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Serial Communications

MOST OF THIS PRESENTATION IS BY DR. GREGG J CHAPMAN (OSU)
INFORMATION ADDED BY DANIEL KOHN (UOFM)

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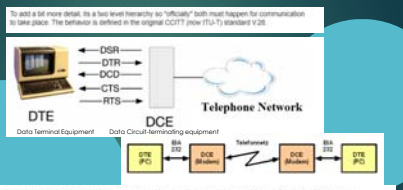
A Brief History of Serial Communications



The DCE is a modem connecting between the terminal and telephone network. In the telephone network was another piece of equipment which split off to the data network, eg. X.25.

The modem has three states: Powered off, Ready (*Data Set Ready* is true), and connected (*Data Carrier Detect*)

The terminal can't do anything until the modem is connected.

When the modem wants to send data, it raises RTS and the modem grants the request with CTS. The modem lowers CTS when its internal buffer is full.

So nostalgic!

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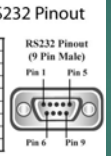
RS-232 STANDARD

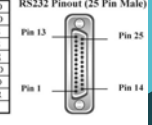
BL-819 RS232 Pinout

Pin 1	N/C
Pin 2	RXD
Pin 3	TXD
Pin 4	DTR
Pin 5	GND
Pin 6	DSR
Pin 7	RTS
Pin 8	CTS
Pin 9	Power Input



RS232 25 Pin

Pin 2	TXD
Pin 3	RXD
Pin 4	RTS
Pin 5	CTS
Pin 6	DSR
Pin 7	GND
Pin 8	DCD
Pin 20	DTR
Pin 22	RI



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FULL MODEM Cable

DCE Device (Modem)			Signal Direction	DTE Device (Computer)		
Pin #	RS-232 Signal Names			Pin #	RS-232 Signal Names	
1	Carrier Detector (DCD)	CD		1	Carrier Detector (DCD)	CD
2	Receive Data (Rx)	RD		2	Receive Data (Rx)	RD
3	Transmit Data (Tx)	TD		3	Transmit Data (Tx)	TD
4	Data Terminal Ready	DTR		4	Data Terminal Ready	DTR
5	Signal Ground/Common (SG)	GND		5	Signal Ground/Common (SG)	GND
6	Data Set Ready	DSR		6	Data Set Ready	DSR
7	Request to Send	RTS		7	Request to Send	RTS
8	Clear to Send	CTS		8	Clear to Send	CTS
9	Ring Indicator	RI		9	Ring Indicator	RI
Soldered to DB9 Metal - Shield		FGND		Soldered to DB9 Metal - Shield		FGND

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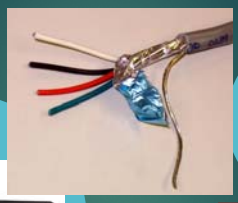
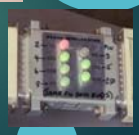
Cable, Breakouts and Testers





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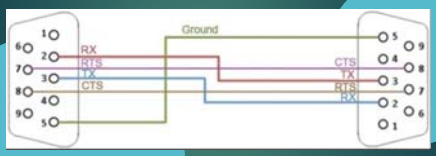
Serial Communications Interface (RS-232)

SCI MODEM CABLE



Handshaking

The RS232 handshake process involves four steps:

1. The data terminal equipment (DTE) puts the RTS line into the "On" state.
2. The data communications equipment (DCE) puts the CTS line into the "On" state.
3. The DTE puts the DTR line into the "On" state.
4. The DTR line remains in the "On" state while data is being transmitted.

- After the transmission of data is completed, the DTE puts the DTR and RTS lines into the "Off" state and the DCE puts the CTS line into the "Off" state.
- With RS232 handshaking, RS232 communications only will take place when both ends of the RS232 link are ready. Thus, the RS232 handshake process enables the DTE to request control of the communications link from a related modem and allows the modem to inform the terminal equipment that the control has been acquired.

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Handshaking

- Handshaking was extremely important back in the days of slow computers and slow modems. Now days, most RS-232 ports and computers do not need to do hardware handshaking in this manner, so most RS-232 ports are now:

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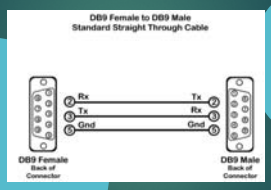
NULL MODEM CABLE



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UART - Universal Asynchronous Receiver Transmitter

- (**U**niversal **A**synchronous **R**eceiver **T**ransmitter) The electronic circuit that makes up the serial port. Also known as "universal serial asynchronous receiver transmitter" (USART), it converts parallel bytes from the CPU into serial bits for transmission, and vice versa. It generates and strips the start and stop bits appended to each character.

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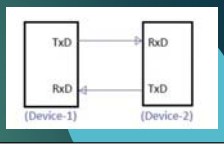
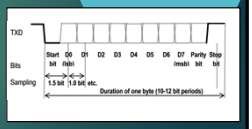
UART - Universal Asynchronous Receiver Transmitter

- one of the most used serial protocols. Most controllers have a hardware UART on board.
- It uses a single data line for transmitting and one for receiving data.
- Most often 8-bit data is transferred, as follows: 1 start bit (low level), 8 data bits and 1 stop bit (high level).
- The low level start bit and high level stop bit mean that there's always a high to low transition to start the communication.





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RS-232 Standard Voltage Level

- Range from +3 to +15 volts or -3 to -15 volts with respect to the common ground
- For Tx and Rx:
  - Logic 1 (Mark) is represented by a negative voltage
  - Logic 0 (space) is represented by a positive voltage

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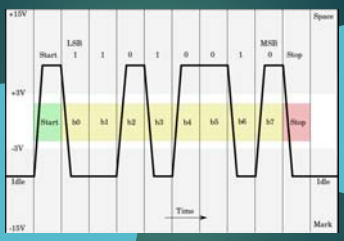
Voltage Level



Diagrammatic oscilloscope trace of voltage levels for an ASCII "K" character (0x4B) with 1 start bit, 8 data bits (least significant bit first), 1 stop bit. This is typical for start-stop communications, but the standard does not dictate a character format or bit order.

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Voltage Level Cont

- Note that many Microcontrollers and other devices put out TTL signals 0-5V and are not TRUE RS-232 devices. They usually need a Driver IC to bring it up to RS-232 Standard.
- The most common of these the MAX232 Dual EIA-232 Driver/Receiver IC.

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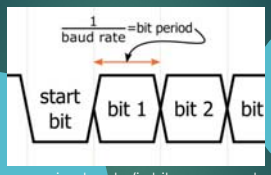
Remember Baud Rate



Baud rate: The approximate rate (in bits per second, or bps) at which data can be transferred. A more precise definition is the frequency (in bps) corresponding to the time (in seconds) required to transmit one bit of digital data. For example, with a 9600-baud system, one bit requires 1/(9600 bps) ≈ 104.2 µs. The system cannot actually transfer 9600 bits of meaningful data per second because additional time is needed for the **overhead bits** and perhaps for delays between one-byte transmissions.

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Standard Baud Rates

- By far the most commonly used baud rate is 9600, but others Are used. When connecting two devices the Baud Rates HAVE TO MATCH!
- Other settings are:
  - Parity (Even, Odd or None)
  - Number of Stop bits
  - Number of Databits
  - Flow Control (Hardware or software)
- One Last word….in the olden days the table would have included 150 and 300 baud.

Baud Rate
230400
115200
57600
38400
19200
9600
4800
2400
1200

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References

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