



Serial Communication

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August 8, 2002



Serial Transmission

■ Characteristics

- One bit transmitted at a time
- Simple electrical circuit (two wires only)
- At least 8 times slower than the corresponding (byte-)parallel transfer
- Improved transmission range and reliability

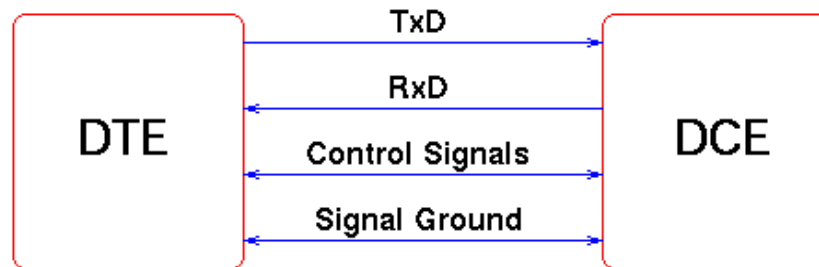
■ Deployment

- Slow devices (in regard to microprocessors)
- Long range
- High interference (field bus)



Serial Interface

- Interconnects Data Terminal Equipment (DTE) and Data Communication Equipment (DCE)



- Standards
 - EIA: RS-232, RS-422, RS-423, and RS-449
 - CCITT: V.24/V.28
- Visible in a computer through an UART



Universal Asynchronous Receiver/Transmitter (UART)

- The computer's serial 'port'
 - The UART takes bytes of data and transmits the individual bits in a sequential fashion
 - At the destination, a second UART re-assembles the bits into complete bytes
- National Semiconductor UART
 - Adopted by the IBM PC
 - Defacto standard
 - 8250/16450/16550



Synchronous Serial Transmission

- Sender and receiver are synchronized by
 - Sharing a *common clock*
 - Sender providing a *strobe*
- More efficient than asynchronous
 - Only data is transmitted
- More expensive than asynchronous
 - Clock/strobe signal
- Not supported by the PC's 8250



Asynchronous Serial Transmission

- Sender and receiver don't share a clock
 - Must agree on timing parameters in advance
 - Handshake
 - Special bits are added to each word for synchronization purpose
 - Start bit: indicates the beginning of a word, synchronizing the receiver with the transmitter's clock
 - Parity bit: enables simple error checking
 - Stop bit(s): indicates the end of a word
 - Data bits
 - Least significant bit (LSB) first
 - Sampled at half the period assigned to each bit



RS-232-C History

- Defined in 1969 by EIA and Bell Laboratories as an standard DCE/DTE interface
 - Electrical, mechanical, and functional characteristics
 - Similar standard by CCITT in Europe
 - V.24 functional
 - V.28 electrical
 - Cost effectiveness led it to connect several peripheral devices in the microcomputer scene
- Extended by standards RS-422, RS-423 and RS-449



RS-232-C Signaling

- Voltage levels
 - Data signals
 - Space (0): +5 -> +15 V
 - Mark (1): -5 -> -15 V
 - Control signals
 - Off (0): -5 -> -15 V
 - On (1): +5 -> + 15 V
- Noise margin
 - Maximum load capacitance: 2500pf
 - Maximum cable length: ~17 m (on 130pf/m cable)



RS-232-C Signals (1)

1 - Frame Ground [FG]

This pin should connect the chassis of the two devices, but this connection is made only when connection of chassis grounds is safe and it is considered optional.

2 - Transmitted Data [TxD, DTE => DCE]

DTE uses this signal to send data to the DCE. It's hold at logic 1 when no data is being transmitted.



RS-232-C Signals (2)

3 - Received Data [RxD, DCE => DTE]

DCE uses this signal to send data to the DTE. It's hold at logic 1 when no data is being transmitted.

4 - Request to Send [RTS, DTE => DCE]

DTE uses this signal when it wants to transmit to the DCE. This signal, in combination with CTS, coordinates data transmission between the DTE and the DCE.



RS-232-C Signals (3)

5 - Clear To Send [CTS, DCE => DTE]

This signal is an answer to the DTE's RTS. It tells the DTE that it can now start transmitting on TxD.

6 - Data Set Ready [DSR, DCE => DTE]

With this signal, the DCE tells the DTE that the communication channel is available.

7 - Signal Ground [GND, DCE <=> DTE]

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



RS-232-C Signals (4)

8 - Data Carrier Detect [DCD, DCE => DTE]

This signal tells the DTE that the DCE is receiving 'a good signal'.

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.

11 - Unassigned



RS-232-C Signals (5)

12 - Secondary DCD [SDCD, DCE => DTE]

DCD for the secondary communication channel.

13 - Secondary CTS [SCTC, DCE => DTE]

CTS for the secondary communication channel.

14 - Secondary TxD [STxD, DTE => DCE]

TxD for the secondary communication channel.

15 - Transmission Signal Element Timing [TC, DCE => DTE]

Clock signal sent by DCE to DTE to synchronize TxD.



RS-232-C Signals (6)

16 - Secondary RxD [SRxD, DCE => DTE]

RxD for the secondary communication channel.

17 - Receiver Signal Element Timing [RT, DCE => DTE]

Clock signal sent by DCE to DTE to synchronize RxD.

18 - Unassigned

19 - Secondary RTS [SRTS, DTE => DCE]

RTS for the secondary communication channel.



RS-232-C Signals (7)

- 20 - Data Terminal Ready [DTR, DTE => DCE]
Tells the DCE that the DTE is available for receiving.
- 21 - Signal Quality Detector [SQ, DCE => DTE]
This line is used by the DCE to indicate whether or not there is a high probability of an error in the received data. Tells the DCE that the DTE is available for receiving.
- 22 - Ring Indicator [RI, DCE => DTE]
DCE signals the DTE that there is an incoming call.



RS-232-C Signals (8)

23 - Data Signal Rate Selector [DTE => DCE]

The DTE uses this line to select the transmission bit rate of the DCE.

24 - Transmitter Signal Element Timing [DCE => DTE]

The DTE sends the DCE a transmit clock on this line.

25 - Unassigned



RS-232-C Signal Summary

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