


# Modulul de comunicare USART

- 
- I. Structura modulului USART  
încorporat
  - II. Modurile de funcționare
  - III. Regiștrii de control

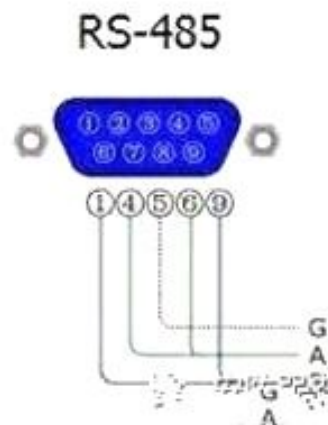
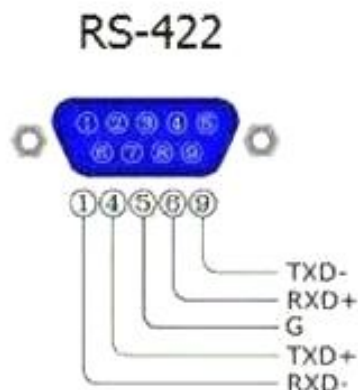
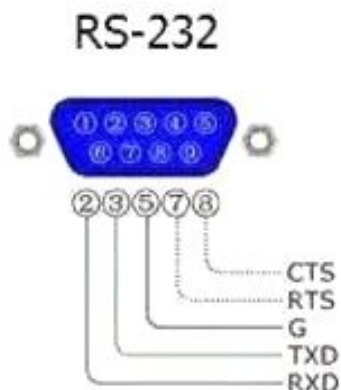
**Modulul USART (Universal Synchronous and Asynchronous Receiver Transmitter) se utilizează pentru comunicarea între două sau mai multe dispozitive (PC, sisteme de control cu microcontroler etc).**

**Dacă în calitate de mediu se utilizează RS-485 distanța între noduri poate fi de pînă la 100m**

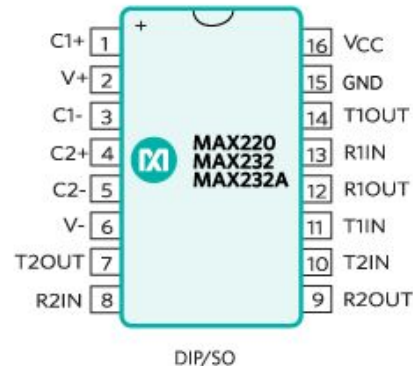
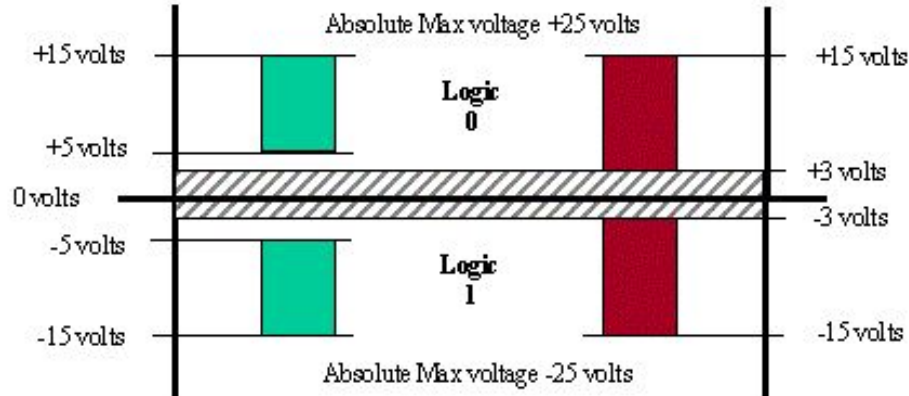
În calitate de mediu de transmitere pot fi utilizate transmițătoare:

- ❑ RS-232
- ❑ RS-422
- ❑ RS-485

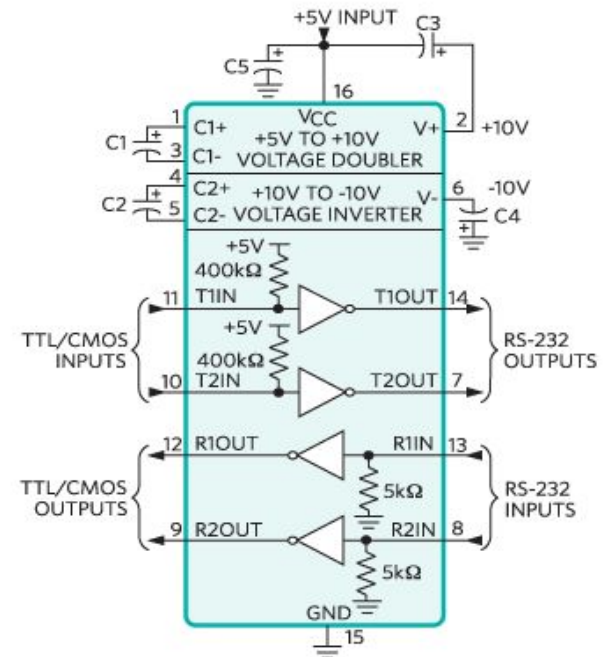
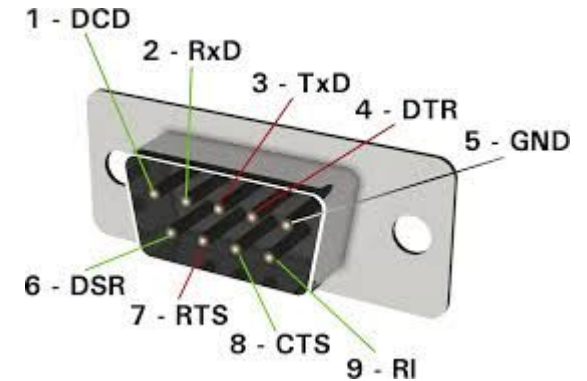
Standarde TIA/EIA (*Telecommunications Industry Association and Electronic Industries Alliance*)



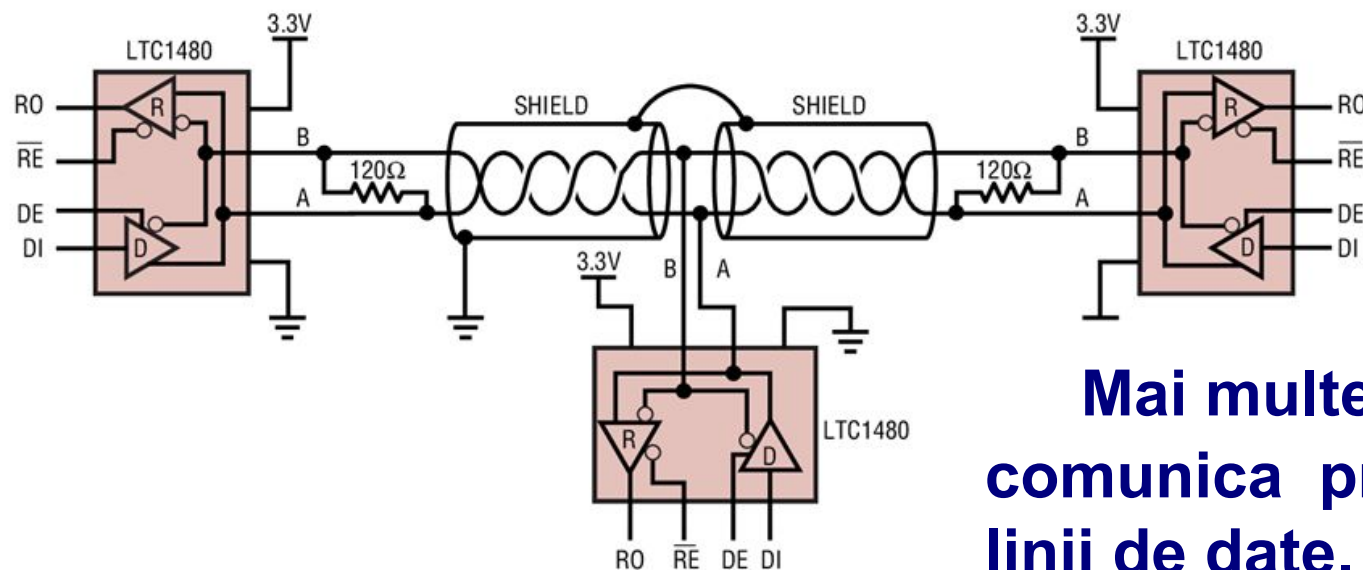
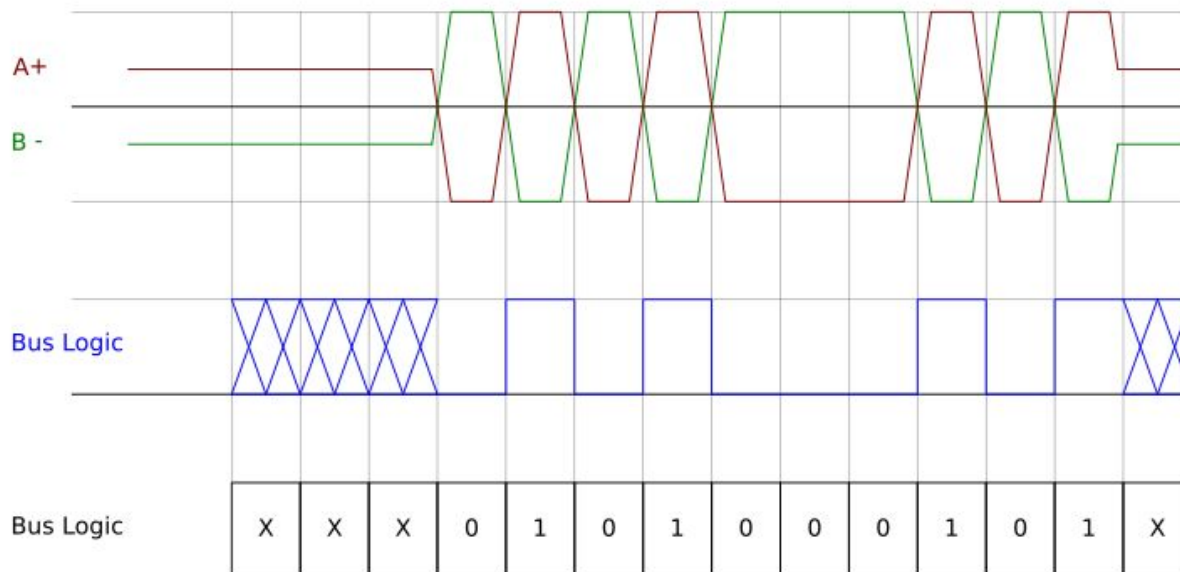
## RS - 232



	CAPACITANCE (μF)				
DEVICE	C1	C2	C3	C4	C5
MAX220	0.047	0.33	0.33	0.33	0.33
MAX232	1.0	1.0	1.0	1.0	1.0
MAX232A	0.1	0.1	0.1	0.1	0.1

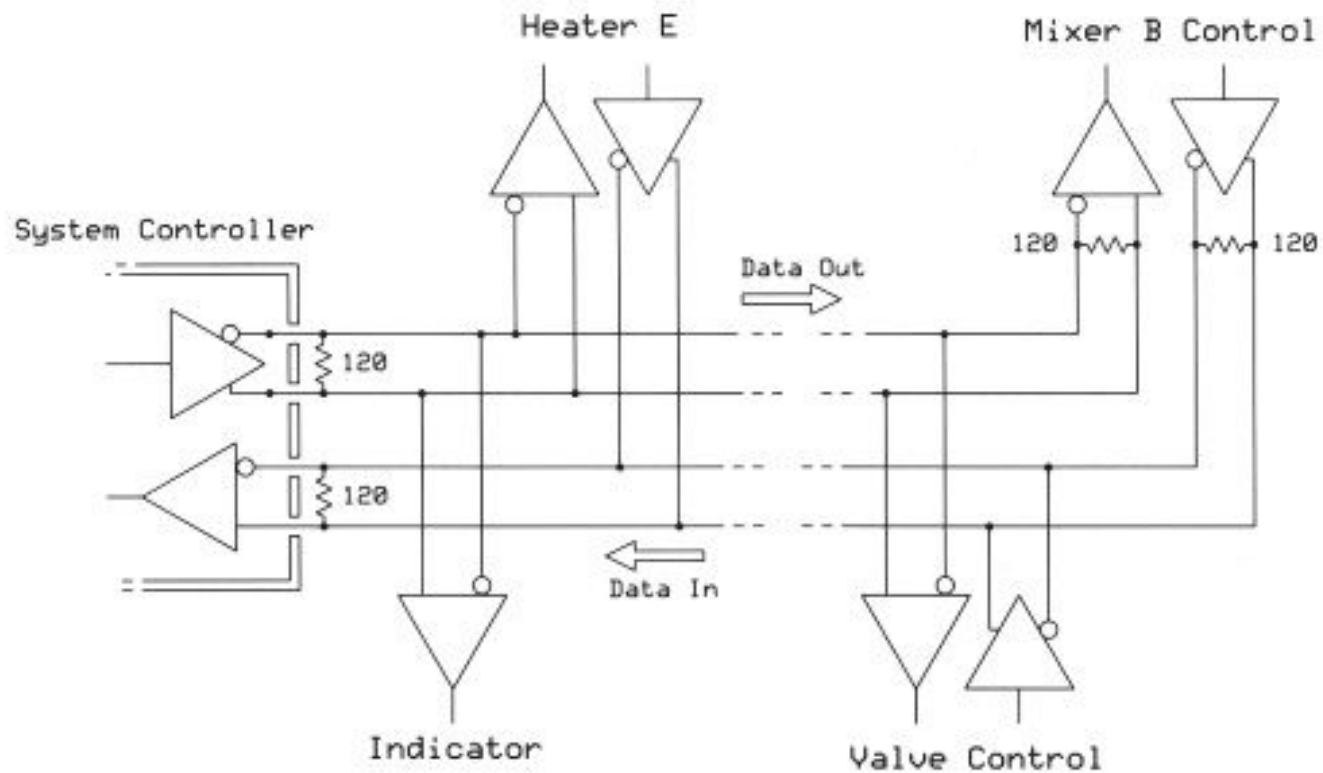


**Standardul RS485  
utilizează transmițătoare  
diferențiale**



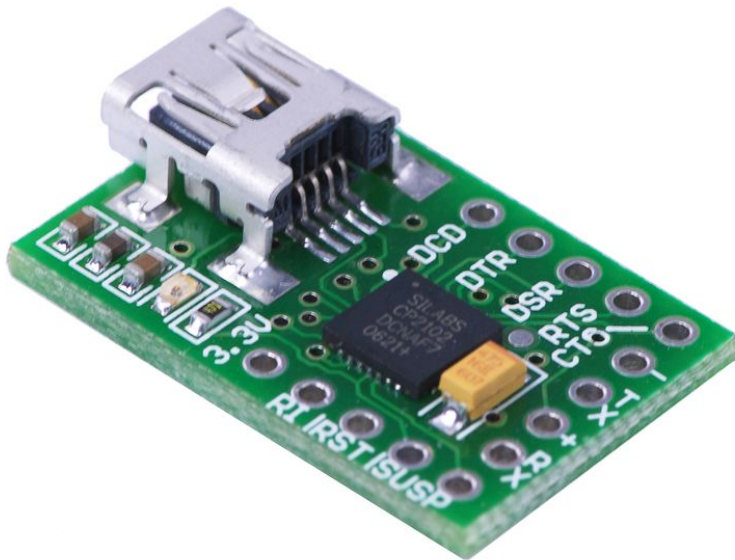
**Mai multe noduri pot  
comunica prin aceleași  
linii de date.**

**Interfața RS-422 utilizează 2 perechi de linii diferențiale**

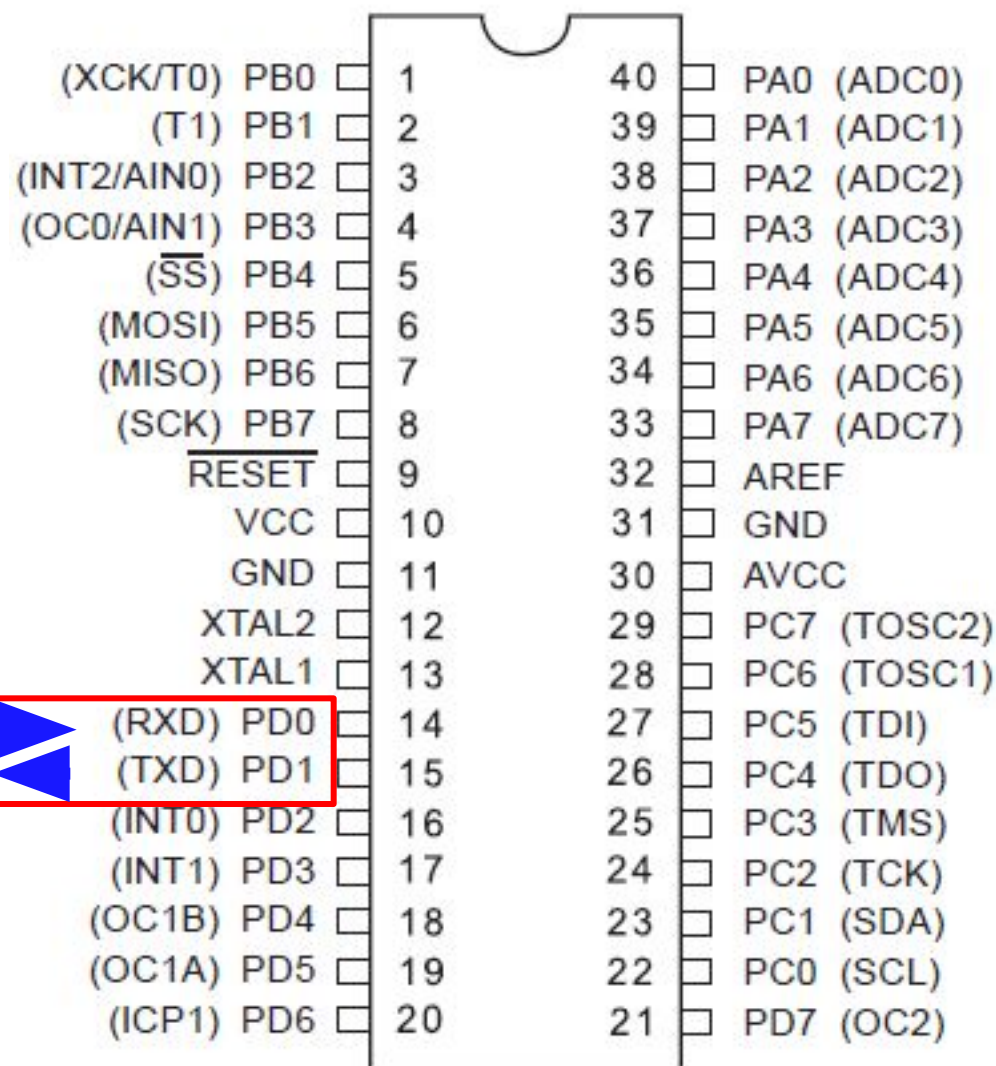


**pentru conectarea MCU la Host (PC/Tab., etc) pot fi utilizate convertoare UART to USB:**

- ☐ FTDI (FT232xx...)
- ☐ SILABS (CP2102)
- ☐ WCH (CH341...)



## I. Structura Modulului USART încorporat



Intrare  
ieșire





# I. Structura Modulului USART încorporat

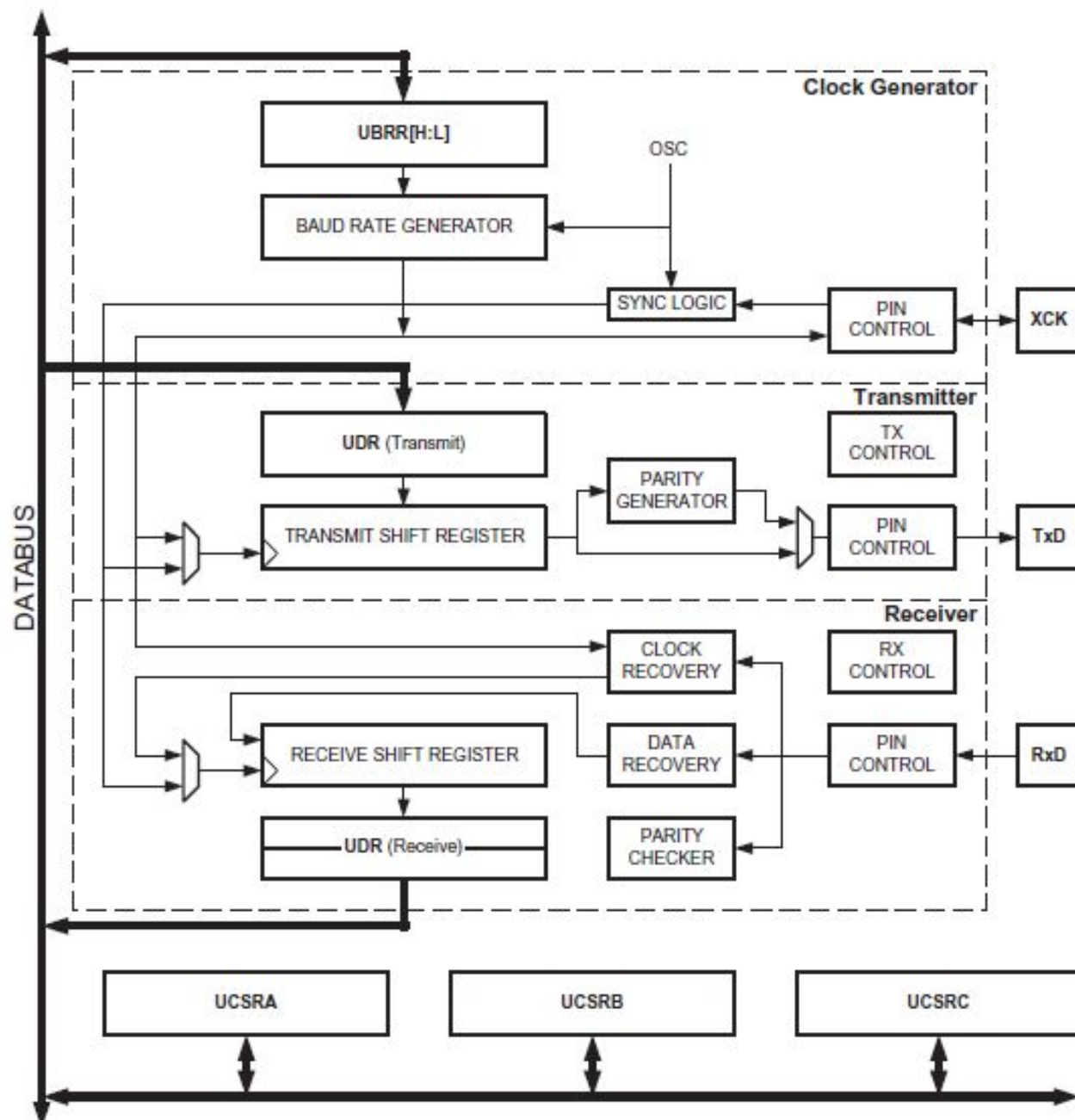
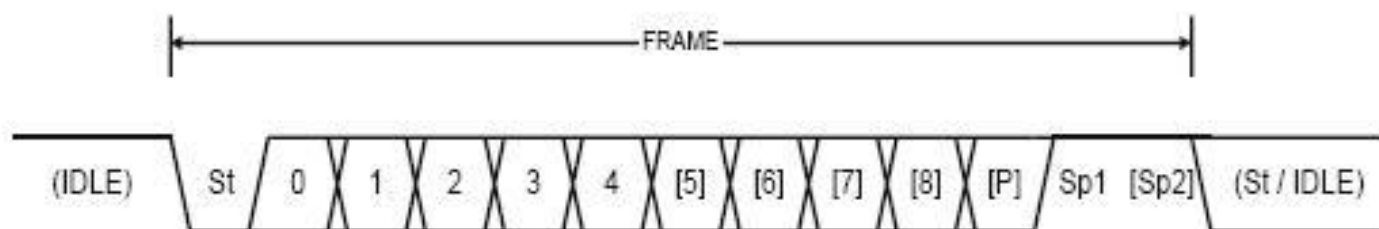


Figure 22-4. Frame Formats



**St** Start bit, always low.

**(n)** Data bits (0 to 8).

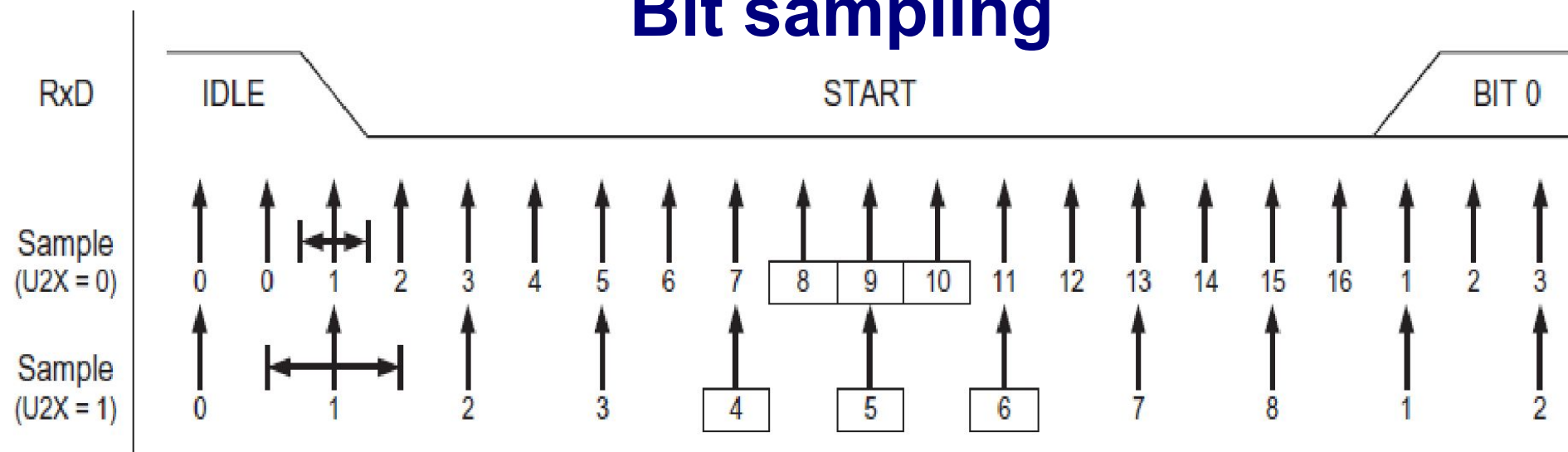
**P** Parity bit. Can be odd or even.

**Sp** Stop bit, always high.

**IDLE** No transfers on the communication line (RxDn or TxDn). An IDLE line must be high.

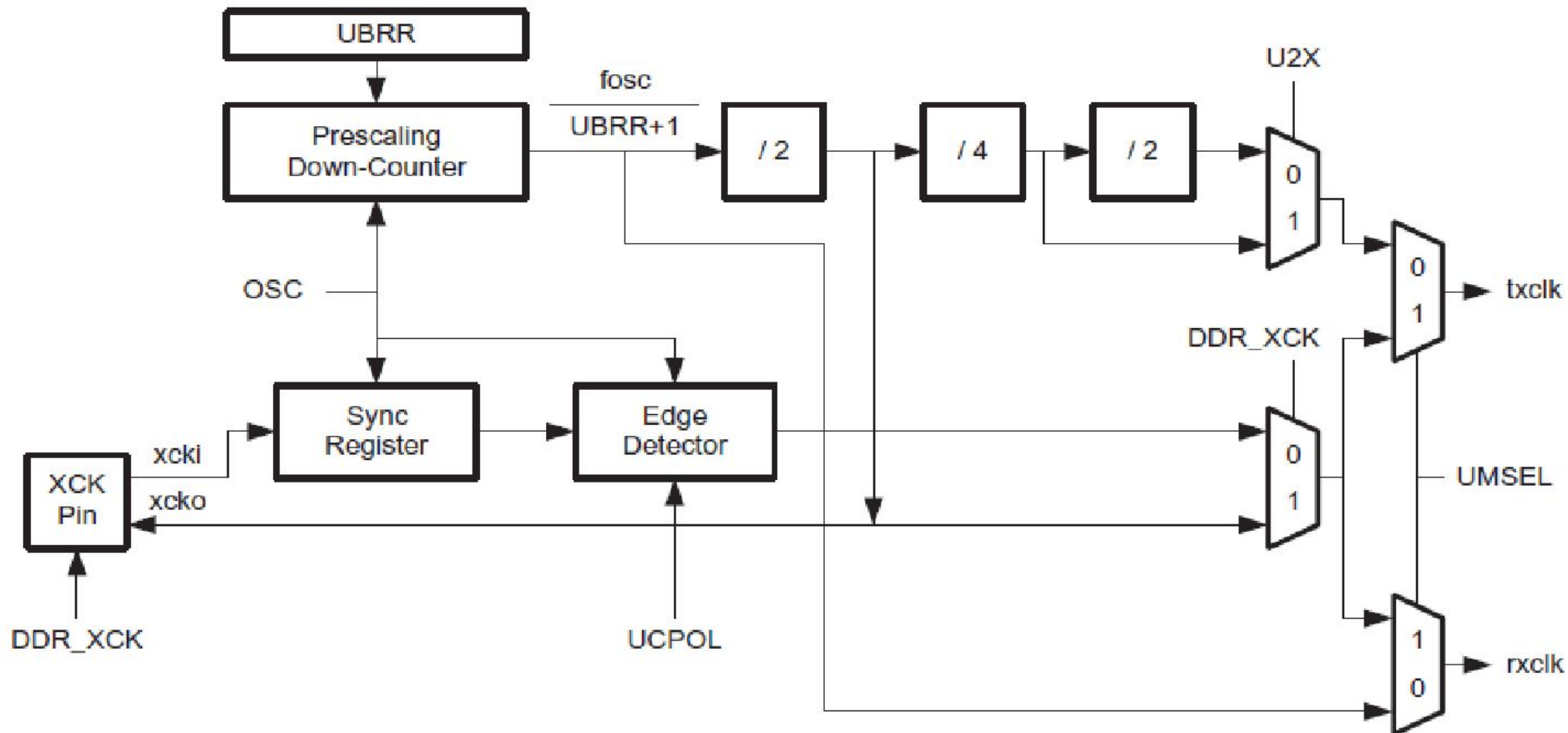
**Pentru minimizarea riscul apariției erorilor – fiecare bit se eșantionează de 16 (8) ori, apoi se aplică funcția de vot majoritar.**

### Bit sampling



**În modul “High Speed” ( $U2X=1$ ) eșanționarea fiecărui bit se face de 8 ori.**

# Generatorul de ceas



Operating Mode	Equation for Calculating Baud Rate <sup>(1)</sup>	Equation for Calculating UBRR Value
Asynchronous Normal Mode (U2X = 0)	$BAUD = \frac{f_{osc}}{16(UBRR + 1)}$	$UBRR = \frac{f_{osc}}{16BAUD} - 1$
Asynchronous Double Speed Mode (U2X = 1)	$BAUD = \frac{f_{osc}}{8(UBRR + 1)}$	$UBRR = \frac{f_{osc}}{8BAUD} - 1$
Synchronous Master Mode	$BAUD = \frac{f_{osc}}{2(UBRR + 1)}$	$UBRR = \frac{f_{osc}}{2BAUD} - 1$

## Registrul de date

USART I/O Data  
Register – UDR

Bit	7	6	5	4	3	2	1	0	
	RXB[7:0]								UDR (Read)
	TXB[7:0]								UDR (Write)
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	

**Registrul receptorului este buferizat (*FIFO*).**

## Registrul de control

USART Control and  
Status Register A –  
UCSRA

Bit	7	6	5	4	3	2	1	0	UCSRA
	RXC	TXC	UDRE	FE	DOR	PE	U2X	MPCM	
Read/Write	R	R/W	R	R	R	R	R/W	R/W	
Initial Value	0	0	1	0	0	0	0	0	

- Bit 7 – RXC: USART Receive Complete
- Bit 6 – TXC: USART Transmit Complete
- Bit 5 – UDRE: USART Data Register Empty
- Bit 4 – FE: Frame Error
- Bit 3 – DOR: Data OverRun
- Bit 2 – PE: Parity Error
- Bit 1 – U2X: Double the USART Transmission Speed
- Bit 0 – MPCM: Multi-processor Communication Mode

## Registrul de control

USART Control and  
Status Register B –  
UCSRB

Bit	7	6	5	4	3	2	1	0
	RXCIE	TXCIE	UDRIE	RXEN	TXEN	UCSZ2	RXB8	TXB8
Read/Write	R/W	R/W	R/W	R/W	R/W	R/W	R	R/W
Initial Value	0	0	0	0	0	0	0	0

- Bit 7 – RXCIE: RX Complete Interrupt Enable
- Bit 6 – TXCIE: TX Complete Interrupt Enable
- Bit 5 – UDRIE: USART Data Register Empty Interrupt Enable
- Bit 4 – RXEN: Receiver Enable
- Bit 3 – TXEN: Transmitter Enable
- Bit 2 – UCSZ2: Character Size
- Bit 1 – RXB8: Receive Data Bit 8
- Bit 0 – TXB8: Transmit Data Bit 8



## Registrul divizorului de ceas

USART Baud Rate  
Registers – UBRRL  
and UBRRH

Bit	15	14	13	12	11	10	9	8	
	URSEL	–	–	–	UBRR[11:8]				UBRRH
	UBRR[7:0]								UBRRL
	7	6	5	4	3	2	1	0	
Read/Write	R/W	R	R	R	R/W	R/W	R/W	R/W	
	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	
	0	0	0	0	0	0	0	0	

**!!! În unele MCU din seria AVR registrul UBRRH și UCSRC este mapat pe aceeași adresă. Selectarea între cele două se face prin intermediul bitului 7 de date.**