

# RS-232 Reference

## A Background

Here's my reference notes on RS232. There's usually an air of frustration with RS232. No, it's not the design, or the detail of the signals. No. It's the cable.

All cables look the same. (Except when they don't: you may have a 25 way female when you really want a 9 way male.)

They might look the same, but not work the same. The internal wiring can be, seemingly, totally random.

(In my early days I was employed by a company that manufactured VDUs - emulations of VT52, VT200... We had a catalogue of 80 different RS232 cables. Different emulations, host interfaces, printer interfaces. Amazing.)

That's why USB is so popular, plug and play, and it might work too!

## Male / female

As you may be aware, males have things that stick out; females have holes. So it is with RS232 connectors.

## PC 9-way COM Port pin-out, male

This is the connector you'll find on a PC.

9-way	Signal	Direction	Class
1	<a href="#">DCD</a>	Modem -> PC	Control
2	<a href="#">RXD</a>	Modem -> PC	Data
3	<a href="#">TXD</a>	PC-> Modem	Data
4	<a href="#">DTR</a>	PC-> Modem	Control
5	<a href="#">GND</a>		
6	<a href="#">DSR</a>	Modem -> PC	Control
7	<a href="#">RTS</a>	PC-> Modem	Control
8	<a href="#">CTS</a>	Modem -> PC	Control
9	<a href="#">RI</a>	Modem -> PC	Control

## 25 way DTE, male

This is the connector you'll find on a VDU, or some other piece of old technology

25-way	Signal	Direction	Class
1	Protective Ground		
2	<a href="#">TXD</a>	PC-> Modem	Data
3	<a href="#">RXD</a>	Modem -> PC	Data
4	<a href="#">RTS</a>	PC-> Modem	Control
5	<a href="#">CTS</a>	Modem -> PC	Control
6	<a href="#">DSR</a>	Modem -> PC	Control
7	<a href="#">GND</a>		
8	<a href="#">DCD</a>	Modem -> PC	Control
20	<a href="#">DTR</a>	PC-> Modem	Control
22	<a href="#">RI</a>	Modem -> PC	Control

Most of the other pins have assigned uses, but are not normally used.

## Glossary

Term	Description	Which <i>typically</i> means
CTS	Clear To Send	A control signal to the PC. The remote host is ready to receive your input. The host (remote DTE) may drop this from time to time as it becomes busy.
DCD	Data Carrier Detect	A control signal to the PC. The modem is receiving a valid carrier signal from the remote modem. AKA Received Line Signal Detect – RLSD.
DCE	Data Communication Equipment.	Normally a Modem
DSR	Data Set Ready	A control signal to the PC. The modem is ready to answer or originate a call – as opposed to being in a test mode. The word <i>set</i> is a noun. It is the same word used by an elderly maiden aunt referring to a television <i>set</i> .
DTE	Data Terminal Equipment	PC, VDU or Data Terminal, Mainframe, terminal concentrator.
DTR	Data Terminal Ready	A control signal from the PC. The PC uses this to enable the modem: the modem is allowed to go on-line or answer a call. (Cynically, this can also be considered as a modem reset line - use this signal to reset the modem after a firmware crash.)
EIA	Electronic Industries Alliance	The US standards body. <a href="http://www.eia.org/">http://www.eia.org/</a> Their version is TIA/EIA-232-F
ITU-T	International Telecommunication Union	An international organization that coordinates global telecom networks and services. Formerly CCITT <a href="http://www.itu.int/">http://www.itu.int/</a> Recommendation V.24 covers the connector and signals. Recommendation V.28 covers the electrical characteristics. Note that the ITU uses the term "Recommendation" as opposed to "Standard". (A pragmatic solution for real-world screw ups.)
GND	Ground	The common signal ground connection. All the other signals refer to this reference. This must be connected at both connectors.

Protective Ground	Protective Ground	A ground screen. Ideally, this should be open at one of the connectors.
RI	Ring Indicator	A control signal to the PC. Indicates the phone line is ringing. This signal follows the cadence of the ringing signal.
RTS	Request To Send	A control signal from the PC. The PC is ready to receive data. The PC may drop RTS from time to time as it "spins its wheels" - having to scroll text and other demanding tasks. The PC will still accept data - all this is defined by the PC application writer. The application will manage an input buffer. RTS drops when a "high-water" mark is reached, and raised when a "low-water" mark is reached.
RXD	Receive Data	The data signal to the PC. What the user sees from the remote host.
TXD	Transmit Data	The data signal from the PC. The data sent by the user.

## The Signals

Voltage signalling is used – as opposed to current. Note the polarity is *different* between data and control signals!

Circuit class	Circuit Condition	Voltage	Logic
Data	Mark (Asynchronous stop bit, idle)	-25v to -3v	1
Data	Space (Asynchronous start bit, break)	+25v to +3v	0
Control	Mark (Asserted)	+25v to +3v	1
Control	Space (Not Asserted)	-25v to -3v	0

(30v/us slew limit, 3k 2500pF load.)

## The connectors

9 way connectors look something like this:

 <p>A photograph of a male DTE connector. It is a rectangular metal plate with a central 9-pin connector. The pins are numbered 1 through 9 in a 2x5 grid: 1-5 on the top row and 6-9 on the bottom row.</p>	<p><b>Male</b> <b>DTE</b>  (The connector fitted in a PC)</p>
 <p>A photograph of a female DCE connector. It is a rectangular metal plate with a central 9-pin connector. The pins are numbered 1 through 9 in a 2x5 grid: 5-1 on the top row and 9-6 on the bottom row.</p>	<p><b>Female</b> <b>DCE</b>  (The connector that's on the cable that plugs in to a PC)</p>

Note – When thinking about the RS-232 spec, view the signal directions from the DTE's viewpoint. That is the DTE transmits on the TXD signal connection.

There are alternate designations. (EIA designate BA, BB, CB etc. ITU-T V.24 designate: 103, 104, 106 etc.) To describe them here in detail would not be particularly helpful, and would obfuscate. Leave them to sad network gurus.

## Cables

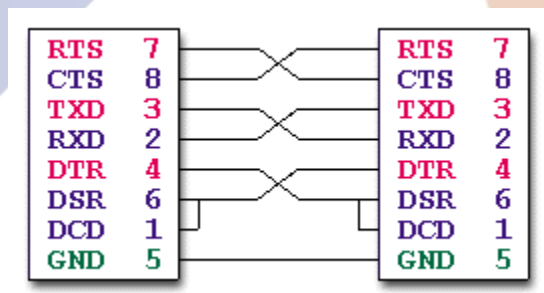
A cable connecting a DTE to DCE is wired "straight through", male to female.

## Null Modem

To connect two computers together, a special cable is required which mimics the behaviour of a modem. This specially wired cable, with two female connectors, is known as a *null-modem* cable.

A null modem cable swaps:

- CTS with RTS
- TXD with RXD
- DSR and DCD with DTR.



## Still Issues?

Try building up and testing with a null cable incrementally. Using the above diagram try connecting only the GND, TXD and RXD between to connectors. You'll then have a null modem with no handshaking.

Try wiring up a loopback on each connector. Connect CTS to RTS on each connector only. DSR and DCD with DTR. These loopbacks are only on the connectors - don't wire between the two individual connectors: you still only have TX RX and GND connected between the two. This will fool the DTE and DCE that hardware conditions are all ready to send and receive.

## RS232 Gender Benders

You can get adapters that are wired "straight through". There are 2 flavours: back-to-back male and back-to-back female. They tend not to be that useful as you usually need to re-assign pin connections too.

## HyperTerminal

Windows comes with a terminal emulator "HyperTerminal." If you are using the HyperTerminal supplied with Windows 98 or HTPE 3.0, you will find that local echo doesn't work when "Echo typed characters locally"

under ASCII Setup/ASCII Sending is checked. This bug has been fixed with HTPE 5.0. You'd better download and install their new version.

Sort of relevant - it caught me out!

## Macintosh, and Linux

When connecting a Macintosh and a pc, funny things happen. The Mac uses rs-422 and the pc uses rs-232. To connect the two the 422 has to be wired together with a common ground, etc. The cable is available as a "Macintosh modem cable".

In Linux it's possible to use DTR in lieu of RTS as the rs-422 lacks RTS when wired to a RS-232. Of course, then you can't use the other lines for modem control and you have to make a custom cable, but it may be useful for those wishing to connect a Mac to a pc via a null modem.

## Cables

Cables can be wired in many different combinations. An unknown, incorrectly wired cable is very unlikely to damage anything. TX and RX may work - but the hardware handshaking will probably be incorrect.

If you do have problems - get a test meter and sketch out the wiring. Or treat yourself to a "Breakout Box" or Bob. (Pronounced "BoB" as Black Adder would say ) This is a set of patch wires and LEDs that lets you isolate and jumper each circuit. Comcraft have such a beast here which Mr Radiospares will be happy to sell you.

## USB Adapters

USB Serial Adapter gives you and your software a RS232 connection.

Make sure you get a decent one! Old serial USB adapters are badly written by inept programmers. You'll get unreliable operation and more blue screens of death than Liptons have tealeaves.

Here's a link for one adapter I regularly recommend. "USB-COM-PL : USB-RS232 with detachable USB cable".

## Errors, omissions, comments

...are welcome, and may be directed to me.

I've not covered these issues:

Serialisation: the components of the bit stream, start, stop, parity.

The difference of bits per second and baud.

Flow control. (XON XOFF, and hardware.)