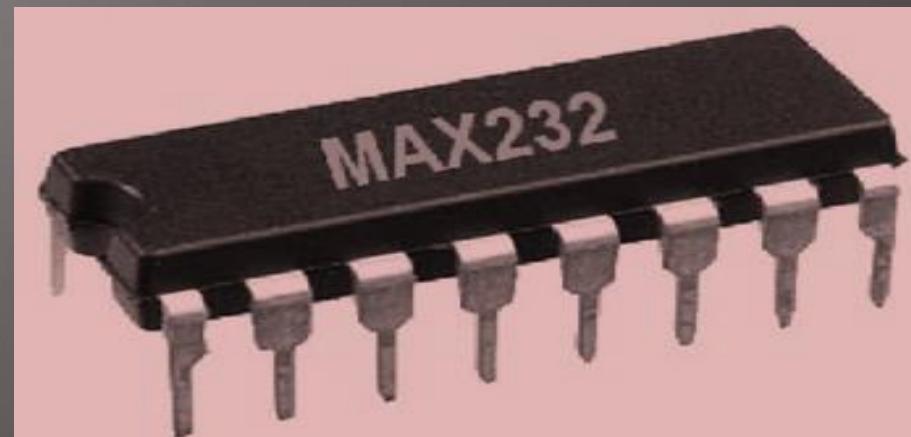


# Serial Data Transmission

## RS232 & MAX232



# Interfaces, buses and connectors

- ▶ It is necessary to organize the communication between elements of the computer measuring system, often communication in both directions.
- ▶ By the communication not only the transferring of the pure data, but also sending messages, commands, instructions and synchronization signals.
- ▶ By *interface system* means the standardized equipment and programs designed for communication between two (or more) independent computer devices.
- ▶ The interface consists of hardware (wires, plugs, sockets) and software (languages and codes) called sometimes protocol.
- ▶ The *protocol* is a common set of rules governing the exchange of the data between the transmitter and the receiver in the communication network.

# Contd..

- ▶ The elements of the system are connected with cables.
- ▶ A special type of connection is the interface bus.
- ▶ The *interface bus* is a connection subsystem that transfers the data between computer components.
- ▶ The bus consists of wires, it can be even a single wire in such case we talk about a *bus line*.
- ▶ The data represented by *digital word* composed from bits can be transferred bit after bit through *serial interface* or through *parallel interface*, in which all the bits are transferred at the same time using several lines.
- ▶ For the serial data transfer it is sufficient to have only two wires (even one wire if we do not take into account the ground common wire).
- ▶ But usually in serial interfaces several wires are used with independent wires for data and commands .
- ▶ The parallel interfaces usually use more lines because apart from the command lines the data words require several lines .

# Serial interface: RS-232C

- ▶ The *RS-232C interface* is still most commonly used interface although it was designed in 1962 as RS-232 interface (*RS – Recommended Standard*).
- ▶ This interface was slightly modified in 1969 and is known as RS-232C.
- ▶ The RS-232C is USA standard and also is described in international standards.
- ▶ Because it has been designed a long time ago its performance is rather poor – speed of transmission not faster than 20 kbps (*bps – bits per second*), connection not longer than 15 m, poor immunity to interferences.
- ▶ But it is still in use because it is traditional equipment of computers – as so-called COM serial port

# Contd..

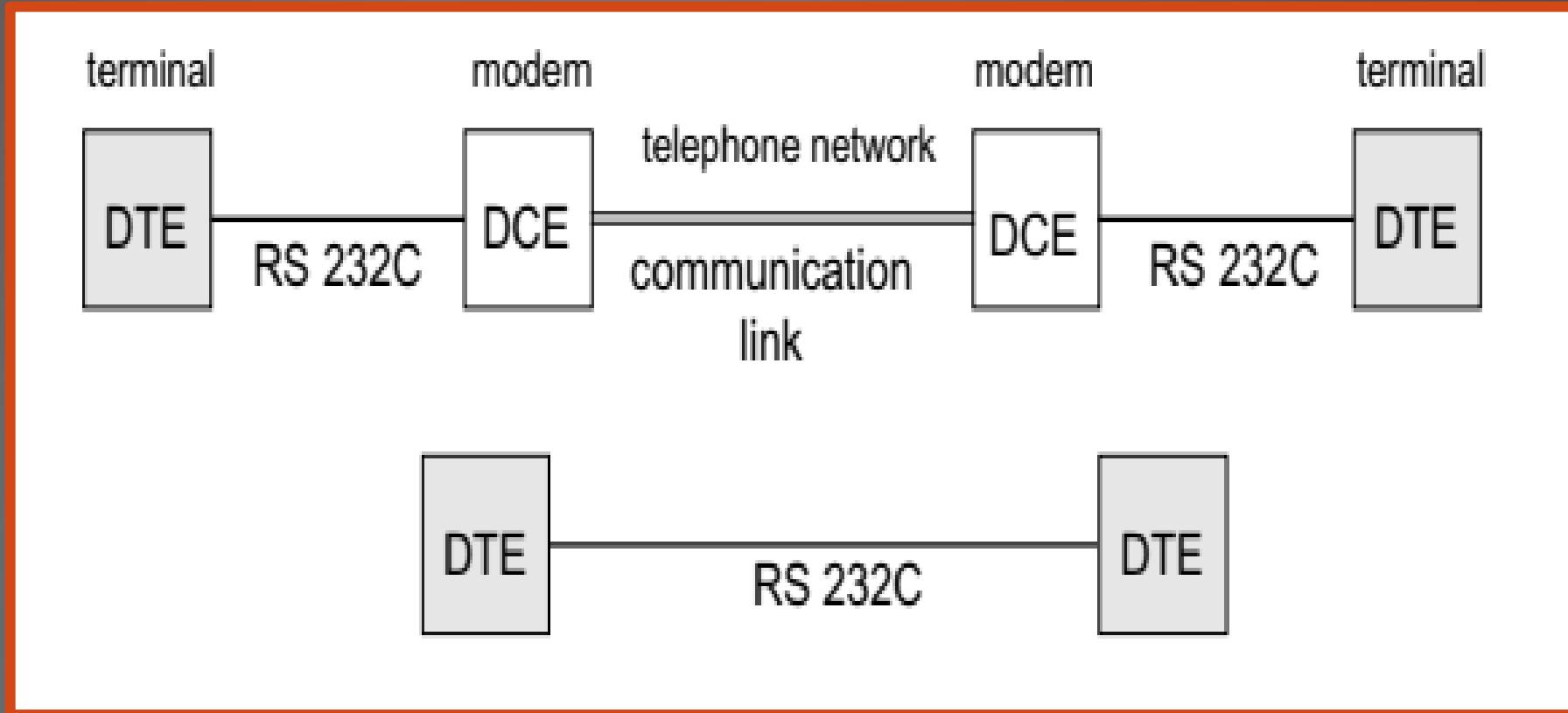


Figure: Connection of two data terminals using RS-232C interface

# RS232C Pinout

- ▶ The RS-232C was designed for telecommunication purposes typically two data terminals DTE (*Data Terminal Equipment*) are connected through modems DCE (*Data Communication Equipment*).
- ▶ It is also possible to connect directly both DTE data terminals – for example the measuring instrument and the computer.
- ▶ In such cases it is necessary to slightly modify the cable in order to obtain a so called null-modem cable.

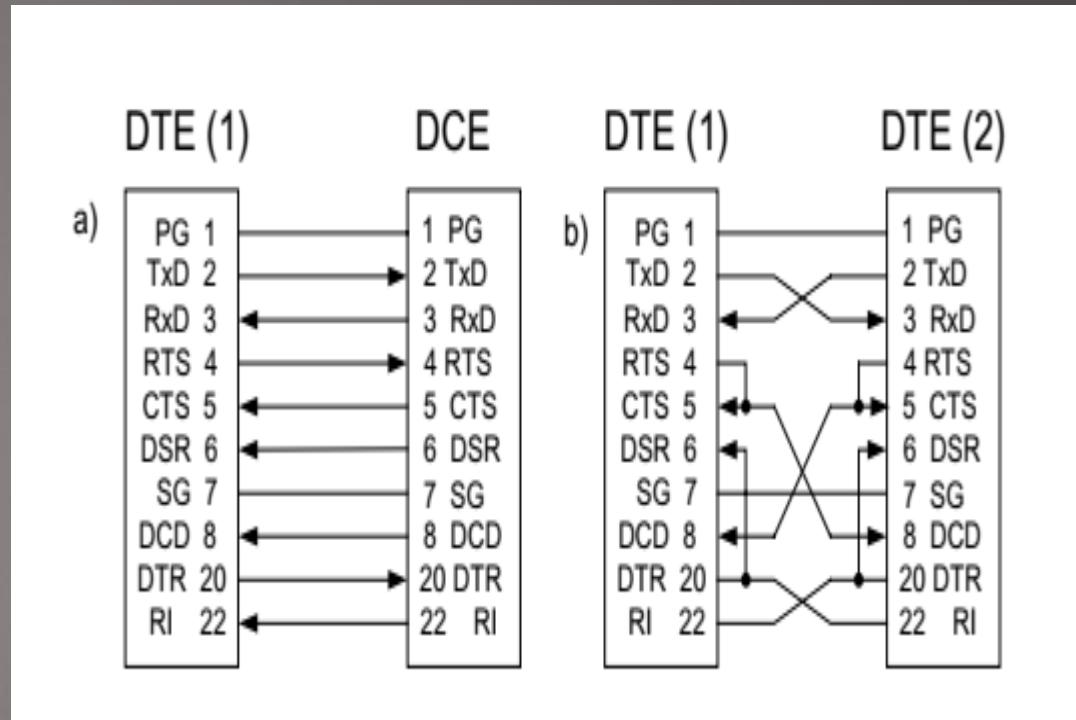


Figure :(a) The standard RS-232C connection  
(b) Null-modem connection

# Simplified 3-wire connection

- The RS-232C bus uses 20 lines in the full version: 4 lines of data, 11 lines for control, 3 lines for synchronization and 2 lines for ground.
- Not all lines are used, normally only 6–7 lines are used and in the simplest case it is possible to use only two lines for data and one for ground
- RS232 uses two voltage states known as MARK and Space.
- Mark is –ve , <-3V
- Space is +ve,>3V
- The dead line is in between +3 and -3 V absorbs noise.

Figure: The simplified 3-wire connection via RS-232C interface

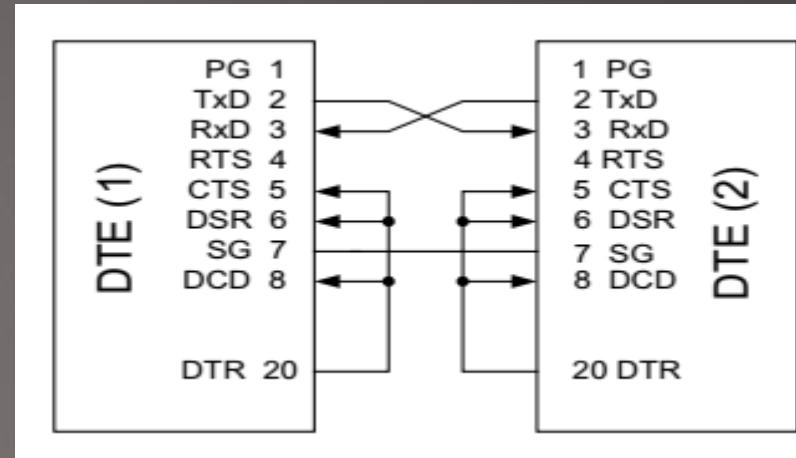


Table The main lines in RS-232C bus interface

Pin No DB-9	Pin No DB-25	Code	Description
-	1	PG	Protective Ground
5	7	SG	Signal Ground
3	2	TxD	Transmitted Data
2	3	RxD	Received Data
7	4	RTS	Request to Send
8	5	CTS	Clear to Send
6	6	DSR	Data Set Ready
4	20	DTR	Data Terminal Ready
1	8	DCD	Data Carrier Detected
9	22	RI	Ring Indicator
	15	DB	Transmitter signal timing
	17	DD	Receiver signal timing
	24	DA	Transmitter signal timing

# Connectors in RS232C

- ▶ The RS-232C interface uses D-9 or D-25 pin connectors.
- ▶ The conversion between 9-pin connector and 25-pin connector can be easily realized using special adapter.
- ▶ The amplitude of the signals can be varied in a wide range - low level corresponds with the voltage -15 – -3V and high level corresponds with the voltage 3 – 15 V.
- ▶ In the data transmission high level is related to the logical 1, low level is related to 0.
- ▶ In the control lines this relation is inverted.

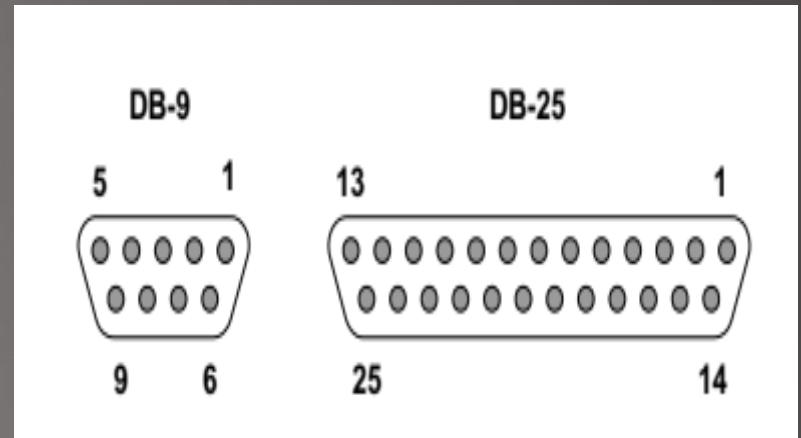


Figure: RS232C layout

# Serial Communication

- ▶ There are two types of serial communication – synchronous and asynchronous.
- ▶ In the asynchronous system the message is send in a form of well defined series of impulses called *SDU* – *serial data unit*, where first bit means the start of the transmission, next 7 or 8 bits are the data bits, next bit is used to detect the error of transmission (parity bit) and last bit (or two bits) means the end of transmission.
- ▶ The parity bit (that may be even or odd) informs about total number of data bits – logic 1 of parity bit means that the total number must be an even number. Statistically such a method of error detection has only a 50% chance of detecting an error.
- ▶ The common data transmission rates used by RS-232C are: 110, 300, 600, 1200, 2400, 4800, 9600 and 19200 bps. Data rate is usually measured in bps (*bits per second*).
- ▶ The term *baud rate* is also used and means how many times the physical signal changes per second.
- ▶ The cable length depends on the baud rate and for 19 200 it is limited to 50 m.

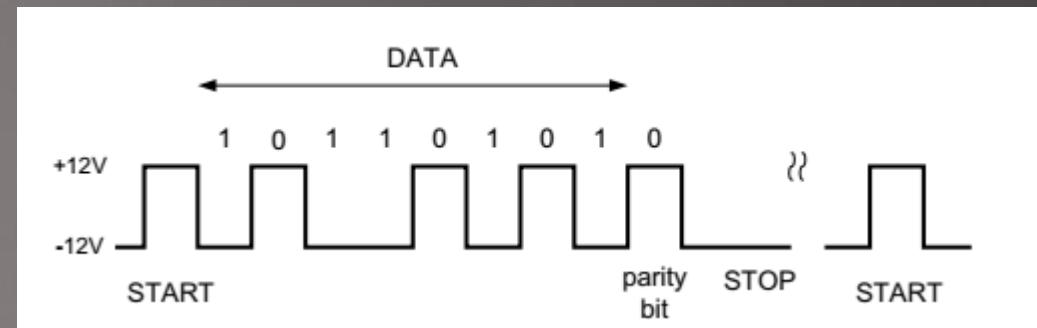


Figure :The serial data unit in asynchronous transmission

# Synchronous mode

- ▶ In the synchronous mode the receiver and the transmitter synchronize initially clock pulses, which enables the receiver to maintain the synchronization throughout large message, typically 4500 bytes (36000 bits).
- ▶ Usually there is no special clock signal line and the synchronization is derived from the data signal.
- ▶ The data bits and accompanying communication bits are sent in the form of a continuous stream called a frame.
- ▶ There are several various transmission protocols. One of them, called *HDLC – high level data link control*.
- ▶ The frame starts with flag bits, next are two fields: address field and control field.
- ▶ After data transmission there is a field reserved for *FCS – Frame Check Sequence* used for the error detection.
- ▶ The cross talk can be reduced by using Low capacitance capable.

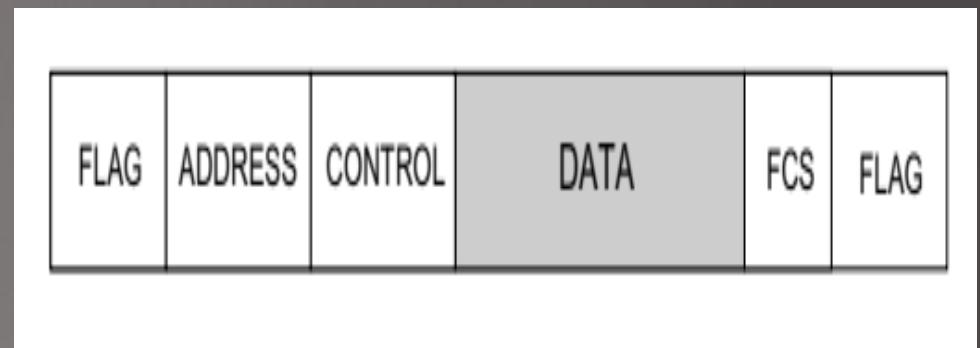
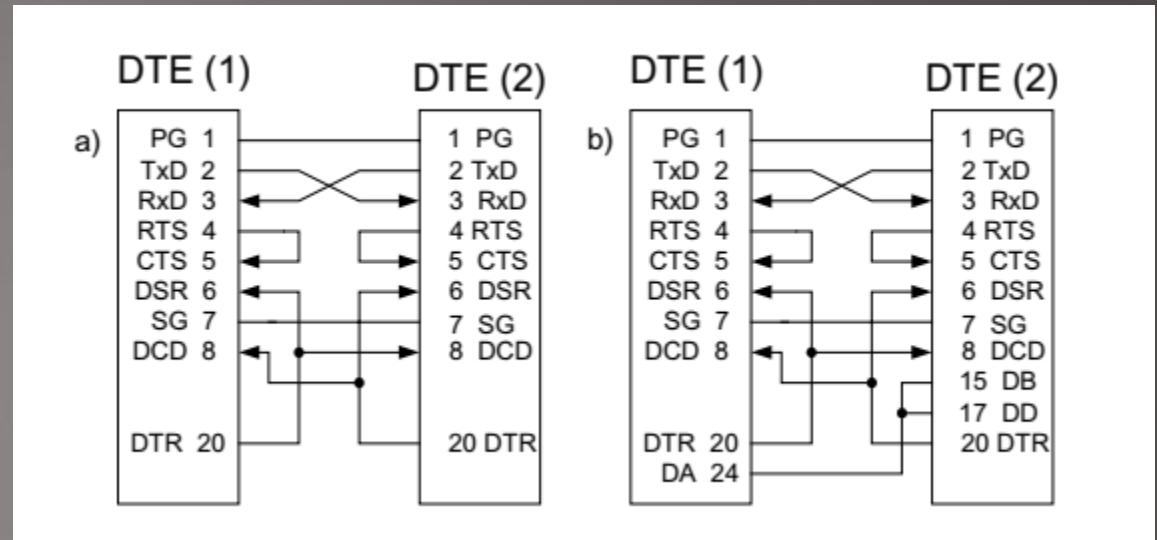


Figure :The synchronous system frame format (HDLC protocol)

# Device connection

- ▶ Although synchronous system is more efficient and enables to send more information at high data rate it is mainly used in telecommunication.
- ▶ For data transmission most often a much simpler asynchronous system is used.
- ▶ Figure presents two examples of device connections via RS-232C interface.
- ▶ The data transmission can be realized as a *simplex* one (sending messages in one direction only), *full-duplex* (data sending in both directions simultaneously) or *half-duplex* (data sensing in both directions but only in one direction at a time).
- ▶ The half-duplex mode is most often used for data transmission.



**Figure** Device connection via RS-232C interface (a) asynchronous (b) synchronous

# Current loop method

- ▶ One of the drawbacks of RS-232C interface is relatively short distance – about 15 mt
- ▶ The current loop method can be used in order to increase that distance.
- ▶ The current loop (application of the voltage/current converter) enables us to transmit the signal at a distance of about 2 000 m.
- ▶ Fig. presents the circuit with the current loop 20 mA.
- ▶ In this loop the optical galvanic separation is used.
- ▶ The main drawbacks of the RS-232C interface (short distance of transmission data, connection only two devices, and influence by interferences)

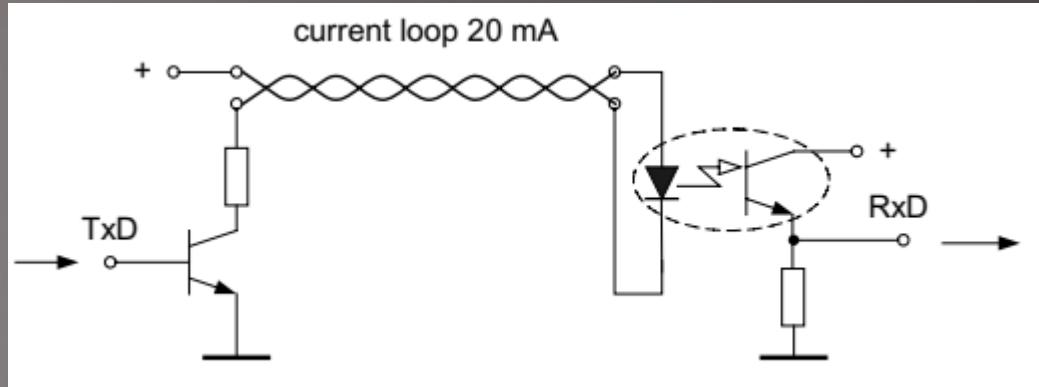


Figure: Application of current loop in RS-232C interface

# Max 232

- ▶ This IC is widely used in RS232 Communication systems in which the conversion of voltage level is required to make TTL devices to be compatible with PC serial port and vice versa.
- ▶ This chip contains charge pumps which pumps the voltage to the Desired Level.
- ▶ It can be powered by a single +5 volt power supply and its output can reach +7.5 volts.
- ▶ It can be used as a hardware layer converter for 2 systems to communicate simultaneously.
- ▶ Max232 is one of the versatile IC to use in most of the signal voltage level conversion problems.

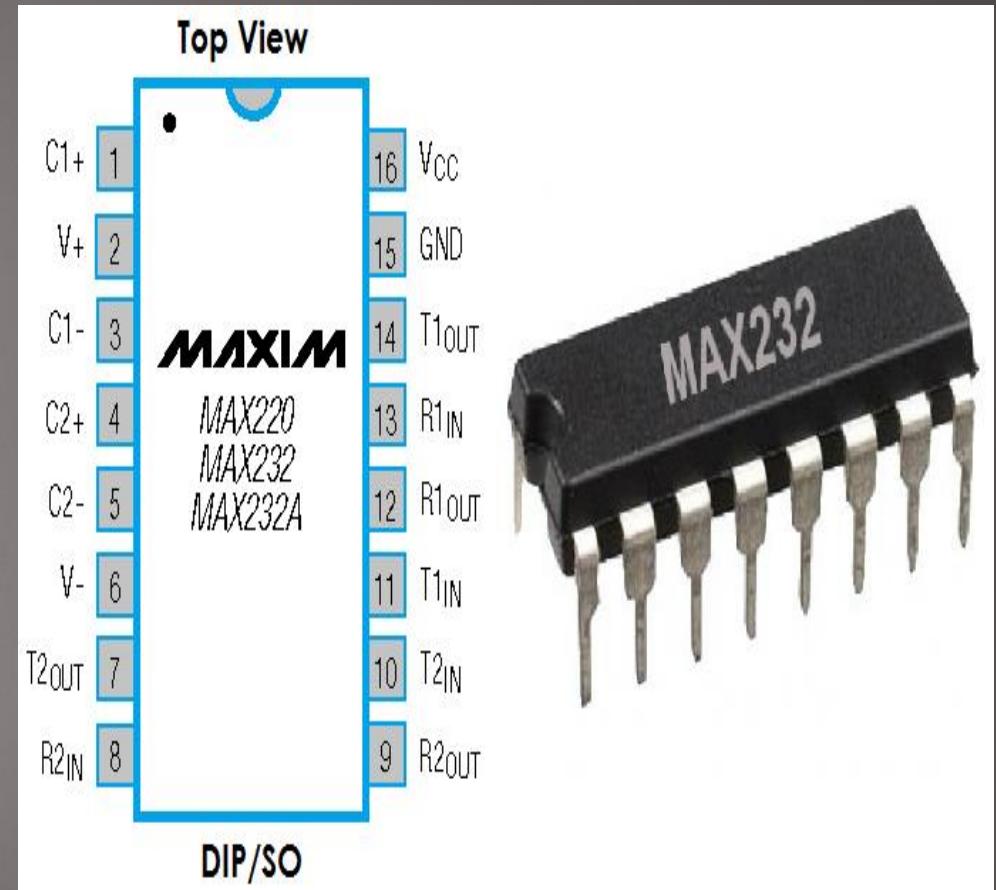


Figure: MAX232 Pinout diagram

# Application of MAX232

- ▶ Serial communication
- ▶ Battery Powered RS 232 Systems
- ▶ Interface Translation
- ▶ Low Power Modems
- ▶ RS 232 Networks (Multi-drop)
- ▶ Portable Computing

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