EIA

EIA-232 Information

This is one of the most misunderstood areas of RS-232. **DTE stands for Data Terminal Equipment**, and **DCE stands for Data Circuit-terminating Equipment or Data Communications Equipment**. The DTE is typically either a dumb terminal or the serial port on a computer/workstation. The DCE is typically a modem, CSU/DSU, or other piece of data communications equipment.

Where it gets confusing is when you start to talk about signal definitions and direction. For example, it's easy for someone to understand that when you transmit data, you send it **out**. However, when you talk in terms of the DCE, it becomes an **input**. This is because the specification was written from the perspective of the DTE end of the link. Another example is that the Receive Data signal is an **input** to DTE, but an **output** from DCE. See Table 1 below.

Table: 1

DTE Signal Direction	Signal	DCE Signal Direction
Bi-directional	Shield	Bi-directional
Output	TxD	Input
Input	RxD	Output
Output	RTS	Input
Input	CTS	Output
Input	DSR	Output
Bi-directional	SG	Bi-directional
Input	DCD	Output
Input	SDCD	Output
Input	SCTS	Output
Output	STxD	Input
Input	TxClk In	Output
Input	SRxD	Output
Input	RxClk	Output
Output	SRTS	Input

Output	DTR	Input
Input	RI	Output
Output	TxClk Out	Input

Therefore, a straight through "one to one" cable is all that is necessary between a modem and a standard DTE serial port. However, if you want to connect two DTE ports together, you have to simulate the existence of the pair of DCE devices, typically modems, that would normally be between the two DTE devices. This is where the null-modem device or cable comes in. See our cabling guide for more info.

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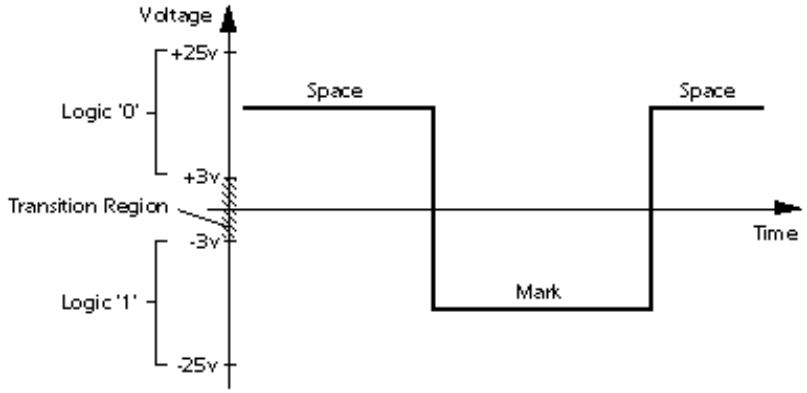
Signal State Voltage Assignments (see figure 1 below):

Voltages of -3v to -25v with respect to signal ground (pin 7) are considered logic '1' (the marking condition), whereas voltages of +3v to +25v are considered logic '0' (the spacing condition). The range of voltages between -3v and +3v is considered a transition region for which a signal state is not assigned.



RS-232 signal information

Pin Number	ITU-T Number	Circuit	Description
1	N/A	N/A	Shield
2	103	BA	Transmitted Data (TxD)
3	104	BB	Received Data (RxD)
4	105/133	CA/CJ	Request to send/ready for receiving (RTS)
5	106	CB	Clear to send (CTS)
6	107	CC	DCE ready (DSR)

7	102	AB	Signal common (SG)
8	109	CF	Received line signal detector (DCD)
9	N/A	N/A	(reserved)
10	N/A	N/A	(reserved)
11	126	N/A	(Unassigned)
12	122/112	SCF/CI	Secondary received line signal detector/data rate selector (SDCD)
13	121	SCB	Secondary clear to send (SCTS)
14	118	SBA	Secondary transmitted data (STxD)
15	114	DB	Transmitter signal element timing (TxClk In)
16	119	SBB	Secondary received data (SRxD)
17	115	DD	Receiver signal element timing (RxClk)
18	141	LL	Local Loopback (LL)
19	120	SCA	Secondary request to send (SRTS)
20	108/1,/2	CD	DTE ready (DTR)
21	140/110	RL/CG	Remote loopback/signal quality detector (RL)
22	125	CE	Ring indicator (RI)
23	111/112	CH/CI	Data signal rate selector
24	113	DA	Transmit signal element timing (TxClk Out)
25	142	TM	Test mode (TM)

Signal Definitions

Protective Ground or Shield:

This circuit establishes a common ground reference potential for all other circuits.

TxD, or Transmit Data:

This is the primary data channel from the DTE device to the DCE device. The DTE device will use this channel to send data to the DCE device.

RxD, or Receive Data:

This is the primary data channel from the DCE device to the DTE device. The DCE

device will use this channel to send data to the DTE device.

RTS, or Request To Send:

This signal is typically used to gate flow from the DCE device's primary data channel to the DTE device. In other words, the workstation serial port would drop this signal to halt flow from the modem, and then later raise it to resume flow.

CTS, or Clear To Send:

This signal typically is used to gate flow from the DTE device's primary data channel to the DCE device. In other words, a modem may drop this signal to halt flow from the workstation, and then later raise it to resume flow. (see the EIA-232 Flow Control Primer below)

DSR, or Data Set Ready or DCE ready:

Originally used in half duplex mode as a response to DTR, it is generally not used in full duplex mode. Notable exceptions are VMS and Windows NT, where it's a response to the signal DTR in full duplex mode.

SG, or Signal common:

This circuit establishes a reference potential for all other circuits.

DCD, or Data Carrier Detect or Received line signal detector:

This signal is used to show that there is a valid connection between two DCE device's primary channel. It is typically used to block opens on a port before connections, and to generate UNIX "hang up" signals upon loss of a connection.

SDCD, or Secondary Data Carrier Detect, or Secondary received line signal detector:

This signal is used to show that there is a valid connection between two DCE device's secondary channel. It is typically used to block opens on a port before connections, and to generate UNIX "hang up" signals upon loss of a connection.

SCTS, or Secondary Clear To Send:

This signal typically is used to gate flow from the DTE device's secondary data channel to the DCE device. In other words, a modem may drop this signal to halt flow from the workstation, and then later raise it to resume flow. (see the EIA-232 Flow Control Primer below)

STxD, or Secondary transmitted data:

This is the secondary data channel from the DTE device to the DCE device. The DTE device will use this channel to send data to the DCE device.

TxClk In, or Transmitter signal element timing (DCE source):

This is the signal the transmitting DTE will use to clock the TxD circuit when it needs to send data, if it is not providing clock (TxClk Out).

SRxD, or Secondary Received Data:

This is the secondary data channel from the DCE device to the DTE device. The DCE device will use this channel to send data to the DTE device.

RxClk, or Receiver Signal Element Timing:

This is the circuit the DTE will use to clock incoming data on the RxD circuit.

LL, or Local Loopback:

This circuit is used by the DTE to force the DCE to loop TxD to RxD. The DCE will also turn the TM (test mode) circuit. This circuit is not implemented on any Digi device.

SRTS, or Secondary Request To Send:

It is an output for DTE devices and an input for DCE devices. This signal is typically used to gate flow from the DCE device's secondary data channel to the DTE device. In other words, the workstation serial port would drop this signal to halt flow from the modem, and then later raise it to resume flow. (see the EIA-232 Flow Control Primer below)

DTR, or Data Terminal Ready:

This signal is generally used to indicate that the DTE is ready to receive and transmit data (the ready state).

RL, or Remote Loopback:

This signal is no longer used in most new designs. This circuit is not implemented on any Digi device.

RI, or Ring Indicator:

This signal indicates that a ring is being received on a communications channel. The On condition should coincide with the received ring.

Data Signal Rate Selector:

This signal is used to select the data rate of dual rate DCEs. This circuit is not implemented on any Digi device.

TM, or Test Mode:

This is a response by the DCE when it's put in Local Loopback or Remote Loopback mode. This circuit is not implemented on any Digi device.

EIA-232 Flow Control Primer

- **Hardware flow control** uses pins RTS and CTS to gate flow back and forth between two connected serial devices. The DTE device uses RTS to start and stop flow from the DCE device, and the DCE device uses CTS to gate flow from the DTE device.

  This method is popular for higher speed connections where flow control reaction time is more critical. It's also popular where the data stream is such that embedded flow control characters can not be tolerated by the protocol running on the link. The cost is that you have to run two more wires in the cable.
- **Software flow control** uses special START (XON) and STOP (XOFF) characters embedded in the data stream to gate flow. In other words, the receiving device would send a STOP character (typically a control-s) to the sending device to halt flow. It would then later send a START character (typically a control-q) to resume flow.

This method of flow control is more popular for slower links whose protocol can support embedded flow control characters. It's popular because it only requires that you run 3 wires for the link to function. Receive (RxD), Transmit (TxD), and Ground (GND).

Further Reading on EIA-232

* Most of the above information was obtained from Mr. Black's book.

- Black, Uyless D.: Physical Layer Interfaces & Protocols, IEEE Computer Society Press, Los Alamitos, CA, 1996. ISBN 0818656972 http://www.bestbookbuys.com/cgi-bin/bbb.cgi?searchparam=0818656972&searchtype=ISBN&search.x=21&search.y=16
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