DATA AND PULSE COMMUNICATION

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Analog & Digital Communication

TOPICS TO BE COVERED

- Data Communication Hardware.
- Serial and Parallel Interfaces.
- Data Communication Circuits.
- Communication Codes.

Data Communication Hardware

1. Data Terminating Equipment.
2. Data Communication Equipment.
3. Serial Interface.

Introduction

- Definition: Any electronic device or system used for the transfer of data or information from one place to another.
- Example
  - Telephone.
  - Computer.
  - Modem.

Telephone Communication Network

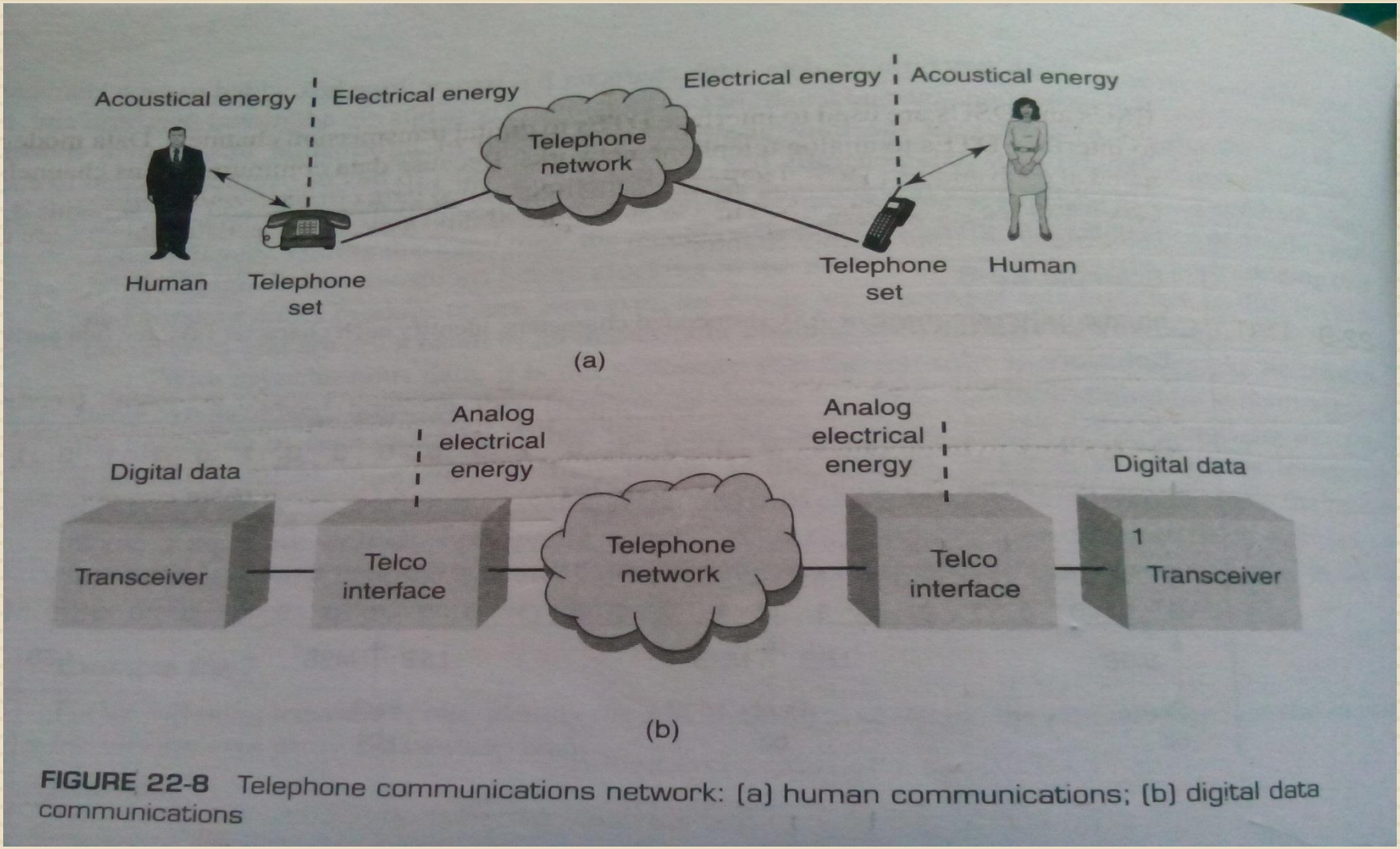


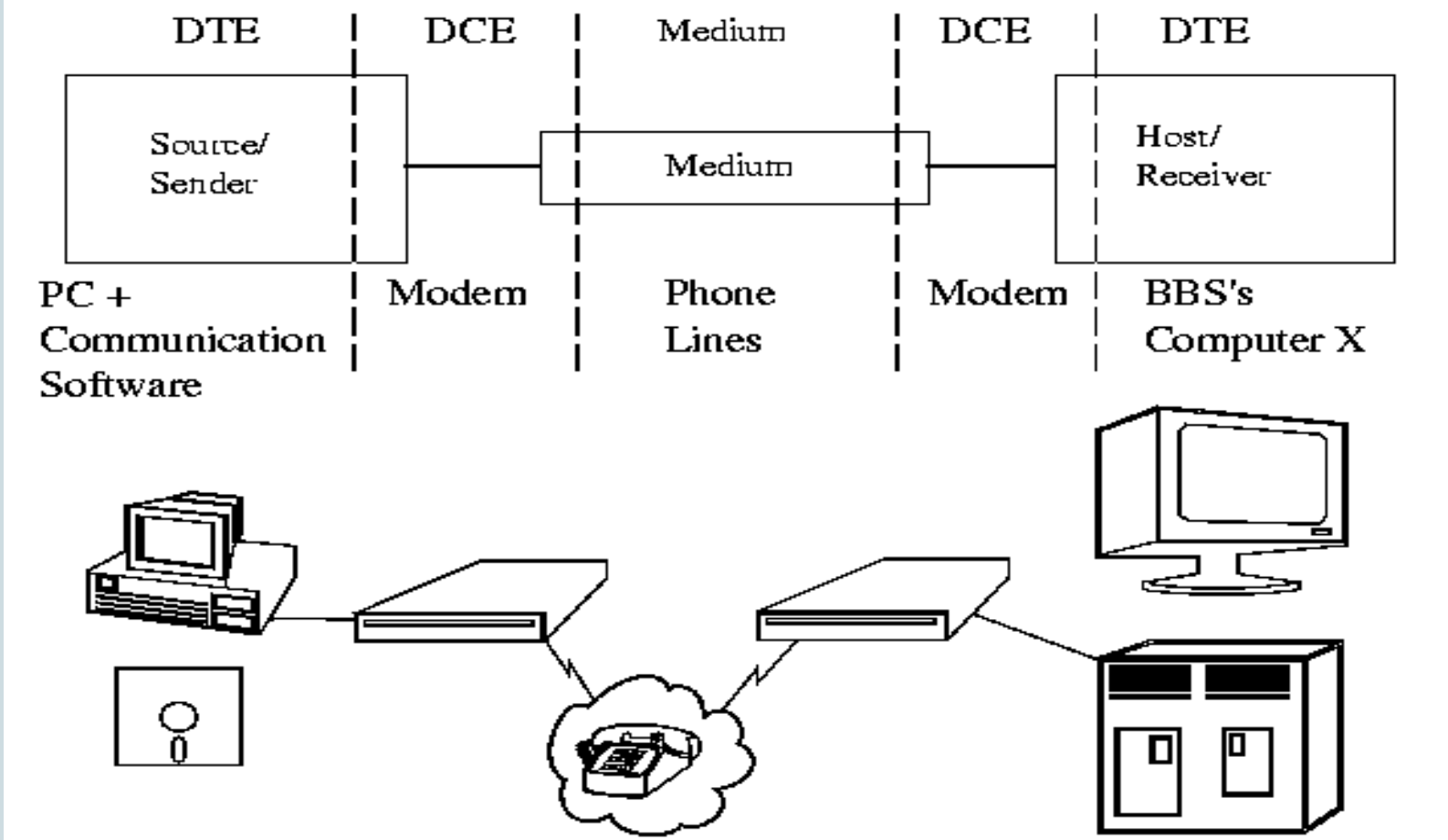
FIGURE 22-8 Telephone communications network: (a) human communications; (b) digital data communications

Data Communication Hardware

- Basic elements of a data communication system[DCS]
  - Transmitter (Source).
  - A Transmission path (Data channel).
  - Receiver (Destination).
- Two-way communication system –
  - Transmission path *"Bidirectional".*
  - Source and Destination interchangeable.
  - Thus, a DCS defined as – 2 *endpoints/nodes* connected through a common communication channel.
- *"The endpoints – may not have same computing capabilities but must be configured with same basic components"*

Data Communication Hardware

- Both endpoints – equipped with special devices that perform unique functions:
  - Make the physical connection to the data channel.
  - Process the data before they are transmitted and after they are received.
- Three fundamental components of endpoints –
  - Data Terminal Equipment (DTE).
  - Data Communications Equipment (DCE).
  - Serial Interface.



Fundamental Components of Endpoints/Nodes

Data Terminal Equipment (DTE)

- Any binary digital device that generates, transmits, receives or interprets data messages.
- Information originates or terminates here.
- Contain the hardware and software necessary to establish and control communication between endpoints.
- *DTEs seldom communicate directly with other DTEs.*
- DTEs include
  - Terminals – devices used to input output and display information. Ex: Keyboard, Printer, Monitor.
  - Clients – Modern day terminals with enhanced computing capabilities.
  - Hosts – High powered high capacity mainframe computers that support terminals.
  - Servers – Modern hosts with low storage and computing capability.

Data Communication Equipment (DCE)/ Data Circuit Terminationg Equipment (DTCE)

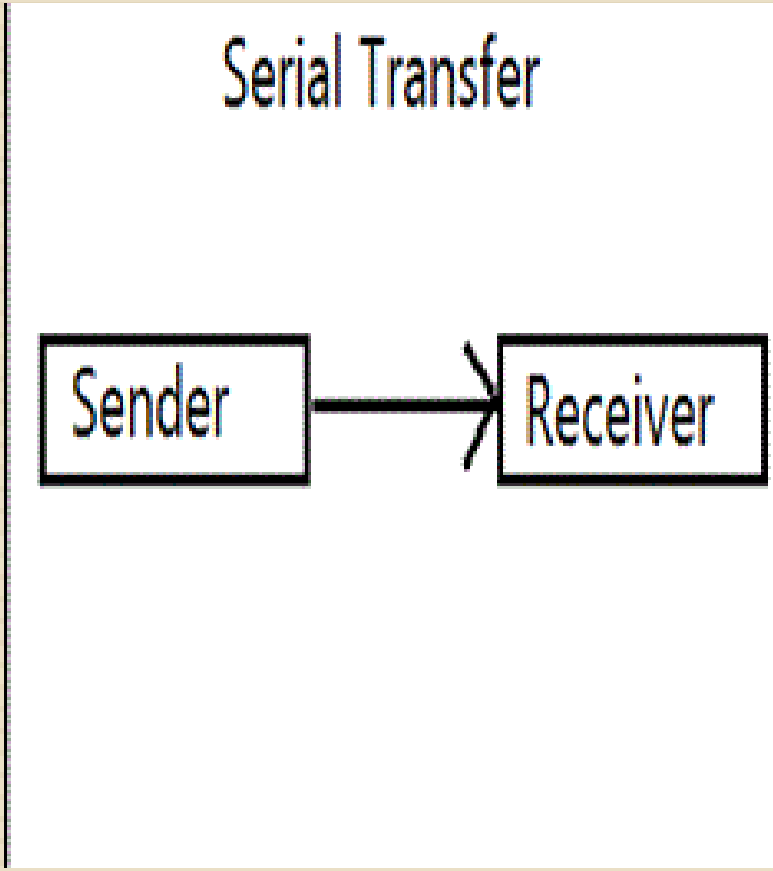
- Refers to equipments that interfaces DTE to a transmission channel.
- DCE is a *signal conversion device* as it converts signals from a DTE to a form more suitable to be transmitted over the transmission channel and vice-versa.
- DCEs are *transparent devices* as they neither know nor care about the content of the data but only convert them to a suitable form for transmission.
- Types of DCEs –
  - *Channel Service Units (CSU)* & *Digital Service Units (DSU)* – interface DTEs to digital transmission channels.
  - *Data Modems* – interfaces DTEs to analog telephone networks.

Serial & Parallel Interfaces

1. Serial Interface :- RS-232.
2. Centronics Parallel Interface

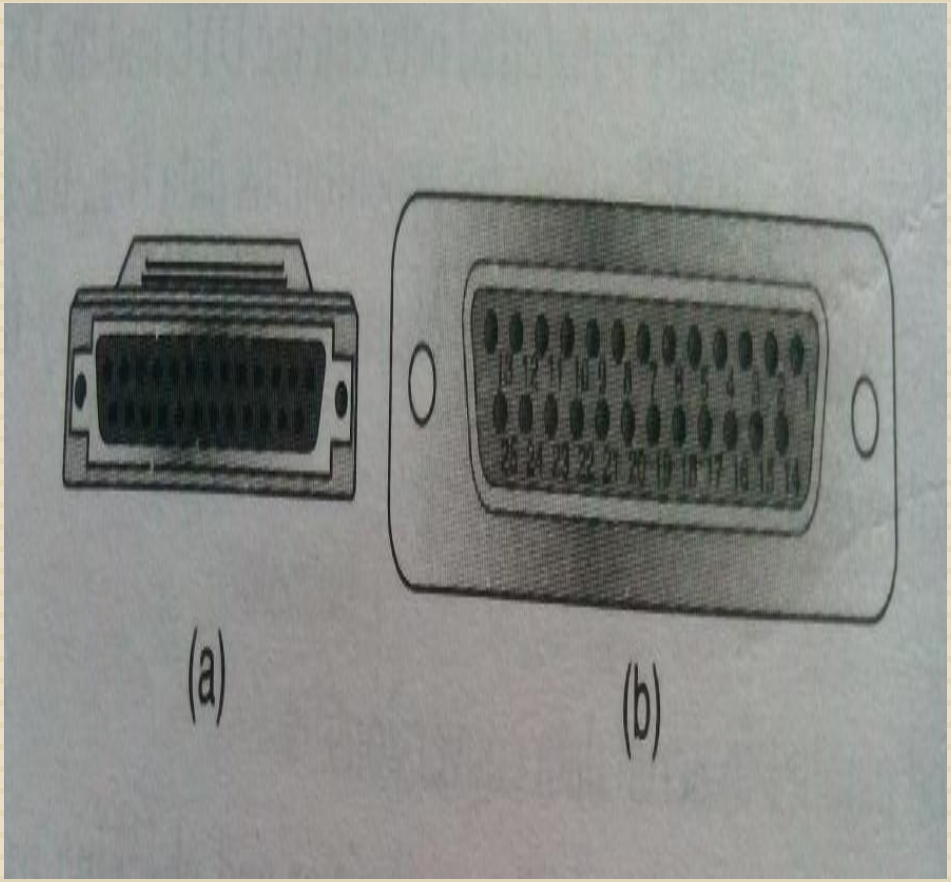
Serial Interface – RS-232

- Proposed by the Electronic Industries Association (EIA).
- RS stands for Recommended Standard.
- RS-232 defines the pin-outs of the connectors and the voltage levels allowed on each pin of a serial port connection. RS-232 is functionally identical to the CCITT V.24/V.28 standards.
- Official name "*Interface between DTE and DCE employing Serial Binary Data Interchange*".
- Identifies electrical, functional, and procedural descriptions of the interface between DTE and DCE.



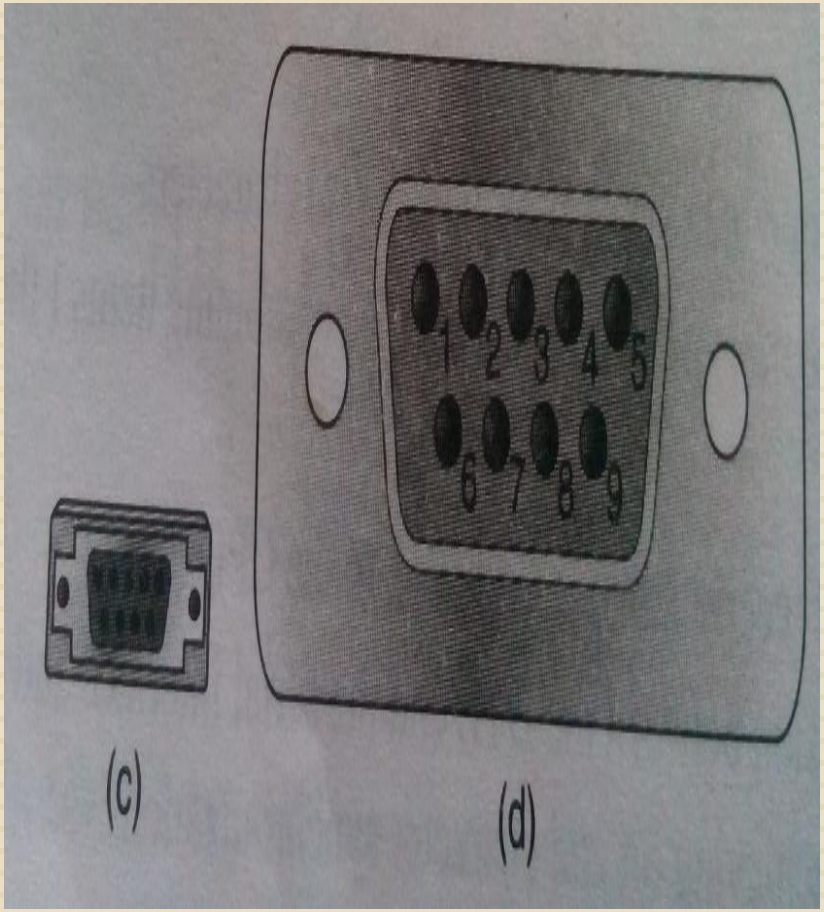
RS-232 : Mechanical Specifications

- RS-232 – sheath containing 25 or 9 wires.
- 25 pin version –
  - DB25P-compatible male connector (plug). (a)
  - DB25S-compatible female connector (receptacle).(b)
- Plug connects to DTE and receptacle to DCE.



Mechanical Specifications

- 9 pin version
  - DB9P-compatible male connector (plug)(c)
  - DB9S-compatible female connector (receptacle)(d)
- 9 pin version for transporting asynchronous data between DTE and DCE or between 2 DTEs.
- 25 pin version for transporting synchronous or asynchronous data.



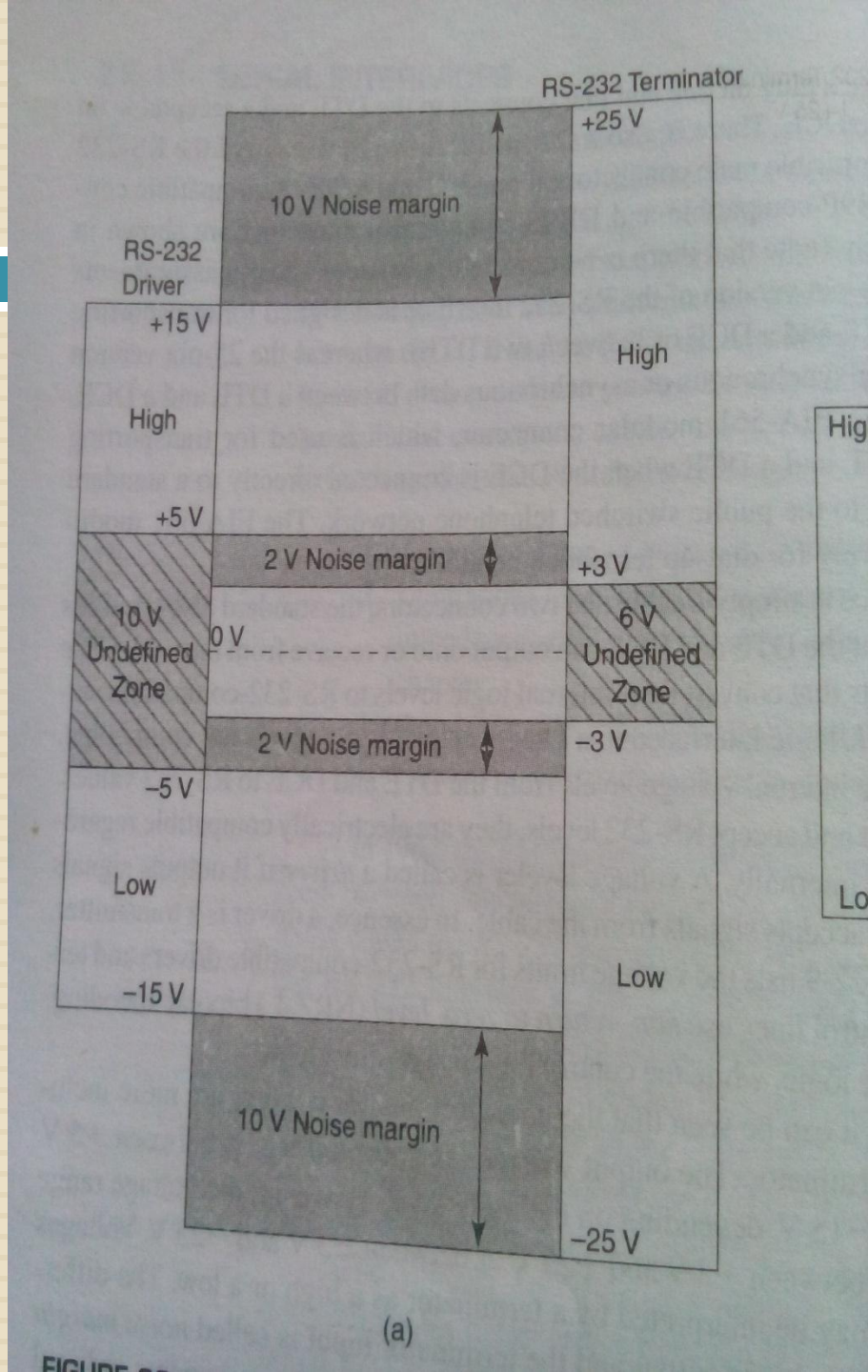
Voltage Limitations

- RS-232 specifies limitations on the voltage levels that the DTE and DCE can output onto or receive from the cable.
- *Voltage-leveling circuits* – convert internal voltage levels of DTE and DCE to RS-232 compatible values.
- Voltage leveler
  - *Driver* – if it outputs signals onto the cable.
  - *Terminator* – if it accepts signals from the cable.

	Data Signals		Control Signals	
	Logic 1	Logic 0	Enable (On)	Disable (Off)
Driver (output)	−5 V to −15 V	+5 V to +15 V	+5 V to +15 V	−5 V to −15 V
Terminator (input)	−3 V to −25 V	+3 V to +25 V	+3 V to +25 V	−3 V to −25 V

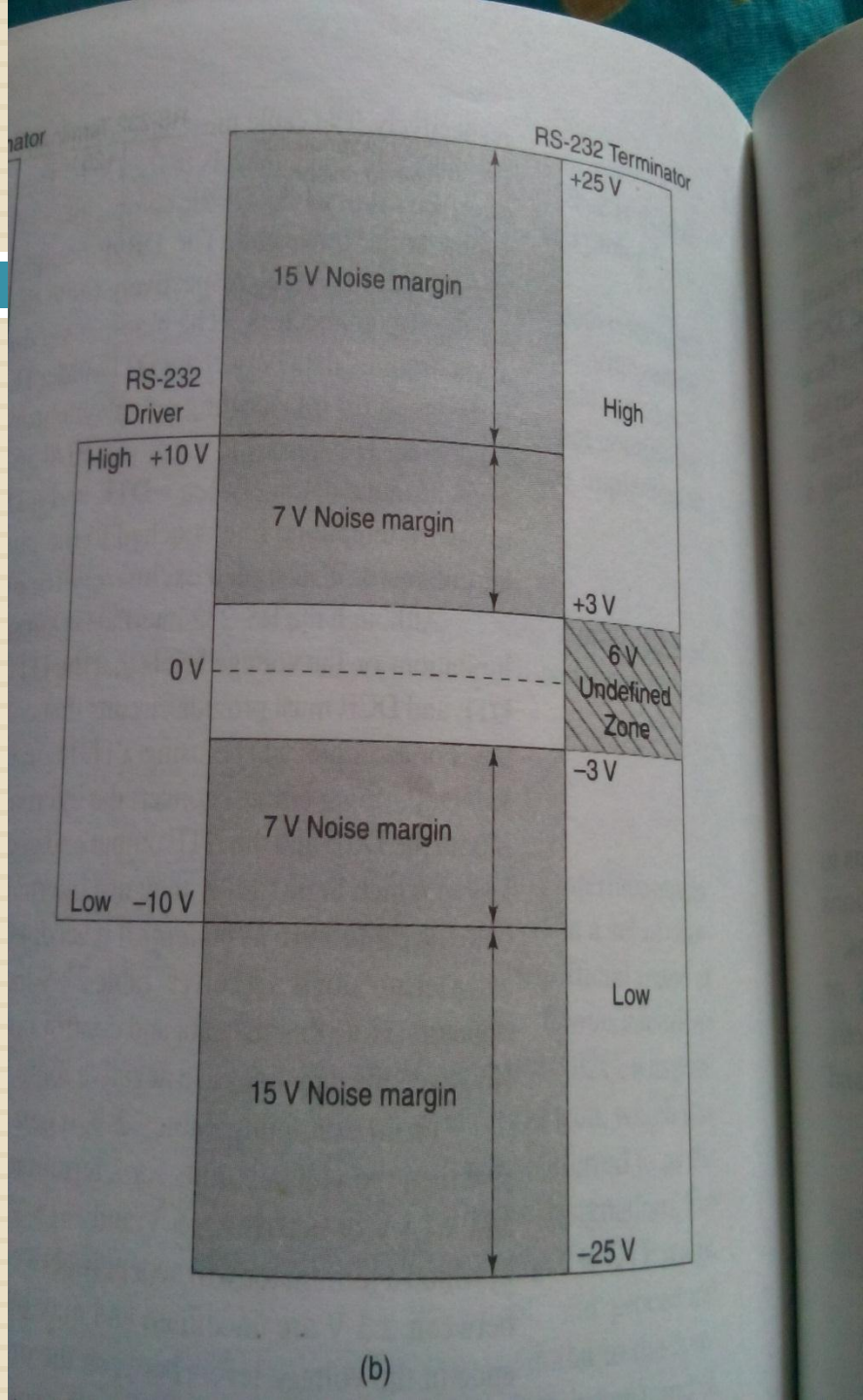
Noise Margin

- *Noise Margin* – The difference in voltage levels between the terminator input and the driver output.
- It reduces the susceptibility to interface caused by noise transients induced into the cable.
- Noise Margin for min. driver output voltage *2V*. (5-3)- *implied Noise Margin*.
- Noise Margin for max. driver output voltage *10V*. (25-15)

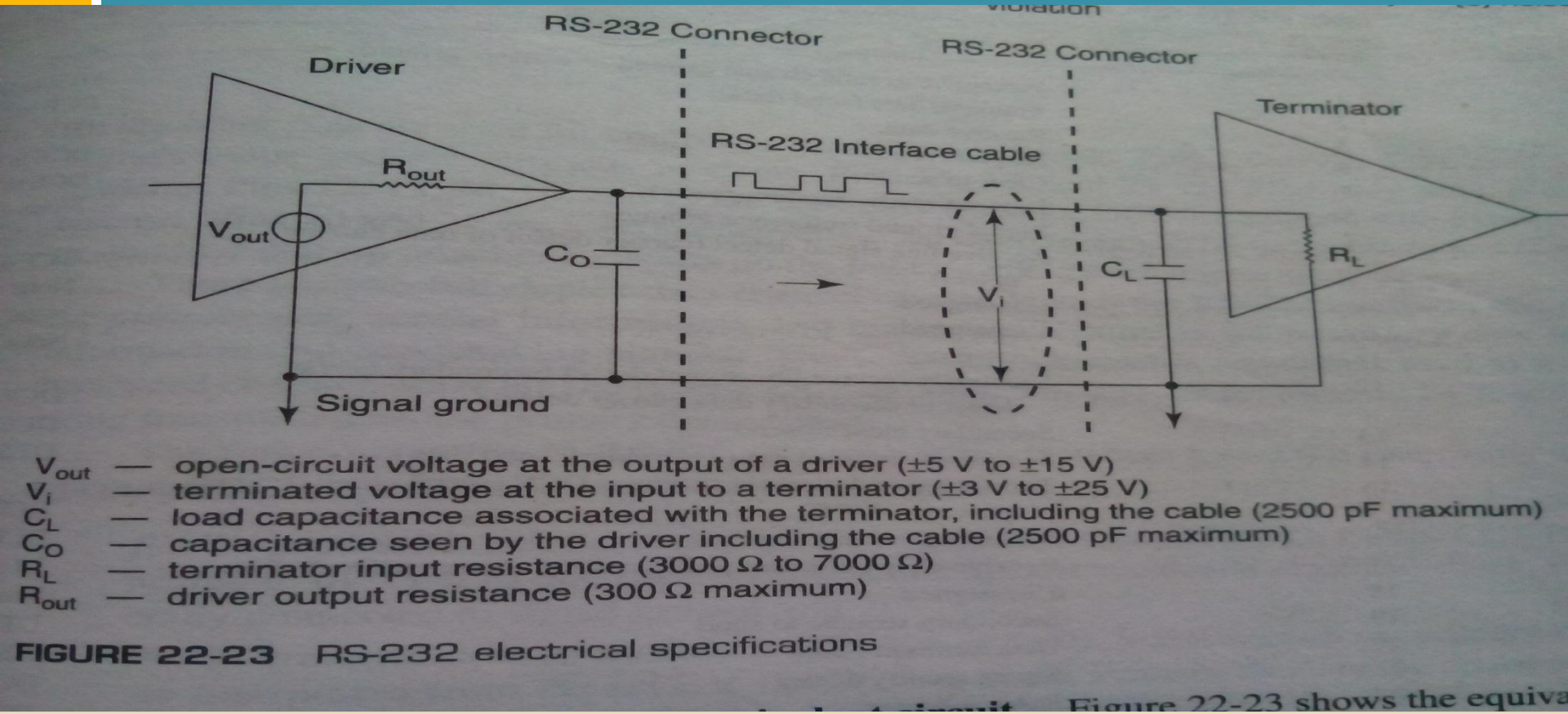


Noise Immunity

- *Noise Margin high – High Noise Immunity.*
- *Noise Margin low – Low Noise Immunity.*
- Typical RS-232 voltage values
  - +10V – High.
  - -10V – Low.
- Noise Margin of 7V in one direction and 15V in other direction produced.



RS-232 : Electrical Descriptions



V_{out} — open-circuit voltage at the output of a driver (±5 V to ±15 V)
V_i — terminated voltage at the input to a terminator (±3 V to ±25 V)
C_L — load capacitance associated with the terminator, including the cable (2500 pF maximum)
C_O — capacitance seen by the driver including the cable (2500 pF maximum)
R_L — terminator input resistance (3000 Ω to 7000 Ω)
R_{out} — driver output resistance (300 Ω maximum)

FIGURE 22-23 RS-232 electrical specifications

Figure 22-23 shows the equiva

- Bit Rate – 20 kbps.
- Nominal Maximum length of cable – 50 feet

RS-232 : Functional Description

- Functional category of pins
  - A – Ground (signal & chassis).
  - B – Data (transmit & receive).
  - C – Control (handshaking & diagnostic).
  - D – Timing (clocking signals).
  - S – Secondary channel.
- Practical identification of pins using EIA nomenclature or common acronyms.

Pin Designations & Direction of Propagation

Pins 1 and 7 are grounds; pins 2, 3, 14, and 16 are data pins; pins 15, 17, and 24 are timing pins; and

Table 22-10 EIA RS-232 Pin Designations and Direction of Propagation

Pin Number	Pin Name	Direction of Propagation
1	Protective ground (frame ground or chassis ground)	None
2	Transmit data (send data)	DTE to DCE
3	Receive data	DCE to DTE
4	Request to send	DTE to DCE
5	Clear to send	DCE to DTE
6	Data set ready (modem ready)	DCE to DTE
7	Signal ground (reference ground)	None
8	Receive line signal detect (carrier detect or data carrier detect)	DCE to DTE
9	Unassigned	None
10	Unassigned	None
11	Unassigned	None
12	Secondary receive line signal detect (secondary carrier detect or secondary data carrier detect)	DCE to DTE
13	Secondary clear to send	DCE to DTE
14	Secondary transmit data (secondary send data)	DTE to DCE
15	Transmit signal element timing—DCE (serial clock transmit—DCE)	DCE to DTE
16	Secondary receive data	DCE to DTE
17	Receive signal element timing (serial clock receive)	DCE to DTE
18	Unassigned	None
19	Secondary request to send	DTE to DCE
20	Data terminal ready	DTE to DCE
21	Signal quality detect	DCE to DTE
22	Ring indicator	DCE to DTE
23	Data signal rate selector	DTE to DCE
24	Transmit signal element timing—DTE (serial clock transmit—DTE)	DTE to DCE
25	Unassigned	None

Pin EIA Nomenclature & common Acronyms

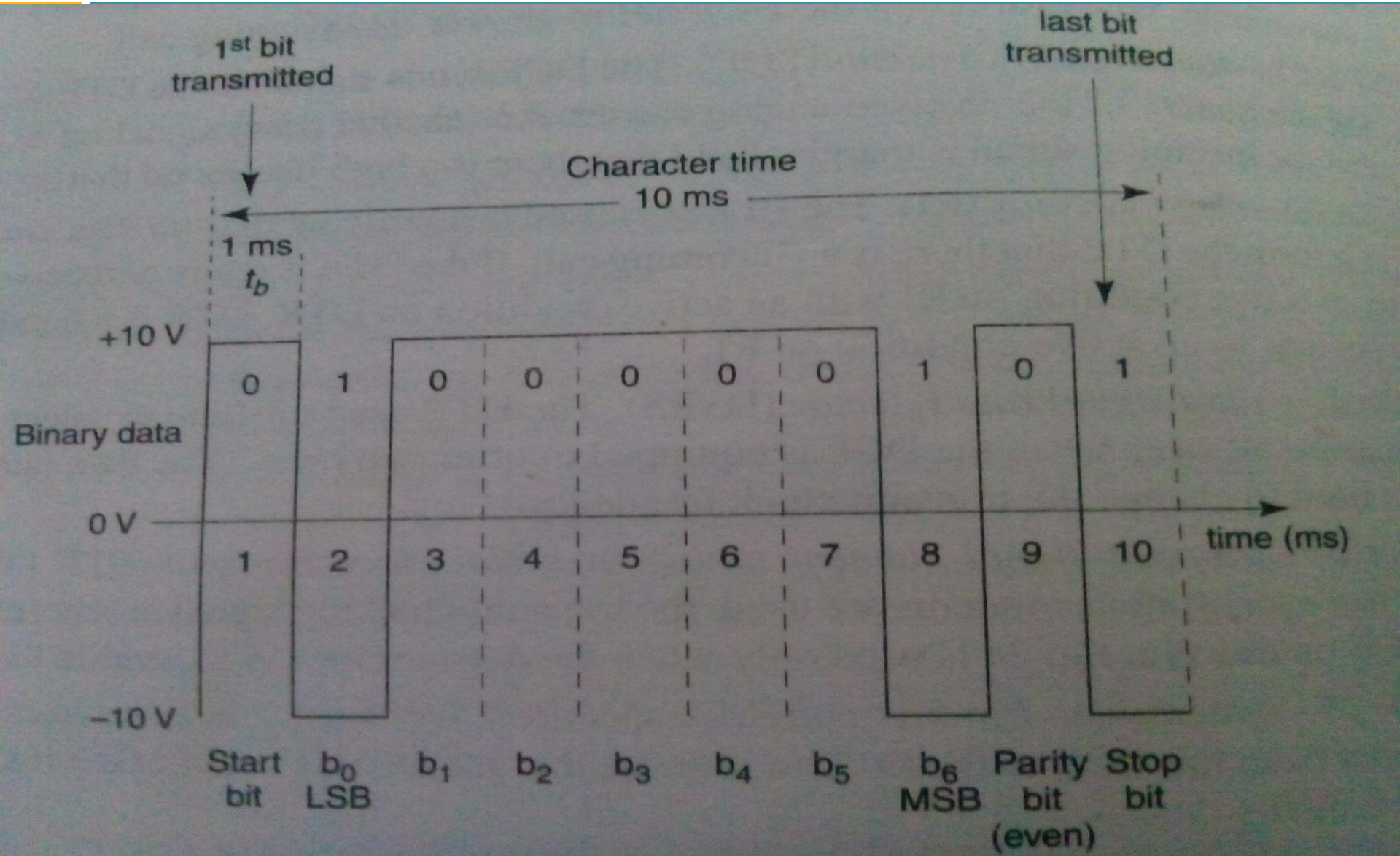
Table 22-11 EIA RS-232 Pin Designations and Designations

Pin Number	Pin Name	EIA Nomenclature	Common U.S. Acronyms
1	Protective ground (frame ground or chassis ground)	AA	GWG, FG, or CG
2	Transmit data (send data)	BA	TD, SD, TxD
3	Receive data	BB	RD, RxD
4	Request to send	CA	RS, RTS
5	Clear to send	CB	CS, CTS
6	Data set ready (modem ready)	CC	DSR, MR
7	Signal ground (reference ground)	AB	SG, GND
8	Receive line signal detect (carrier detect or data carrier detect)	CF	RLSD, CD, DCD
9	Unassigned	—	—
10	Unassigned	—	—
11	Unassigned	—	—
12	Secondary receive line signal detect (secondary carrier detect or secondary data carrier detect)	SCF	SRLSD, SCD, SDCD
13	Secondary clear to send	SCB	SCS, SCTS
14	Secondary transmit data (secondary send data)	SBA	STD, SSD, STxD
15	Transmit signal element timing—DCE (serial clock transmit—DCE)	DB	TSET, SCT-DCE
16	Secondary receive data	SBB	SRD, SRxD
17	Receive signal element timing (serial clock receive)	DD	RSET, SCR
18	Unassigned	—	—
19	Secondary request to send	SCA	SRS, SRTS
20	Data terminal ready	CD	DTR
21	Signal quality detect	CG	SQD
22	Ring indicator	CE	RI
23	Data signal rate selector	CH	DSRS
24	Transmit signal element timing—DTE (serial clock transmit—DTE)	DA	TSET, SCT-DTE
25	Unassigned	—	—

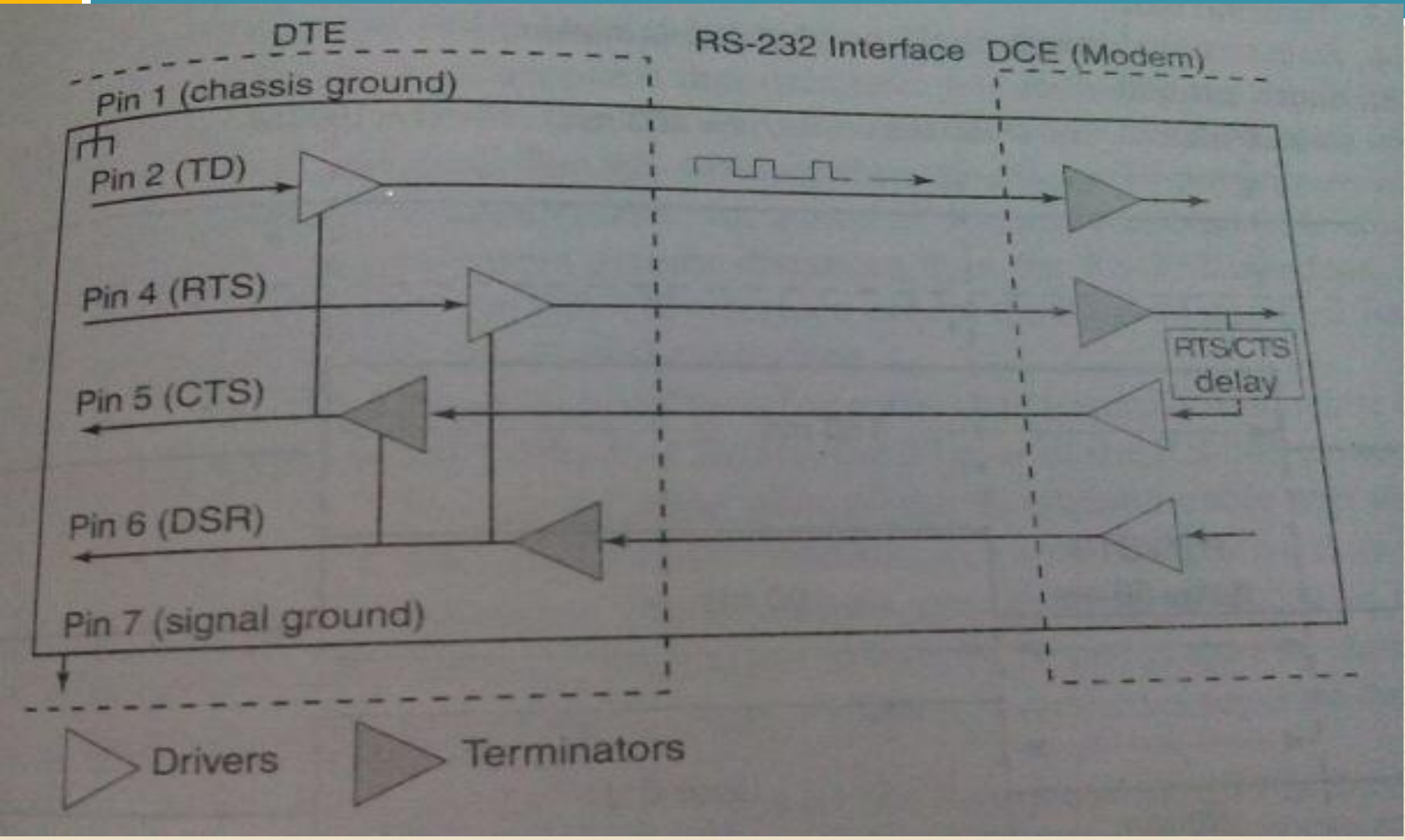
Asynchronous Data Transfer

1. Timing Diagram.
2. Transmission Circuit & Timing Diagram.
3. Reception Circuit & Timing Diagram.

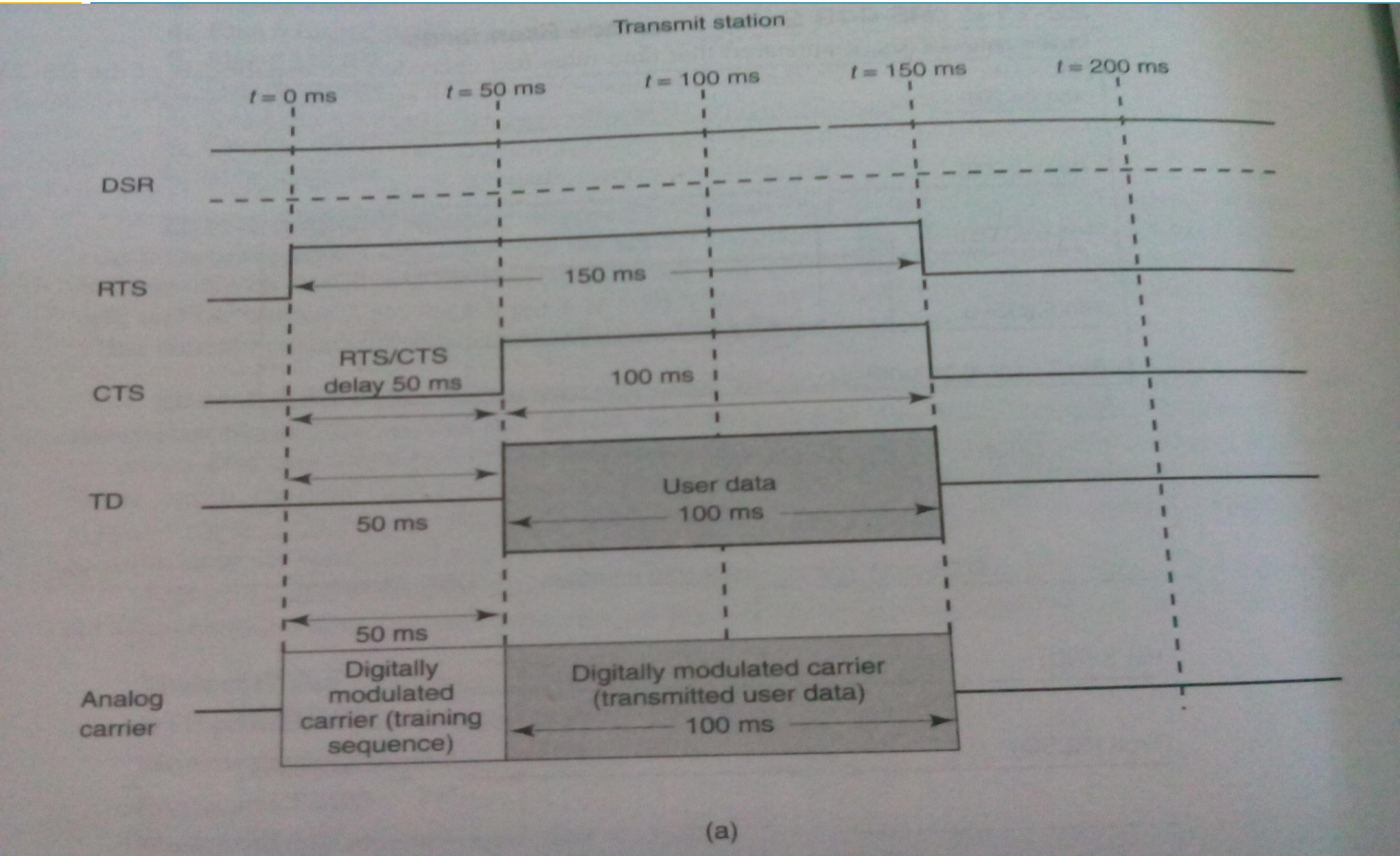
RS-232 : Timing Diagram



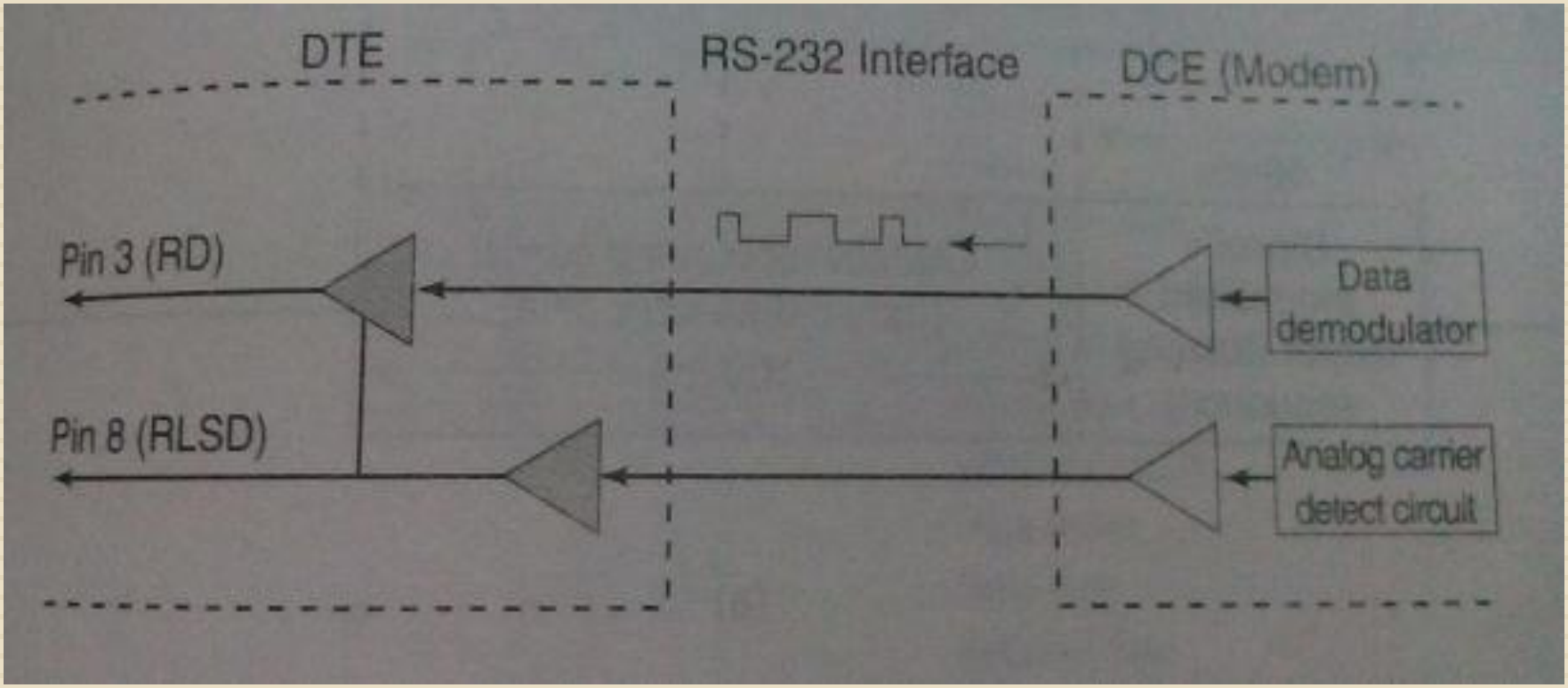
RS-232 Transmit circuit



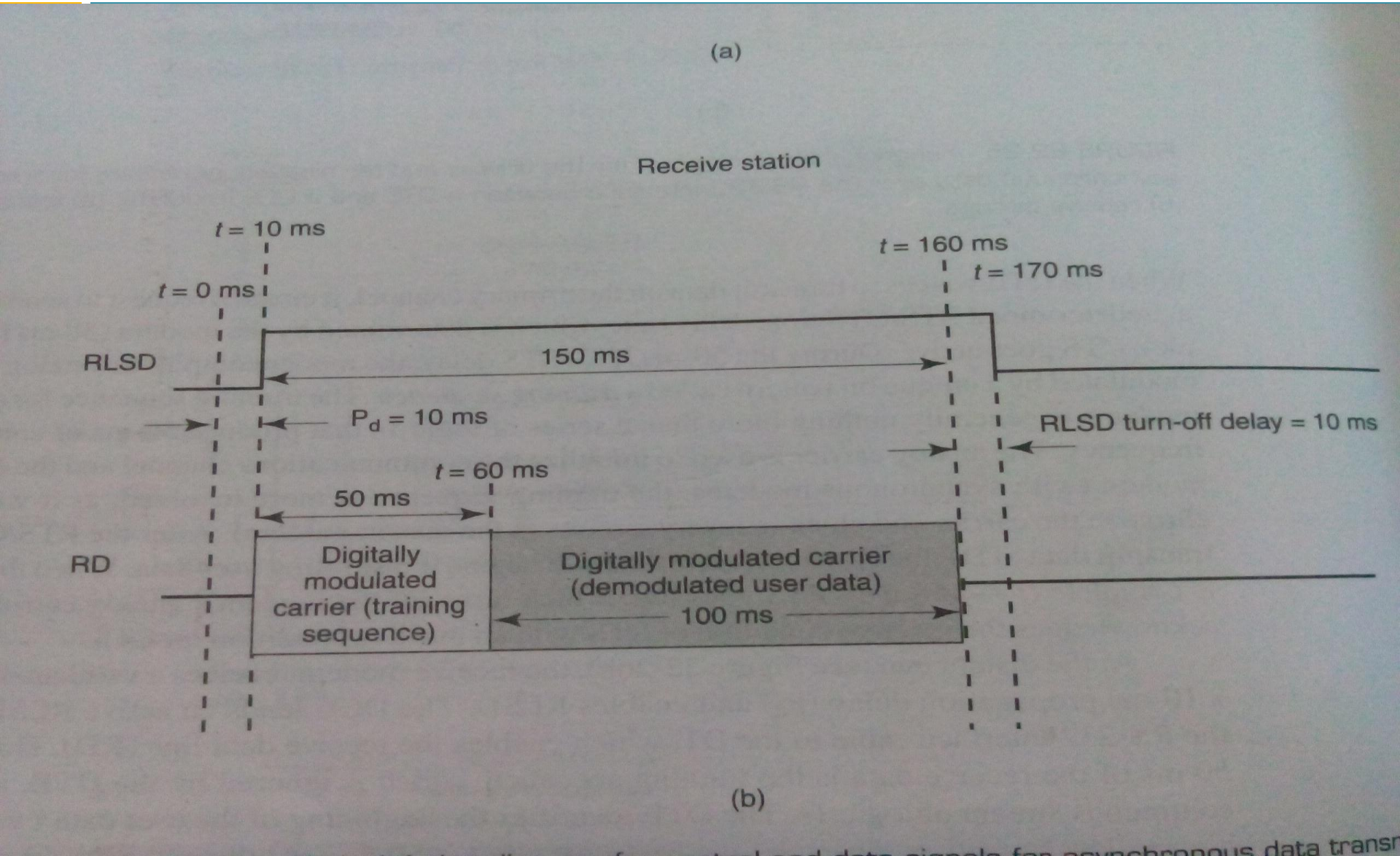
Transmit Timing Diagram



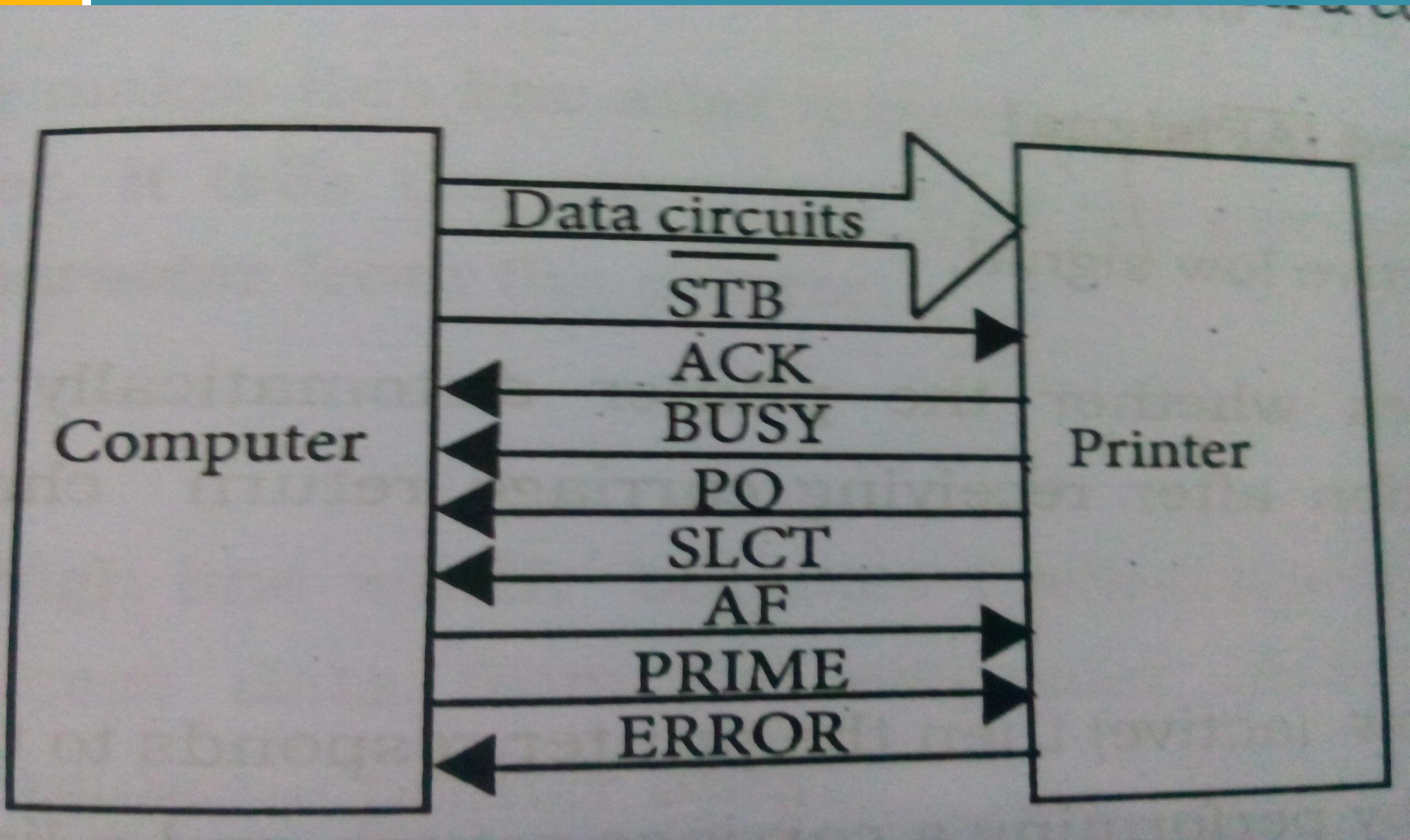
RS-232 Receive circuit



Receive Timing Diagram



Centronics Parallel Interface



Functions

- *Data Lines* – Transmission and reception of data from the computer to printer and vice-versa.
- *Control Lines* –
  - *Strobe* - -ve edge triggered, directs printer to accept data.
  - *Autofed* – active low, If active printer responds to carriage return character by performing a carriage return and linefeed.
  - *Prime* – initialize line, active low, clears printer memory.
  - *Select* – A low on this line should be seen by the printer to accept data from computer.

Functions

- Status Lines –
  - *Acknowledge* – When low, it tells the computer that the printer is ready to receive further data.
  - *Busy* – active high line, Indicates printer is busy when
    - Printer is inputting data or buffer is busy.
    - Printer is printing or processing data.
    - Printer is off or in error.
  - *Pper pot* – becomes active when the printer is out of paper.
  - *Error* – active low indicates printer problem
    - Printer is offline.
    - Printer is out of paper.
    - Some other problem

Data communication circuits

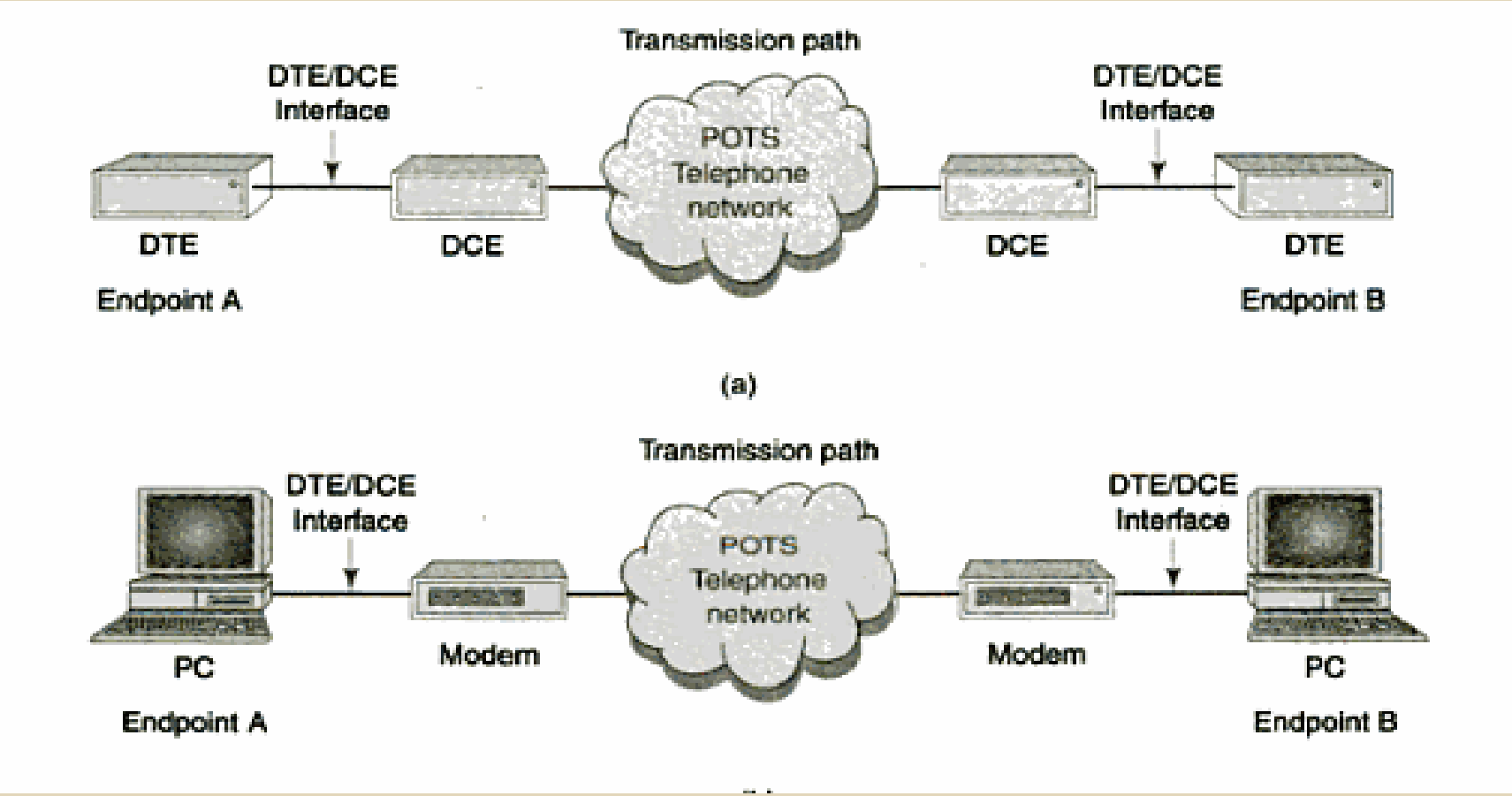
1. Data transmission types.
2. Data communication circuit configurations.
3. Topologies.

Data Transmission types

- Serial Transmission.
  - Synchronous Transmission.
  - Asynchronous Transmission.
- Parallel Transmission.

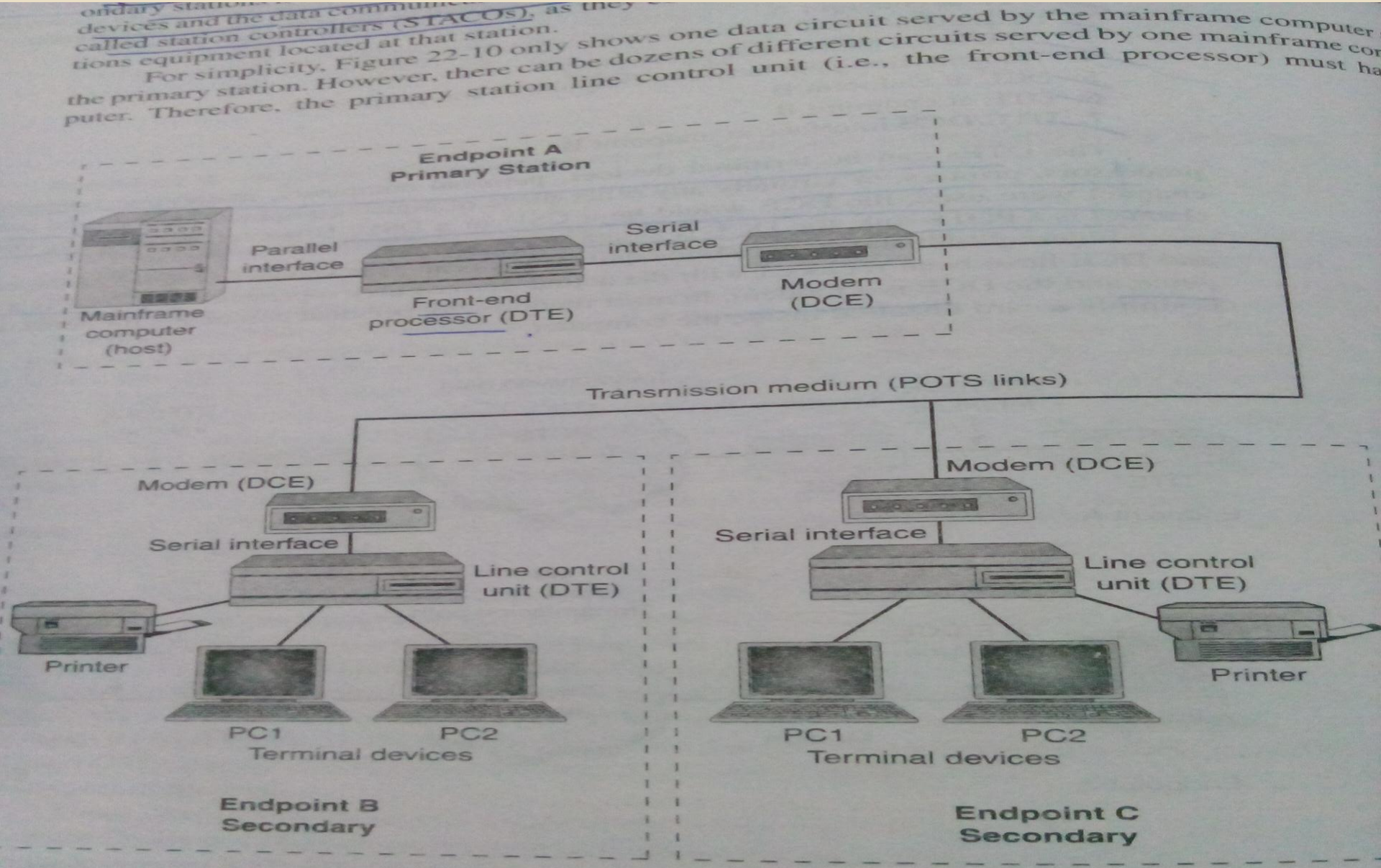
Circuit Configurations

- Point to Point Communication



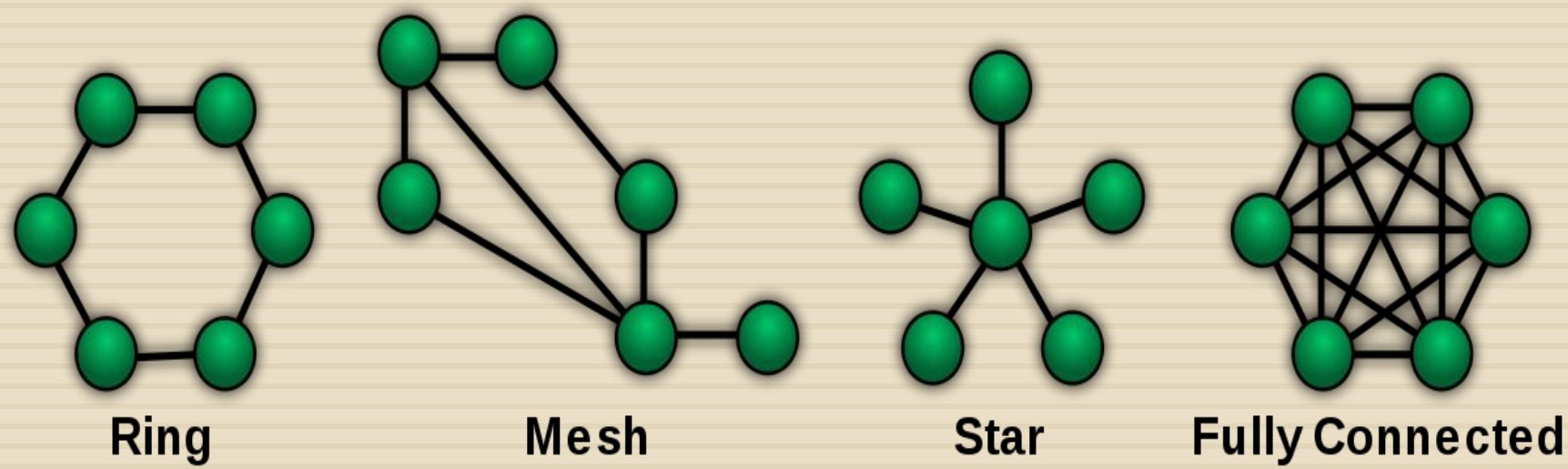
Multipoint communication circuit

devices and the data communi
called station controllers (STACOs), as the
tions equipment located at that station.
For simplicity, Figure 22-10 only shows one data circuit served by the mainframe computer
the primary station. However, there can be dozens of different circuits served by one mainframe co
puter. Therefore, the primary station line control unit (i.e., the front-end processor) must ha



GURE 22-10 Multipoint data communications circuit using POTS links

Topologies



Data Communication Codes

1. Baudot Code.
2. ASCII Code.
3. EBCDIC Code.
4. Bar Code.

Baudot Code

- First fixed length (5 bit) character code developed for machines rather than people.
- Developed by Thomas Murray
- Named after Emile Baudot, an early pioneer in telegraph printing.
- With fixed length source codes, all characters represented in binary and have same number of symbols.
- Used for low speed teletype equipment.

ASCII Code

- American Standard Code for Information Interchange.
- Defined by ANSI – 7 bit code with 128 possible combinations.
- 8^{th} bit is parity bit in MSB to detect transmission errors.
- Consists of 94 printable characters, space and del and 32 control symbols.
- Acknowledgement and –ve acknowledgement for error control.

EBCDIC Code

- Extended Binary Coded Decimal Interchange Code.
- No parity bit present in the basic code set.
- 5 bit code used for teleprinters.
- With 5 bits only 32 combinations possible but there are 58 symbols.
- Same code used for 2 symbols. Variation introduced by shift keys.
- Code normally transmitted asynchronously.

Bar Codes

- Developed in the early 1970s.
- A bar code is a series of vertical black bars separated by vertical white bars called spaces.
- Width of bars and spaces and their reflective abilities represent binary 1s and 0s.
- Combination of bits represent different items.
- Types
  - Discrete code – has spaces or gaps between characters. Each character within the code is independent of every other character. Ex: code 39.

Bar Codes

- Continous Code – No spaces between characters. Ex: Universal Product Code.(UPC)
- 2D Code – stores data in 2 dimensions.