

# Politecnico di Milano

## Microcontrollori 3/3

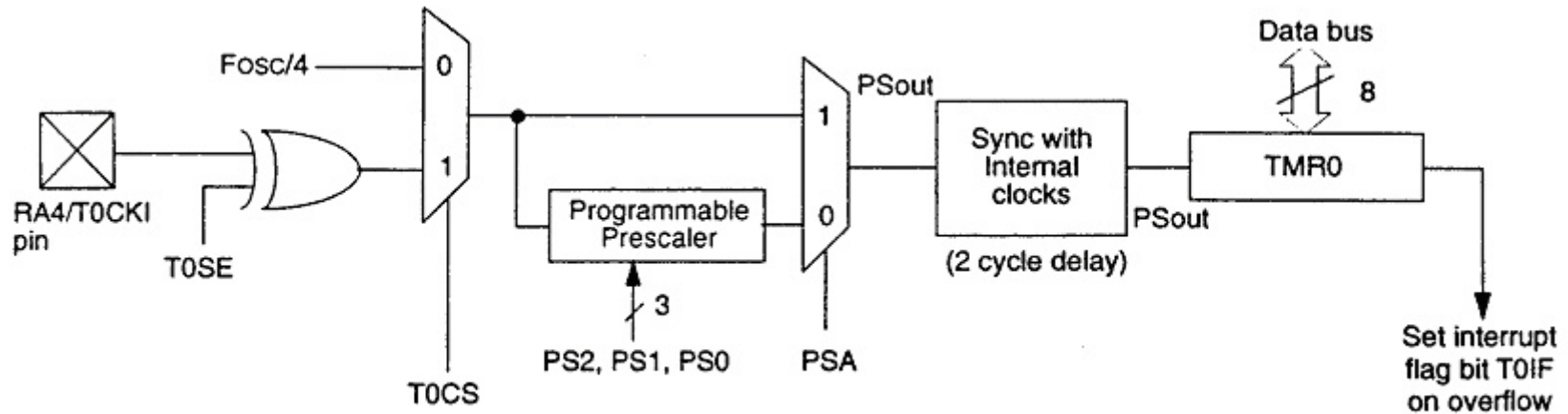
ing. Enrico Migliore

Fondamenti di Elettronica

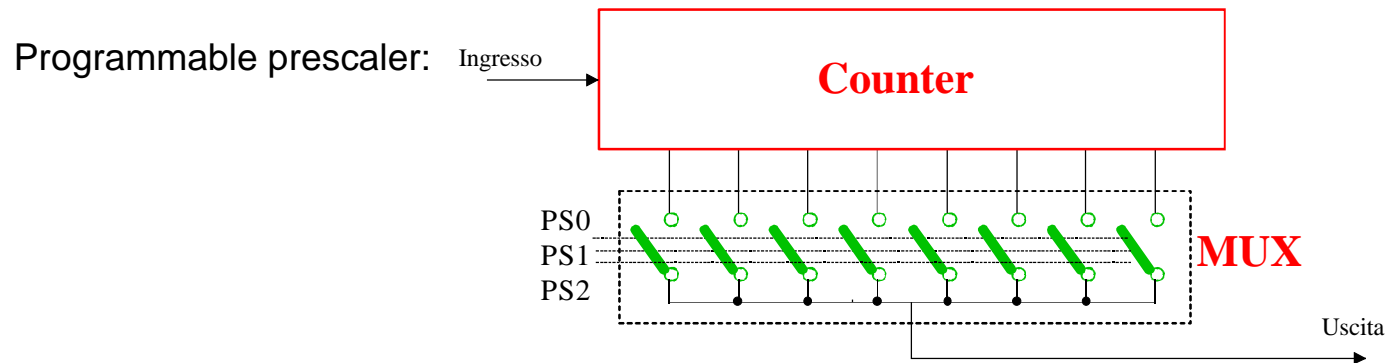
# Timer e Counter

Duplica funzione:

- contatore di eventi
- misuratore del trascorrere del tempo



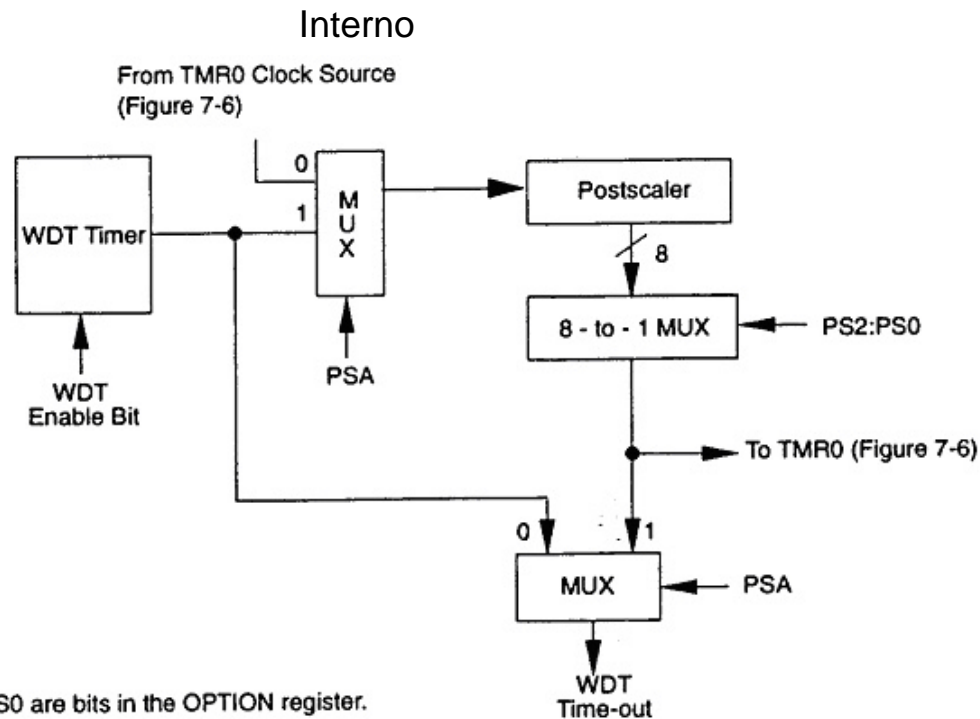
Note 1: T0CS, T0SE, PSA, PS2:PS0 (OPTION<5:0>).



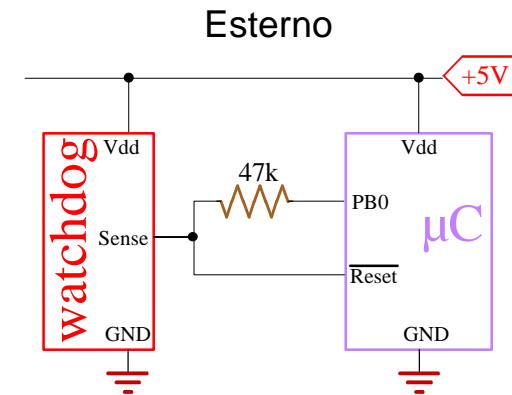
# Watchdog: sicurezza

Funzione:

- evita che il  $\mu\text{C}$  vada in stallo
- permette il risveglio del  $\mu\text{C}$  dalla modalità di “sleep”
- Il suo clock è indipendente da quello del  $\mu\text{C}$
- Raggiunge il time-out in circa 500ms

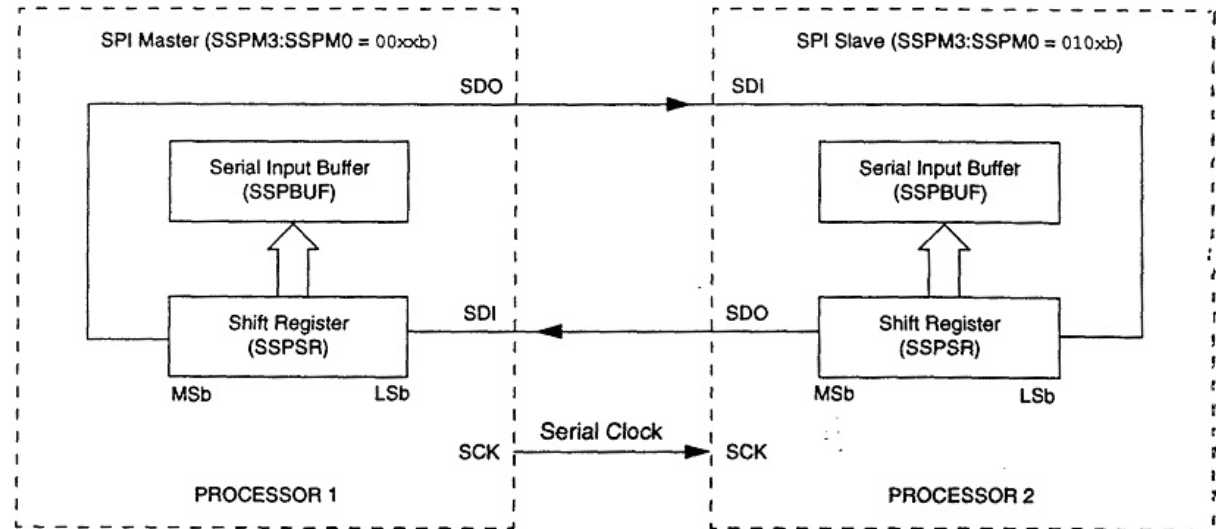


Note: PSA and PS2:PS0 are bits in the OPTION register.



# Periferiche di Comunicazione Seriale interscheda

## Porta Seriale Sincrona **SPI**



Write

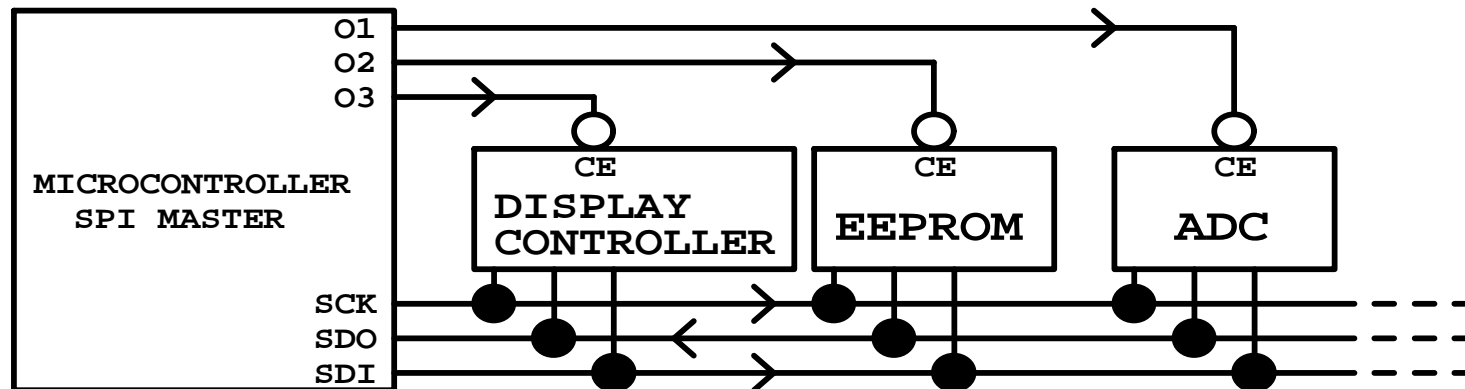
Write and Read

Read

il master trasmette dati utili, mentre lo slave rimanda dati inutili (dummy);

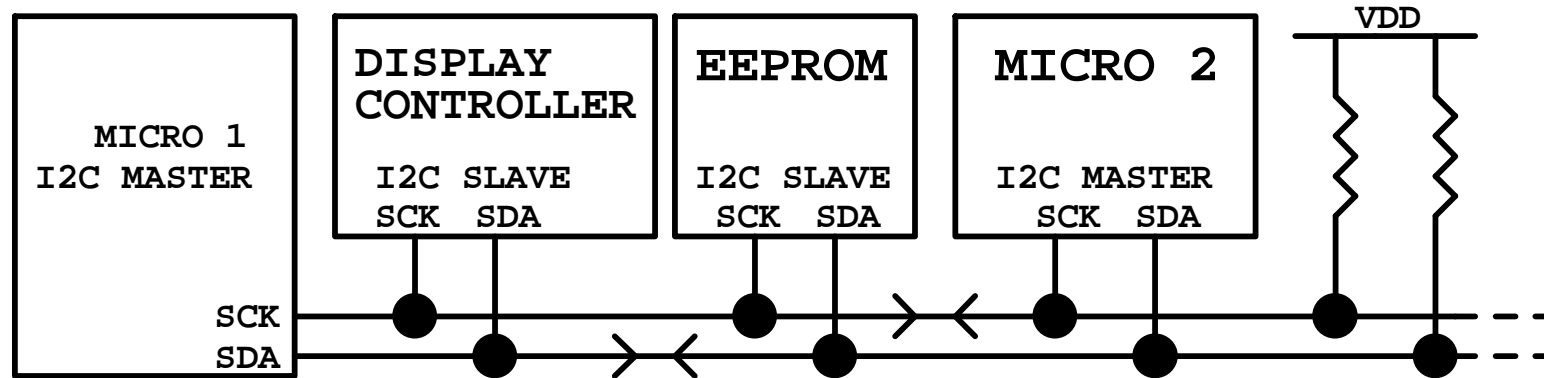
sia il master che lo slave trasmettono dati utili;

il master invia dati dummy, mentre lo slave rimanda dati utili.



# Periferiche di Comunicazione Seriale interscheda

## Porta Seriale Sincrona I<sup>2</sup>C

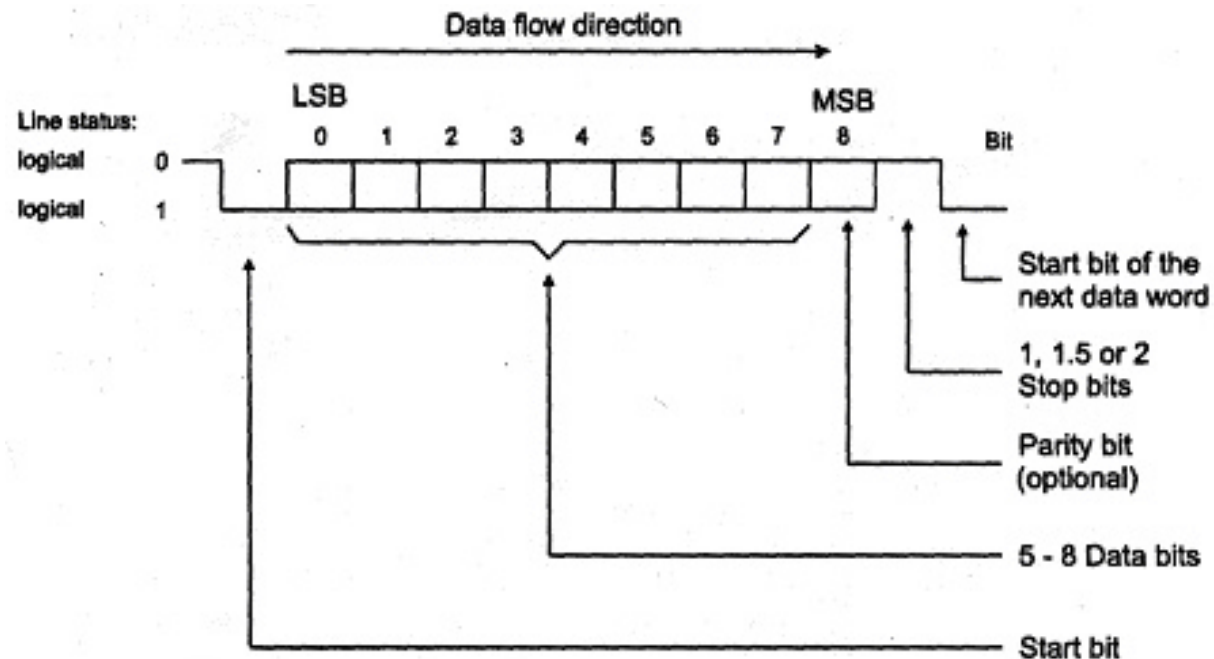


Su due fili solamente

Gestisce indirizzamento, arbitraggio, multimaster...

# Periferiche di Comunicazione Seriale inter/intra scheda

## Porta Seriale Asincrona **UART (com1 e com2 del PC)**

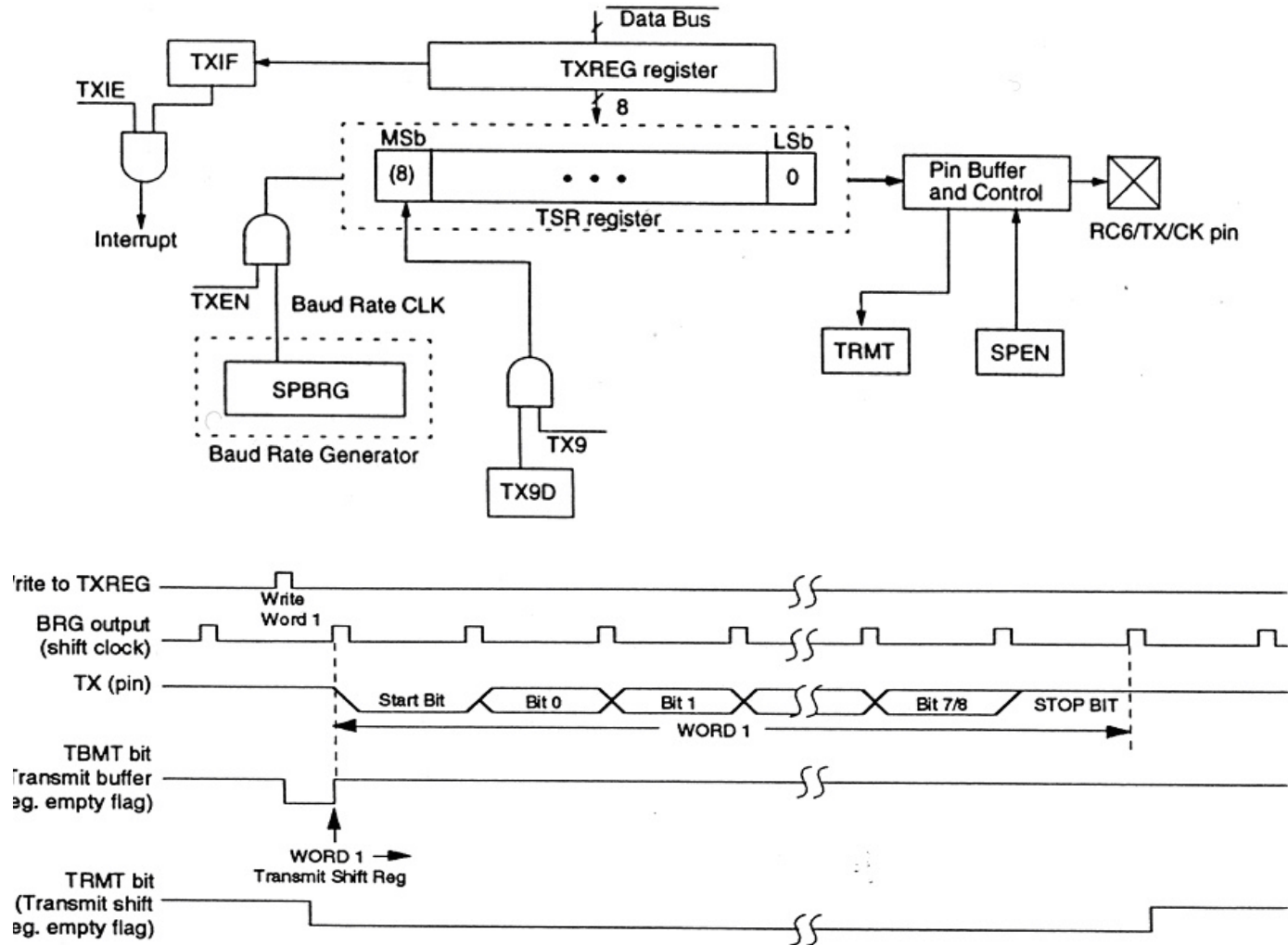


Vengono trasmessi pacchetti di 10 bit: 1 byte + bit di start e stop

# Periferiche di Comunicazione Seriale

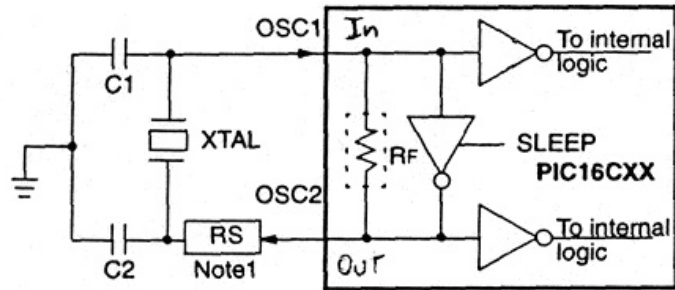
## Porta Seriale Asincrona **UART**

Struttura interna della periferica:



# Oscillatore: Genera tutti i sincronismi nel $\mu C$

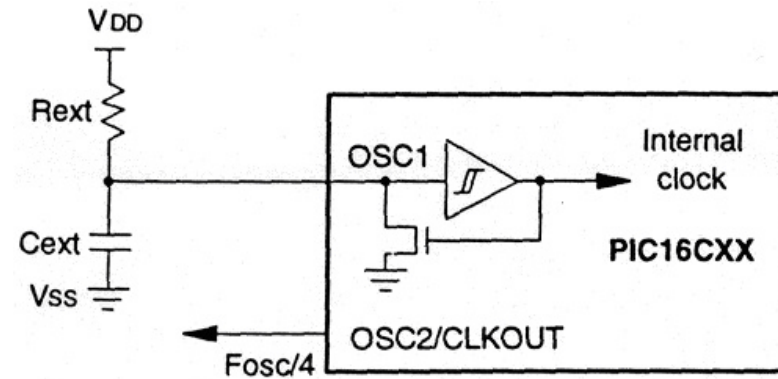
## Oscillatore al quarzo



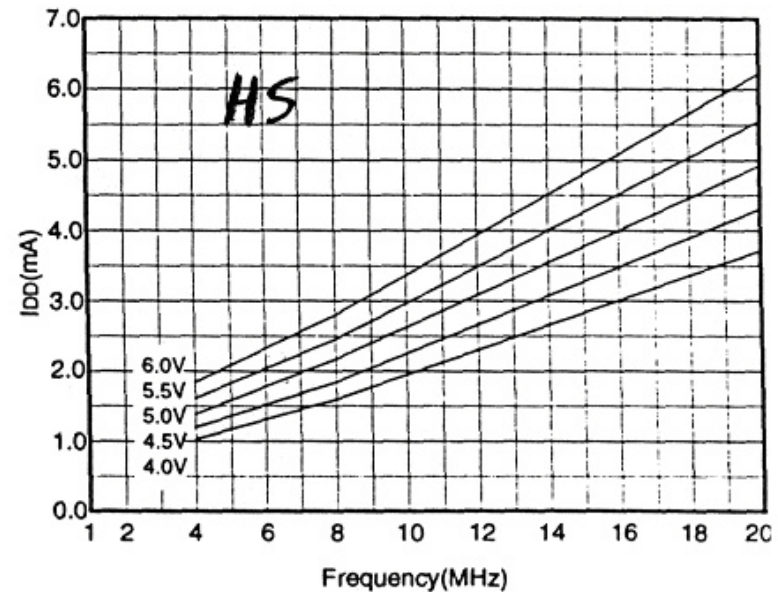
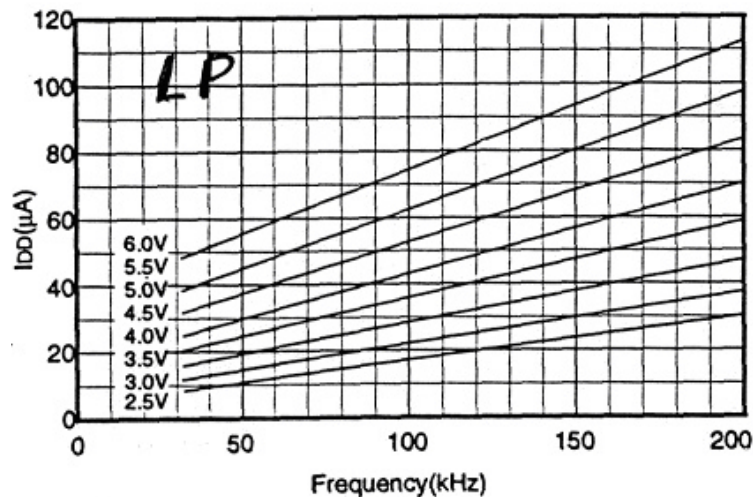
See Table 14-1, Table 14-2, Table 14-3 and Table 14-4 for recommended values of C1 and C2.

Note 1: A series resistor may be required for AT strip cut crystals.

## Oscillatore a Trigger di Schmidt



## Proporzionalità tra $f_{ck}$ e Potenza dissipata



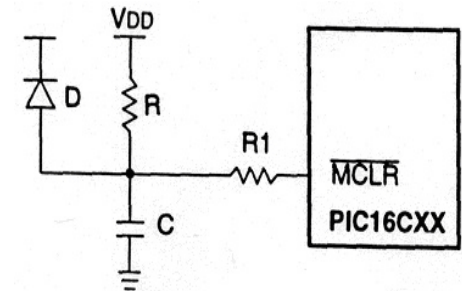
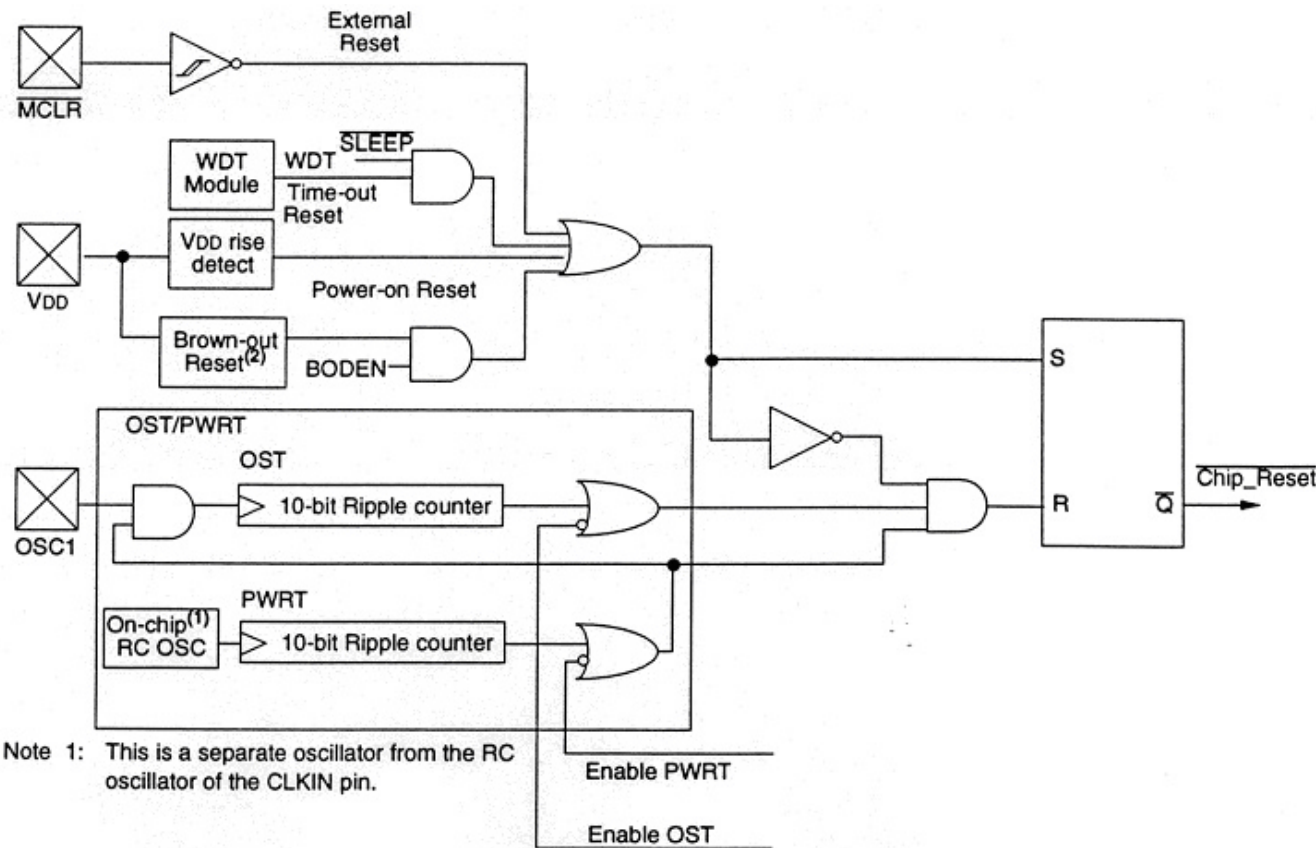


# Reset

Diverse cause:

- Power-on Reset
- Master-Clear Reset
- Master-Clear Reset
- Watchdog-timer reset
- Brown-Out Reset

all'accensione dell'alimentazione  
 durante la normale esecuzione, mediante piedino **/MCLR**;  
 durante la modalità SLEEP, sempre mediante il piedino **/MCLR**;  
 al raggiungimento dell'overflow del timer di watchdog (**WDT**);  
 se si verificano fluttuazioni dell'alimentazione.

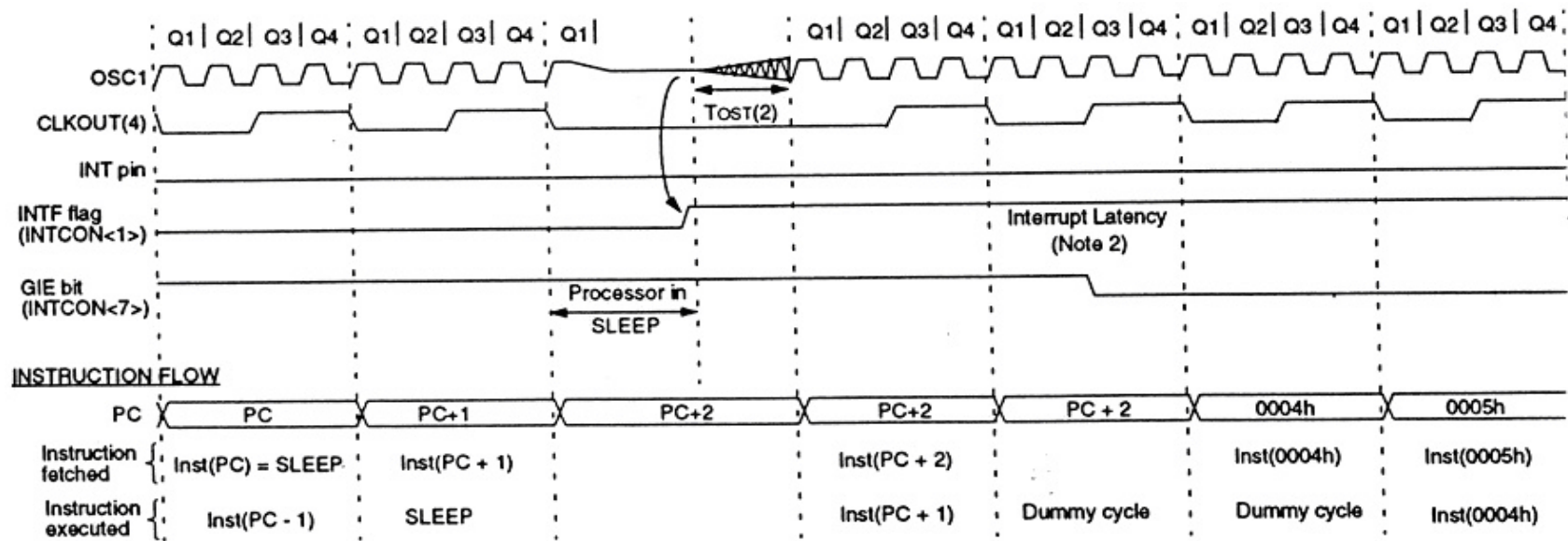


# Sleep-Mode

Utilità:

- permette di economizzare i consumi
- permette di ridurre l'attività ed i disturbi del  $\mu\text{C}$

Timing:



- Note 1: XT, HS or LP oscillator mode assumed.  
 Note 2:  $T_{OST} = 1024T_{OSC}$  (drawing not to scale) This delay will not be there for RC osc mode.  
 Note 3: GIE = '1' assumed. In this case after wake-up, the processor jumps to the interrupt routine. If GIE = '0', execution will continue in-lir  
 Note 4: CLKOUT is not available in these osc modes, but shown here for timing reference.

# Data-Sheet

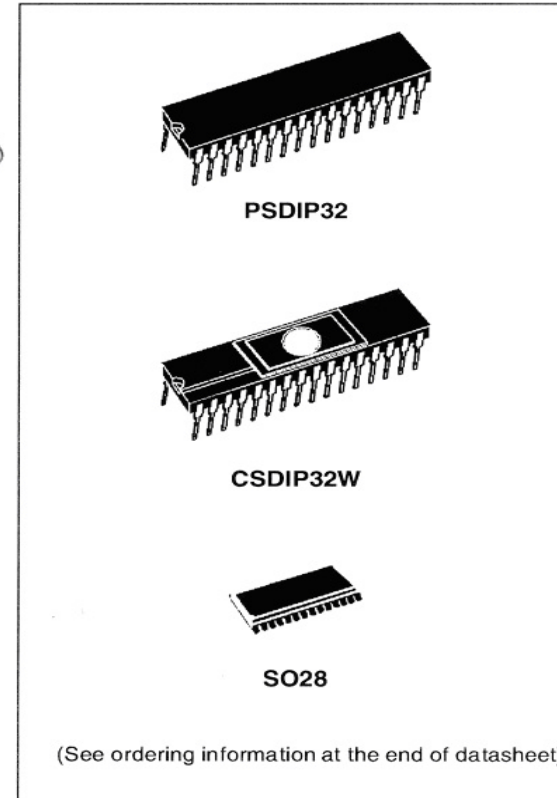


## ST72101/ST72212/ST72213

8-BIT MCU WITH 4 TO 8K ROM/OTP/EPROM,  
256 BYTES RAM, ADC, WDG, SPI AND 1 OR 2 TIMERS

PRELIMINARY DATA

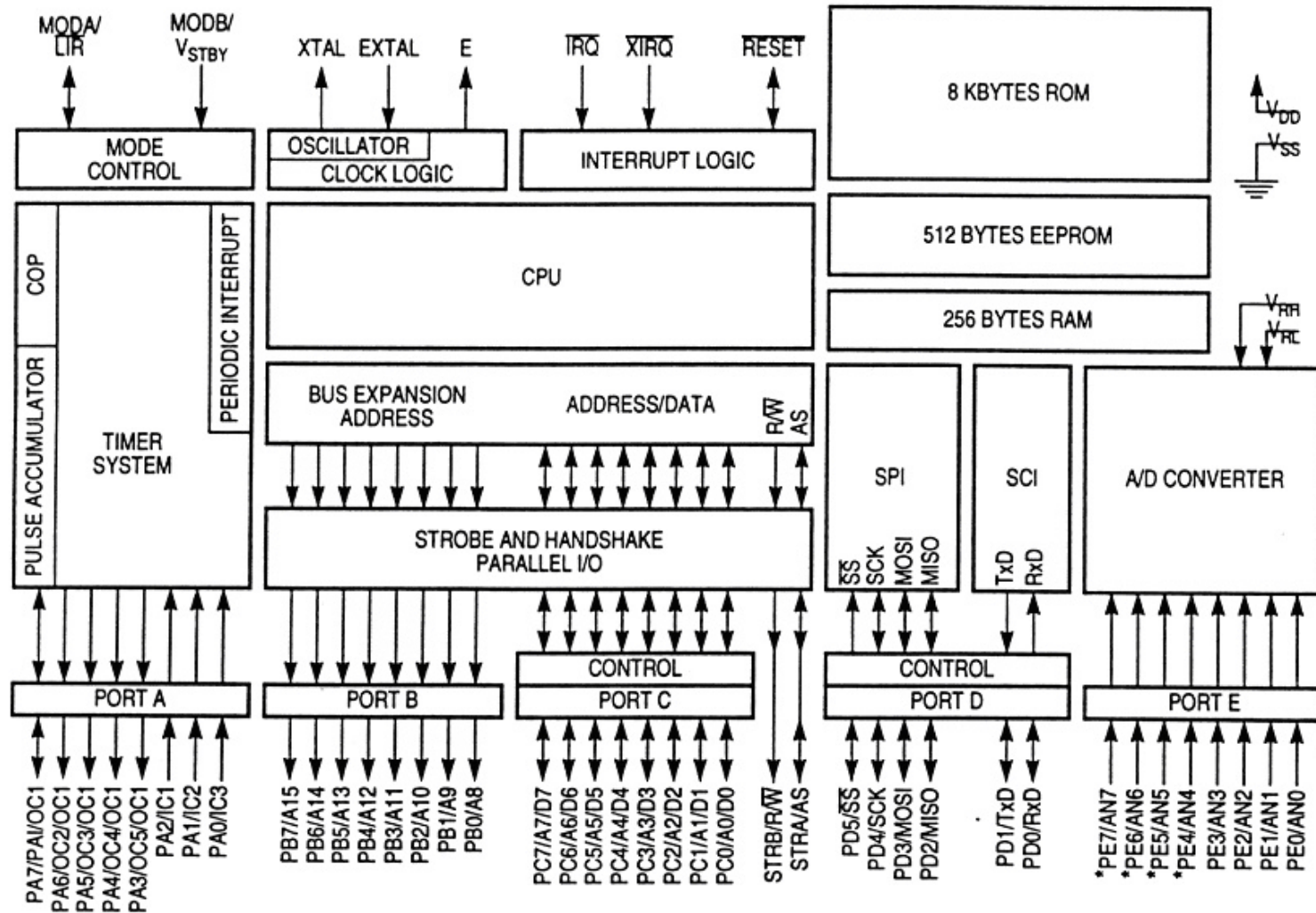
- User Program Memory (ROM/OTP/EPROM):  
4 to 8K bytes
- Data RAM: 256 bytes, including 64 bytes of stack
- Master Reset and Power-On Reset
- Run, Wait, Slow, Halt and RAM Retention modes
- 22 multifunctional bidirectional I/O lines:
  - 22 programmable interrupt inputs
  - 8 high sink outputs
  - 6 analog alternate inputs
  - 10 to 14 alternate functions
  - EMI filtering
- Programmable watchdog (WDG)
- One or two 16-bit Timers, each featuring:
  - 2 Input Captures
  - 2 Output Compares
  - External Clock input (on Timer A only)
  - PWM and Pulse Generator modes
- Synchronous Serial Peripheral Interface (SPI)
- 8-bit Analog-to-Digital converter (6 channels)  
(ST72212 and ST72213 only)
- 8-bit Data Manipulation
- 63 Basic Instructions
- 17 main Addressing Modes
- 8 x 8 Unsigned Multiply Instruction
- True Bit Manipulation
- Complete Development Support on PC/DOS-WINDOWS™ Real-Time Emulator
- Full Software Package on DOS/WINDOWS™ (C-Compiler, Cross-Assembler, Debugger)



### Device Summary

Features	ST72101G1	ST72101G2	ST72213G1	ST72212G2
Program Memory- bytes	4K	8K	4K	8K
RAM (stack) - bytes	256 (64)			
16-bit Timers	one	one	one	two
ADC	no	no	yes	yes
Other Peripherals	Watchdog, SPI			
Operating Supply	3 to 6 V			
CPU Frequency	8MHz max (16MHz oscillator)			
Temperature Range	- 40°C to + 85°C			
Package	SO28 - SDIP32			

# Data-Sheet





# Data-Sheet



## 87C196CA/87C196CB 20 MHz ADVANCED 16-BIT CHMOS MICROCONTROLLER WITH INTEGRATED CAN 2.0

*Automotive*

- High Performance CHMOS 16-Bit CPU (up to 20 MHz Operation)
- Register-Register Architecture
- Up to 56 Kbytes of On-Chip EPROM
- Up to 1.5 Kbyte of On-Chip Register RAM
- Up to 512 Bytes of Additional RAM (Code RAM)
- Up to 16 Mbyte Linear Address Space
- Supports CAN (Controller Area Network) Specification 2.0
- 15 Message Objects of 8 Bytes Data Length
- 10-Bit A/D with Sample/Hold
- 38 Prioritized Interrupts
- Up to Seven 8-Bit (60) I/O Ports
- Full Duplex Serial Port (SIO) with Dedicated Baudrate Generator
- Full Duplex Synchronous Serial I/O Port (SSIO)
- Interprocessor Communication Slave Port
- Selectable Bus Timing Modes for Flexible Interfacing
- Oscillator Fail Detection Circuitry
- High Speed Peripheral Transaction Server (PTS)
- Two Dedicated 16-Bit High-Speed Compare Registers
- High Speed Capture/Compare (EPA)
- Two Flexible 16-Bit Timer Counters
- Flexible 8-/16-Bit External Bus (Programmable)
- Programmable Bus (HLD/HLDA)
- 1.4  $\mu$ s 16 x 16 Multiply
- 2.4  $\mu$ s 32/16 Divide

– 40°C to + 125°C Ambient

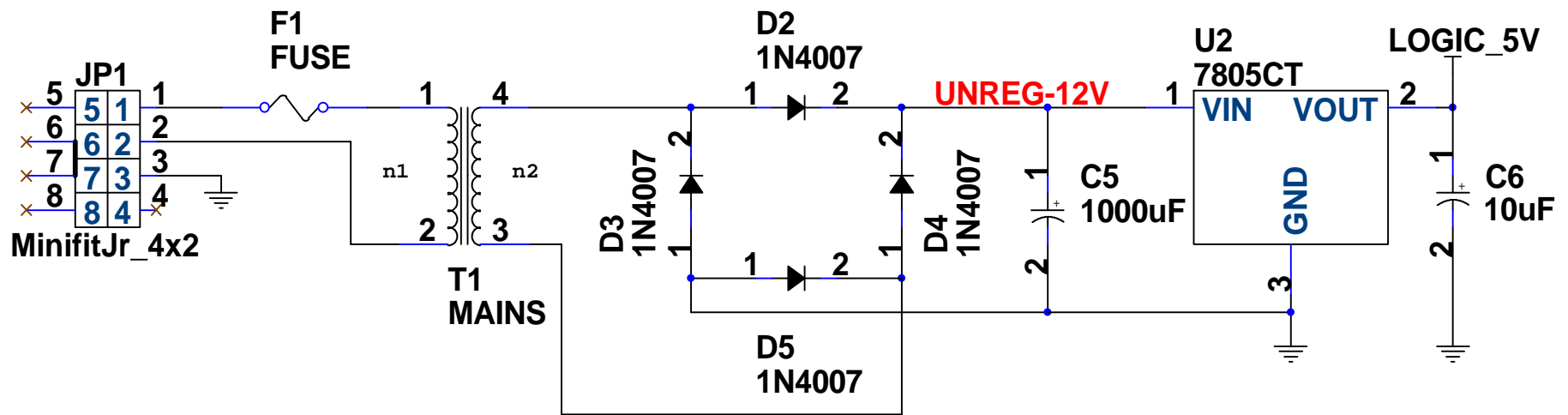
Device	Pins/Package	EPROM	Reg RAM	Code RAM	I/O	EPA	SIO	SSIO	CAN	A/D	Address Space
87C196CB	84-Pin PLCC	56K	1.5K	512b	56	10	Y	Y	Y	8	1 Mbyte
87C196CB	100-Pin QFP	56K	1.5K	512b	60	10	Y	Y	Y	8	16 Mbyte
87C196CA	66-Pin PLCC	32K	1.0K	256b	38	6	Y	Y	Y	6	64 Kbyte

The 87C196CA/CB are new members of the MCS<sup>®</sup> 96 microcontroller family. These devices are based upon the MCS 96 Kx/Jx microcontroller product families with enhancements ideal for automotive and industrial applications. The CA/CB are the first devices in the Kx family to support networking through the integration of the CAN 2.0 (Controller Area Network) peripheral on-chip. The 87C196CB offers the highest memory density of the MCS 96 microcontroller family, with 56K of on-chip EPROM, 1.5K of on-chip register RAM, and 512 bytes of additional RAM (Code RAM). In addition, the 87C196CB provides up to 16 Mbyte of Linear Address Space. The 87C196CA is a sub-set of the CB, offering 32K of on-chip EPROM, up to 1.0K of on-chip register RAM, and 256 bytes of additional RAM (Code RAM).

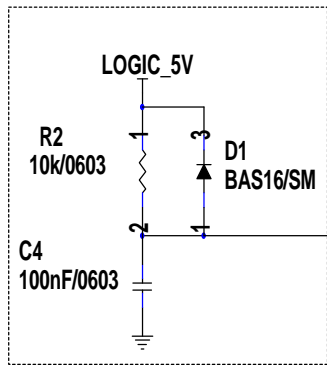
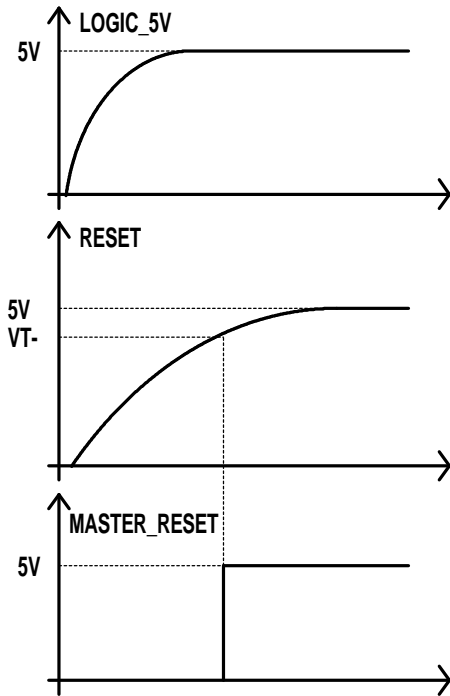
# Applicazione

## Letture di Tastiera a Microcontrollore

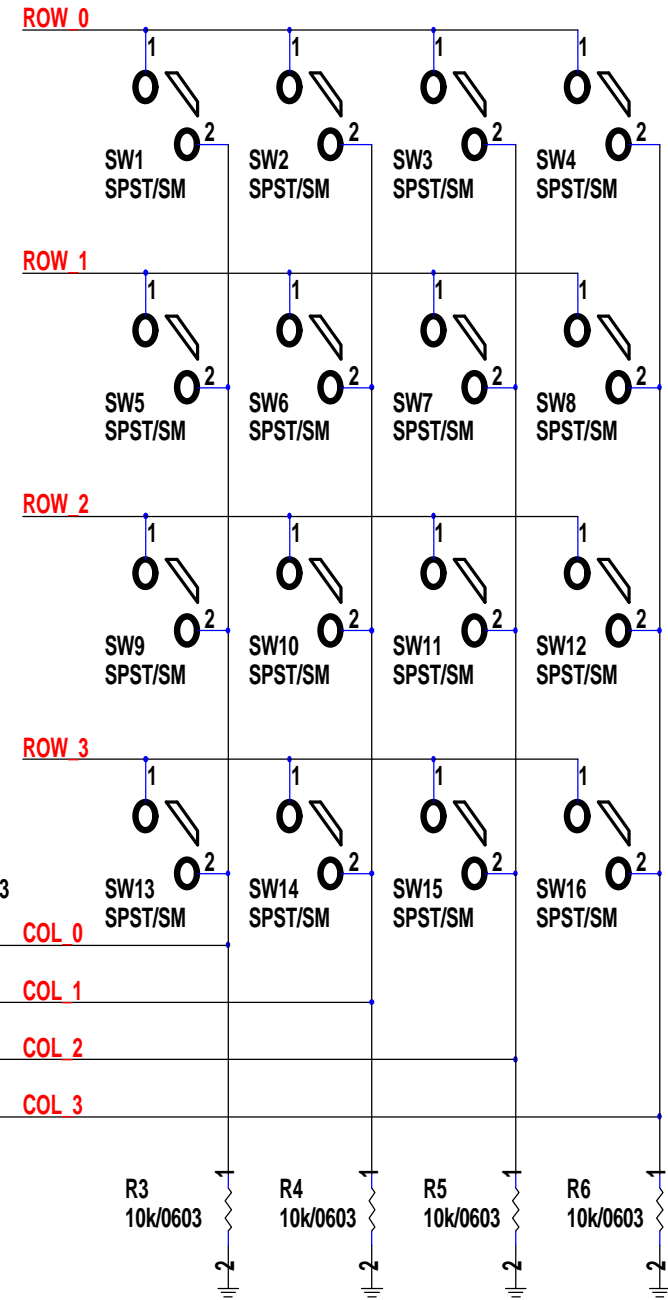
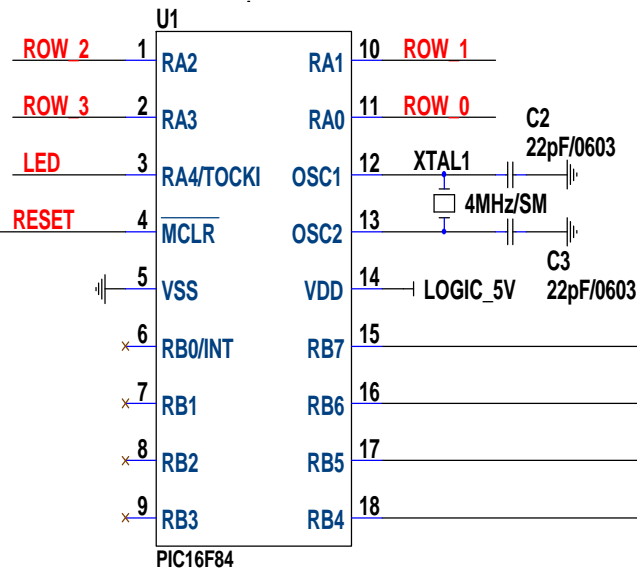
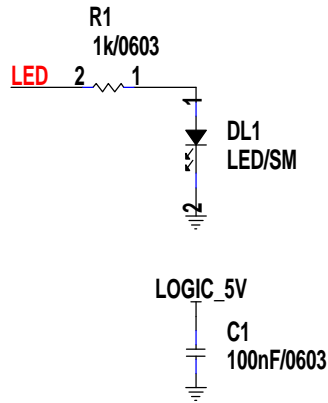
- Il microcontrollore ad ogni pressione di un tasto accende il led se era spento e viceversa.
- Microcontrollore = PIC16F84 (8 bit, Flash Program Memory)



## Hardware: Alimentazione



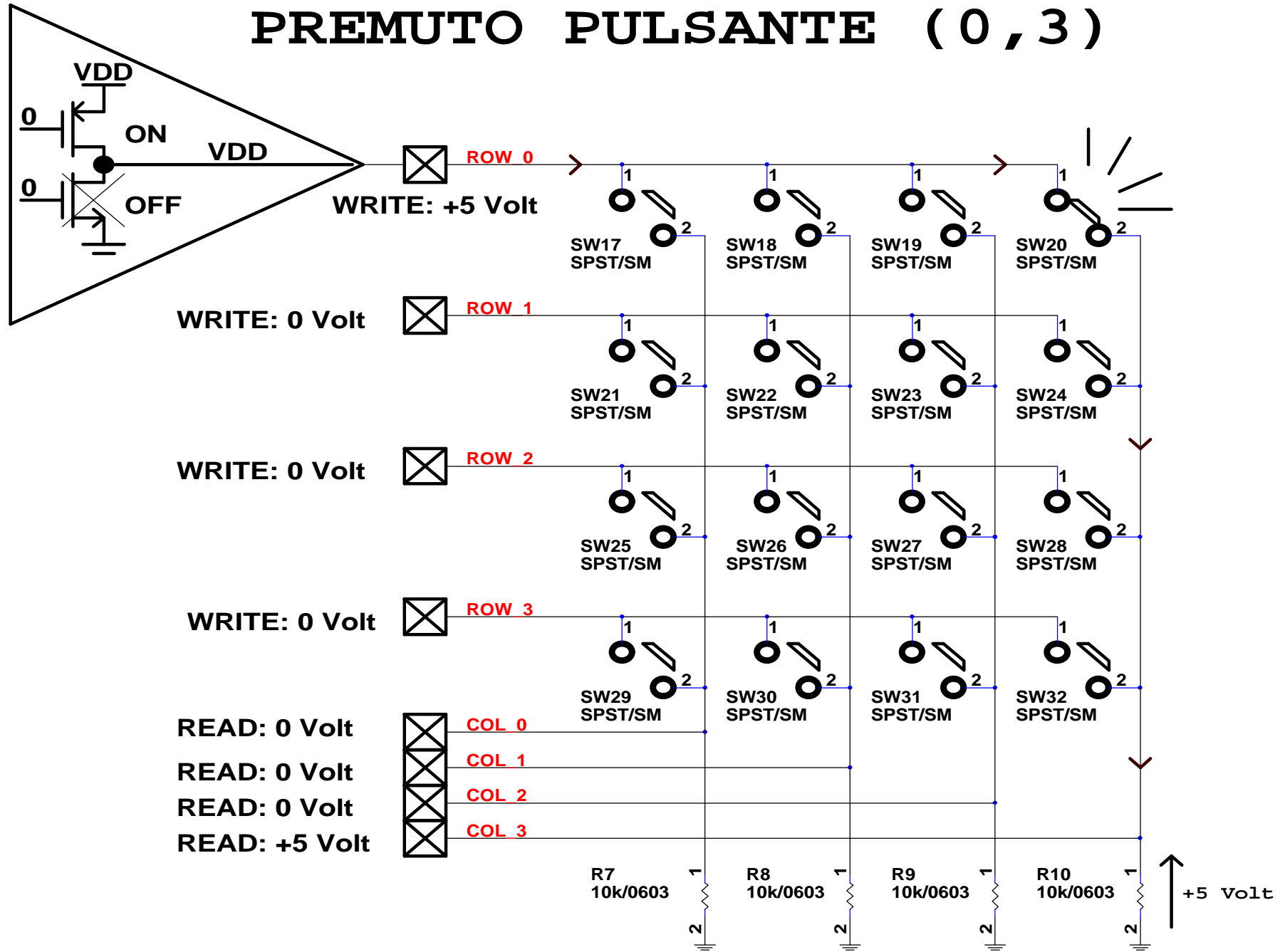
RETE RESET

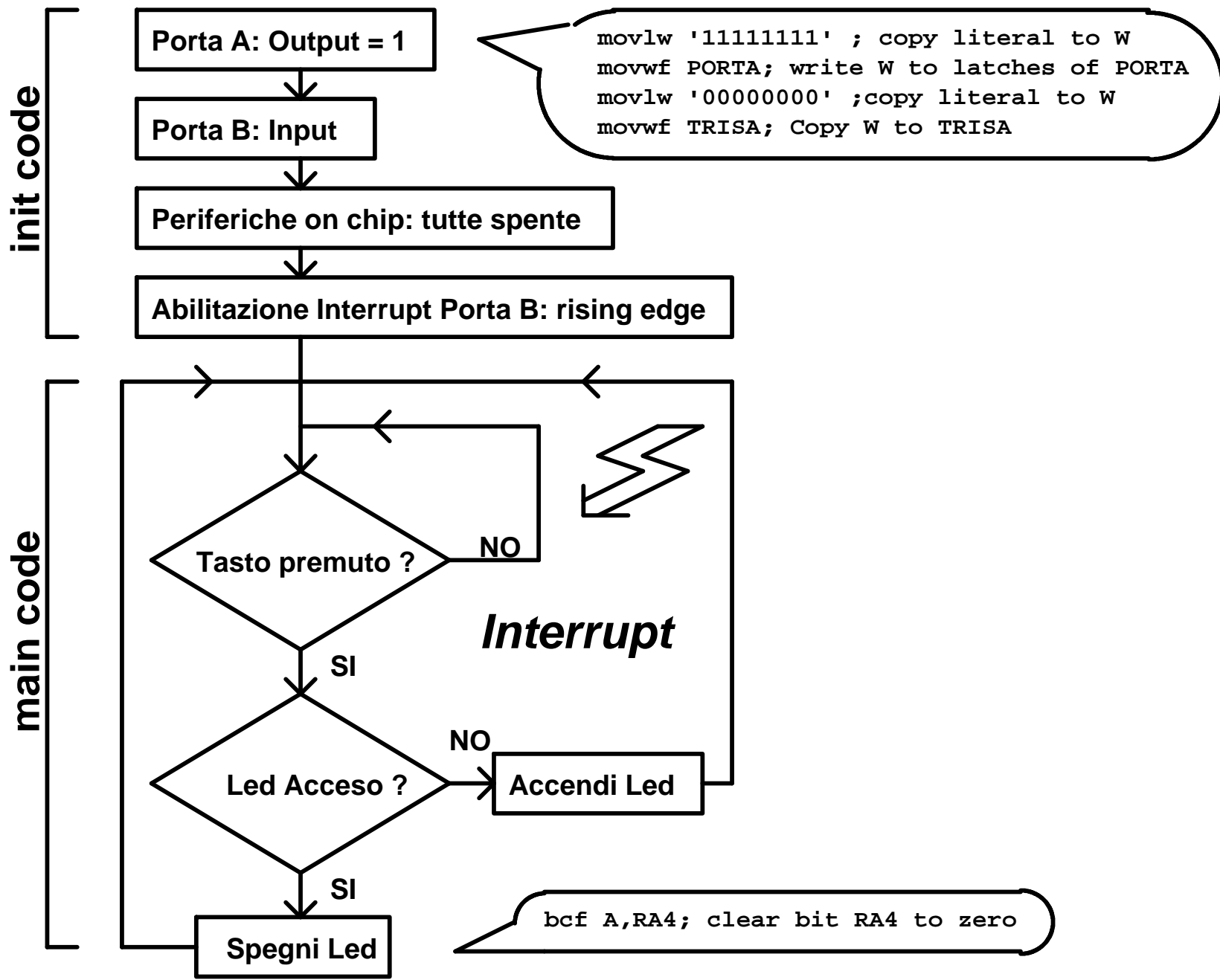


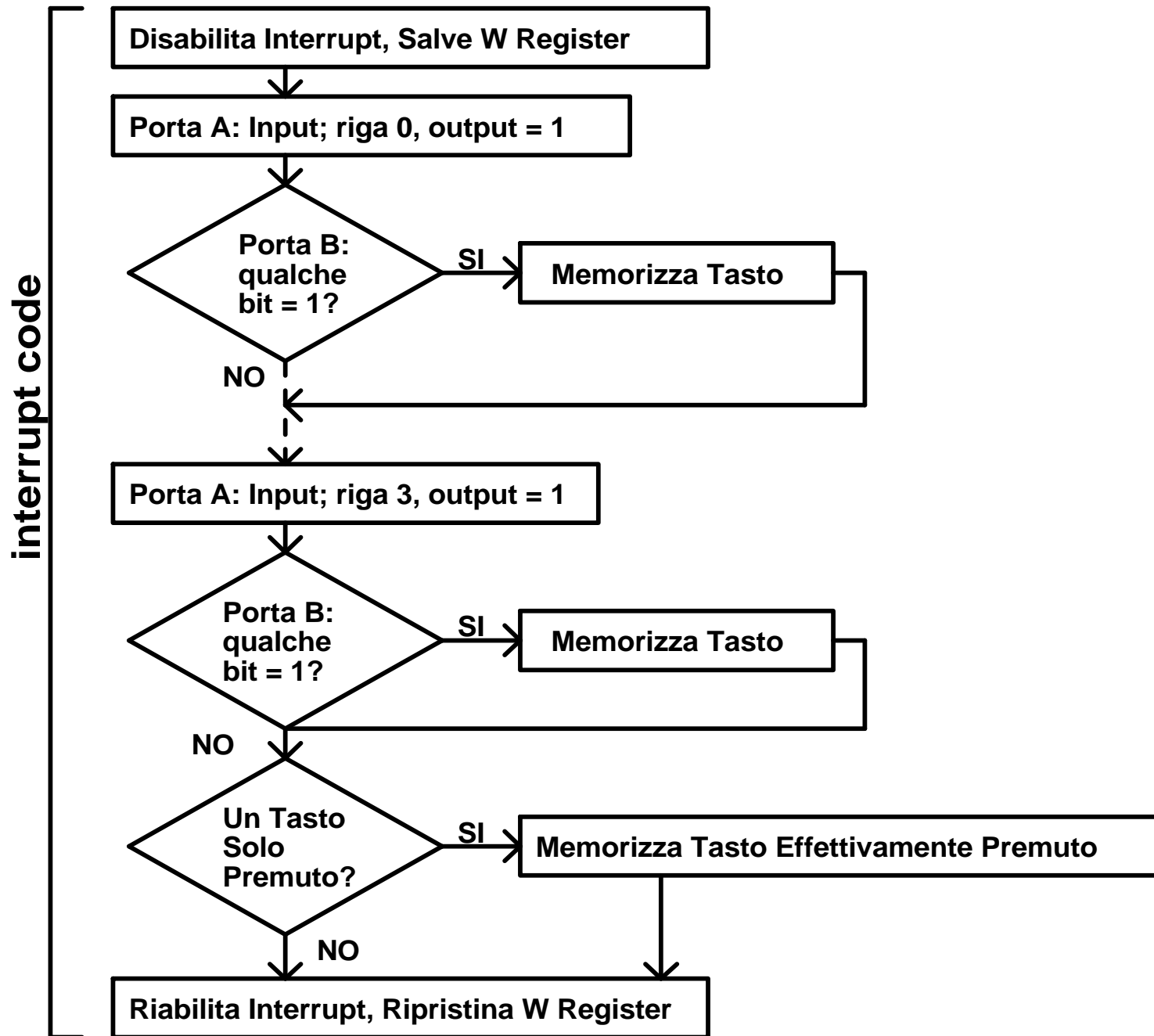
# Hardware: Microcontrollore



# PREMUTO PULSANTE (0,3)







# Miglioramenti

- Gestire il bouncing dei contatti meccanici dei tasti (lettura doppia della tastiera con delay di 20 ms)
- Gestire la funzione di repeat (leggere la durata della pressione di un tasto con l'ausilio del TIMER hardware del micro)

# **Politecnico di Milano**

**Microcontrollori**

**Fine**