

# RS232 Data Interface

a Tutorial on Data Interface and cables

RS-232 is simple, universal, well understood and supported but it has some serious shortcomings as a data interface. The standards to 256kbps or less and line lengths of 15M (50 ft) or less but today we see high speed ports on our home PC running very high speeds and with high quality cable maxim distance has increased greatly. The rule of thumb for the length a data cable depends on speed of the data, quality of the cable.

## a Tutorial

Electronic data communications between elements will generally fall into two broad categories: single-ended and differential. RS232 (single-ended) was introduced in 1962, and despite rumors for its early demise, has remained widely used through the industry.

Independent channels are established for two-way (full-duplex) communications. The RS232 signals are represented by voltage levels with respect to a system common (power / logic ground). The "idle" state (MARK) has the signal level negative with respect to common, and the "active" state (SPACE) has the signal level positive with respect to common. RS232 has numerous handshaking lines (primarily used with modems), and also specifies a communications protocol.

The RS-232 interface presupposes a common ground between the DTE and DCE. This is a reasonable assumption when a short cable connects the DTE to the DCE, but with longer lines and connections between devices that may be on different electrical busses with different grounds, this may not be true.

RS232 data is bi-polar.... +3 TO +12 volts indicates an "ON or 0-state (SPACE) condition" while A -3 to -12 volts indicates an "OFF" 1-state (MARK) condition.... Modern computer equipment ignores the negative level and accepts a zero voltage level as the "OFF" state. In fact, the "ON" state may be achieved with lesser positive potential. This means circuits powered by 5 VDC are capable of driving RS232 circuits directly, however, the overall range that the RS232 signal may be transmitted/received may be dramatically reduced.

The output signal level usually swings between +12V and -12V. The "dead area" between +3v and -3v is designed to absorb line noise. In the various RS-232-like definitions this dead area may vary. For instance, the definition for V.10 has a dead area from +0.3v to -0.3v. Many receivers designed for RS-232 are sensitive to differentials of 1v or less.

This can cause problems when using pin powered widgets - line drivers, converters, modems etc. These type of units need enough voltage & current to power them self's up. Typical UART (the RS-232 I/O chip) allows up to 50ma per output pin - so if the device needs 70ma to run we would need to use at least 2 pins for power. Some devices are very efficient and only require one pin (some times the Transmit or DTR pin) to be high - in the "SPACE" state while idle.

An RS-232 port can supply only limited power to another device. The number of output lines, the type of interface driver IC, and the state of the output lines are important considerations.

The types of driver ICs used in serial ports can be divided into three general categories:

- Drivers which require plus (+) and minus (-) voltage power supplies such as the 1488 series of interface integrated circuits. (Most desktop and tower PCs use this type of driver.)
- Low power drivers which require one +5 volt power supply. This type of driver has an internal charge pump for voltage conversion. (Many industrial microprocessor controls use this type of driver.)
- Low voltage (3.3 v) and low power drivers which meet the EIA-562 Standard. (Used on notebooks and laptops.)

Data is transmitted and received on pins 2 and 3 respectively. Data Set Ready (DSR) is an indication from the Data Set (i.e., the modem or DSU/CSU) that it is on. Similarly, DTR indicates to the Data Set that the DTE is on. Data Carrier Detect (DCD) indicates that a good carrier is being received from the remote modem.

Pins 4 RTS (Request To Send - from the transmitting computer) and 5 CTS (Clear To Send - from the Data set) are used to control. In most Asynchronous situations, RTS and CTS are constantly on throughout the communication session. However where the DTE is connected to a multipoint line, RTS is used to turn carrier on the modem on and off. On a multipoint line, it's imperative that only one station is transmitting at a time (because they share the return phone pair). When a station wants to transmit, it raises RTS. The modem turns on carrier, typically waits a few milliseconds for carrier to stabilize, and then raises CTS. The DTE transmits when it sees CTS up. When the station has finished its transmission, it drops RTS and the modem drops CTS and carrier together.

Clock signals (pins 15, 17, & 24) are only used for synchronous communications. The modem or DSU extracts the clock from the data stream and provides a steady clock signal to the DTE. Note that the transmit and receive clock signals do not have to be the same, or even at the same baud rate.

Note: Transmit and receive leads (2 or 3) can be reversed depending on the use of the equipment - DCE Data Communications Equipment or a DTE Data Terminal Equipment.

## Glossary of Abbreviations etc.

CTS	Clear To Send [DCE --> DTE]
DCD	Data Carrier Detected (Tone from a modem) [DCE --> DTE]

DCE	Data Communications Equipment eg. modem
DSR	Data Set Ready [DCE --> DTE]
DSRS	Data Signal Rate Selector [DCE --> DTE] (Not commonly used)
DTE	Data Terminal Equipment eg. computer, printer
DTR	Data Terminal Ready [DTE --> DCE]
FG	Frame Ground (screen or chassis)
NC	No Connection
RcK	Receiver (external) Clock input
RI	Ring Indicator (ringing tone detected)
RTS	Request To Send [DTE --> DCE]
RxD	Received Data [DCE --> DTE]
SG	Signal Ground
SCTS	Secondary Clear To Send [DCE --> DTE]
SDCD	Secondary Data Carrier Detected (Tone from a modem) [DCE --> DTE]
SRTS	Secondary Ready To Send [DTE --> DCE]
SRxD	Secondary Received Data [DCE --> DTE]
STxD	Secondary Transmitted Data [DTE --> DTE]
TxD	Transmitted Data [DTE --> DTE]

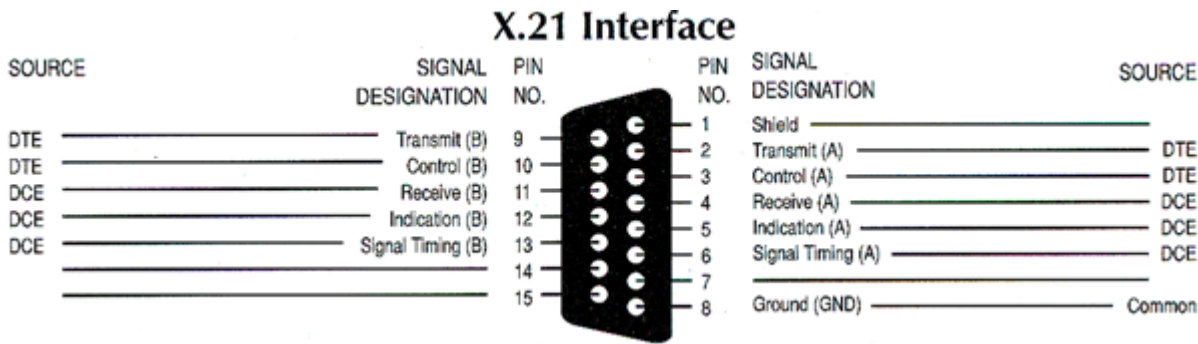
Is Your Interface a DTE or a DCE?

One of the stickiest areas of confusion in datacom is over the terms "transmit" and "receive" as they pertain to DTE (data terminal equipment) and DCE (data communication equipment). In synchronous communication, this confusion is particularly acute, because more signals are involved. So why is it that you sometimes send data on TD, and other times you send data on RD? Is this just a cruel form of mental torture? Not really. The secret lies in adopting the proper perspective. In data-com, the proper perspective is always from the point of view of the DTE. When you sit at a PC, terminal or workstation (DTE) and transmit data to somewhere far away, you naturally do so on the TD (transmit data) line. When your modem or CSU/DSU (DCE) receives this incoming data, it receives the data on the TD line as well. Why? Because the only perspective that counts in data-com is the perspective of the DTE. It does not matter that the DCE thinks it is receiving data; the line is still called "TD". Conversely, when the modem or CSU/DSU receives data from the outside world and sends it to the DTE, it sends it on the RD line. Why? Because from the perspective of the DTE, the data is being received! So when wondering, "Is this line TD or RD? Is it TC or RC?" Ask yourself, "What would the DTE say?"

Find out by following these steps: The point of reference for all signals is the terminal (or PC).

- 1 ) Measure the DC voltages between (DB25) pins 2 & 7 and between pins 3 & 7. Be sure the black lead is connected to pin 7 (Signal Ground) and the red lead to whichever pin you are measuring.
- 2) If the voltage on pin 2 is more negative than -3 Volts, then it is a DTE, otherwise it should be near zero volts.
- 3) If the voltage on pin 3 is more negative than -3 Volts, then it is a DCE.
- 4) If both pins 2 & 3 have a voltage of at least 3 volts, then either you are measuring incorrectly, or your device is not a standard EIA-232 device. Call technical support.
- 5) In general, a DTE provides a voltage on TD, RTS, & DTR, whereas a DCE provides voltage on RD, CTS, DSR, & CD.

X.21 interface on a DB 15 connector



also see [X.21 write up](#)  
also see end of page for more info

X.21

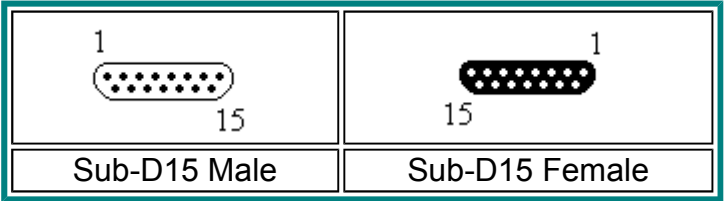
General

Voltages:	+/- 0.3Vdc
Speeds:	Max. 100Kbps (X.26)
	Max. 10Mbps (X.27)

The X.21 interface was recommended by the CCITT in 1976. It is defined as a digital signaling interface between customers (DTE) equipment and carrier's equipment (DCE). And thus primarily used for telecom equipment.

All signals are balanced. Meaning there is always a pair (+/-) for each signal, like used in RS422. The X.21 signals are the same as RS422, so please refer to RS422 for the exact details.

Pinning according to ISO 4903



Pin	Signal	abbr.	DTE	DCE
1	Shield		-	-
2	Transmit (A)		Out	In
3	Control (A)		Out	In
4	Receive (A)		In	Out
5	Indication (A)		In	Out
6	Signal Timing (A)		In	Out
7	Unassigned			
8	Ground		-	-
9	Transmit (B)		Out	In
10	Control (B)		Out	In
11	Receive (B)		In	Out
12	Indication (B)		In	Out
13	Signal Timing (B)		In	Out
14	Unassigned			
15	Unassigned			

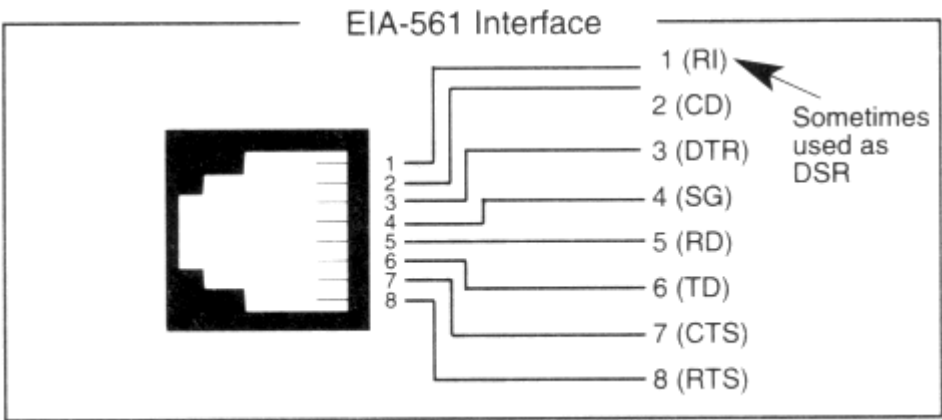
Functional Description

As can be seen from the pinning specifications, the Signal Element Timing (clock) is provided by the DCE. This means that your provider (local telco office) is responsible for the correct clocking and that X.21 is a synchronous interface. Hardware handshaking is done by the Control and Indication lines. The Control is used by the DTE and the Indication is the DCE one.

Cross-cable pinning

X.21 Cross Cable	
X.21	X.21
1	1
2	4
3	5
4	2
5	3
6	7
7	6
8	8
9	11
10	12
11	9
12	10
13	14
14	13
15	

**EIA-561** defines RS-232 on a modular connector. (For nonsynchronous applications only, since it does not provide for the synchronous clocking signals.)



**RS232D uses RJ45 type connectors (similar to telephone connectors)**

		Male	Female			
		8 1	1			
Pin No.	Signal Description	Abbr.	DTE	DCE		
1	DCE Ready, Ring Indicator	DSR/RI	←→	→←		
2	Received Line Signal Detector	DCD	←→	→←		
3	DTE Ready	DTR	→←	←→		
4	Signal Ground	SG				
5	Received Data	RxD	←→	→←		
6	Transmitted Data	TxD	→←	←→		
7	Clear To Send	CTS	←→	→←		
8	Request To Send	RTS	→←	←→		

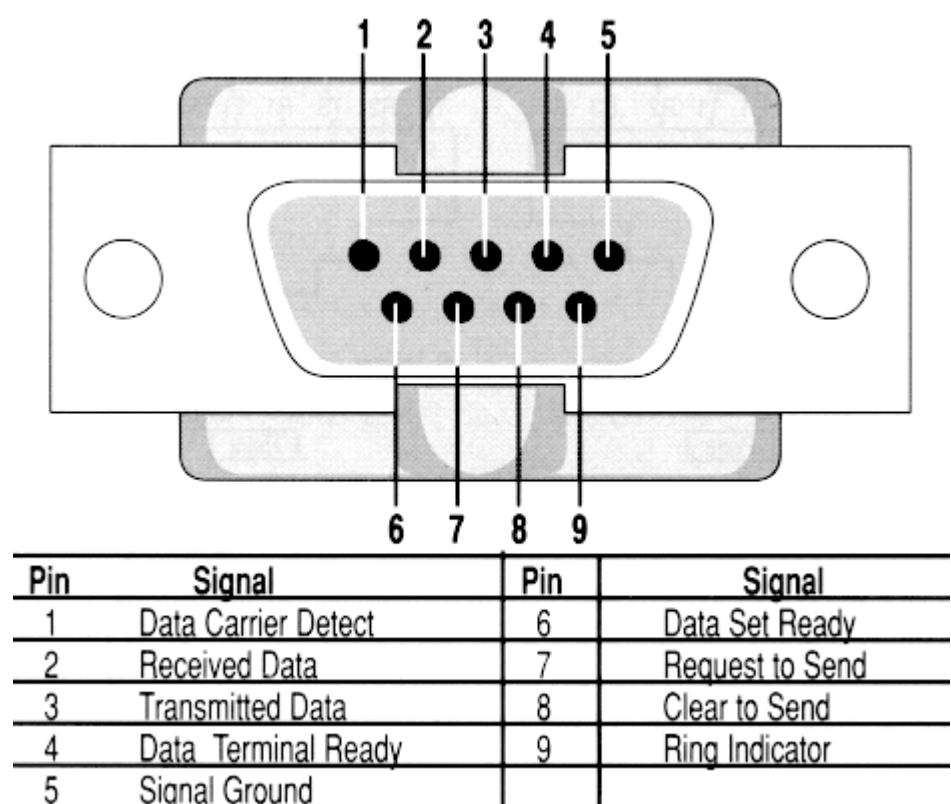
This is a standard 9 to 25 pin cable layout for async data on a PC AT serial cable

Description	Signal	9-pin DTE	25-pin DCE	Source DTE or DCE
Carrier Detect	CD	1	8	from Modem
Receive Data	RD	2	3	from Modem
Transmit Data	TD	3	2	from Terminal/Computer
Data Terminal Ready	DTR	4	20	from Terminal/Computer
Signal Ground	SG	5	7	from Modem
Data Set Ready	DSR	6	6	from Modem
Request to Send	RTS	7	4	from Terminal/Computer
Clear to Send	CTS	8	5	from Modem
Ring Indicator	RI	9	22	from Modem

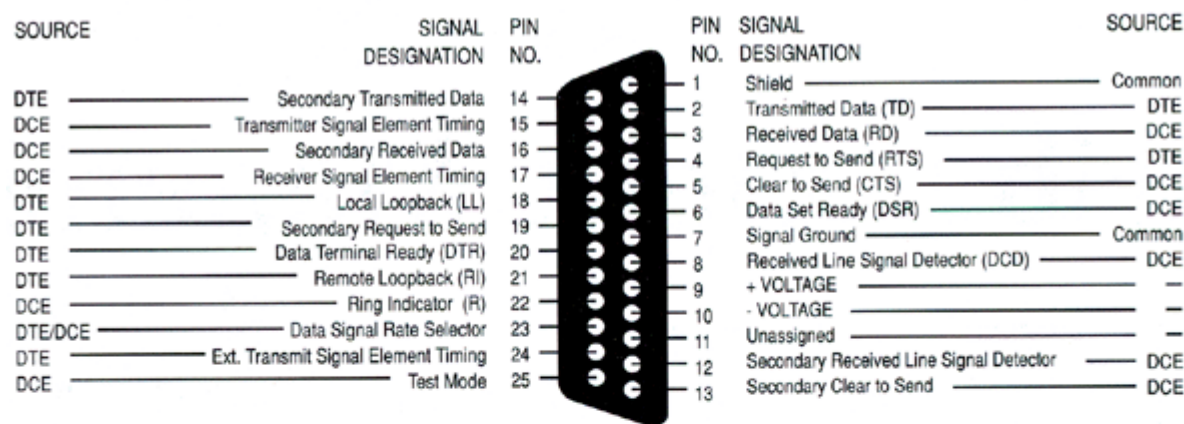
**This a DTE port as on the back of a PC Com Port - EIA-574 RS-232/V.24 pin out on a DB-9 pin used for Asynchronous Data**



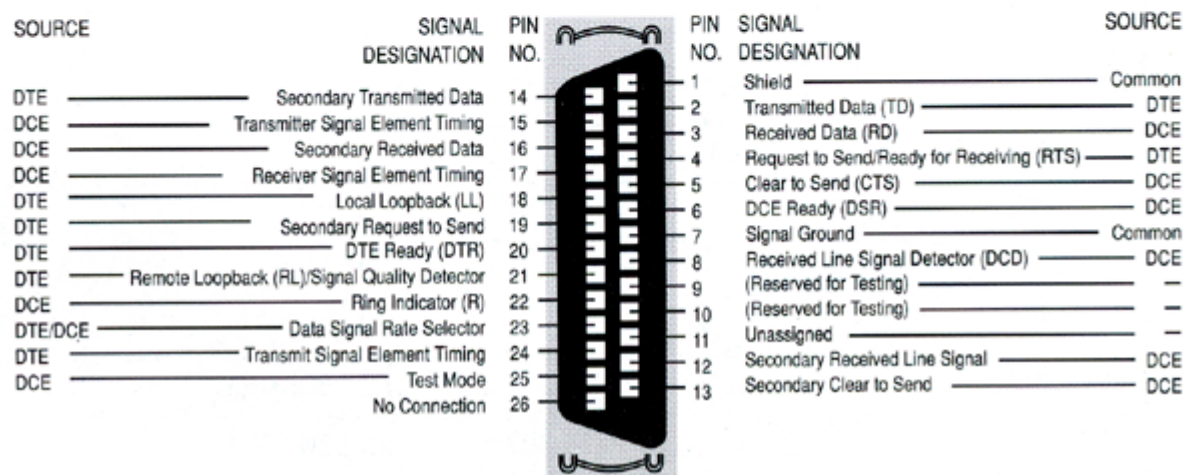




V.24/RS-232 Interface



V.24/RS-232E ALT A Connector



25 pin D-shell connector RS232 commonly used for Async. data

PIN SIGNAL DESCRIPTION

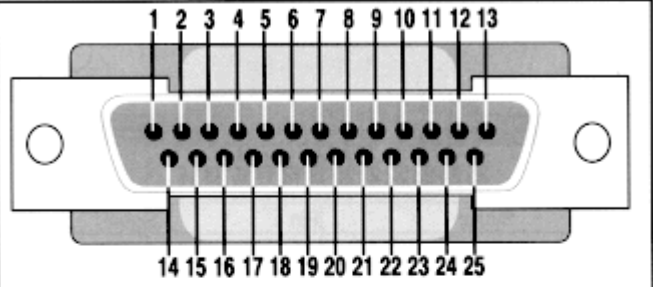
- 1 PGND Protective Ground
- 2 TXD Transmit Data
- 3 RXD Receive Data
- 4 RTS RequestTo Send
- 5 CTS Clear To Send
- 6 DSR Data Set Ready
- 7 SG Signal Ground
- 8 CD Carrier Detect

20 DTR Data Terminal Ready  
22 RI Ring Indicator

Some applications require more pins  
than a simple async. configurations.

**RS-232 Interface**

RS-232 (EIA Std.) applicable to the 25 pin interconnection of Data Terminal Equipment (DTE) and Data Communications Equipment (DCE) using serial binary data



Pin	Description	EIA CKT	From DCE	To DCE
1	Frame Ground	AA		
2	Transmitted Data	BA		D (Data)
3	Received Data	BB	D	
4	Request to Send	CA		C (Control)
5	Clear to Send	CB	C	
6	Data Set Ready	CC	C	
7	Signal Gnd/Common Return	AB		
8	Rcvd. Line Signal Detector	CF	C	
11	Undefined			
12	Secondary Rcvd. Line Sig. Detector	SCF	C	
13	Secondary Clear to Send	SCB	C	
14	Secondary Transmitted Data	SBA		D
15	Transmitter Sig. Element Timing	DB	T (Timing)	
16	Secondary Received Data	SBB	D	
17	Receiver Sig. Element Timing	DD	T	
18	Undefined			
19	Secondary Request to Send	SCA		C
20	Data Terminal Ready	CD		C
21	Sig. Quality Detector	CG		C
22	Ring Indicator	CE	C	
23	Data Sig. Rate Selector (DCE)	CI	C	
23	Data Sig. Rate Selector (DTE)	CH		C
24	Transmitter Sig. Element Timing	DA		T
25	Undefined			

Pins used for [Synchronous](#) data

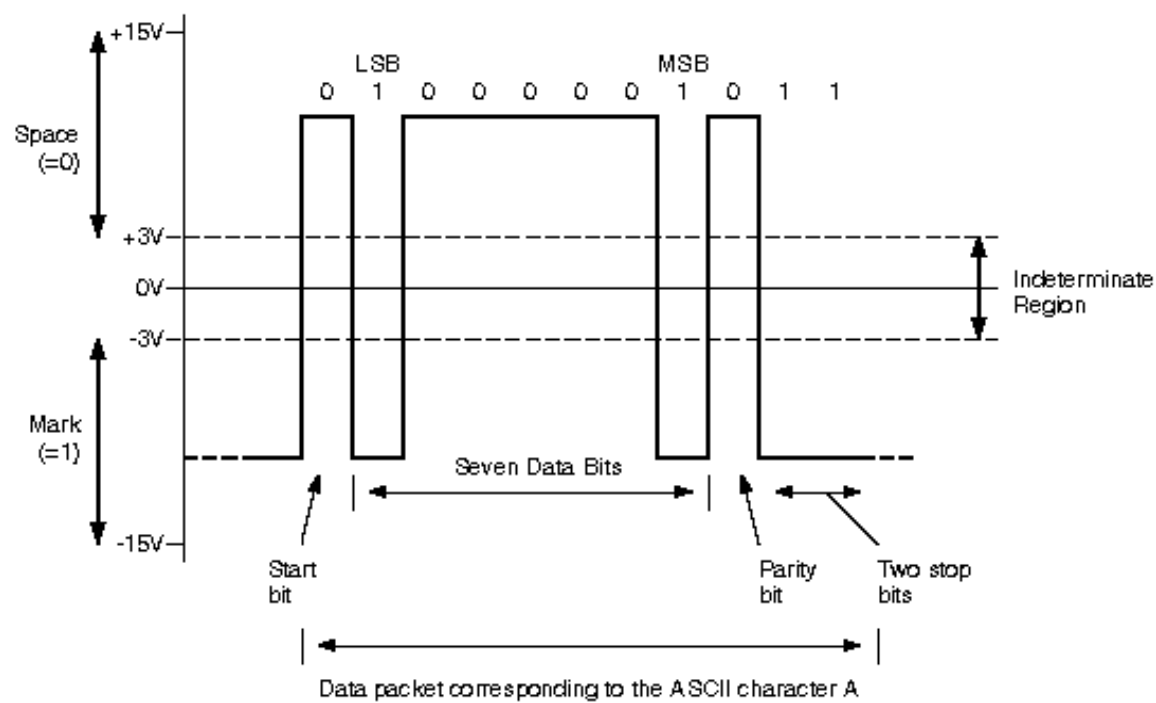
[jump to Other Connector](#) pages

RS-232 Specs.

SPECIFICATIONS		RS232	RS423
Mode of Operation		SINGLE -ENDED	SINGLE -ENDED
Total Number of Drivers and Receivers on One Line		1 DRIVER 1 RECVR	1 DRIVER 10 RECVR
Maximum Cable Length		50 FT.	4000 FT.
Maximum Data Rate		20kb/s	100kb/s
Maximum Driver Output Voltage		+/-25V	+/-6V
Driver Output Signal Level (Loaded Min.)	Loaded	+/-5V to +/-15V	+/-3.6V
Driver Output Signal Level (Unloaded Max)	Unloaded	+/-25V	+/-6V
Driver Load Impedance (Ohms)		3k to 7k	>=450
Max. Driver Current in High Z State	Power On	N/A	N/A
Max. Driver Current in High Z State	Power Off	+/-6mA @ +/- 2v	+/-100uA

Slew Rate (Max.)	30V/uS	Adjustable
Receiver Input Voltage Range	+/-15V	+/-12V
Receiver Input Sensitivity	+/-3V	+/-200mV
Receiver Input Resistance (Ohms)	3k to 7k	4k min.

One byte of async data



Cabling considerations - you should use cabling made for RS-232 data but I have seen low speed data go over 250' on 2 pair phone cable. Level 5 cable can also be used but for best distance use a low capacitance data grade cable.

The standard maxim length is 50' but if data is async you can increase that distance to as much as 500' with a good grade of cable.

The RS-232 signal on a single cable is impossible to screen effectively for noise. By screening the entire cable we can reduce the influence of outside noise, but internally generated noise remains a problem. As the baud rate and line length increase, the effect of capacitance between the different lines introduces serious crosstalk (this especially true on synchronous data - because of the clock lines) until a point is reached where the data itself is unreadable. Signal Crosstalk can be reduced by using low capacitance cable and shielding each pair

Using a high grade cable (individually shield low capacitance pairs) the distance can be extended to 4000'

At higher frequencies a new problem comes to light. The high frequency component of the data signal is lost as the cable gets longer resulting in a rounded, rather than square wave signal.

The maxim distance will depend on the speed and noise level around the cable run.

On longer runs a line driver is needed. This is a simple modem used to increase the maxim distance you can run RS-232 data.

Making sense of the specifications

Selecting data cable isn't difficult, but often gets lost in the shuffle of larger system issues. Care should be taken. however, because intermittent problems caused by marginal cable can be very difficult to troubleshoot.

Beyond the obvious traits such as number of conductors and wire gauge, cable specifications include a handful of less intuitive terms.

Characteristic Impedance (Ohms): A value based on the inherent conductance, resistance, capacitance and inductance of a cable that represents the impedance of an infinitely long cable. When the cable is out to any length and terminated with this Characteristic Impedance, measurements of the cable will be identical to values obtained from the infinite length cable. That is to say that the termination of the cable with this impedance gives the cable the appearance of being infinite length, allowing no reflections of the transmitted signal. If termination is required in a system, the termination impedance value should match the Characteristic Impedance of the cable.

Shunt Capacitance (pF/ft): The amount of equivalent capacitive load of the cable, typically listed in a per foot basis One of the factors limiting total cable length is the capacitive load. Systems with long lengths benefits from using low capacitance cable.

Propagation velocity (% of c): The speed at which an electrical signal travels in the cable. The value given typically must be multiplied by the speed of light (c) to obtain units of meters per second. For example, a cable that lists a propagation velocity of 78% gives a velocity of 0.78 X 300 X 106 - 234 X 106 meters per second.

Plenum cable

Plenum rated cable is fire resistant and less toxic when burning than non-plenum rated cable. Check building and fire codes for requirements. Plenum cable is generally more expensive due to the sheathing material used.

The specification recommends 24AWG twisted pair cable with a shunt capacitance of 16 pF per foot and 100 ohm characteristic impedance.

It can be difficult to qualify whether shielding is required in a particular system or not, until problems arise. We recommend erring on the safe side and using shielded cable. Shielded cable is only slightly more expensive than unshielded.

There are many cables available meeting the recommendations of RS-422 and RS-485, made specifically for that application. Another choice is the same cable commonly used in the Twisted pair Ethernet cabling. This cable, commonly referred to as Category 5 cable, is defined by the EIA/TIA/ANSI 568 specification The extremely high volume of Category 5 cable used makes it widely available and very inexpensive, often less than half the price of specialty RS422/485 cabling. The cable has a maximum capacitance of 17 pF/ft (14.5 pF typical) and characteristic impedance of 100 ohms.

Category 5 cable is available as shielded twisted pair (STP) as well as unshielded twisted pair (UTP) and generally exceeds the recommendations making it an excellent choice for RS232 systems.

RS232 - V.24/V.28 - IS2110 - X.20 bis (for Async) - X.21 bis (for Sync)

General

In this document the term RS232 will be used when refered to this serial interface. The description of RS232 is an EIA/TIA norm and is identical to CCITT V.24/V.28, X.20bis/X.21bis and ISO IS2110. The only difference is that CCITT has split the interface into its electrical description (V.28) and a mechanical part (V.24) or Asynchronous (X.20 bis) and Synchronous (X.21 bis) where the EIA/TIA describes everything under RS232.

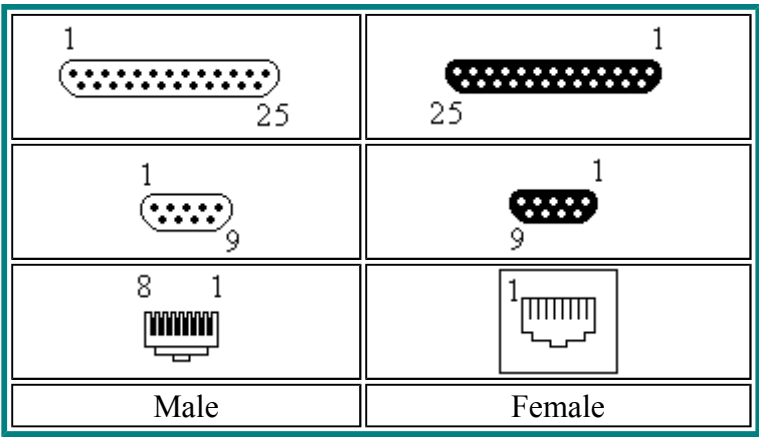
As said before RS232 is a serial interface. It can be found in many different applications where the most common ones are modems and Personal Computers. All pinning specifications are written for the DTE side.

All DTE-DCE cables are straight through meaning the pins are connected one on one. DTE-DTE and DCE-DCE cables are cross cables. To make a destiction between all different types of cables we have to use a naming convention.

- DTE - DCE: Straight Cable
- DTE - DTE: Null-Modem Cable
- DCE - DCE: Tail Circuit Cable

Interface Mechanical

RS232 can be found on different connectors. There are special specifications for this. The CCITT only defines a Sub-D 25 pins version where the EIA/TIA has two versions RS232C and RS232D which are resp. on a Sub-D25 and a RJ45. Next to this IBM has added a Sub-D 9 version which is found an almost all Personal Computers and is described in TIA 457.



Pinnings

RS232-C	Description	Circuit EIA	Circuit CCITT	RJ45	TIA 457
1	Shield Ground	AA			
7	Signal Ground	AB	102	4	5
2	Transmitted Data	BA	103	6	3
3	Received Data	BB	104	5	2
4	Request To Send	CA	105	8	7
5	Clear To Send	CB	106	7	8



6	DCE Ready	CC	107	1	6
20	DTE Ready	CD	108.2	3	4
22	Ring Indicator	CE	125	1	9
8	Received Line Signal Detector	CF	109	2	1
23	Data Signal Rate Select (DTE/DCE Source>	CH/CI	111/112		
24	Transmit Signal Element Timing (DTE Source)	DA	113		
15	Transmitter Signal Element Timing (DCE Source)	DB	114		
17	Receiver Signal Element Timing (DCE Source)	DD	115		
18	Local Loopback / Quality Detector	LL	141		
21	Remote Loopback	RL/CG	140/110		
14	Secondary Transmitted Data	SBA	118		
16	Secondary Received Data	SBB	119		
19	Secondary Request To Send	SCA	120		
13	Secondary Clear To Send	SCB	121		
12	Secondary Received Line Signal Detector/ Data signal Rate Select (DCE Source)	SCF/CI	122/112		
25	Test Mode	TM	142		
9	Reserved for Testing				
10	Reserved for Testing				
11	Unassigned				

Interface Electrical

All signals are measured in reference to a common ground, which is called the signal ground (AB). A positive voltage between 3 and 15 Vdc represents a logical 0 and a negative voltage between 3 and 15 Vdc represents a logical 1. This switching between positive and negative is called bipolar. The zero state is not defined in RS232 and is considered a fault condition (this happens when a device is turned off). According to the above a maximum distance of 50 ft or 15 m. can be reached at a maximum speed of 20k bps. This is according to the official specifications, the distance can be exceeded with the use of Line Drivers.

Functional description

Description	Circuit	Function
Shield Ground	AA	Also known as protective ground. This is the chassis ground connection between DTE and DCE.
Signal Ground	AB	The reference ground between a DTE and a DCE. Has the value 0 Vdc.
Transmitted Data	BA	Data send by the DTE.
Received Data	BB	Data received by the DTE.
Request To Send	CA	Originated by the DTE to initiate transmission by the DCE.
Clear To Send	CB	Send by the DCE as a reply on the RTS after a delay in ms, which gives the DCEs enough time to energize their circuits and synchronize on basic modulation patterns.
DCE Ready	CC	Known as DSR. Originated by the DCE indicating that it is basically operating (power on, and in functional mode).
DTE Ready	CD	Known as DTR. Originated by the DTE to instruct the DCE to setup a connection. Actually it means that the DTE is up and running and ready to communicate.
Ring Indicator	CE	A signal from the DCE to the DTE that there is an incomming call (telephone is ringing). Only used on switched circuit connections.
Received Line Signal Detector	CF	Known as DCD. A signal send from DCE to its DTE to indicate that it has received a basic carrier signal from a (remote) DCE.
Data Signal Rate Select (DTE/DCE Source>	CH/CI	A control signal that can be used to change the transmission speed.
Transmit Signal Element Timing (DTE Source)	DA	Timing signals used by the DTE for transmission, where the clock is originated by the DTE and the DCE is the slave.
Transmitter Signal Element Timing (DCE Source)	DB	Timing signals used by the DTE for transmission.
Receiver Signal Element Timing (DCE Source)	DD	Timing signals used by the DTE when receiving data.
Local Loopback / Quality Detector	LL	
Remote Loopback	RL/CG	Originated by the DCE that changes state when the analog signal received from the (remote) DCE becomes marginal.

Test Mode	TM	
Reserved for Testing		

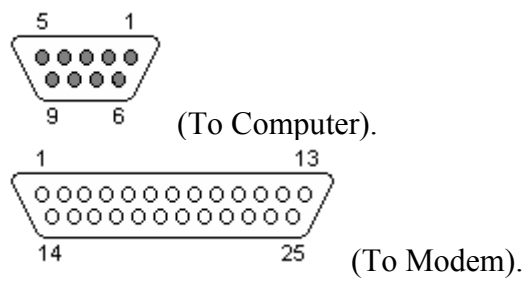
The secondary signals are used on some DCE's. Those units have the possibility to transmit and/or receive on a secondary channel. Those secondary channels are mostly of a lower speed than the normal ones and are mainly used for administrative functions.

Cable pinning

Here are some cable pinning that might be useful. Not all applications are covered, it is just a help:

Straight DB25 Cable	DB25 Null- modem or cross over cable (Async)	DB25 Tail- circuit or cross over cable (Sync)	DB25 to DB9 DTE - DCE cable																																																																																																																																		
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This cable should be used for DTE to DCE (for instance computer to modem) connections with hardware handshaking.



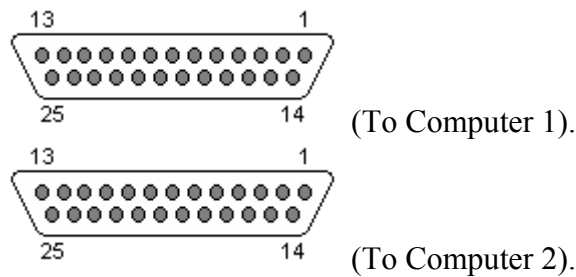
9 PIN D-SUB FEMALE to the Computer  
25 PIN D-SUB MALE to the [Modem](#)

	Female	Male	Dir
Shield		1	
Transmit Data	3	2	
Receive Data	2	3	
Request to Send	7	4	
Clear to Send	8	5	
Data Set Ready	6	6	
System Ground	5	7	
Carrier Detect	1	8	
Data Terminal Ready	4	20	

Ring Indicator	9	22	
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## Nullmodem (25-25) Cable

Use this cable between two DTE devices (for instance two computers).

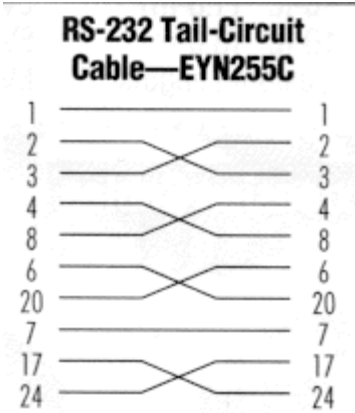


25 PIN D-SUB FEMALE to Computer 1.  
25 PIN D-SUB FEMALE to Computer 2.

	D-Sub 1	D-Sub 2	
Recieve Data	3	2	Transmit Data
Transmit Data	2	3	Receive Data
Data Terminal Ready	20	6+8	Data Set Ready + Carrier Detect
System Ground	7	7	System Ground
Data Set Ready + Carrier Detect	6+8	20	Data Terminal Ready
Request to Send	4	5	Clear to Send
Clear to Send	5	4	Request to Send

*Note: DSR & CD are jumpered to fool the programs to think that their online.*

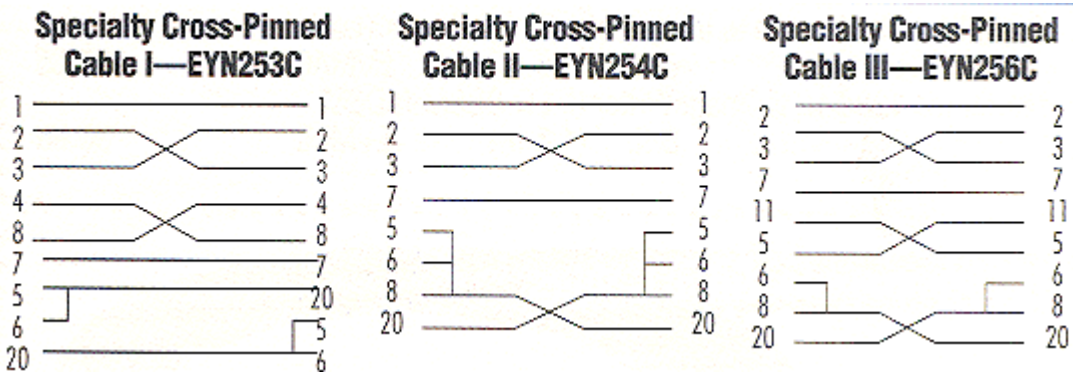
### RS232 (25 pin) Tail Circuit Cable



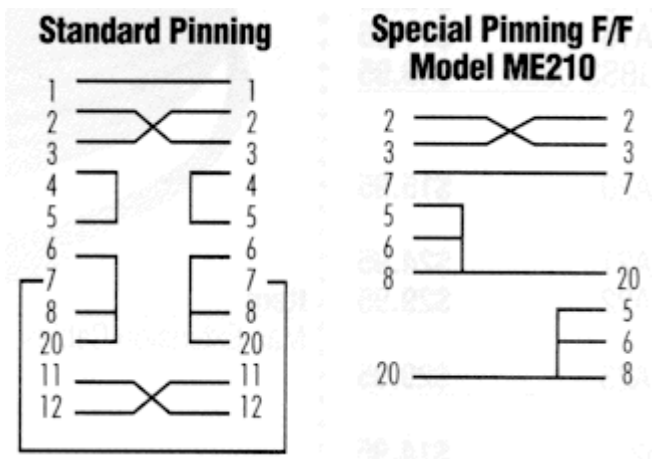
### Null Modem cable diagrams

- [Nullmodem \(9p to 9p\)](#)
- [Nullmodem \(9p to 25p\)](#)
- [Nullmodem \(25p to 25p\)](#)

### Cross Pinned cables for Async data.

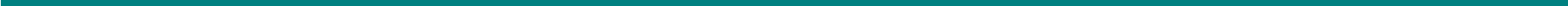


## Pin out for local Async Data transfer

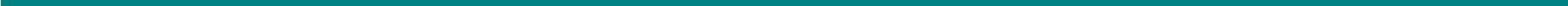


**Loopback plugs:**

- [Serial Port Loopback \(9p\)](#)
- [Serial Port Loopback \(25p\)](#)

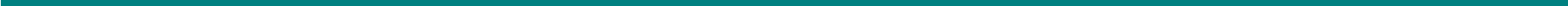


- jump to [The Belden Cable Company's cable selection tutorial](#) pages
- jump to [RS232 I/O](#)
- jump to [General Hardware Input/Output](#)
- jump to <http://www.hardwarebook.info/>



(in-depth write ups)

- jump to [RS232 by CAMI Research Inc](#)
- jump to [Interfacing the Serial / RS232 Port](#)
- jump to [Introduction to Serial Communications](#)
- jump to [Serial Communications](#)
- jump to [Serial Port Basics](#)
- jump to <http://electrosofts.com/serial>
- jump to [Parallel port](#)
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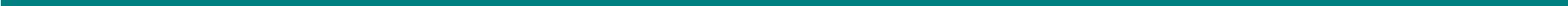


- jump to [related fiber Optic cable pages](#)

jump to [Data Modems for phone lines](#)

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jump to [Interface converters](#)



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