

RS-232 INTERFACE

Introduction:

The RS-232 interface is the Electronic Industries Association (EIA) standard for the interchange of serial binary data between two devices. It was initially developed by the EIA to standardize the connection of computers with telephone line modems. The standard allows as many as 20 signals to be defined, but gives complete freedom to the user. Three wires are sufficient: send data, receive data, and signal ground. The remaining lines can be hardwired on or off permanently. The signal transmission is bipolar, requiring two voltages, from 5 to 25 volts, of opposite polarity.

Communication Standards:

The industry custom is to use an asynchronous word consisting of: a start bit, seven or eight data bits, an optional parity bit and one or two stop bits. The baud rate at which the word sent is device-dependent. The baud rate is usually 150 times an integer power of 2, ranging from 0 to 7 (150, 300, 600 ,..., 19,200). Below 150 baud, many system-unique rates are used. The standard RS-232-C connector has 25 pins, 21 pins which are used in the complete standard. Many of the modem signals are not needed when a computer terminal is connected directly to a computer, and Figure 1 illustrates how some of the "spare" pins should be linked if not needed. Figure 1 also illustrates the pin numbering used in the original DB-25 connector and that now commonly used with a DB-9 connector normally used in modern computers

Specifying compliance to RS-232 only establishes that the signal levels in two devices will be compatible and that if both devices use the suggested connector, they may be able to be connected. Compliance to RS-232 does not imply that the devices will be able to communicate or even acknowledge each other's presence.

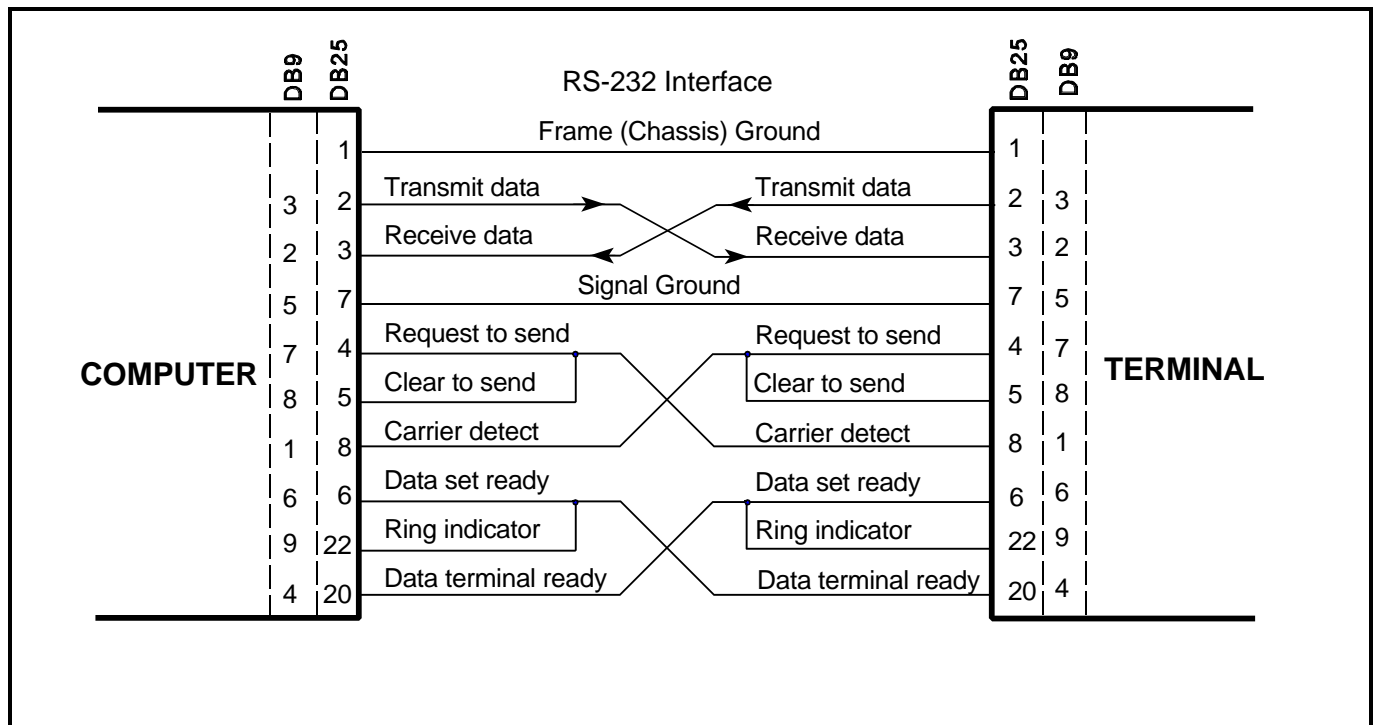


Figure 1. Direct-to-computer RS-232 Interface

Table 1 shows the signal names, and functions of the RS-232 serial port pinout. Table 2 shows a complete pin description

Table 1. RS-232 Serial Port Pinout

| Name | Pin | Signal Name | Function |
|------|-----|----------------------------|--|
| AA | 1 | PG Protective Ground | This line is connected to the chassis ground of the GPIB-232CV. Since the GPIB-232CV chassis ground is not connected to earth ground, pin 1 should be connected on both serial devices. |
| BA | 2 | TxD Transmit Data | This line carries serial data from the GPIB-232CV to the serial host. |
| BB | 3 | RxD Receive Data | This line carries serial data from the serial host to the GPIB-232CV. |
| CA | 4 | RTS Request to Send | This signal line is driven by the GPIB-232CV and when asserted indicates that the GPIB-232CV is ready to accept serial data. The GPIB-232CV unasserts RTS when it is no longer ready to accept serial data because of a buffer full condition. |
| CB | 5 | CTS Clear to Send | This signal line is asserted by the serial host and sensed by the GPIB-232CV. When asserted, it indicates that the serial host is ready to accept serial data. When unasserted, it indicates that data transmission should be disabled. |
| AB | 7 | SG Signal Ground | This line establishes a reference point for all interface voltages. |
| CD | 20 | DTR Data Terminal Ready | This signal line is asserted by the GPIB-232CV to signal that it has been powered on, and is ready to operate. |

Table 2. RS-232C Interface Signals.

| Pin | Description | Pin | Description | Pin | Description |
|-----|---------------------------------|-----|---|-----|---|
| 1 | Protective Ground | 10 | (Reserved for Data Set Testing) | 19 | Secondary Request to Send |
| 2 | Transmitted Data | 11 | Unassigned | 20 | Data Terminal Ready |
| 3 | Received Data | 12 | Sec. Rec'd. Line Sig. Detector | 21 | Signal Quality Detector |
| 4 | Request to Send | 13 | Sec. Clear to Send | 22 | Ring Indicator |
| 5 | Clear to Send | 14 | Secondary Transmitted Data | 23 | Data Signal Rate Selector (DTE/DCE Source) |
| 6 | Data Set Ready | 15 | Transmission Signal Element Timing (DCE Source) | 24 | Transmit Signal Element Timing (DTE Source) |
| 7 | Signal Ground (Common Return) | 16 | Secondary Received Data | 25 | Unassigned |
| 8 | Received Line Signal Detector | 17 | Receiver Signal Element Timing (DCE Source) | | |
| 9 | (Reserved for Data Set Testing) | 18 | Unassigned | | |

Electrical Characteristics: The RS-232-C specifies the signaling rate between the DTE and DCE, and a digital signal is used on all interchange circuits. The RS-232 standard specifies that logic "1" is to be sent as a voltage in the range -15 to -5 V and that logic "0" is to be sent as a voltage in the range +5 to +15 V. The standard specifies that voltages of at least 3 V in amplitude will always be recognized correctly at the receiver according to their polarity, so that appreciable attenuation along the line can be tolerated. The transfer rate is rated > 20 kbps and a distance of < 15m. Greater distance and data rates are possible with good design, but it is reasonable to assume that these limits apply in practice as well as in theory. The load impedance of the terminator side of the interface must be between 3000 and 7000 ohms, and not more than 2500pF.

Table 3, summarizes the functional specifications of the most important circuits.

Table 3. RS-232-C Circuit Definitions

| Name | Direction to: | Function |
|--|---------------|---|
| Data Signals | | |
| Transmitted Data (BA) | DCE | Data generated by DTE |
| Received Data (BB) | DTE | Data Received by DTE |
| Timing signals | | |
| Transmitter Signal Element Timing (DA) | DCE | Clocking signal, transitions to ON and OFF occur at center of each signal element |
| Transmitter Signal Element Timing (DB) | DTE | Clocking signal, as above; both leads relate to signals on BA |
| Receiver Signal Element Timing (DD) | DTE | Clocking signal, as above, for circuit BB |
| Control Signals | | |
| Request to Send (CA) | DCE | DTE wishes to transmit |
| Clear to Send (CB) | DTE | DCE is ready to transmit; response to request to send |
| Data Set Ready (CC) | DTE | DCE is ready to operate |
| Data Terminal Ready (CD) | DCE | DTE is ready to operate |
| Ring Indicator (CE) | DTE | Indicates that DCE is receiving a ringing signal on the communication channel |
| Carrier Detect (CF) | DTE | Indicates that DCE is receiving a carrier signal |
| Signal Quality Detector (CG) | DTE | Asserted when there is reason to believe there is an error in the received data |
| Data Signal Rate Selector (CH) | DCE | Asserted to select the higher of two possible data rates |
| Data Signal Rate Selector (CI) | DTE | Asserted to select the higher of two possible data rates |
| Ground | | |
| Protective Ground (AA) | NA | Attached to machine frame and possibly external grounds |
| Signal Ground (AB) | NA | Establishes common ground reference for all circuits |

Range: The RS-232-C standard specifies that the maximum length of cable between the transmitter and receiver should not exceed 100 feet, Although in practice many systems are used in which the distance between transmitter and receiver exceeds this rather low figure. The limited range of the RS-232C standard is one of its major shortcomings compared with other standards which offer greater ranges within their specifications. One reason why the range of the RS-232C standard is limited is the need to charge and discharge the capacitance of the cable connecting the transmitter and receiver.

Mechanical Characteristics: The connector for the RS-232-C is a 25 pin connector with a specific arrangement of wires. In theory, a 25 wire cable could be used to connect the Data Terminal Equipment (DTE) to the Data Communication Equipment (DCE). The DTE is a device that is acting as a data source, data sink, or both, e.g. a terminal, peripheral or computer. The DCE is a device that provides the functions required to establish, maintain, and terminate a data-transmission connecting, as well as the signal conversion, and coding required for communication between data terminal equipment and data circuit; e.g. a modem. Table 4, shows the complete summary of the RS-232-C, e.g., descriptor, sponsor, data format, etc.

Table 4. Summary of the RS-232-C

| | |
|----------------|---|
| Data Format | 5- to 8- bit serial |
| Transfer Type | Asynchronous |
| Error Handling | Optional Parity Bit |
| Connector | 25-pin female connector on DCE; 25-pin male connector on DTE |
| Length | 20 meters |
| Speed | 20 kb/s |
| Remarks | RS-232 is used in the microcomputer world for communications between two DTEs. The null-modem is included into one or both connecting devices, and/or cable and is seldom documented. As a result, establishing an RS-232 connection between two DTEs is frequently a difficult task. |