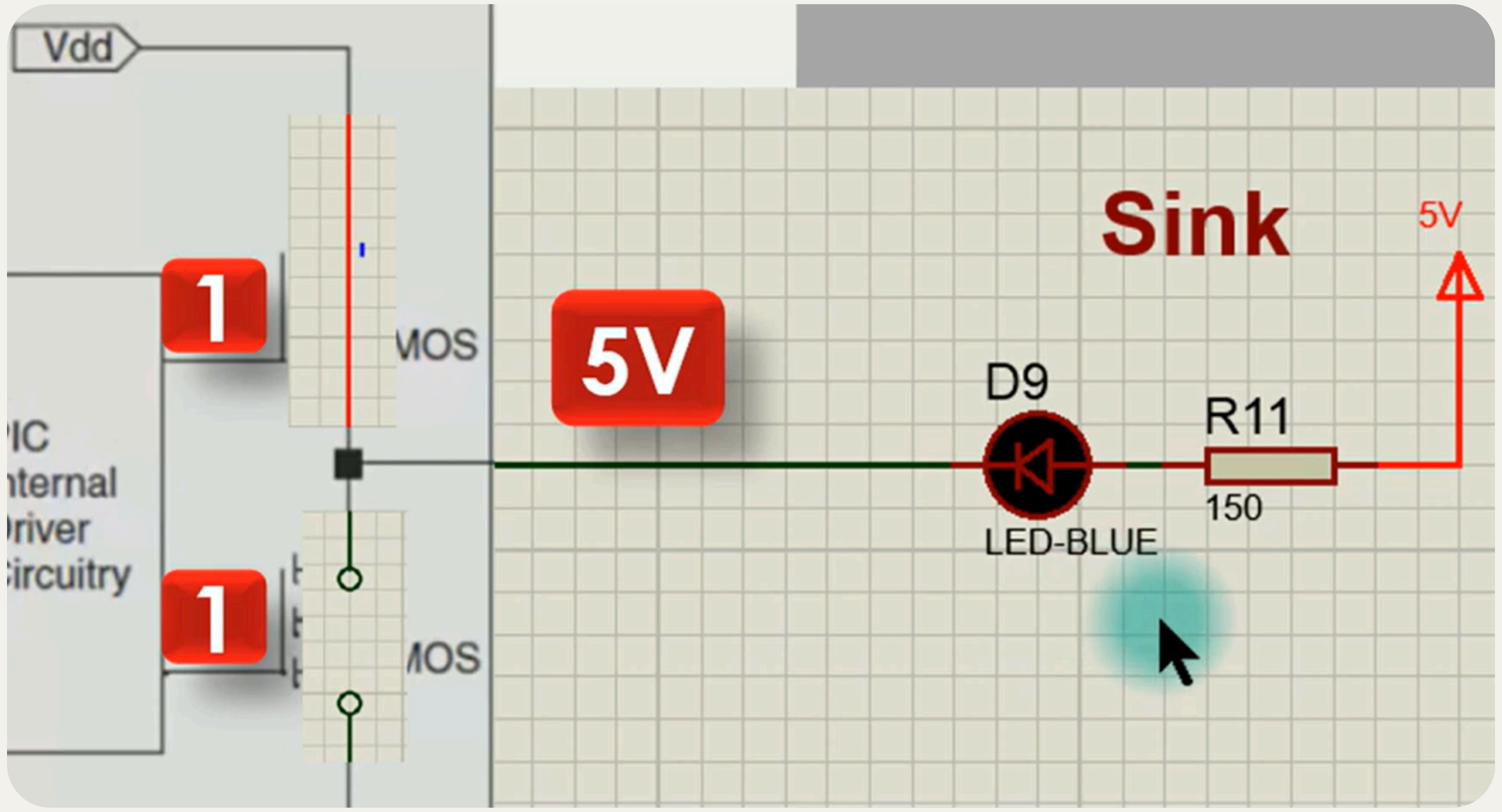
Case 0V (Logic 0) :

PMOS is OFF (Open-Circuit) & NMOS is ON (Short-Circuit) , So Output is 0V and LED is OFF

Case 5V (Logic 1) :

PMOS is ON (Short-Circuit) & NMOS is OFF (Open-Circuit) , So Output is 5V and LED is ON





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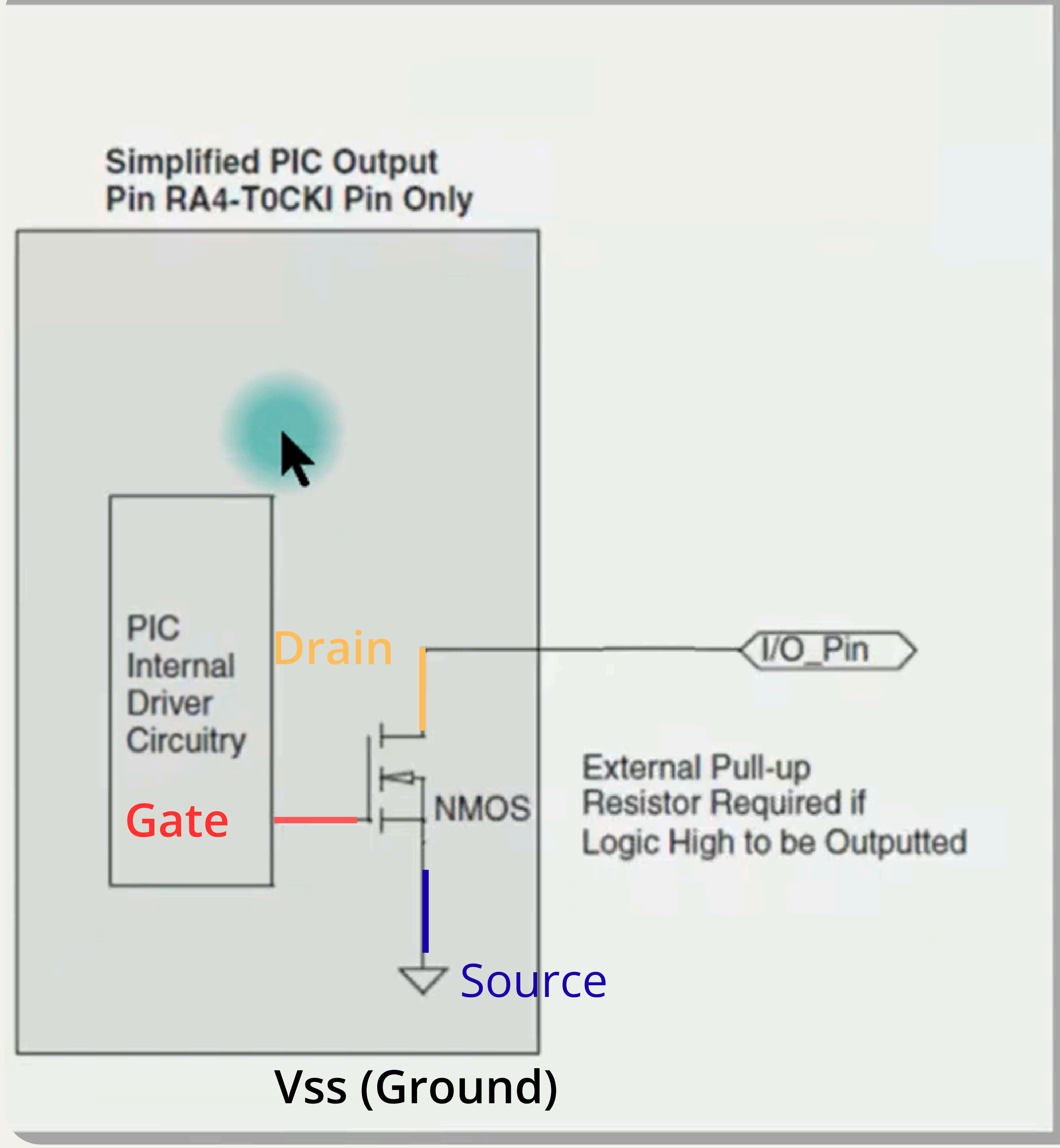
PMOS is OFF (Open-Circuit) & NMOS is ON (Short-Circuit) , So Output is 0V and LED is ON

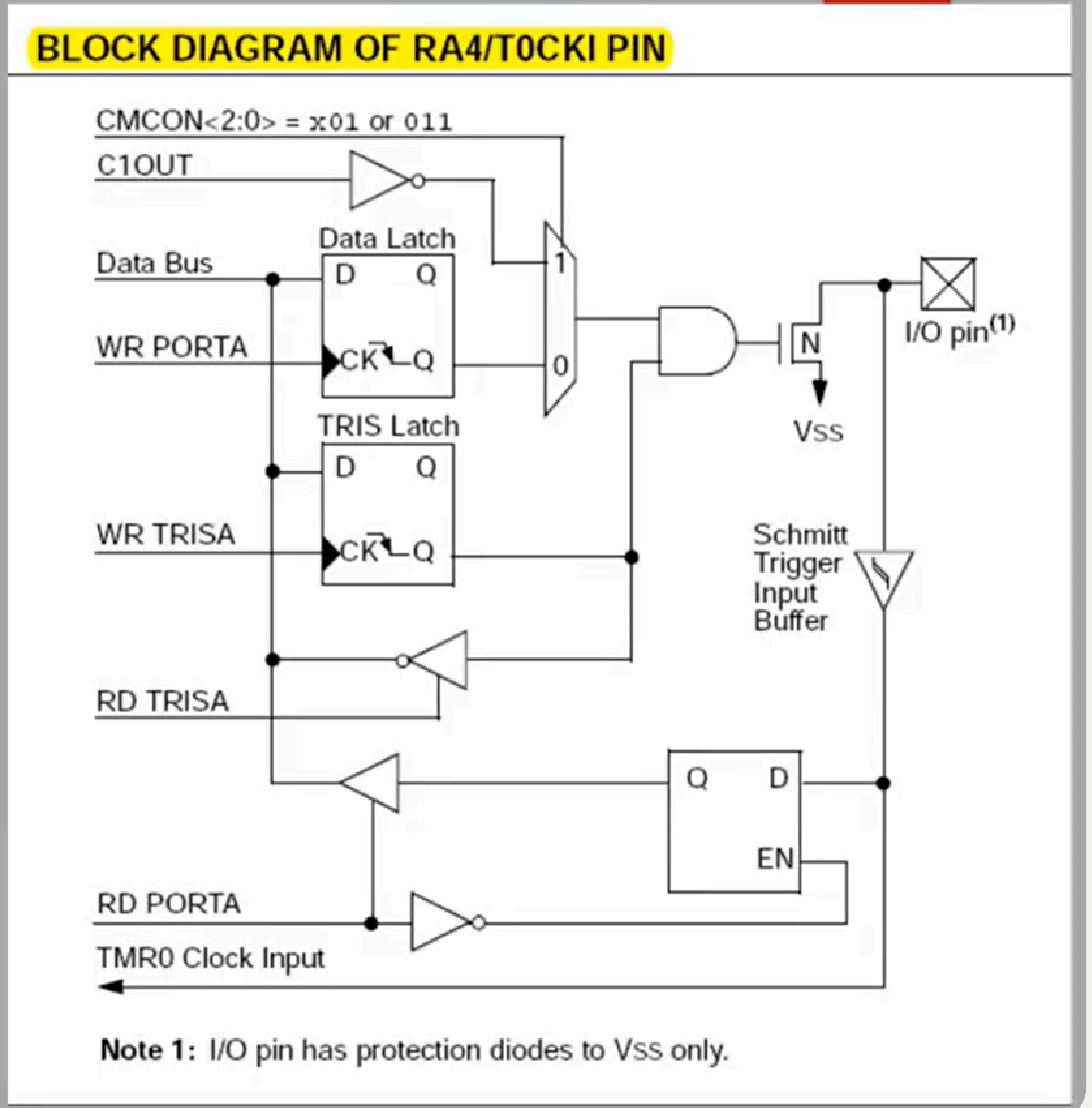
Case 5V (Logic 1) :

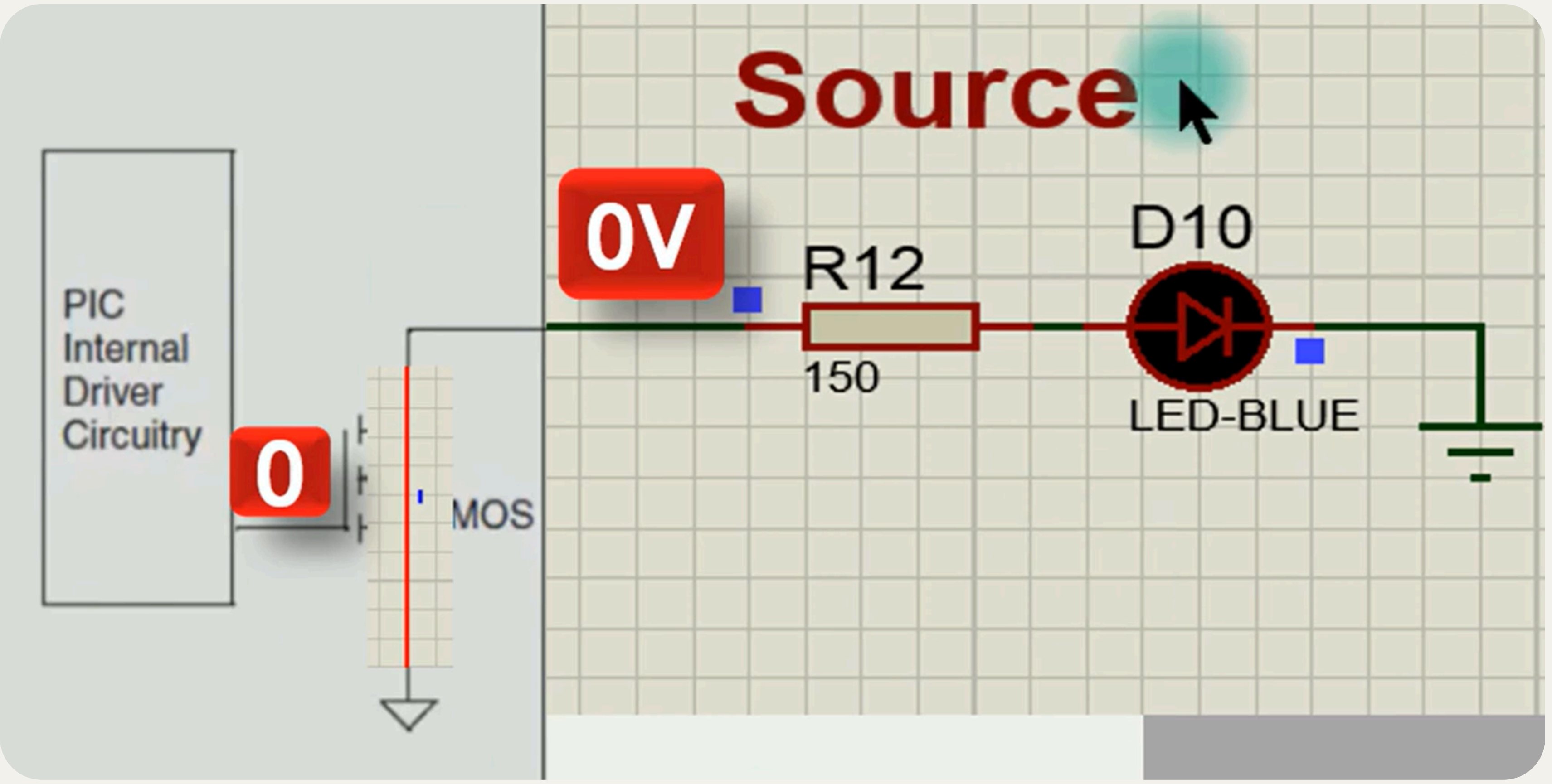
PMOS is ON (Short-Circuit) & NMOS is OFF (Open-Circuit) , So Output is 5V and LED is OFF

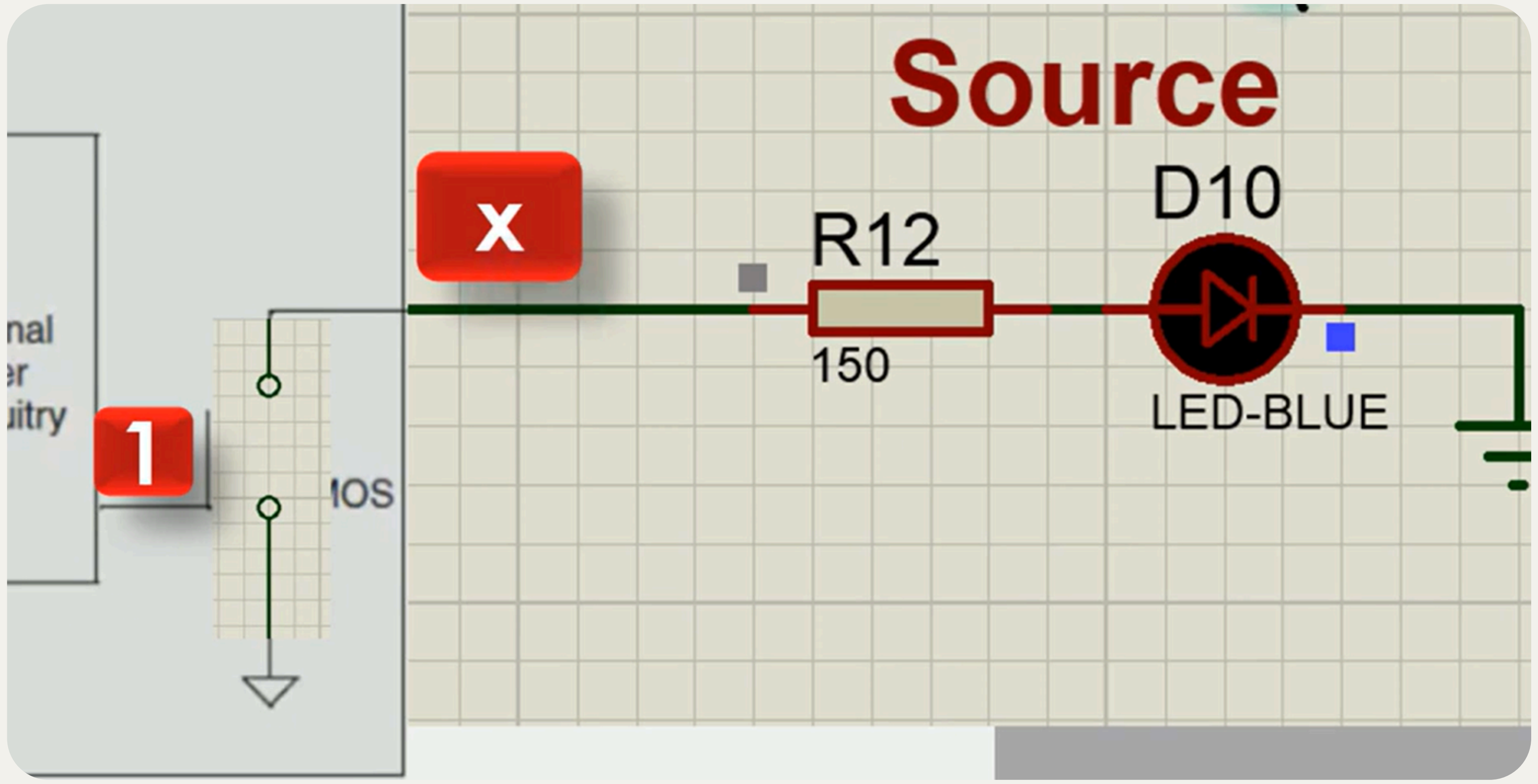
Block Diagram of RA4 PIN

PIC16F877A



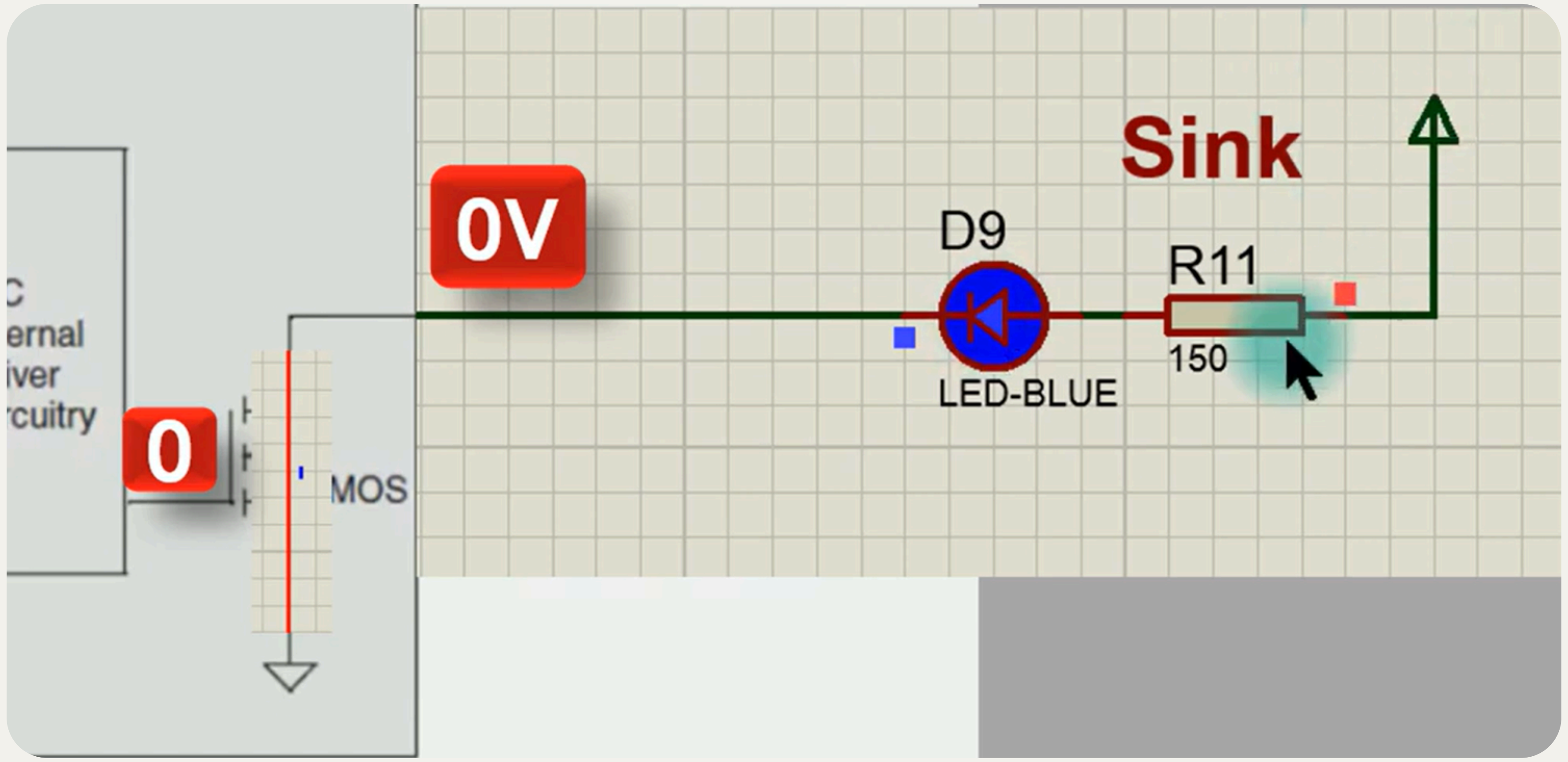


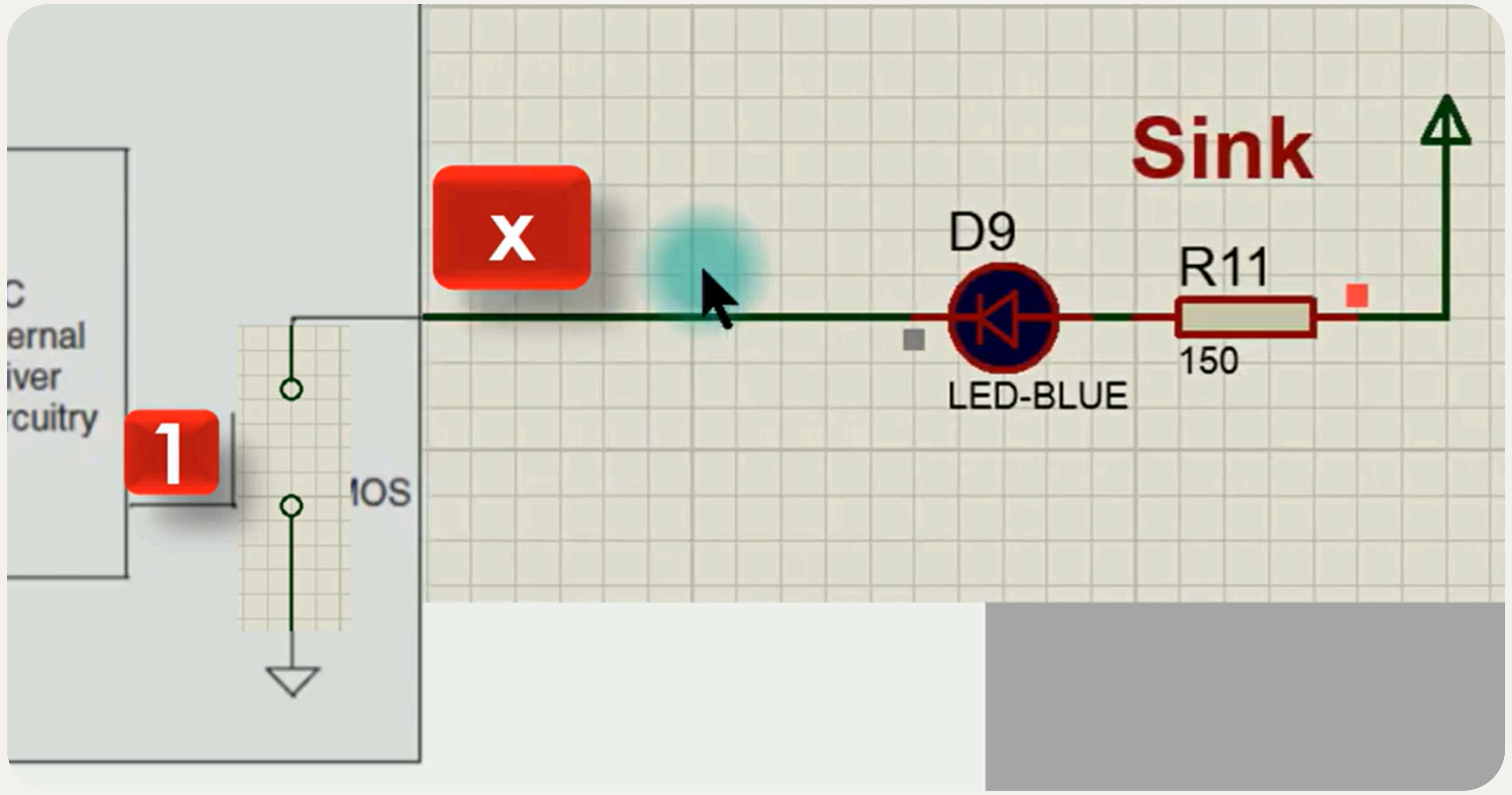




Case 0V (Logic 0) :
NMOS is ON (Short-Circuit) , So Output is 0V and LED is OFF

Case 5V (Logic 1) :
NMOS is OFF (Open-Circuit) , So Output is UNKNOWN and LED is OFF





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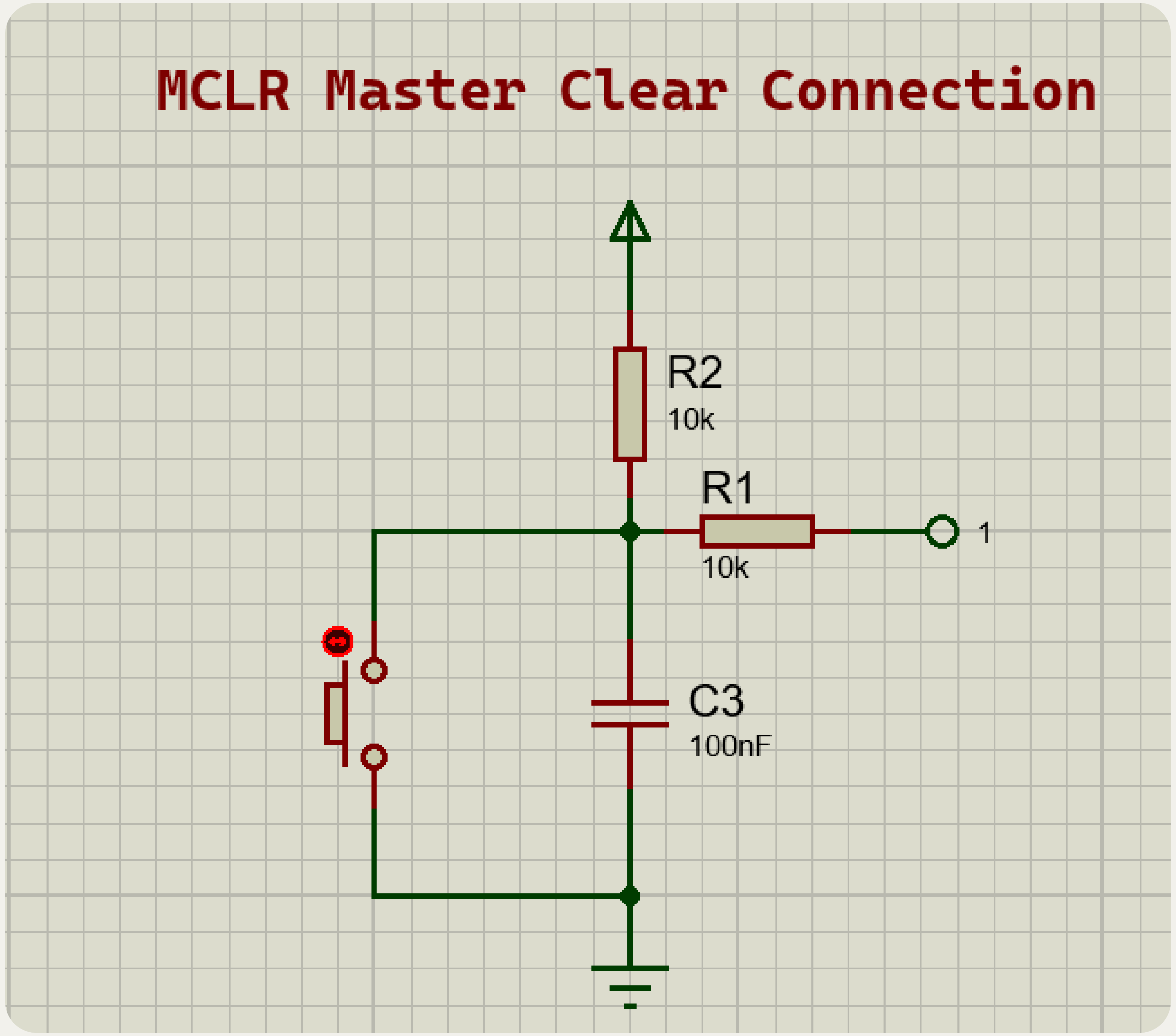
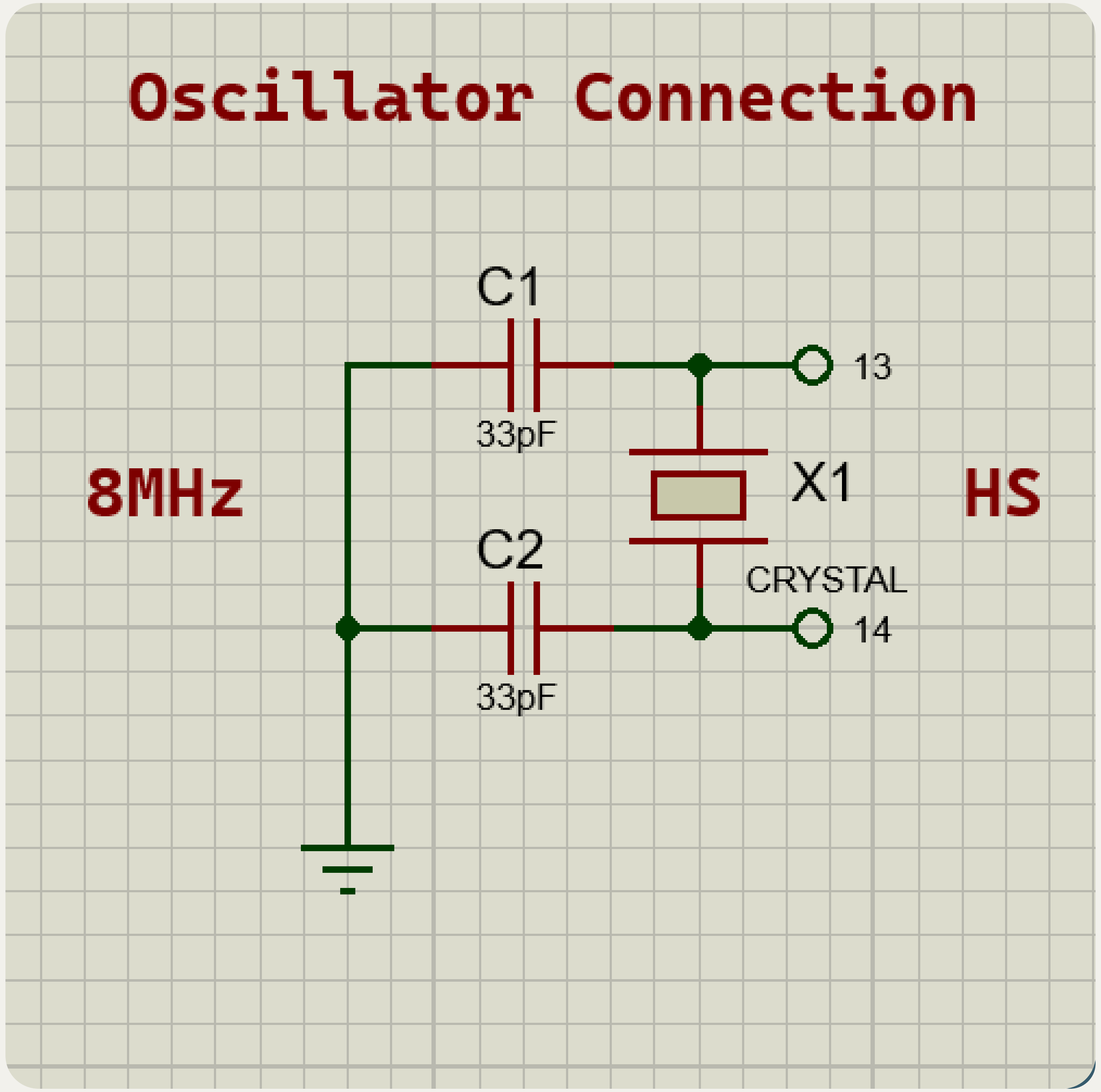

MCLR Master Clear Connection
R2
10k
R1
10k
1
C3
100nF


Oscillator Connection
C1
33pF
13
8MHz
X1
HS
C2
CRYSTAL
14
33pF

Storage temperature	-65°C to +150°C
Voltage on any pin with respect to VSS (except VDD, $\overline{\text{MCLR}}$. and RA4)	-0.3V to (VDD + 0.3V)
Voltage on VDD with respect to VSS	-0.3 to +7.5V
Voltage on $\overline{\text{MCLR}}$ with respect to VSS **(Note 2)**	0 to +14V
Voltage on RA4 with respect to Vss	0 to +8.5V
Total power dissipation **(Note 1)**	1.0W
Maximum current out of VSS pin	300 mA
Maximum current into VDD pin	250 mA
Input clamp current, IIK (VI < 0 or VI > VDD)	± 20 mA
Output clamp current, IOK (VO < 0 or VO > VDD)	± 20 mA
Maximum output current sunk by any I/O pin	25 mA
Maximum output current sourced by any I/O pin	25 mA
Maximum current sunk by PORTA, PORTB and PORTE (combined) **(Note 3)**	200 mA
Maximum current sourced by PORTA, PORTB and PORTE (combined) **(Note 3)**	200 mA
Maximum current sunk by PORTC and PORTD (combined) **(Note 3)**	200 mA
Maximum current sourced by PORTC and PORTD (combined) **(Note 3)**	200 mA

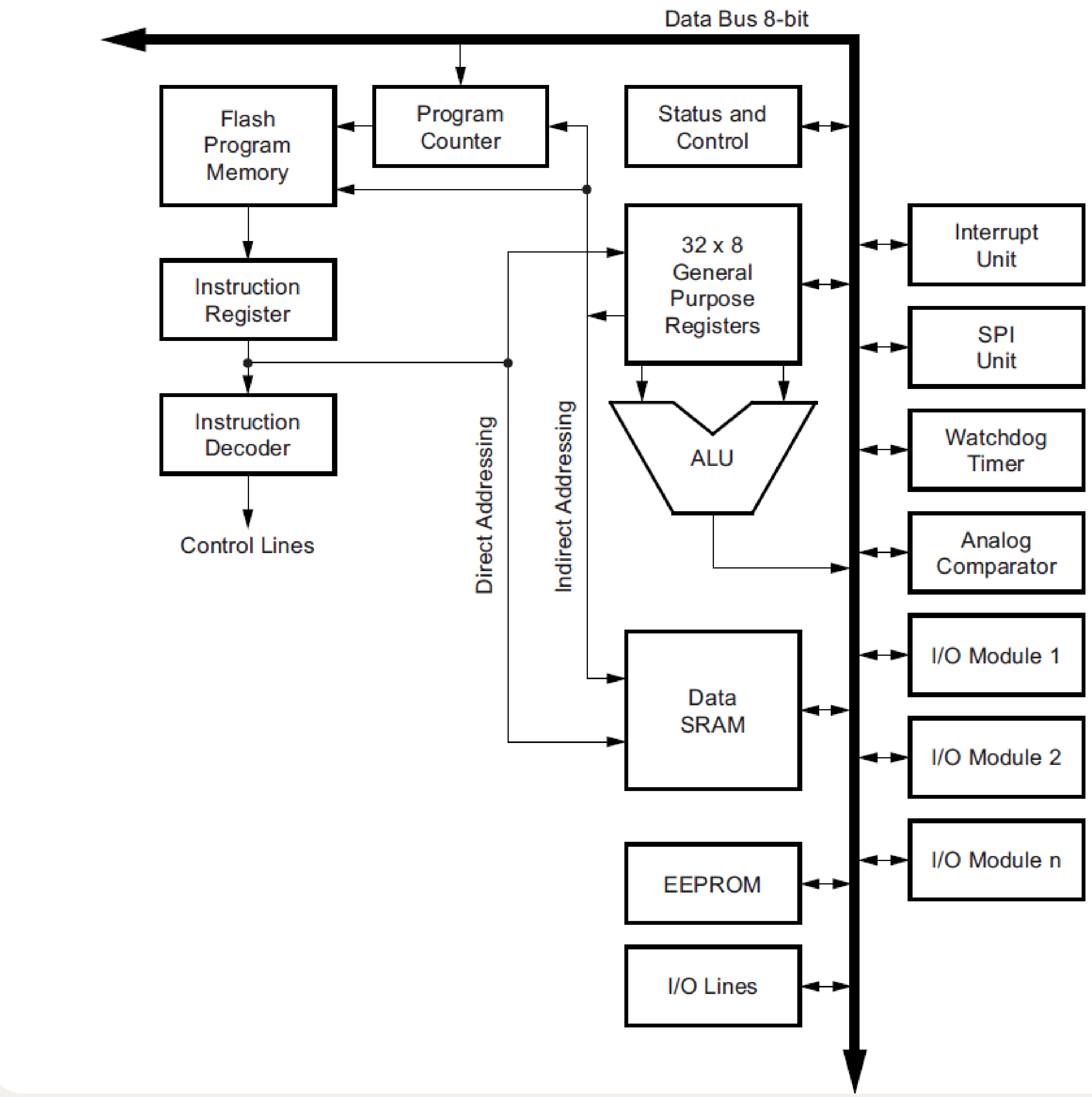
Note 1: Power dissipation is calculated as follows: Pdis = VDD x {IDD - Σ IOH} + Σ {(VDD - VOH) x IOH} + Σ(VOL x IOL)

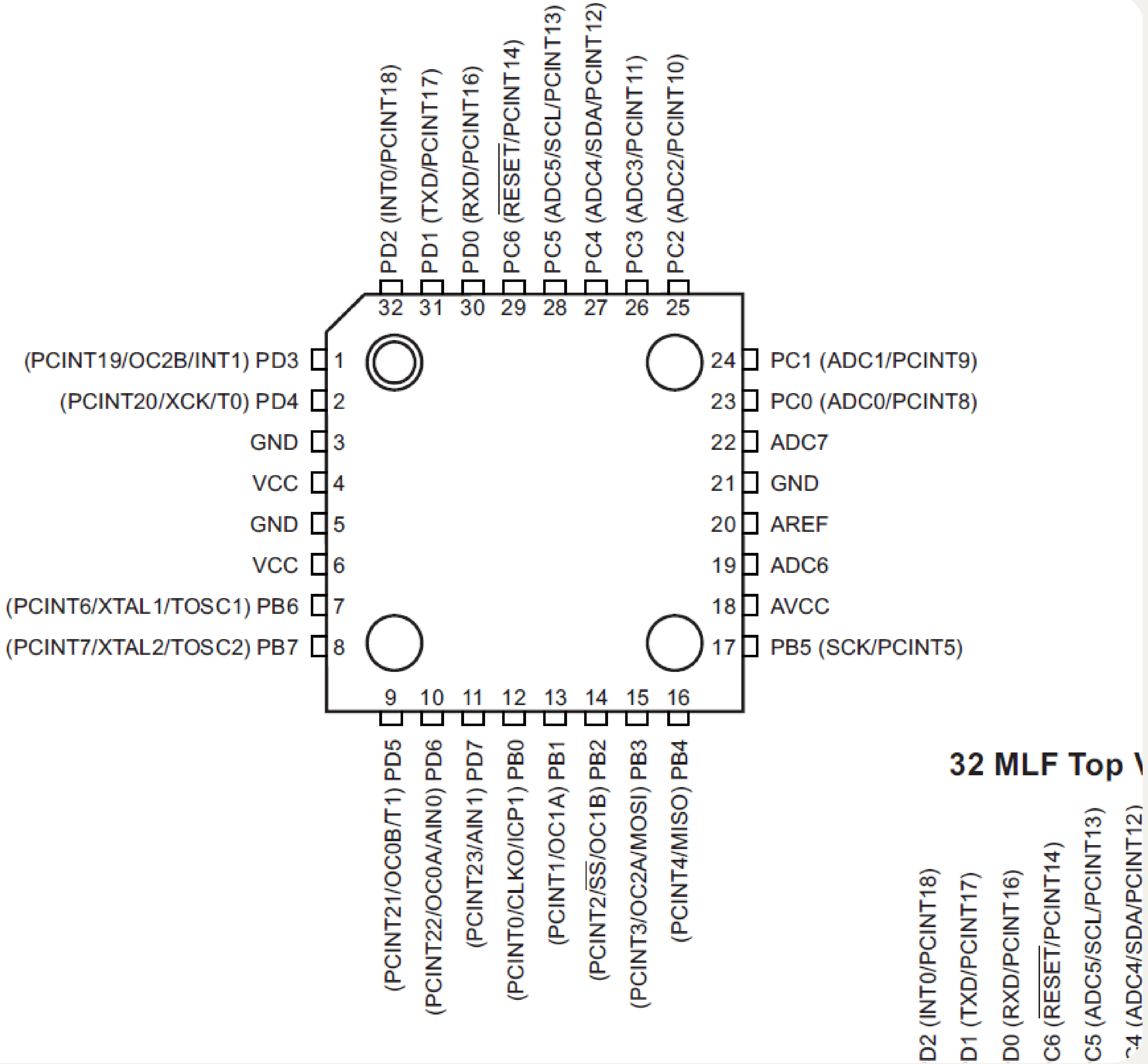
PIC16F877A VS ATMega328P

Block Diagram

ATMega328P

Block Diagram of the AVR Architecture





Feature	ATMega328P	PIC16F877A
Architecture	8-bit AVR RISC	8-bit PIC Mid-Range
Program Memory (Flash)	32 KB	14 KB
EEPROM	1 KB	256 Bytes
Power Consumption	Lower	Higher compared to ATMega at similar clock
Package Options	28-pin	40-pin
Number of I/O Pins	23 Programmable I/O	33 Programmable I/O
Operating Voltage	1.8 V – 5.5 V	2.0 V – 5.5 V

Example Applications Where ATMega328P is a Better Choice

1. Battery-Powered Devices

- Because it uses very little power in sleep mode, it’s great for things like small weather stations or remote sensors that run on batteries.

2. Arduino Projects

- It’s the main chip in the Arduino Uno, so it’s easy to program and has lots of ready-made code for beginners and quick prototypes.

Thank You For Your Attention