

RS-232 CHARACTERISTICS

- [RS-232 Signals](#)
 - [A note on signal travel direction](#)
 - [Electrical Signal Characteristics](#)
 - [Voltage levels defined in the standard](#)
 - [The noise margin issue](#)
 - [Interface Mechanical characteristics](#)
 - [Pin Designation for the DB Connector](#)
 - [Diagram of the DB Connector](#)
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RS-232 Signals

The number preceding each signal name correspond to the pin number defined in the standard

1. [Protective Ground](#)
 2. [Transmitted Data](#)
 3. [Received Data](#)
 4. [Request to Send](#)
 5. [Clear To Send](#)
 6. [Data Set Ready](#)
 7. [Signal Ground](#)
 8. [Received Line Signal Detect \(Carrier Detect\)](#)
 9. [+P \(for testing only\)](#)
 10. [-P \(for testing only\)](#)
 11. (unassigned)
 12. [Secondary Received Line Signal Detect](#)
 13. [Secondary Clear To Send](#)
 14. [Secondary Transmitted Data](#)
 15. [Transmission signal element Timing](#)
 16. [Secondary Received Data](#)
 17. [Receiver Signal Element Timing](#)
 18. (unassigned)
 19. [Secondary Request To Send](#)
 20. [Data Terminal Ready](#)
 21. [Signal Quality Detector](#)
 22. [Ring Indicator](#)
 23. [Data Signal Rate Selector](#)
 24. [Transmitter Signal Element Timing](#)
 25. (unassigned)
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RS-232 Signals Functional Description

General: The first letter of the EIA signal name categorizes the signal into one of five groups, each representing a different "circuit":

- *A - Ground*

- *B - Data*
 - *C - Control*
 - *D - Timing*
 - *S - Secondary channel*
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- **1 Protective Ground**

- **Name: AA**
- **Direction: -**
- **CCITT: 101**

This pin is usually connected to the frame of one of the devices, either the DCE or the DTE, which is properly grounded. The sole purpose of this connection is to protect against accidental electric shock and usually this pin should not be tied to [Signal Ground](#).

This pin should connect the chassis (shields) of the two devices, but this connection is made only when connection of chassis grounds is safe (see ground loops below) and it is considered optional.

Ground loops are low impedance closed electric loops composed from ground conductors. When two grounded devices are connected together, say by a RS-232 cable, the alternating current on the lines in the cable induces an electric potential across the ends of the grounding line (either Protective Ground or [Signal Ground](#)), and an electric current will flow across this line and through the ground.

Since the loops impedance is low, this current can be quite high and easily burn out electric components. Electrical storms could also cause a burst of destructive current across such a loop. Therefore, connection of the Protective Ground pin is potentially hazardous. Furthermore, not all signal grounds are necessarily isolated from the chassis ground, and using a RS-232 interface, especially across a long distance, is unreliable and could be hazardous. 30 meters is considered the maximum distance at which the grounding signals can be connected safely.

- **2 Transmit Data**

- **Name: BA**
- **Direction: DTE -> DCE**
- **CCITT: 103**

Serial data (primary) is sent on this line from the DTE to the DCE. The DTE holds this line at logic 1 when no data are being transmitted. A "On" (logic 0) condition must be present on the following signals, where implemented, before data can be transmitted on this line : CA, CB,CC and CD ([Request To Send](#), [Clear To Send](#),[Data Set Ready](#), [Data Terminal Ready](#)).

- **3 Receive Data**

- **Name: BB**
- **Direction: DTE <- DCE**
- **CCITT: 104**

Serial data (primary) is sent on this line from the DCE to the DTE. This pin is held at logic 1 (Mark) when no data are being transmitted, and is held "Off" for a brief interval after an "On" to "Off" transition on the [Request To Send](#) line, in order to allow the transmission to complete.

- **4 Request To Send**

- Name: CA
- Direction: DTE -> DCE
- CCITT: 105

Enables transmission circuits. The DTE uses this signal when it wants to transmit to the DCE. This signal, in combination with the Clear To Send signal, coordinates data transmission between the DTE and the DCE.

A logic 0 on this line keeps the DCE in transmit mode. The DCE will receive data from the DTE and transmit it on to the communication link.

The Request To Send and [Clear To Send](#) signals relate to a half- duplex telephone line. A half duplex line is capable of carrying signals on both directions but only one at a time. When the DTE has data to send, it raises Request To Send, and then waits until the DCE changes from receive to transmit mode. This "On" to "Off" transition instructs the DCE to move to "transmit" mode, and when a transmission is possible, the DCE sets Clear To Send and transmission can begin.

On a full duplex line, like a hard-wired connection, where transmission and reception can occur simultaneously, the [Clear To Send](#) and Request To Send signals are held to a constant "On" level.

A "On" to "Off" transition on this line instructs the DCE to complete the transmission of data that is in progress, and to move to a "receive" (or "no transmission") mode.

- **5 Clear To Send**

- Name: CB
- Direction: DTE <- DCE
- CCITT: 106

An answer signal to the DTE. When this signal is active, it tells the DTE that it can now start transmitting (on [Transmitted Data](#) line). When this signal is "On" and the [Request To Send](#), [Data Set Ready](#), and [Data Terminal Ready](#) are all "On", the DTE is assured that its data will be sent to the communications link. When "Off", it is an indication to the DTE that the DCE is not ready, and therefor data should not be sent.

When the [Data Set Ready](#) and [Data Terminal Ready](#) signals are not implemented, in a local connection which does not involve the telephone network, the Clear To Send and [Request To Send](#) signals are sufficient to control data transmission.

- **6 Data Set Ready**

- Name: CC
- Direction: DTE <- DCE
- CCITT: 107

On this line the DCE tells the DTE that the communication channel is available (i.e., in an automatic calling system, the DCE (modem) is not in the dial, test or talk modes and therefore is available for transmission and reception). It reflects the status of the local data set, and does not indicate that an actual link has been established with any remote data equipment.

- **7 Signal Ground**

- **Name:** AB
- **Direction:** -
- **CCITT:** 102

This pin is the reference ground for all the other signals, data and control.

- **8 Receive Line Signal Detect or Data Carrier Detect**

- **Name:** CF
- **Direction:** DTE <- DCE
- **CCITT:** 109

The DCE uses this line to signal the DTE that a good signal is being received (a "good signal" means a good analog carrier, that can ensure demodulation of received data).

- **9 +P**

This pin is held at +12 volts DC for test purposes.

- **10 -P**

This pin is held at -12 volts DC for test purposes.

- **12 Secondary Receive Line Signal Detect**

- **Name:** SCF
- **Direction:** DTE <- DCE
- **CCITT:** 122

This signal is active when the secondary communication channel is receiving a good analog carrier (same function as the [Receive Line Signal Detect](#) signal).

- **13 Secondary Clear To Send**

- **Name:** SCB
- **Direction:** DTE <- DCE
- **CCITT:** 121

An answer signal to the DTE. When this signal is active, it tells the DTE that it can now start transmitting on the secondary channel (on the [Secondary Transmitted Data](#) line).

- **14 Secondary Transmitted Data**

- Name: SBA
- Direction: DTE -> DCE
- CCITT: 118

Serial data (secondary channel) is sent on this line from the DTE to the DCE. This signal is equivalent to the [Transmitted Data line](#) except that it is used to transmit data on the secondary channel.

- **15 Transmission Signal Element Timing**

- Name: DB
- Direction: DTE <- DCE
- CCITT: 114

The DCE sends the DTE a clock signal on this line. This enables the DTE to clock its output circuitry which transmits serial data on the [Transmitted Data](#) line.

The clock signal frequency is the same as the bit rate of the [Transmitted Data](#) line. A "On" to "Off" transition should mark the center of each signal element (bit) on the [Transmitted Data](#) line.

- **16 Secondary Receive Data**

- Name: SBB
- Direction: DTE <- DCE
- CCITT: 119

Serial data (secondary channel) is received on this line from the DCE to the DTE. When the secondary channel is being used only for diagnostic purposes or to interrupt the flow of data in the primary channel, this signal is normally not provided.

- **17 Receiver Signal Element Timing**

- Name: DD
- Direction: DTE <- DCE
- CCITT: 115

The DCE sends the DTE a clock signal on this line. This clocks the reception circuitry of the DTE which receives serial data on the [Received Data](#) line.

The clock signal frequency is the same as the bit rate of the [Received Data](#) line (BB). The "On" to "Off" transition should indicate the center of each signal element (bit) on the [Received Data](#) line.

- **19 Secondary Request To Send**

- Name: SCA
- Direction: DTE -> DCE
- CCITT: 120

The DTE uses this signal to request transmission from the DCE on the secondary channel. It is equivalent to the [Request To Send](#) signal.

When the secondary channel is only used for diagnostic purposes or to interrupt the flow of data in the primary channel, this signal should turn "On" the secondary channel un-modulated carrier.

- **20 Data Terminal Ready**

- Name: CD
- Direction: DTE -> DCE
- CCITT: 108.2

When on, tells the DCE that the DTE is available for receiving. This signal must be "On" before the DCE can turn [Data Set Ready](#) "On", thereby indicating that it is connected to the communications link.

The Data Terminal Ready and [Data Set Ready](#) signals deal with the readiness of the equipment, as opposed to the [Clear To Send](#) and [Request To Send](#) signals that deal with the readiness of the communication channel.

When "Off", it causes the DCE to finish any transmission in progress and to be removed from the communication channel.

- **21 Signal Quality Detector**

- Name: CG
- Direction: DTE <- DCE
- CCITT: 110

This line is used by the DCE to indicate whether or not there is a high probability of an error in the received data. When there is a high probability of an error, it is set to "Off", and is "On" at all other times.

- **22 Ring Indicator**

- Name: CE
- Direction: DTE <- DCE
- CCITT: 125

On this line the DCE signals the DTE that there is an incoming call. This signal is maintained "Off" at all times except when the DCE receives a ringing signal.

- **23 Data Signal Rate Selector**

- Name: CH/CI
- Direction: DTE -> DCE
- CCITT: 111/112

The DTE uses this line to select the transmission bit rate of the DCE. The selection is between two rates in the case of a dual rate synchronous connection, or between two ranges of data rates in the case of an asynchronous connection.

Typically, when this signal is "On", it tells the DCE (modem) that the receive speed is greater than 600 baud.

- **24 Transmitter Signal Element Timing**

- Name: DA
- Direction: DTE -> DCE
- CCITT: 113

The DTE sends the DCE a transmit clock on this line. This is only when the master clock is in the DTE.

A "On" to "Off" transition should indicate the center of each signal element (bit) on the [Transmitted Data](#) line.

- **A note on signal travel direction**

The pin names are the same for the DCE and DTE. The Transmit Data (pin number 2) is a transmit line on the DTE and a receive line on the DCE, Data Set Ready (pin number 6) is a receive line on the DTE and a transmit line on the DCE, and so forth.

- **Electrical Signal Characteristics**

- **Voltage levels defined in the standard**

• Data signals	"0", "Space"	"1", "Mark"	
• Driver (Required)	5 - 15	-5 - -15	Volts
• Terminator (expected)	3 - 25	-3 - -25	Volts
• Control signals	"Off"	"On"	
• Driver (Required)	-5 - -15	5 - 15	Volts
• Terminator (expected)	-3 - -25	3 - 25	Volts

- **The Noise Margin Issue**

Note that terminator (receiving end) voltages are not the same as driver required voltages. This voltage level definition compensates for voltage losses across the cable.

Signals traveling along the cable are attenuated and distorted as they pass. Attenuation increases as the length of the cable increases. This effect is largely due to the electrical capacitance of the cable.

The maximum load capacitance is specified as 2500pf (picofarad) by the standard. The capacitance of one meter of cable is typically around 130pf, thus the maximum cable length is limited to around 17 meters. However, This is a nominal length defined by the standard, and it is possible to use longer cables up to 30 meters, with low-capacitance cables, or with slow data rates and a proper error correction mechanism.

- **Interface Mechanical Characteristics**

The connection of the DCE and the DTE is done with a pluggable connector. The female connector should be associated with the DCE. The following table lists the pin assignments defined by the standard. The type of connector to be used is not mentioned in the standard, but the DB-25 (or on IBM-AT's, a minimal DB-9) connectors are almost always used.

- **Pin designation for the 25-pin and 9-pin DB connector**

includes equivalent CCITT V.24 identification, and signal direction

DB-25 Pin #	DB-9 Pin #	Common Name	EIA Name	CCITT	DTE-DCE	Formal Name
1		FG	AA	101	-	Frame Ground
2	3	TD	BA	103	--->	Transmitted Data, TxD
3	2	RD	BB	104	<---	Received Data, RxD
4	7	RTS	CA	105	--->	Request To Send
5	8	CTS	CB	106	<---	Clear To Send
6	6	DSR	CC	107	<---	Data Set Ready
7	5	SG	AB	102	----	Signal Ground, GND
8	1	DCD	CF	109	<---	Data Carrier Detect
9		--	--	-	-	+P
10		--	--	-	-	-P
11		--	--	-	-	unassigned
12		SDCD	SCF	122	<---	Secondary Data Carrier Detect
13		SCTS	SCB	121	<---	Secondary Clear To Send
14		STD	SBA	118	--->	Secondary Transmitted Data
15		TC	DB	114	<---	Transmission Signal Element Timing
16		SRD	SBB	119	<---	Secondary Received Data
17		RC	DD	115	--->	Receiver Signal Element Timing
18		--	--	-	-	unassigned
19		SRTS	SCA	120	--->	Secondary Request To Send
20	4	DTR	CD	108.2	--->	Data Terminal Ready
21		SQ	CG	110	<---	Signal Quality Detector
22	9	RI	CE	125	<---	Ring Indicator
23		--	CH/CI	111/112	--->	Data Signal Rate Selector
24		--	DA	113	<---	Transmitter Signal Element Timing
25		--	--	-	-	unassigned

- **Diagram of the DB-25 and DB-9 connectors**

male connectors , front view

