

## EIA-232 Bus

Interface Between Data Terminal Equipment and Data Circuit Terminating Equipment Employing Serial Binary Data Interchange

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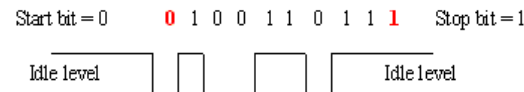
### EIA-232 Description

The **RS232** specification defines both the Mechanical, Electrical, and Functional characteristics of the interface.

RS232 is an Unbalanced (Single Ended), unidirectional (point-to-point) interface, with the signal referenced to ground.

RS232 drivers feature a controlled slew rate. Normal output levels are  $\pm 5$  volts.

The RS-232 interface uses Asynchronous Framing [Known data width, 8bits] with [NRZ](#) encoding.



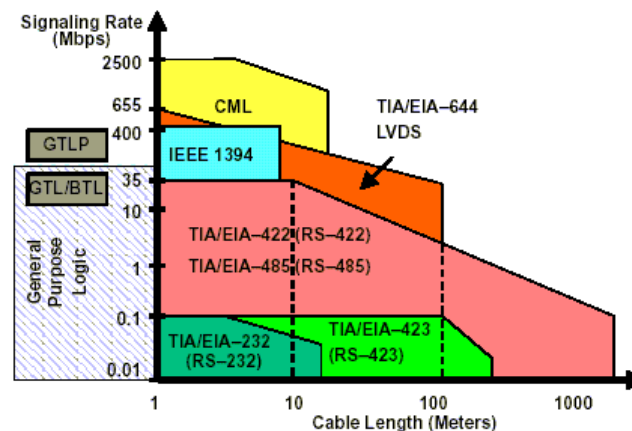
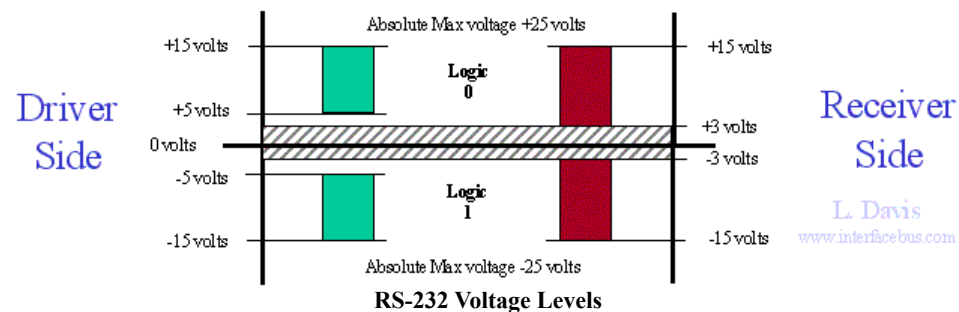
The RS232 interface is synchronous when the clocks are used (DA / DB), otherwise its asynchronous.

The RS232 interface is rated to operate up to 20kbps. Use [TIA/EIA-562](#) (low voltage version of RS232) or [TIA/EIA 423](#) for higher data rates.

The maximum cable length is not defined, but the maximum line capacitance is; at 2500pF, with a load impedance of 3K to 7K ohms. This produces a maximum cable length of something less than 20 meters.

The RS-232 interface does not define the [\[Layer 2\]](#) protocol used. Normally data is sent as 7 or 8 bit words [least significant bit]. A **START** bit marks the beginning of the frame. The start bit is active low [RS232 drivers invert the signaling, so it's active high as seen on the RS232 cable; between +3v and +15v]. The figure above shows a framed 8 bit data word [before inversion]. The data word follows the start bit; a logic high will appear as a low voltage between -3v and -15v when probed on the bus. A **parity** bit may follow the data word depending on the protocol used. A mark parity bit [always set high] may be used, a space parity bit [always set low] may be used, or an even/odd [parity](#) bit may be used. The even parity bit will be a 1 if the number of ones/zeros is even, or a zero if there are an odd number. The odd parity bit will be high if there is an odd number of ones/zeros in the data field. No parity bit is used in the example above. Normally an even parity generator circuit will produce a logic '1' at its output if the data word contains an odd number of ones. When the data word contains an even number of ones then the output of the parity generator will be low. A **stop** bit will normally follow the data field [or parity bit if used].

The stop bit is used to bring [or insure] the signal rests at a logic high following the end of the frame; so when the next start bit arrives it will bring the bus from a high to low ~ remember we will invert, so on the RS232 cable the stop bit is low and the start bit will transition low to high. Remember TIA/EIA232 does not define the protocol or parity.



EIA-232 Cable Distance vs. Bus Speed

Graph extracted from a Texas Instruments Application note

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## EIA/TIA-232-F Standard Organizations

**EIA/TIA-232-F** Interface Between Data Terminal Equipment and Data Circuit Terminating Equipment Employing Serial Binary Data Interchange

**EIA/TIA-561** 8 Position Non-Synchronous Interface Between Data Terminal Equipment and Data Circuit Terminating Equipment Employing Serial Binary Data Interchange

**EIA/TIA-574** 9 Position Non-Synchronous Interface Between Data Terminal Equipment and Data Circuit Terminating Equipment Employing Serial Binary Data Interchange

Telecommunications Industry Association; TIA [[www.tiaonline.org](http://www.tiaonline.org)]

Note the Electronic Industries Alliance {EIA} ceased operations on Feb 22 2011.

**V.28**: Electrical characteristics for unbalanced double-current interchange circuits

ITU {International Telecommunication Union}, [www.itu.int](http://www.itu.int)

**TIA/EIA-694** is another electrical standard which is very similar to TIA/EIA-232-F, but supports higher data rates (512 kbps). It is an electrical only standard, which is intended to be referenced by complete standards, such as TIA/EIA-723. TIA/EIA-694 specifies an unbalanced, unidirectional, point-to-point interface. This standard supports interoperability with TIA/EIA-232-F devices.

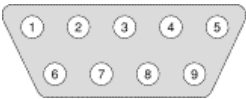
**MIL-STD-188C** [Military Standard 188C] is similar to TIA/EIA-232-F as an unbalanced point-to-point interface. MIL-STD-188C uses a maximum driver output of 7 volts.

**EIA-334-A** defines signal quality terms for synchronous serial DTE/DCE interfaces. This standard is referenced by the complete synchronous standards.  
**EIA-363** defines signal quality terms for non-synchronous serial DTE/DCE interfaces. This standard is referenced by the complete non-synchronous standards.  
**EIA-404-A** defines signal quality for start-stop non-synchronous DTE/DCE interfaces.

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## EIA-232 Bus Pin-Out

**RS232 Pinout:**  
The RS232 specification only defines the pin-out for a 25 pin D-sub connector;  
however, the 9 pin is used more often (defined by EIA-574).  
A 26 pin connector is also called out in the RS232 spec.  
EIA-561 calls out an 8 pin connector (RJ-45).  
RS232C indicates a DB25, RS232D indicates an RJ45.  
Although this site, in general, calls out DB9 and DB25 style connectors, the real term for a 9-pin D-sub is DE9.  
A listing of Dsub connector manufacturers is listed on the [D-Sub Connector Manufacturers](#) page.  
[D-Sub Shell Dimensions](#),  
[D-Sub Insert Arrangements](#).  
Many RS232 pinouts listed here are also listed on the [RS232 Pinout](#) page.  
An RS232 Pin out table may also be termed RS232 Signal Assignments.



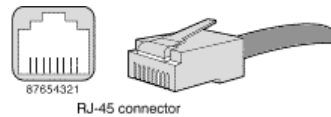
RS232 DB-9 Connector Pin Out

Pin #	Signal name	Signal Description
1	CD	Carrier Detect
2	RXD	Receive Data
3	TXD	Transmit Data
4	DTR	Data Terminal Ready
5	GND	Signal Ground / Common
6	DSR	Data Set Ready
7	RTS	Request To Send
8	CTS	Clear To Send
9	RI	Ring Indicator

RS232 Pinout, DB-25 Connector Signal Assignments

Pin #	Signal name	Signal Function	Pin #	Signal name	Signal Function
1	----	Protective Ground	14	SBA	2nd Transmitted Data
2	TXD	Transmitted Data	15	DB	DCE Element Timing
3	RXD	Receive Data	16	SBB	2nd Received Data

4	RTS	Request To Send	17	DD	Received Element Timing
5	CTS	Clear To Send	18	-----	Unassigned
6	DSR	Data Set Ready	19	SCA	2nd Request To Send
7	GND	Signal Ground/Common	20	DTR	Data Terminal Ready
8	CD	Carrier Detect	21	CG	Signal Quality Detector
9	---	+Voltage	22	RI	Ring Detector
10	---	-Voltage	23	CH/CI	Data Signal Rate Detector
11	---	----	24	DA	DTE Element Timing
12	SCF	2nd Line Detector	25	----	Unassigned
13	SCB	2nd Clear To Send	--	---	---



#### RS232 RJ-45 Connector Pin Out

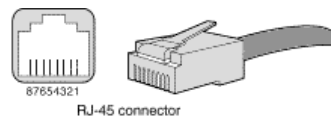
Pin #	Signal name	Signal Description
1	RI	Ring Indicator
2	DCD	Carrier Detect
3	DTR	Data Terminal Ready
4	GND	Signal Ground / Common
5	RXD	Receive Data
6	TXD	Transmit Data
7	CTS	Clear To Send
8	RTS	Request To Send

TXD: Transmit Data; The data sent from the Data Terminal and received by the Data Set. [RS232 Transmit]

RXD: Receive Data; The data sent from the Data Set and received by the Data Terminal. [RS232 Receive]

DTR: Data Terminal Ready; Used by the Data Terminal to signal to the Data Set that it is ready for operation, active high.

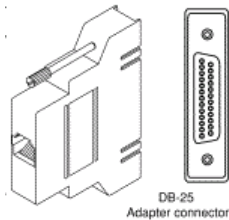
DSR: Data Set Ready; Used by the Data Set to signal to the Data Terminal that



#### RJ45 Phone Jack

RS232 RJ-45 - 8 and 4 wire Pin Out, RS232 Pinout

DB9, DTE		RJ45		DB9, DCE		***	DB25		RJ45		DB9	
Pin	Signal	Pin	Signal	Pin	Signal		Pin	Signal	Pin	Signal	Pin	Signal
7	RTS	1	DCD	1	DCD		4	RTS	1	DCD	7	RTS
8	CTS	2	RTS	7	RTS		N/A	N/A	2	N/A	N/A	N/A
Shell	GND	3	GND	Shell	GND		Shell	GND	3	GND	Shell	GND
3	RxD	4	TxD	3	TxD		3	RxD	4	TxD	2	RxD
2	TxD	5	RxD	2	RxD		2	TxD	5	RxD	3	TxD
5	GND	6	GND	5	GND		7	GND	6	GND	5	GND
4	DTR	7	CTS	8	CTS		N/A	N/A	7	N/A	N/A	N/A
6	DSR	8	DTR	4	DTR		N/A	N/A	8	N/A	N/A	N/A
RJ45 to DTE, DB9				N/A		RJ45 to DB25				N/A		
N/A		RJ45 to DCE, DB9				N/A		RJ45 to DB9				
@ 8 wire 8 pin RJ45						@ 4 wire 8 pin RJ45						

RJ45 to DB25  
Adapter

Computers or peripherals which use serial cables for their communication are split into two categories. These are DCE (Data Communications Equipment) and DTE (Data Terminal Equipment.) Data Communications Equipment are peripheral devices such as a modem, or plotter while Data Terminal Equipment is the Computer or Terminal.

An RS232 Null Modem cable is used to connect two DTE devices together. The table below provides the connector pinout used on each of a Null Modem cable. A Null Modem cable only really requires three wires; TD to RD, RD to TD, and SG to SG. The other pins may be crossed at each terminating connector [DTR to DSR, CD] and [RTS to CTS].

A LoopBack plug may be constructed by tying TD to RD, DTR to DSR/CD, and RTS to CTS.

RS232 Null Modem Cable {25 pin D Connector Pin Out}, RS232 Pinout

Pin #	Signal name	Signal Description	Cable	Pin #	Signal name	Signal Description
2	RXD	Receive Data	Cross	3	TXD	Transmit Data
3	TXD	Transmit Data	Cross	2	RXD	Receive Data
4	RTS	Request To Send	Cross	5	CTS	Clear To Send
5	CTS	Clear To Send	Cross	4	RTS	Request To Send
6	DSR	Data Set Ready	Cross	20	DTR	Data Terminal Ready
7	GND	Ground	Cross	7	GND	Ground
8	CD	Carrier Detect	Cross	20	DTR	Data Terminal Ready
20	DTR	Data Terminal Ready	Cross	6	DSR	Data Set Ready
20	DTR	Data Terminal Ready	Cross	8	CD	Carrier Detect

The serial port found on a [Personal Computer](#) uses either a 9-pin D or 25-pin D connector. The pinout for both those connector types is listed above.

This page also lists both of these connector types as they relate to the Personal Computer; [RS232 pinout](#). Serial cables are longer than parallel cables because of the data transmission used.

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## EIA-562 Bus Description

**EIA-562:** Electrical Characteristics for an Unbalanced Digital Interface

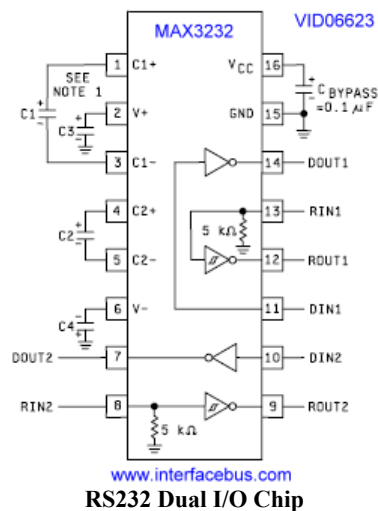
EIA-562 or TIA-562 is the low voltage version of the RS232 standard. EIA-562 operates at 20kbps over a single-ended line just as RS232 does.

How ever; EIA562 has a minimum output of +/- 3.7 volts, and a maximum output of +/- 25 volts.

The TIA/EIA-562 specification does allow for inter-operation with RS232.

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## EIA-232 Bus Interface IC Vendors



### RS232 Manufacturers

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[Analog Devices](#) {RS 232 - RS232 xceivers}  
[Fairchild Semiconductor, Corp.](#) {RS232 Line Driver / Receiver IC Manufacturer}  
[Freescale Semiconductor, Inc.](#) {RS232 IC Manufacturer}  
[Intersil Semiconductor, Corp.](#) {Radiation Hardened Line Driver / RS232 Receiver ICs}  
[Linear Technology](#) {RS232 IC Manufacturer}  
[Maxim](#) {RS232 Transmitter / Receiver-Transceiver IC Manufacturer}  
[Microchip](#) {RS232 Transceiver ICs}  
[National Semiconductor](#) {RS232 Driver / Receiver ICs}  
[NEC](#) {RS-232 Line Driver / Receiver ICs}  
[NXP](#) {MC145406 EIA-232-D/V.28 driver/receiver}  
[ON Semiconductor](#) (Quad Line EIA-232D Driver; MC1488, Quad Line EIA-232D Receiver MC1489)  
[Texas Instruments](#) 'TI' {RS-232 Differential Driver / RS232 Differential Receiver - all IC types}

### Government Specifications [Standard Microcircuit Drawing]

5962-06207; Microcircuit, Digital-Linear, 3 V, RS-232, Receiver / Transmitter Transceiver with Shutdown [2,3, or 5 receivers]

5962-87666; Microcircuit, Linear, Dual RS232 Transceivers [LT1080MJ/883]

5962-89877; Microcircuit, Linear, CMOS, Dual, RS232, Transceiver [MAX232, MAX230, MAX231, MAX234, MAX236]

5962-91729; Microcircuits, Linear, Dual RS-232 Transceiver [LT1180, LT1181]

5962-94565; Microcircuit, Linear, Driver/Receiver, Dual, RS-232, CMOS [MAX220, MAX220, MAX242, MAX243]

A common design consideration is the protection of the I/O lines leading to the interface ICs. Two common methods are to use protection diodes or TVS components. A number of different TVS part numbers in two different package configurations is shown on the [TVS DIP Components](#) page. Steering diodes may be also be used to protect the data lines from voltage spike and surges. Three different circuit configurations in two different package options are provided; [Diode Array in a DIP Package](#), [Diode Array in a Flat Package](#).

[IC Manufacturers](#) {All other Integrated Circuit device types}

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## RS232 Color Code

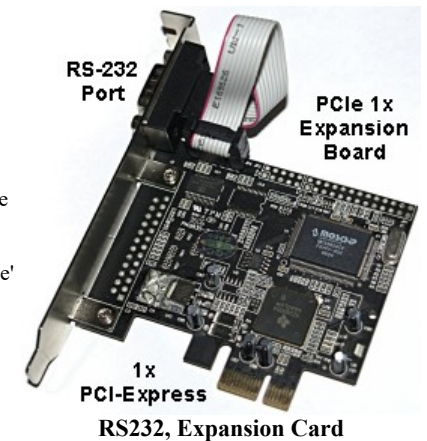
The RS232 standard does not define a cable, just the cable capacitance and two different forms of connectors.

So by definition there is no RS232 color code standard. However there may be an industry standard color code, but there would be no guarantee that a data cable purchased for RS232 usage would conform to a particular color code.

Much of the color coding information found on the internet is based on different equipment using RS232 interfaces. So one page may show one RS232 color code while another shows a completely different one. Of course many pages also may just be copies of some other page. In some cases when an RS232 cable is used to translate to another interface, than that interface standard might be used as the wiring color code for the cable. However, any color coding used with RS232 will be non-standard.

If connecting to a legacy system, or wiring to a design standard use that RS232 pinout color coding scheme. Otherwise use a multiconductor or multipair, shielded or unshielded 'data cable' that contains either 24 or 26 AWG wires and use the color code that comes with the cable. Note the wire color codes normally change with the number of individual wires contained in the cable. A Data Grade Cable is a category of cable.

Of course the example RS232 interface card to the right uses no color coding at all, just a red strip to indicate pin 1.



## RS232 Interface Usage

RS232 usage continues to decline.

The chart indicates Google searches for "RS232"

The term "EIA232" did not even register.

However RS232 is the more common term.

The blip in 2007 may just be a data glitch.

Most PCs dropped the RS232 interface years ago.

A RS232 port was added to the STE in 2008,

So RS232 DOD usage is still high.



RS232, Google Search Trend, 2004 to 2010

Topic Navigation: [Engineering Home](#) > [Interface Buses](#) > [Cabled Interface Standards](#) > RS232 Cable Interface



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