Chapter 13

Serial Interfacing

Expected Outcomes

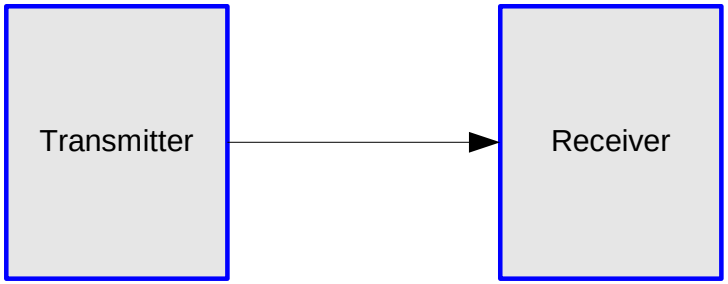
- Explain the fundamental idea of operation of serial interface
- List and describe type of serial interface
- Identify the serial interface characteristic such as data framing and baud rate
- Explain and describe the role line driver in serial interface
- Write a program using serial interface

Introduction

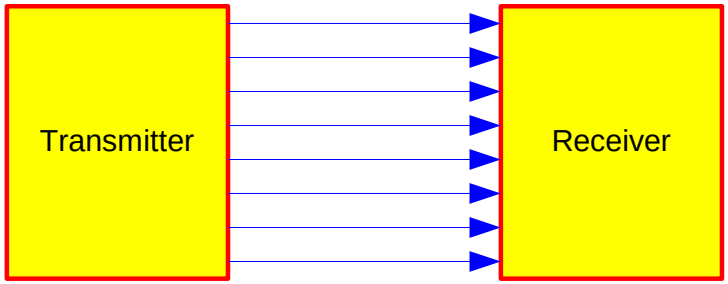
- Computers transfer data in two ways
  - **Parallel**
  - **Serial**
- Parallel data transfers often 8 or more lines are used to transfer data to a device that is only a few feet away such as printers and hard disks
- Parallel requires a short amount of time to transfer data
- However, the distance of the devices are limited and impractical to be used in a long distance
- The parallel is complex to be designed and prone to error
- In serial method, the data is sent one bit at a time

Parallel vs Serial

- Computers transfer data in two ways
  - Parallel
  - Serial



Serial Communication



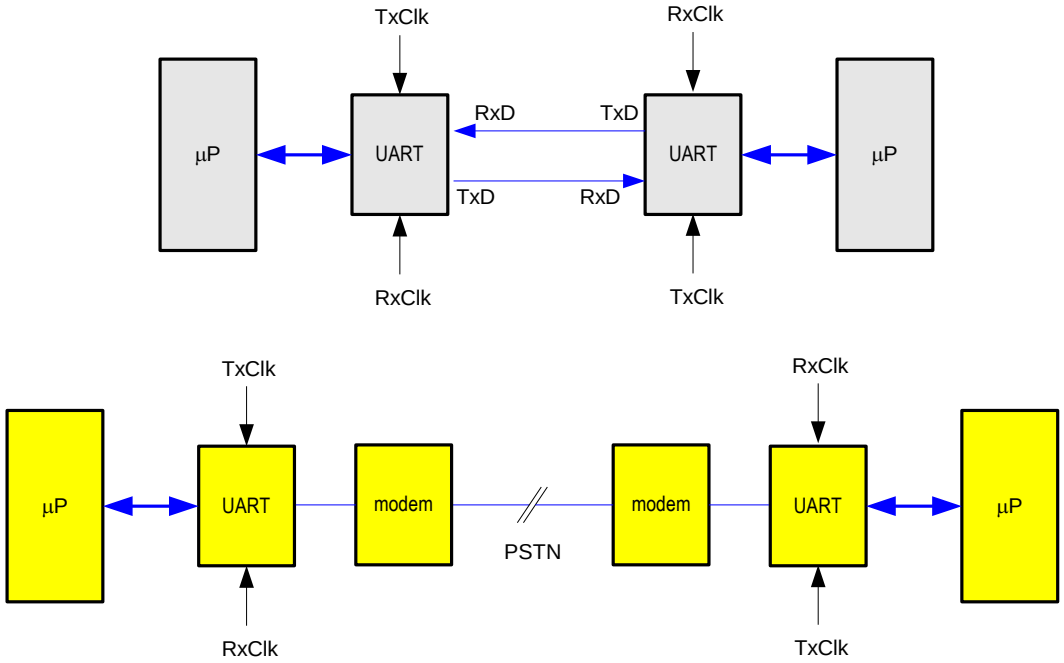
Parallel Communication

Serial Communication

- Serial data communication uses two methods
  - **Asynchronous**
  - **Synchronous**
- The synchronous transfers a block of data (characters) at a time, thus requiring the transmitter and receiver to have the same clock system
- The asynchronous transfers a single byte at a time
- For a small system, normally asynchronous method is preferred as the design is simple and cheap
- Specialized chips are designed for both method: **UART** (Universal Asynchronous Receiver and Transmitter) and **USART**
- M68000 family peripheral **– MC68681 DUART**
- M6800 family peripheral **- MC6850 ACIA**

UART

- Some of the possible connections



DUART 68681

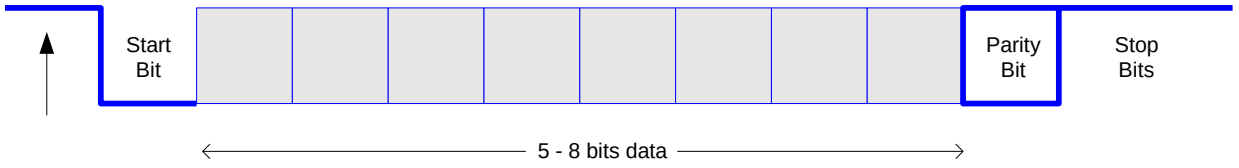
- The MC68681 (dual universal asynchronous receiver/transmitter) is part of M68000 peripheral using asynchronous bus structure
- **Features**
  - 2 independent full-duplex asynchronous channels
  - Maximum data transfer rate up to 1 MB/s
  - Programmable data format
  - Programmable channel mode
  - Independent programmable baud rate
  - Versatile interrupt system
  - Multi-function 16-bit programmable counter/timer
  - Multi-function 8-bit output port and etc…

ACIA 6850

- Alternatively, M6800 family peripheral such as ACIA 6850 can be used in serial transmission
- **Asynchronous Communication Interface Adapter (ACIA 6850)** is widely used due to cost and simplicity
- **Features**
  - Data lines (D0-D7)
  - Chip selects (CS0,CS1 and CS2*)
  - Enable (E)
  - Read and Write (R/W*)
  - Register Select (RS)
  - Received Data (RxD) and Transmit Data (TxD)
  - Transmit Clock (TxClk) and Receive Clock (RxClk)
  - Modem Control Line (CTS*, RTS*, DCD*)

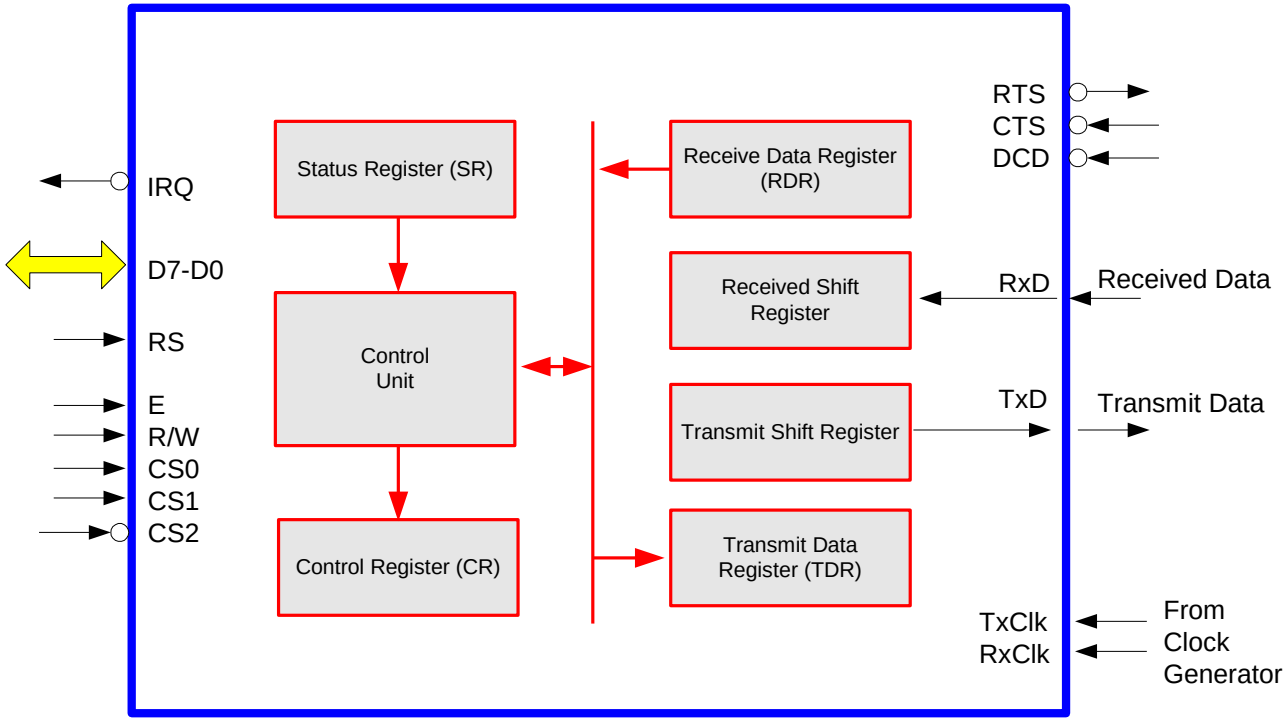
Data Framing

- Before transmission each character must be framed
- Data framing for asynchronous method
- **1 start bit**
  - Always “0” to indicate the beginning of character
- **5-8 bits data**
  - It begins with LSB
- **1 parity bit (optional)**
  - Can be odd or even parity depending on the programmer
- **1 or more stop bits**
  - Always “1” to indicate the end of character



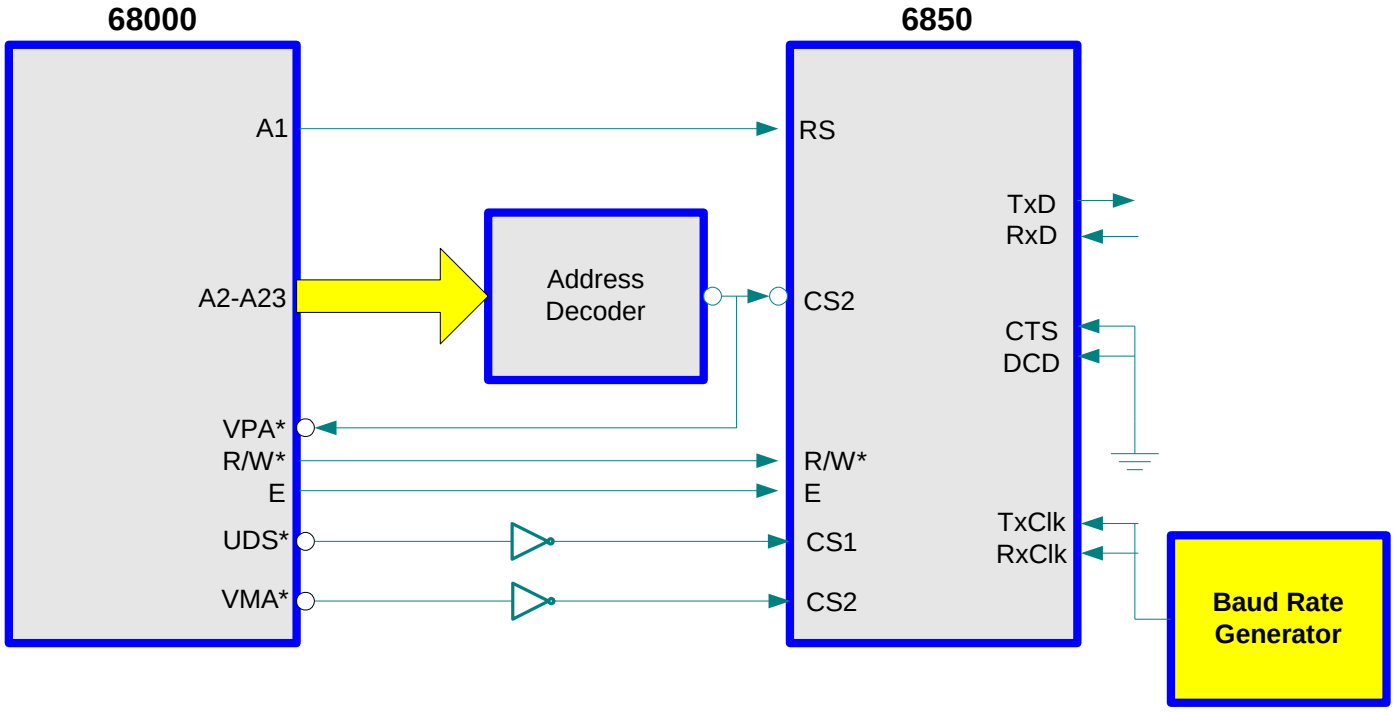
ACIA 6850

Internal architecture of ACIA 6850



ACIA 6850

- **Baud rate generator circuit** : Baud rate generator chips such as MC14411or oscillator circuit



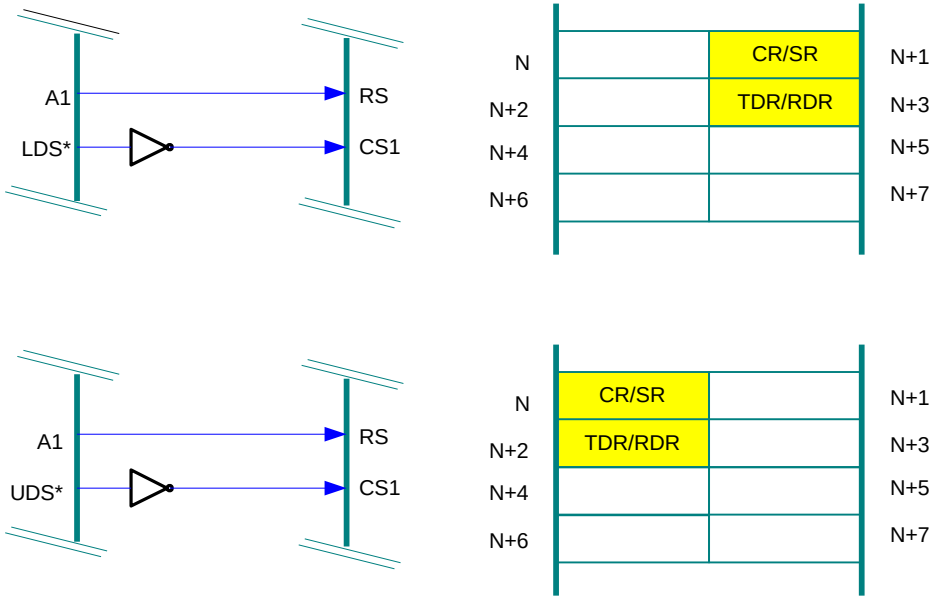
Registers

- There are 4 registers
  - Control Register (CR)
  - Status Register (SR)
  - Transmit Data Register (TDR)
  - Receive Data Register (RDR)

RS	R/W	Name	Register
0	0	CR	Control Register
0	1	SR	Status register
1	0	TDR	Transmit Data Register
1	1	RDR	Receive Data Register

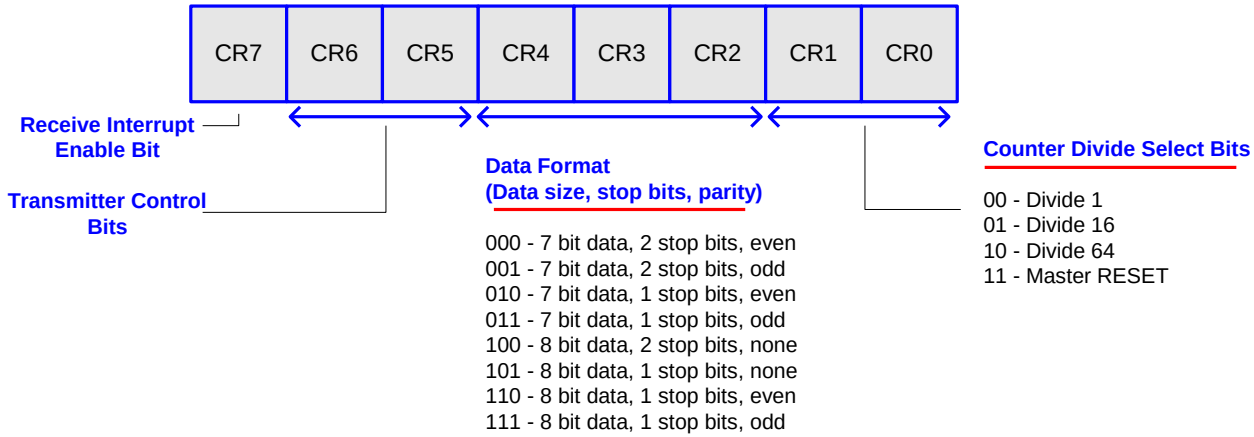
Registers

- The address register depends on
  - **Address decoder**
  - **UDS*/LDS***



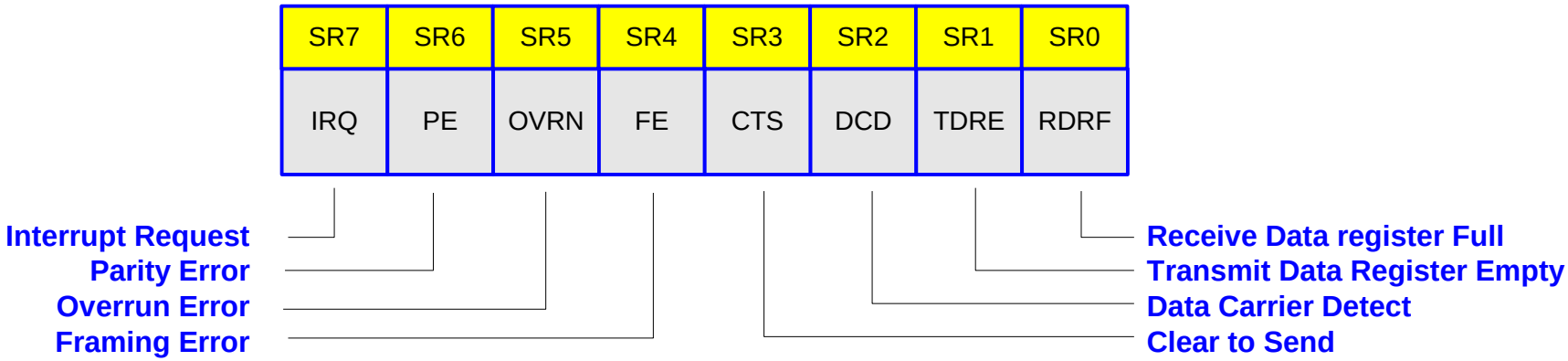
Control Register

- The control register (CR) controls the function of the receiver, transmitter, interrupt enables, and the Request-to-Send peripheral/modem control output



Status Register

- Information on the status of ACIA is available by reading the Status Register (SR)



Programming ACIA 6850

- ACIA must be initialize in order to operate properly
- Four parameter must be set between transmitter and receiver
  - Data rate
  - Number of bits
  - Type of parity
  - Number of stop bits

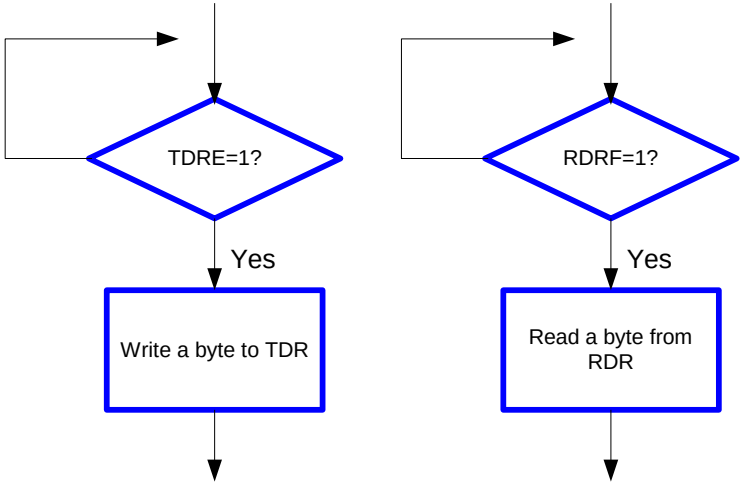
Programming ACIA 6850

- **Example**: Write a routine to initialize ACIA with the following characteristic; 8 bits, 1 stop bit, no parity. Assume clock frequency is 153.6 kHz

```
INIT MOVE.B   #3,ACIACR          ;RESET
     MOVE.B   #$15,ACIACR        ;Set CR
     MOVE.W   #$400,D0           ;Delay
LOOP SUBQ.W   #1,D0
     BNE      LOOP
     RTS
```

Programming ACIA 6850

- In order to transmit or receive data, TDRE and RDRF must be monitored
- If TDR is empty, TDRE is set, allowing new data to be transmitted
- Similarly, if RDR is full, RD is set and a new data must be read



Programming ACIA 6850

- **Example**: Write a routine to send a character 'A' continuously

```
SCAN BTST.B #1,ACIASR    ;TDRE = 1?
     BEQ   SCAN          ;No, scan again
     MOVE.B #'A',ACIADR  ;Load 'A' into DR
     BRA   SCAN          ;Repeat sending
     RTS
```

Programming ACIA 6850

- **Example**: Read a byte from Data Receive register and store in D0

```
SCAN BTST.B #0,ACIASR   ; Read Status Register
     BEQ  SCAN          ; RDRF=0,scan again
     MOVE.B ACIADR,D0   ; Store a byte in D0
     RTS
```

Line Driver

- The 6850 provides two pins (`TxD` and `RxD`) to be used specifically to transfer and receive data serially
- Since the pins are TTL compatible, they require line driver to allow data to be transmitted at a longer distance
- The most common line drivers are RS-232, RS422 and RS423
- However, RS-232 (EIA 232) is widely used as it s the simplest and the cheapest line driver
- Some examples of the ICs that provide the EIA-232 line driver are MAX 233, MAX 232 , MC145407 or a pair of MC1488/MC1489

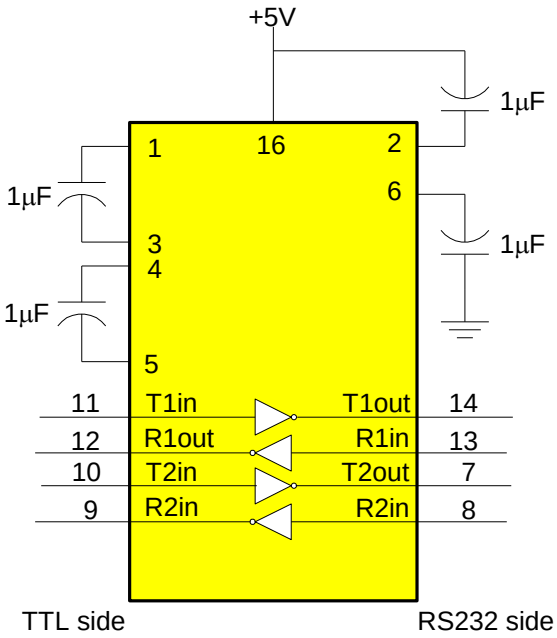
EIA-232

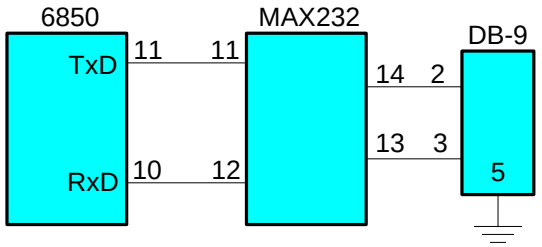
- Widely used for serial interface standard
- Logic “1” is represented by -30 to -25 V and logic “0” is +3 to +25 V allowing the communication to be up to 10 meter
- There are two type of RS232 connectors; DB-25 and DB-9

Pin	Description	Pin	Description
1	Data Carrier Detect (DCD)	6	Data Set Ready (DSR*)
2	Received Data (RxD)	7	Request To Send (RTS*)
3	Transmitted Data (TxD)	8	Clear To Send (CTS*)
4	Data Terminal Ready (DTR)	9	Ring Indicator (RI)
5	Signal Ground (GND)		

EIA-232

- MAX232 internal architecture





Baud Rate

- To ensure a proper communication, the baud rate of the system must match the baud rate of the PC's COM port
- The baud rate for the system depends on baud rate generator (`TxClk` and `RxClk`)

Standard baud rate
110
150
300
600
1200
2400
4800
9600
19200
28800

Self-Test

- **Exercise**

  Explain the advantage of using serial transmission compare to parallel transmission

- **Exercise**

  Describe the important of using line driver such as EIA232 or RS422

- **Exercise**

  What is the difference between MAX232 and MAX233?

- **Exercise**

  State and elaborate the pin requirement for asynchronous transmission

Self-Test

Exercise

Briefly explain the procedure for sending a byte of data using ACIA 6850

Exercise

State and explain bits (TDRE and RDRF) in status register

Exercise

What is the difference between synchronous and asynchronous transmission

Exercise

A 1024 x 512 x 16-grey-level image is to be transmitted to a printer using serial communication at the rate of 19.6 kbps. The data format is one start bit, 8 data bit and one stop bit. How long does it takes to transmit the image?