RS232 tester & universal connector

Emil

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Abstract

In this paper an universal RS-232 connector is presented. The novelty resides in the way that the connector can be configured with the aid of only four double jumpers to obtain most of RS-232 links (Pass through, Null Modem RTS-CTS, Null Modem with or without Handshake, Loop back).

1 Introduction

RS-232-C is a version of the EIA (Electronics Industry Association) standard for low speed serial data communication. It defines a number of parameters concerning voltage levels, loading characteristics and timing relationships. The DB-25P and DB-25S connectors are almost universally used. Typical practice requires mounting the female (DB-25S) connector on the chassis of communication equipment, and male (DB-25P) connectors on the cable connecting two such devices.

There are two main classes of RS-232 devices, namely DTE (Data Terminal Equipment), such as terminals, and DCE (Data Communication Equipment), such as modems. Typically, one only interfaces a DTE to a DCE, as opposed to one DTE to another DTE, or one DCE to another DCE, although there are ways to do the later two by building nonstandard cables. Rarely if ever are more than two devices involved in a given interface (multidrop is not supported). A serial port on a computer may be implemented as either DTE or DCE, depending on what type of device it is intended to support. In order to interface two DTE devices, it is usually sufficient to provide a 'flipped' cable, in which the pairs (TxD, RxD), (RTS,CTS) and (DTR,DSR) have been flipped. Hence, the TxD of one DTE is connected to the RxD of the other DTE, and vice versa. It may be necessary to wrap various of the handshaking lines back around from the DTR on each end in order to have both ends work. In a similar manner, two DCE devices can be interfaced to each other.

2 The Breakout box

An RS-232 'breakout box' is particularly useful in solving interfacing problems. This is a device which is inserted between the DTE and DCE. Firstly, it allows you to monitor the state of the various handshaking lines (green light on = signal ON / logic 0 & red light on = signal OFF / logic 1), and watch the serial data flicker on TxD and/or RxD. Secondly, it allows you to break the connection on one or more of the lines (with dip-switches), and make any kind of cross-connections and/or wraparounds (with jumper wires). Using this, it is fairly easy to determine which line(s) are not functioning as required, and quickly build a prototype of a cable that will serve to interface the two devices. At this point, the breakout box can be removed and a real cable built that performs the same function. Care should be taken with this type of device to connect the correct end of it to the DTE device, or the lights and switches do not correspond to the actual signals.

The universal RS-232 connector I've designed is composed of a classical bicolor led monitor for eight signals, and four rows of pins where double jumpers are inserted (see figure 1). The first two rows are the signals from the male and female connector respectively. Jumpers inserted in this two rows will provide direct signal pass through or loopbacks according with the double jumpers orientation. The next row is a duplicate of the male connector signals but this time crossed practically two by two. Jumpers inserted

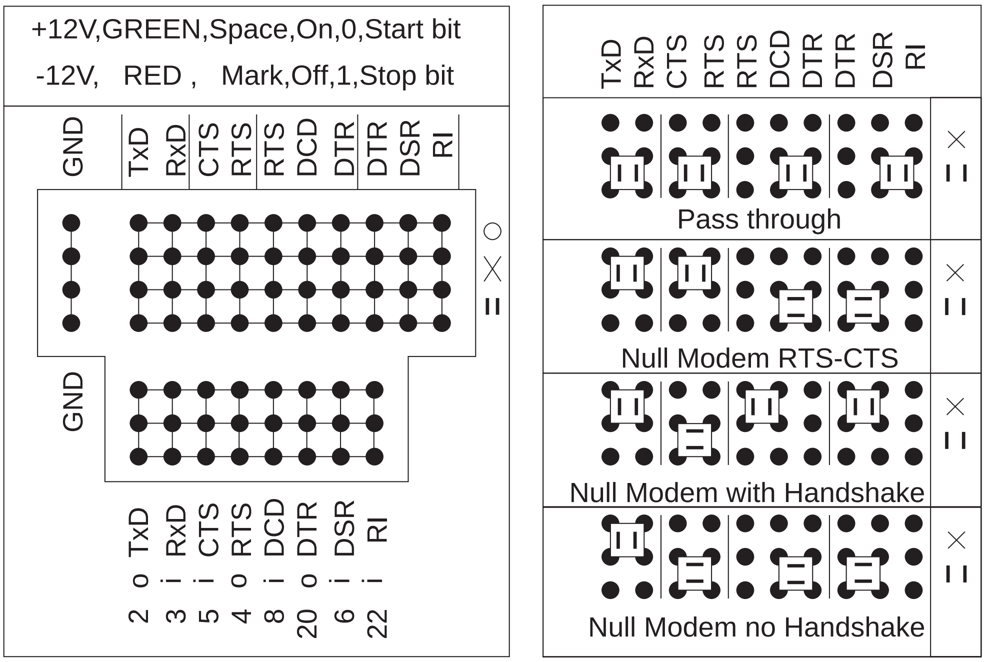


Figure 1: Layout and commonly used configurations of the universal connector

between the second and the third row provide cross links (typical null modem links). The last row is an unconnected row where unused jumpers (open connections) can rest.

To all the benefits of a breakout box this device adds:

- only four double jumpers have to be moved
- a very short configuration time
- no need of building a special cable since no jumper wires or other unreliable connections are used
- both side signals are available for an eventual external monitoring
- special odd connections are still available using jumper wires

Schematics of the universal RS-232 connector can be found in appendix B.

3 Bibliography

- ”A Practical Guide to RS-232 Interfacing”
  by Lawrence E. Hughes. Mycroft Labs, Inc. P.O. Box 6045, Tallahassee, FL 32301

A Appendix – Quick RS-232 guide

RS-232 will support simplex, half-duplex, or full-duplex type channels. In a simplex channel, data will only ever be travelling in one direction, e.g. from DCE to DTE. An example might be a 'Receive Only' printer. In a half-duplex channel, data may travel in either direction, but at any given time data will only be travelling in one direction, and the line must be 'turned around' before data can travel in the other direction. In a full-duplex channel, data may travel in both directions simultaneously. Certain of the RS-232 'handshaking' lines are used to resolve problems associated with these modes, such as which direction data may travel at any given instant.

The usually used signals of the RS-232 are listed bellow:

Pin	Name	dte-dce	function
2	TxD	→	Transmit Data
3	RxD	←	Receive Data
4	RTS	→	Request To Send
5	CTS	←	Clear To Send
6	DSR	←	Data Set Ready
7	SG	—	Signal Ground
8	DCD	←	Data Carrier Detect
20	DTR	→	Data Terminal Ready
22	RI	←	Ring Indicator

Signal names are from the viewpoint of the DTE (e.g. Transmit Data is data being sent by the DTE, but received by the DCE). Also, arrow direction indicates which end (DTE or DCE) originates each signal, except for the ground lines (—). For example, signal 2 (TxD) is originated by the DTE, and received by the DCE.

On the above signals, all voltages are with respect to the Signal Ground (SG) line. The following conventions are used:

Voltage	Signal	Logic	Control
+3 to +25	SPACE	0	On
-3 to -25	MARK	1	Off

The voltage values are inverted from the logic values (e.g. the more positive logic value corresponds to the more negative voltage) and a logic 0 corresponds to the signal name being 'true'.

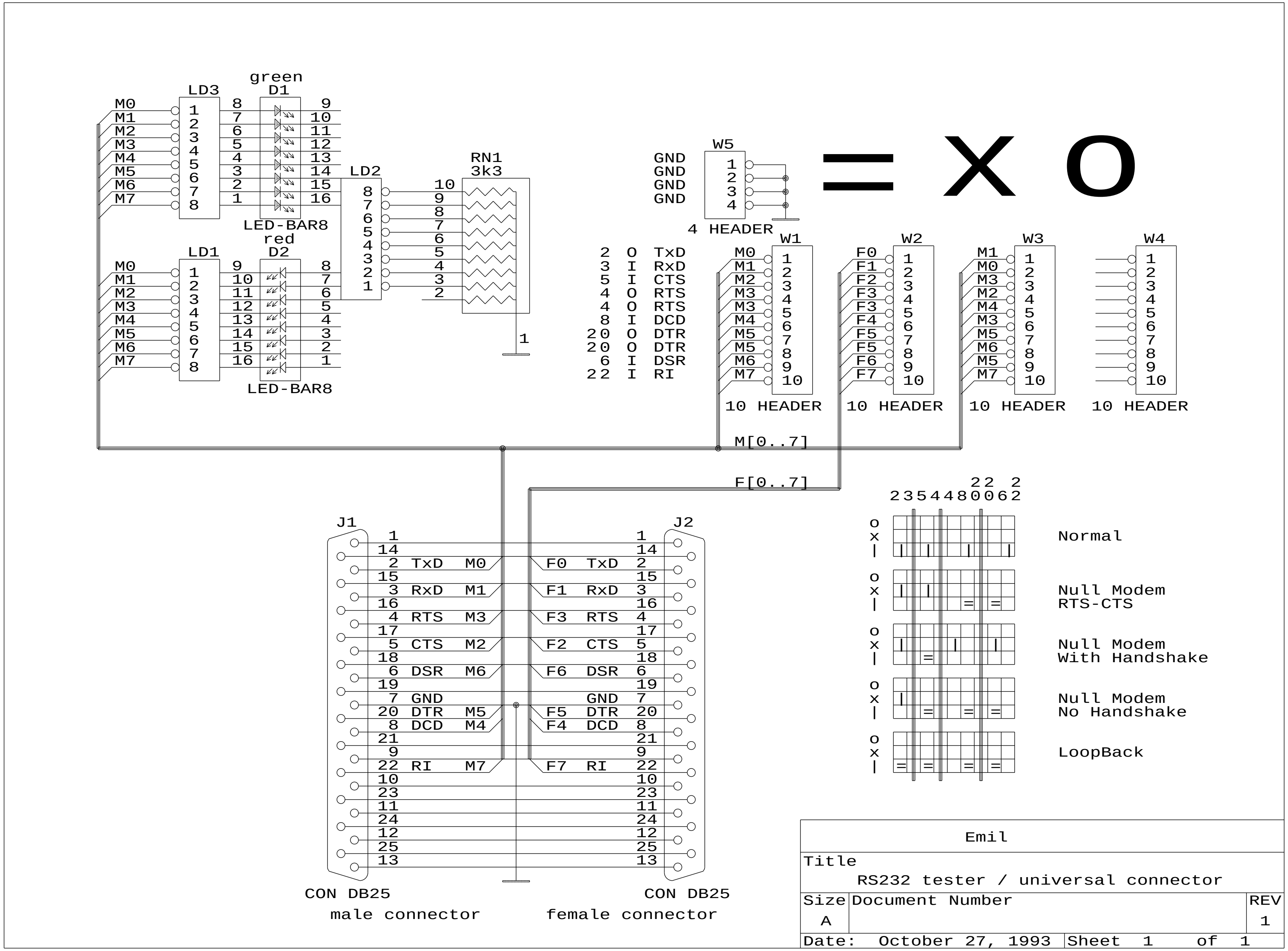
Electrical and timing considerations:

- the driver shall assert a voltage between -5V and -15V relative to the signal ground to represent a MARK signal condition. The driver shall assert a voltage between 5V and 15V relative to the Signal Ground to represent a SPACE signal condition. This in conjunction with the defined signal voltage intervals allows for 2V of noise margin. In practice, -12V and 12V are typically used.
- the driver shall change the output voltage at a rate not exceeding 30 volts per microsecond, but the time required for the signal to pass through the -3V to +3V transition region shall not exceed 1 millisecond, or 4 percent of a bit time, whichever is smaller.

Definition of the most common signals:

- **1 CG** Chassis Ground
  this signal (also called Frame Ground) is a mechanism to insure that the chassis of the two devices are at the same potential, to prevent electrical shock to the operator. This signal is not used as the reference for any of the other voltages and is optional. If it is used, care should be taken to not set up ground loops.
- **2 TxD** Transmit Data
  the path whereby serial data is sent from the DTE to the DCE. This signal must be present if data is to travel in that direction at any time.

- **3 RxD** Receive Data
  the path whereby serial data is sent from the DCE to the DTE. This signal must be present if data is to travel in that direction at any time.
- **4 RTS** Request To Send
  indicates that the DTE wishes to send data to the DCE (note that no such line is available for the opposite direction, hence the DTE must always be ready to accept data). In normal operation, the RTS line will be OFF (logic 1 / MARK). Once the DTE has data to send, and has determined that the channel is not busy, it will set RTS to ON (logic 0 / SPACE), and await an ON condition on CTS from the DCE, at which time it may then begin sending. Once the DTE is through sending, it will reset RTS to OFF (logic 1 / MARK). On a full-duplex or simplex channel, this signal may be set to ON once at initialization and left in that state. Note that some DCEs must have an incoming RTS in order to transmit (although this is not strictly according to the standard). In this case, this signal must either be brought across from the DTE, or provided by a wraparound (e.g. from DSR) locally at the DCE end of the cable.
- **5 CTS** Clear To Send
  indicates that the DCE is ready to accept data from the DTE. In normal operation, the CTS line will be in the OFF state. When the DTE asserts RTS, the DCE will do whatever is necessary to allow data to be sent (e.g. a modem would raise carrier, and wait until it stabilized). At this time, the DCE would set CTS to the ON state, which would then allow the DTE to send data. When the RTS from the DTE returns to the OFF state, the DCE releases the channel (e.g. a modem would drop carrier), and then set CTS back to the OFF state. Note that a typical DTE must have an incoming CTS before it can transmit. This signal must either be brought over from the DCE, or provided by a wraparound (e.g. from DTR) locally at the DTE end of the cable.
- **6 DSR** Data Set Ready
  informs the DTE that the DCE is alive and well. It is normally set to the ON state by the DCE upon power-up and left there. Note that a typical DTE must have an incoming DSR in order to function normally. This line must either be brought over from the DCE, or provided by a wraparound (e.g. from DTR) locally at the DTE end of the cable. On the DCE end of the interface, this signal is almost always present, and may be wrapped back around (to DTR and/or RTS) to satisfy required signals whose normal function is not required.
- **7 SG** Signal Ground
  ground to which all other voltages are relative. It must be present in any RS-232 interface.
- **8 DCD** Data Carrier Detect
  signal whereby the DCE informs the DTE that it has an incoming carrier. It may be used by the DTE to determine if the channel is idle, so that the DTE can request it with RTS. Note that some DTEs must have an incoming DCD before they will operate. In this case, this signal must either be brought over from the DCE, or provided locally by a wraparound (e.g. from DTR) locally at the DTE end of the cable.
- **20 DTR** Data Terminal Ready
  signal that informs the DCE that the DTE is alive and well. It is normally set to the ON state by the DTE at power-up and left there. Note that a typical DCE must have an incoming DTR before it will function normally. This signal must either be brought over from the DTE, or provided by a wraparound (e.g. from DSR) locally at the DCE end of the cable. On the DTE side of the interface, this signal is almost always present, and may be wrapped back around to other signals (e.g. DSR, CTS and/or DCD) to satisfy required hand shaking signals if their normal function is not required.


green
D1
LD3
LD-BAR8
red
D2
LD1
LED-BAR8
LD2
RN1
3k3
W5
GND
GND
GND
GND
4 HEADER
= x o
W1
W2
W3
W4
2 O TxD
3 I RxD
5 I CTS
4 O RTS
4 O RTS
8 I DCD
20 O DTR
20 O DTR
6 I DSR
22 I RI
10 HEADER
M[0..7]
F[0..7]
J1
J2
CON DB25
male connector
CON DB25
female connector
Normal
Null Modem
RTS-CTS
Null Modem
With Handshake
Null Modem
No Handshake
LoopBack
Emil
Title
RS232 tester / universal connector
Size Document Number
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Date: October 27, 1993 Sheet 1 of 1