

External interrupts



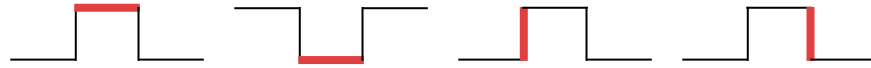
By: Yehia M. Abu Eita

Outlines

- **Types of external interrupts**
- **ATmega32 external interrupts**
- **External interrupt registers**
- **Steps to program external interrupts**

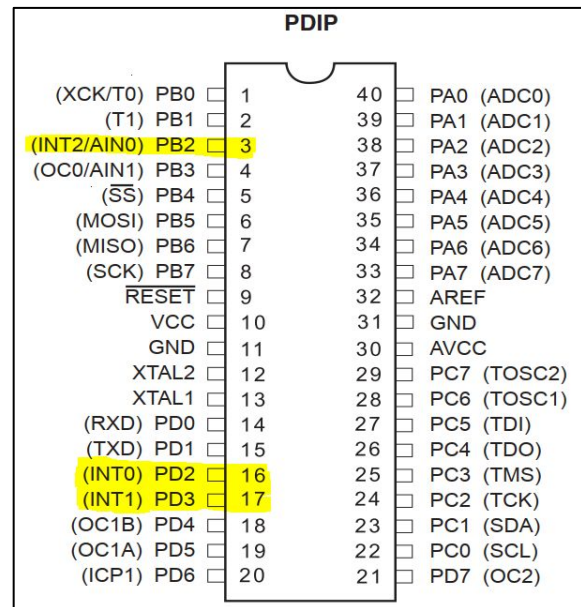
Types of external interrupts

- External interrupts are those interrupts came **from DIO pins**.
- There are **two types** of external interrupts:
 - **Level interrupts**
 - **Edge interrupts**
- **Level interrupts** are those interrupts occurred when a pin is **drived high or low**.
- **Edge interrupts** are those interrupts occurred when a pin is pulled from high to low (**falling edge**) or from low to high (**rising edge**).



ATmega32 external interrupts

- ATmega32 provides **three external** interrupts.
- **PD2 as INT0**
- **PD3 as INT1**
- **PB3 as INT2**



External interrupt registers

MCUCR – MCU Control Register

The MCU Control Register contains control bits for interrupt sense control and general MCU functions.

Bit	7	6	5	4	3	2	1	0	
	SE	SM2	SM1	SM0	ISC11	ISC10	ISC01	ISC00	MCUCR
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0	0	0	0	0	0	

ISC11	ISC10	Description
0	0	The low level of INT1 generates an interrupt request.
0	1	Any logical change on INT1 generates an interrupt request.
1	0	The falling edge of INT1 generates an interrupt request.
1	1	The rising edge of INT1 generates an interrupt request.

ISC01	ISC00	Description
0	0	The low level of INT0 generates an interrupt request.
0	1	Any logical change on INT0 generates an interrupt request.
1	0	The falling edge of INT0 generates an interrupt request.
1	1	The rising edge of INT0 generates an interrupt request.

MCUCSR – MCU Control and Status Register

Bit	7	6	5	4	3	2	1	0	
	JTD	ISC2	–	JTRF	WDRF	BORF	EXTRF	PORF	MCUCSR
Read/Write	R/W	R/W	R	R/W	R/W	R/W	R/W	R/W	
Initial Value	0	0	0			See Bit Description			

GICR – General Interrupt Control Register

Bit	7	6	5	4	3	2	1	0
	INT1	INT0	INT2	-	-	-	IVSEL	IVCE
Read/Write	R/W	R/W	R/W	R	R	R	R/W	R/W
Initial Value	0	0	0	0	0	0	0	0

GIFR – General Interrupt Flag Register

Bit	7	6	5	4	3	2	1	0
	INTF1	INTF0	INTF2	–	–	–	–	–
Read/Write	R/W	R/W	R/W	R	R	R	R	R
Initial Value	0	0	0	0	0	0	0	0

Steps to program external interrupts

- **Enable global interrupts:**

- Set the **I-bit** in **SREG** to 1 or
- Use this assembly instruction, `__asm__ __volatile__ ("sei" ::: "memory");`
- You can disable global interrupts using, `__asm__ __volatile__ ("cli" ::: "memory");`

- **Choose interrupt sense:**

- Low-level, falling edge, rising edge, or any logical change, for INT0 and INT1.
- Falling edge or rising edge, for INT2.

- **Enable external interrupt:**

- For INT0: Set **bit 6** in the **GICR**.
- For INT1: Set **bit 7** in the **GICR**.
- For INT2: Set **bit 5** in the **GICR**.

- **Write your ISR** that will be executed when the interrupt happens.

Summary

- Now you are familiar with ATmega32 external interrupts
- Remember to enable global interrupts
- Remember that the ISR must be a small routine
- Remember that interrupt flags can be set by writing 1 to it