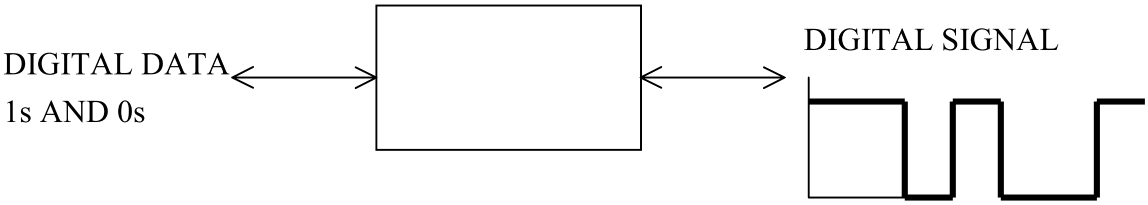
OVERVIEW

- Digital Data, Digital Signals
  -- Baseband Signals
- Digital Data, Analog Signals
  -- Modulation Techniques
- Analog Data, Digital Signals
  -- Digitization of Analog Data
- Analog Data, Analog Signals
  -- Product Modulation

PART I: DIGITAL DATA, DIGITAL SIGNALS



- User Data Is Digital

    -- Discrete Values

    -- Examples: Text and Integers

- Transmitted Signal Is Digital

    -- Discrete Levels

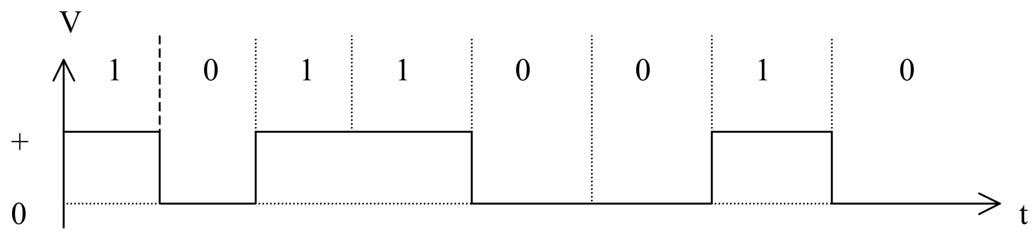
    -- Baseband Signal

BASEBAND SIGNALS

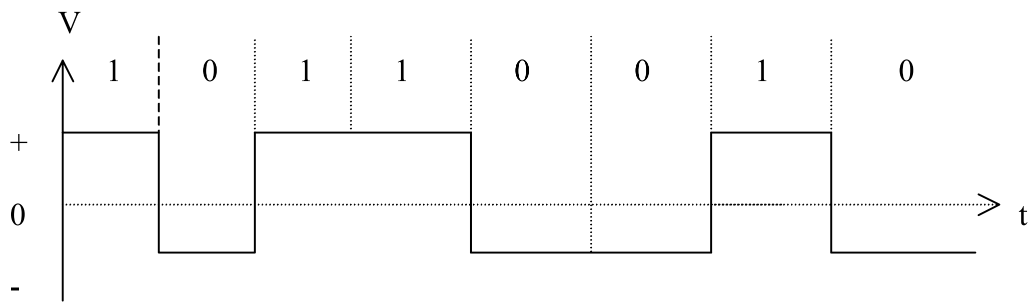
The digital signals that will be discussed in this unit are:

- Nonreturn to Zero-Level (NRZ-L)
- Polar
- Nonreturn to Zero-Inverse (NRZI)
- Bipolar Return to Zero (BPRZ)
- Pseudo-ternary
- Manchester
- Differential Manchester

NONRETURN TO ZERO – LEVEL AND POLAR SIGNALS

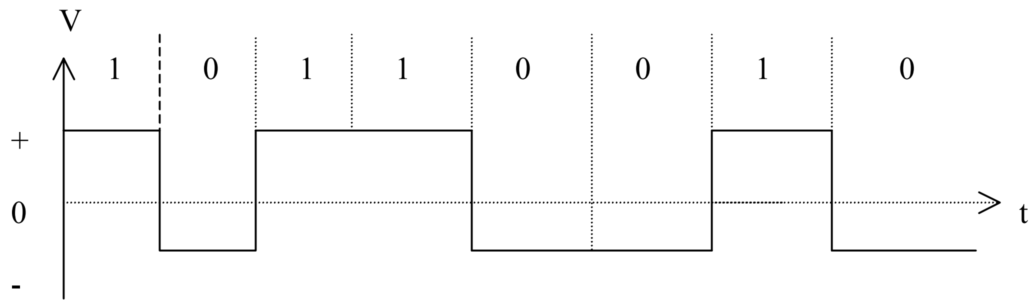


NONRETURN TO ZERO – LEVEL (NRZ-L)



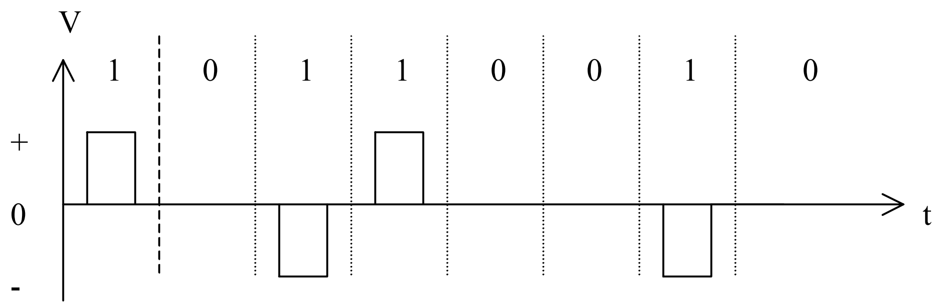
POLAR

NONRETURN TO ZERO-INVERSE SIGNAL

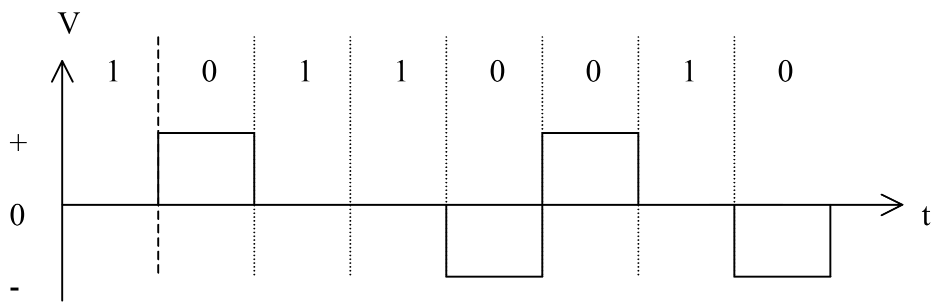


NONRETURN TO ZERO-INVERSE (NRZ-1)

BIPOLAR RETRUN TO ZERO AND PSEUDO-TERNARY SIGNALS

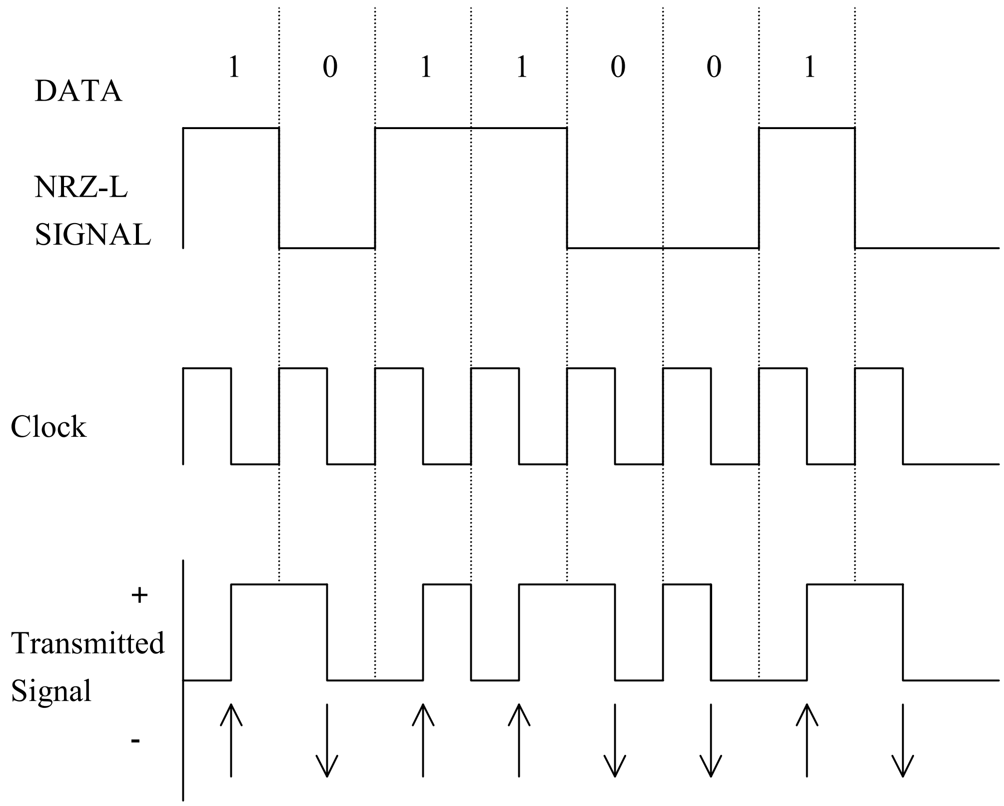


BIPOLAR RETURN TO ZERO



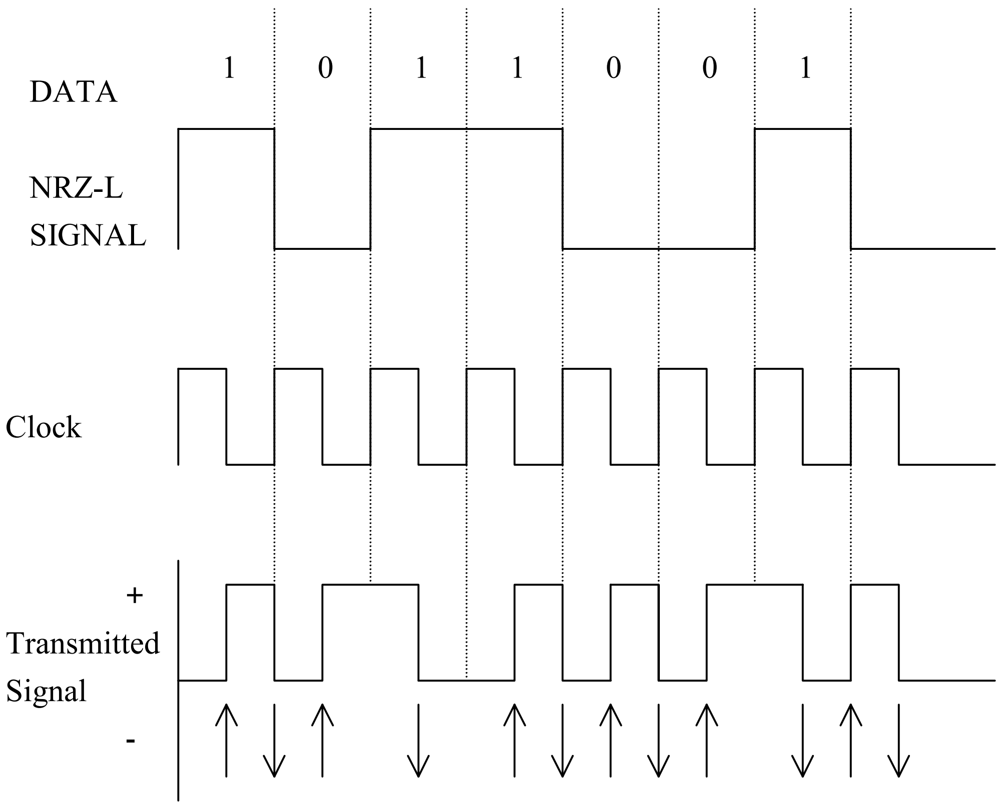
PSEUDO-TERNARY

MANCHESTER SIGNAL



- Transitions at mid-bit are for clocking and data

DIFFERENTIAL MANCHESTER SIGNAL



- TRANSITIONS
  - Mid-bit for clock only
  - Beginning of interval

    1 = no transition

    0 = transition

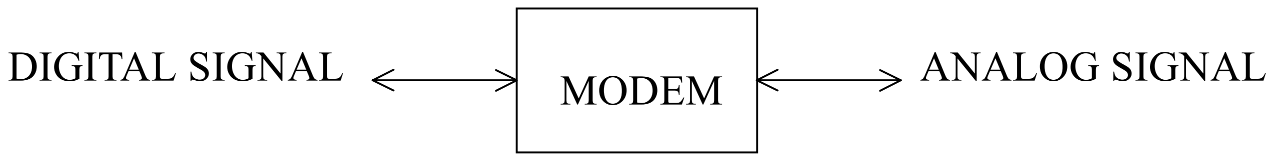
BASEBAND SIGNALS: A REVIEW

METHOD	PROPERTIES	APPLICATIONS
Nonreturn to Zero-Level (NRZ-L)	Simple, inexpensive	TTL
Polar	Simple detection of signal values	Low-speed interfaces e.g., EIA-232-D
Nonreturn to Zero- Inverse (NRZI)	Simple detection of signal values, partially self-clocking	Magnetic tape, IBM’s SNA
Bipolar Return To Zero (BPRZ)	Simple detection of signal values, partially self-clocking, no net dc bias, BPVs	T1 carrier

BASEBAND SIGNALS: A REVIEW (cont.)

METHOD	PROPERTIES	APPLICATIONS
Pseudo-Ternary	(Same as BPRZ)	ISDN
Manchester	Simple detection of signal values, fully self-clocking, error detection possible, no nit dc bias	Rotating disks; Local area networks, especially buses (e.g., Ethernet)
Differential Manchester	(Same as Manchester)	Local area networks, especially token rings

PART II: DIGITAL DATA, ANALOG SIGNALS



- User Data is Digital

  -- Represented as a digital signal

- Transmitted Signal is Analog

  -- Continuously Varying

- Modulation techniques

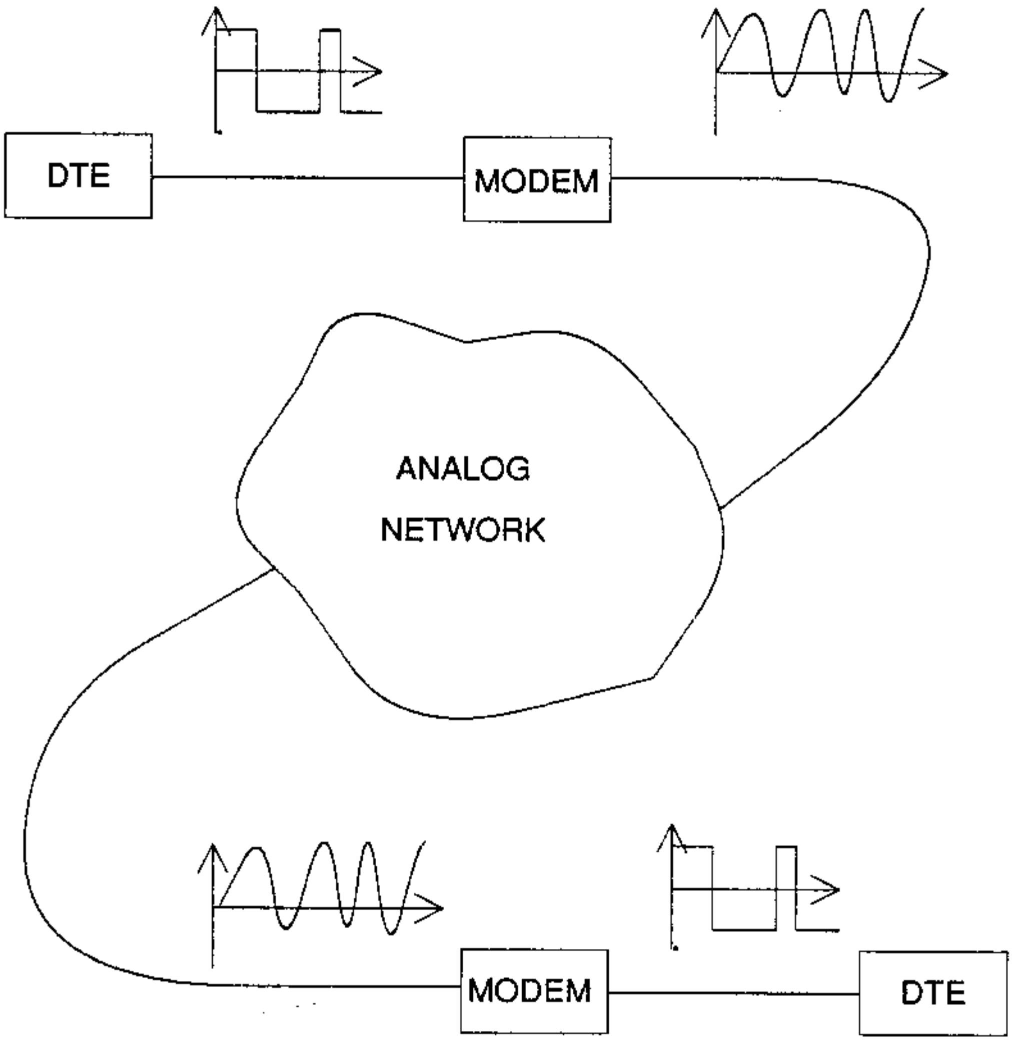
  -- Amplitude Shift Keying

  -- Frequency Shift Keying

  -- Differential Phase Shift Keying

  -- Quadrature Amplitude Modulation

ROLE OF THE MODEM IN DATA COMMUNICATIONS



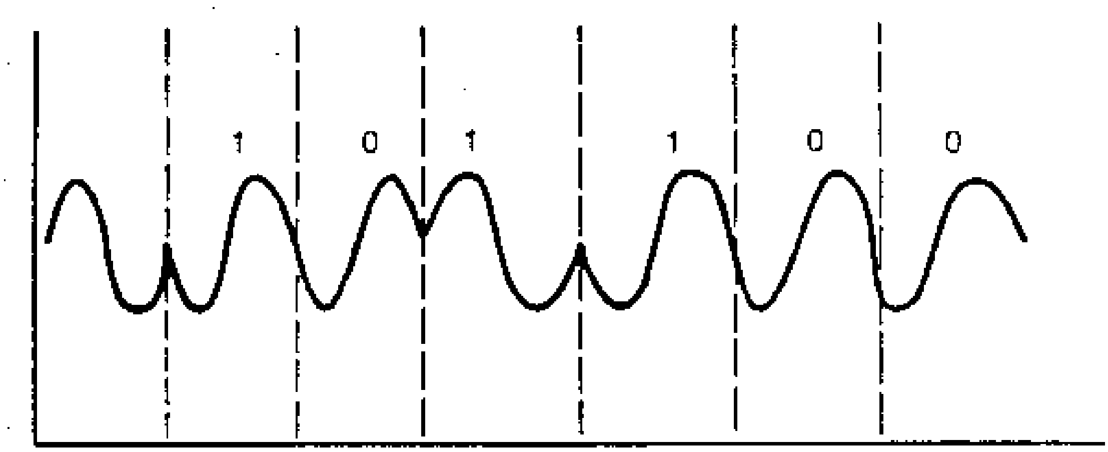
- Network Provides a Bandwidth-Limited Channel

  -- ex. Passband = 300 Hz To 3300 Hz

- Modem Allows Transmission of Digital Data in that Channel

MODEM MODULATION TECHNIQUES (cont.)

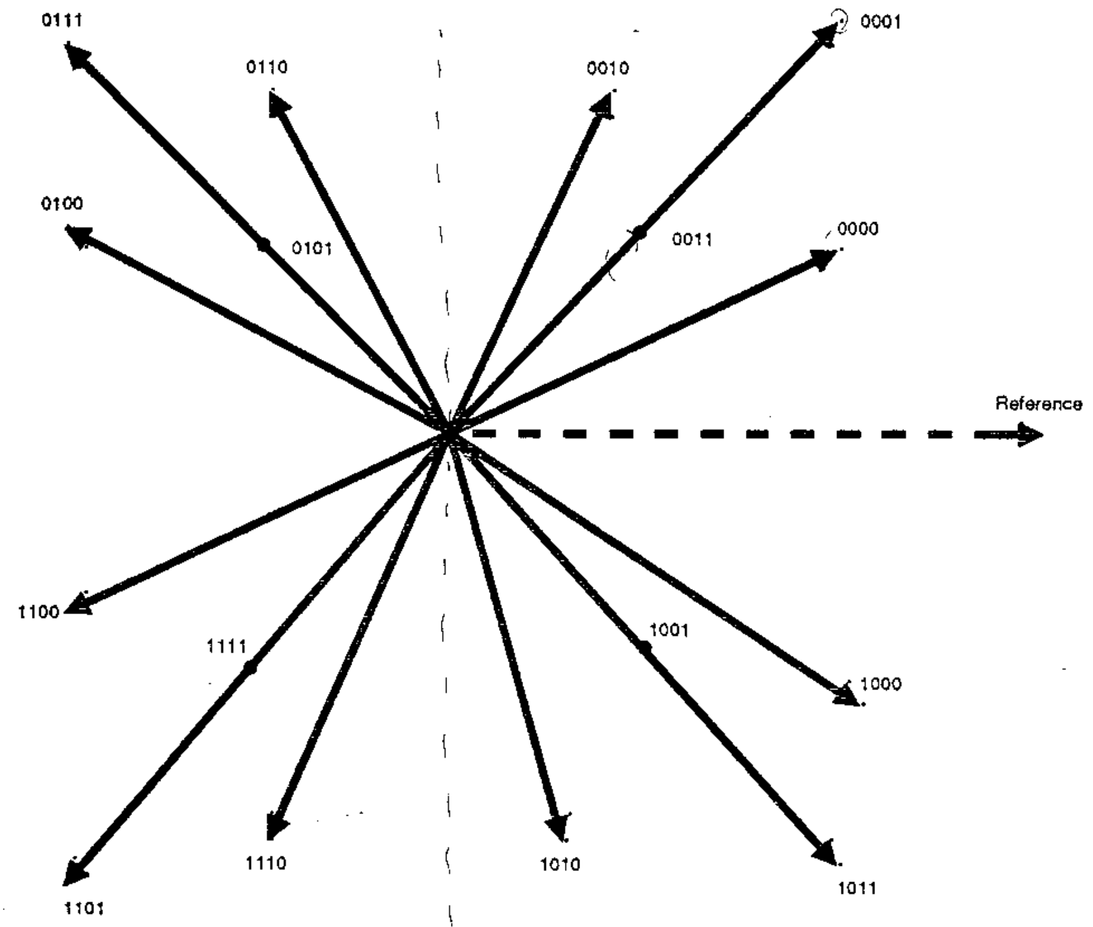
DIFFERENTIAL PHASE SHIFT MODULATION



Because the shift in phase is from the present phase rather than from an absolute standard, the procedure is called differential phase shift keying (DPSK).

MODEM MODULATION TECHNIQUES (cont.)

QUADRATURE AMPLITUDE MODULATION (QAM)

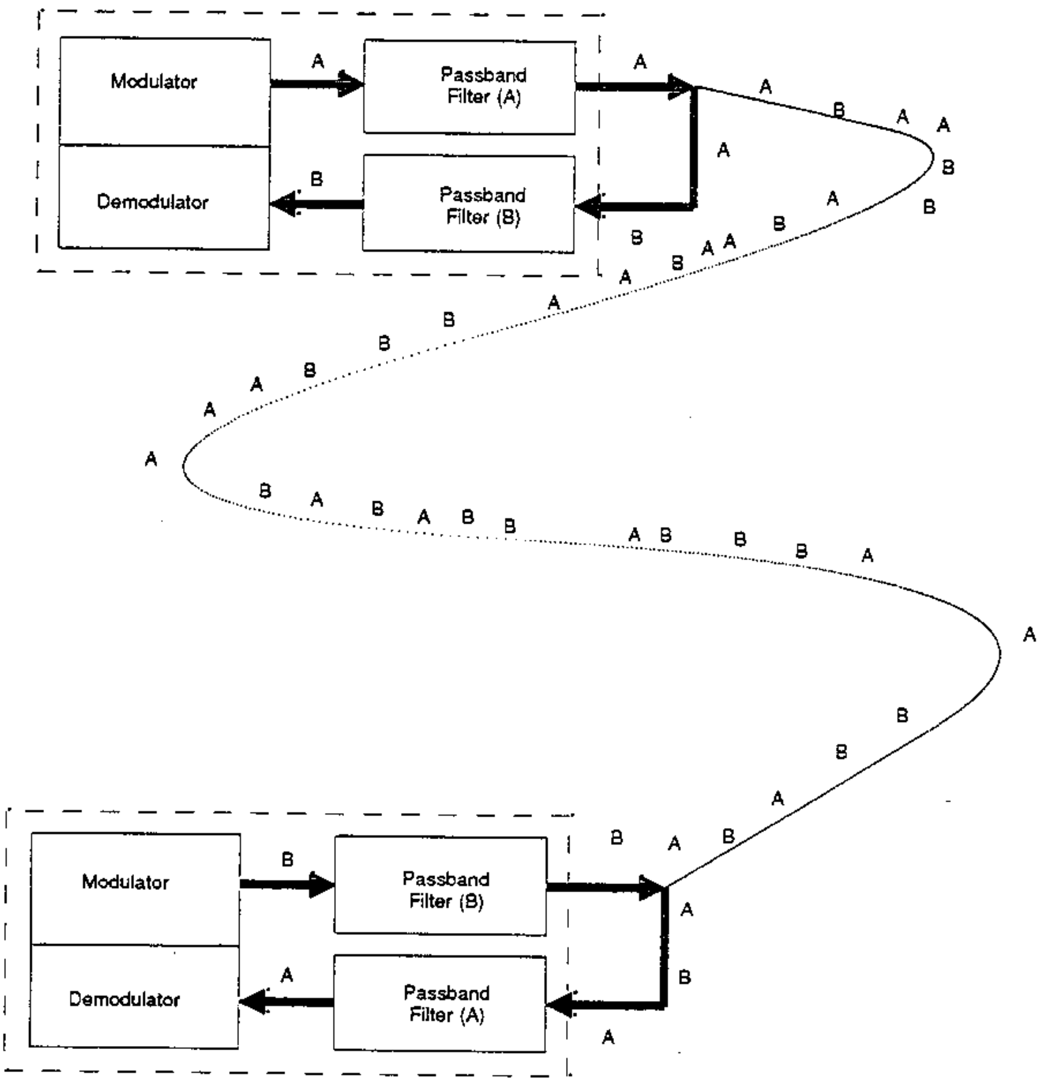


- Each arrow represents a sinusoid with a specified amplitude and phase shift.

MODULATION METHOD OVERVIEW

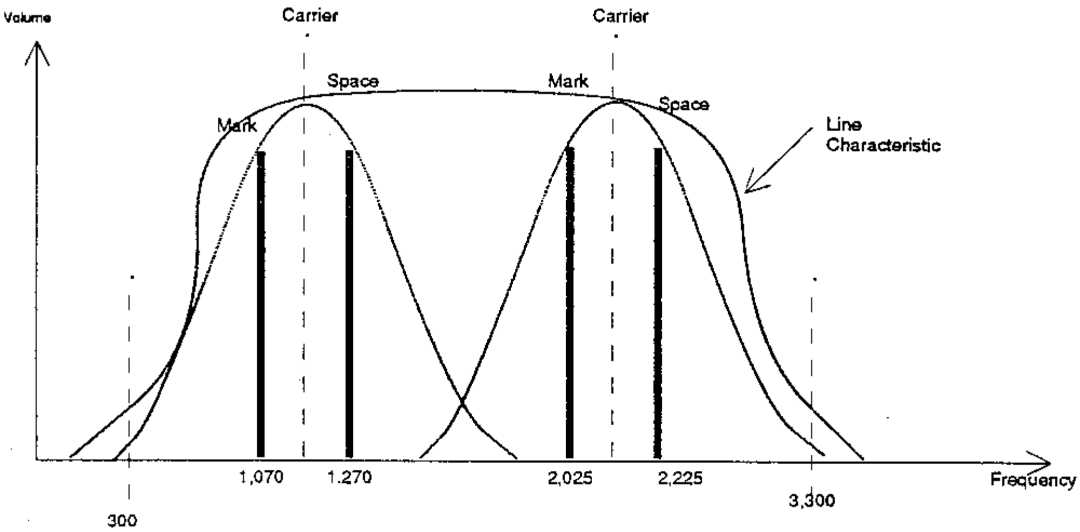
Modulation Technique	Varying parameter	Major properties	Applications
AMPLITUDE SHIFT KEYING	Amplitude	Simple, but susceptible to noise	None
FREQUENCY SHIFT KEYING	Frequency	Simple	Low speed
DIFFERENTIAL PHASE SHIFT KEYING	Phase	Self-clocking, easy to carry multiple bits/signaling elements	Moderate-speed modems
QUARATURE AMPLITUDE	Amplitude and phase	Self-clocking, error-detection possible	High speed error-checking modems

TWO-WIRE, FULL-DUPLEX OPERATION



Two-wire, full duplex operation: Signals from both ends coexist on the loop, but filters assure that only the correct signals are received.

FSK MODEM



Bell 103FTM STANDARD-300-baud full-duplex modem (data set).

ADDITIONAL MODEM FEATURES

- Echo Cancellation
  - -- Provides high-speed, full duplex communication over a two-wire path
  - -- Used in V.26*ter* and V.32 Modems

- Fallback Speeds
  - -- For use on noisy lines
  - -- Typical fallback speed is one-half maximum bit rate

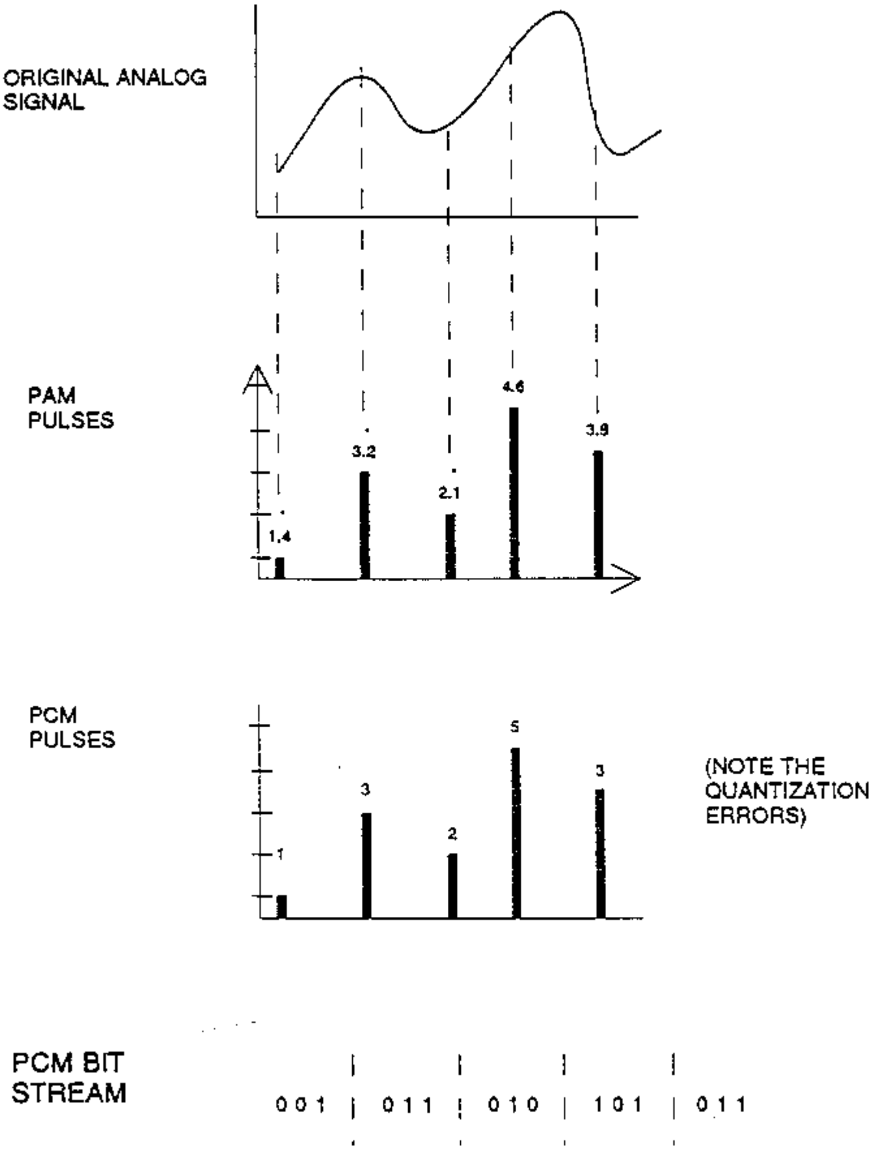
PART III: ANALOG DATA, DIGITAL SIGNALS

- User Data Is Analog
  - -- Represented as an analog signal
  - -- Examples: Voice and Video

- Transmitted Siganl Is Digital
  - -- Digitization of Analog Data

- Digitization Techniques
  - -- Pulse Amplitude Modulation
  - -- Pulse Code Modulation

PULSE AMPLITUDE MODULATION (PAM) AND PULSE CODE MODULATION (PCM)



NYQUIST'S SAMPLING THEOREM

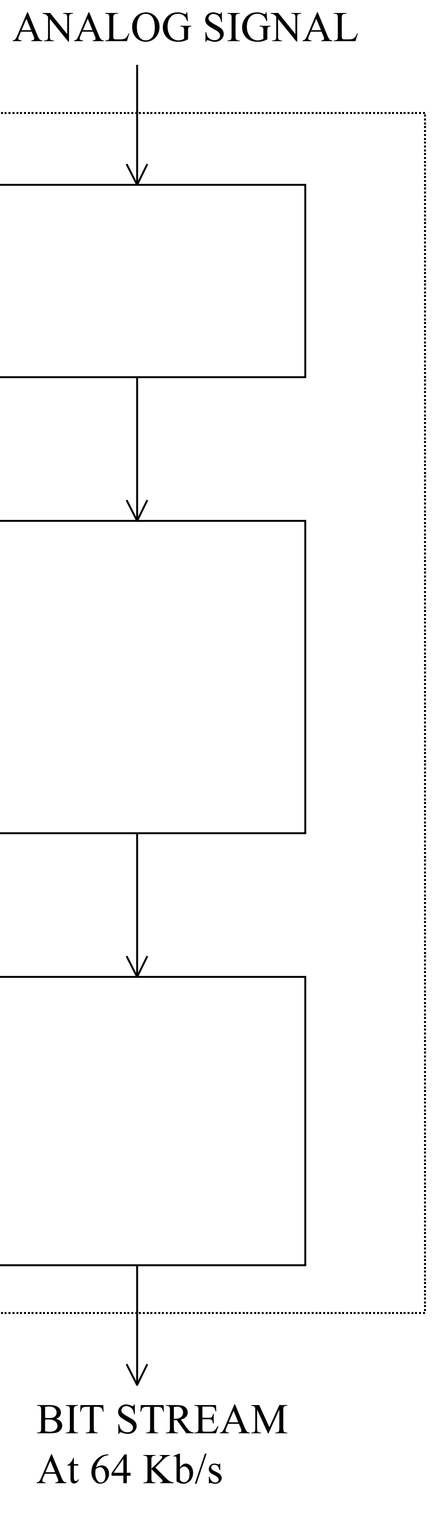
- Sampling Rate of Analog Signal Is Critical

- Nyquist's Sampling Theorem:
  - -- Sample Analog Signal at Regular Intervals

  - -- Sampling Rate $\geq$ 2 x (Highest Frequency)

  - -- Samples Will Contain All Information of Original Signal

TRANSMIT CODEC BLOCK DIAGRAM

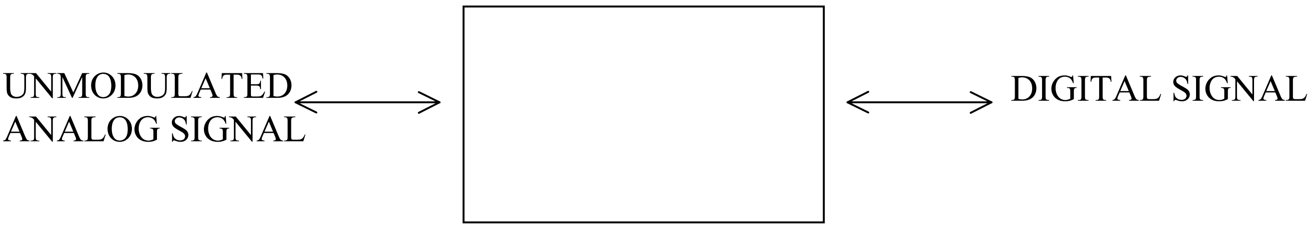


SPEECH CODING TECHNIQUES

TECHNIQUE	BIT RATE Kb/s	QUALITY
Pulse-Code Modulation	64	High
Adaptive Differential Pulse-Code Modulation	32	High
Adaptive Subband Coding	16	High
Multipulse Linear-Predictive Coding	8	Communication
Stochastically Excited Linear-Predictive Coding	4	Communication
LPC Vocoder	2	Synthetic

Note: Communication Quality
-- Distortion present but not obvious
-- Intelligibility very high

PART IV: ANALOG DATA, ANALOG SIGNALS



- User Data Is Analog
  - -- Represented as an unmodulated analog signal
  - -- Examples: Voice and Video

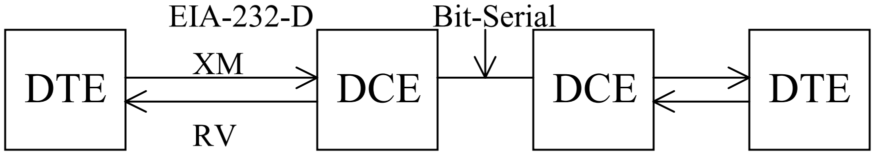
- Transmitted Signal Is a Modulated Analog Signal

- Motivation:
  - -- Effective transmission may require a higher frequency (e.g., unguided transmission)
  - -- Permits frequency division multiplexing

PHYSICAL INTERFACE STANDARD

- A physical interface standard specifies:
  - -- Electrical properties
  - -- Mechanical properties
  - -- Function of each interchange circuit
  - -- Interactions between devices
  - -- Subsets of leads for specific uses

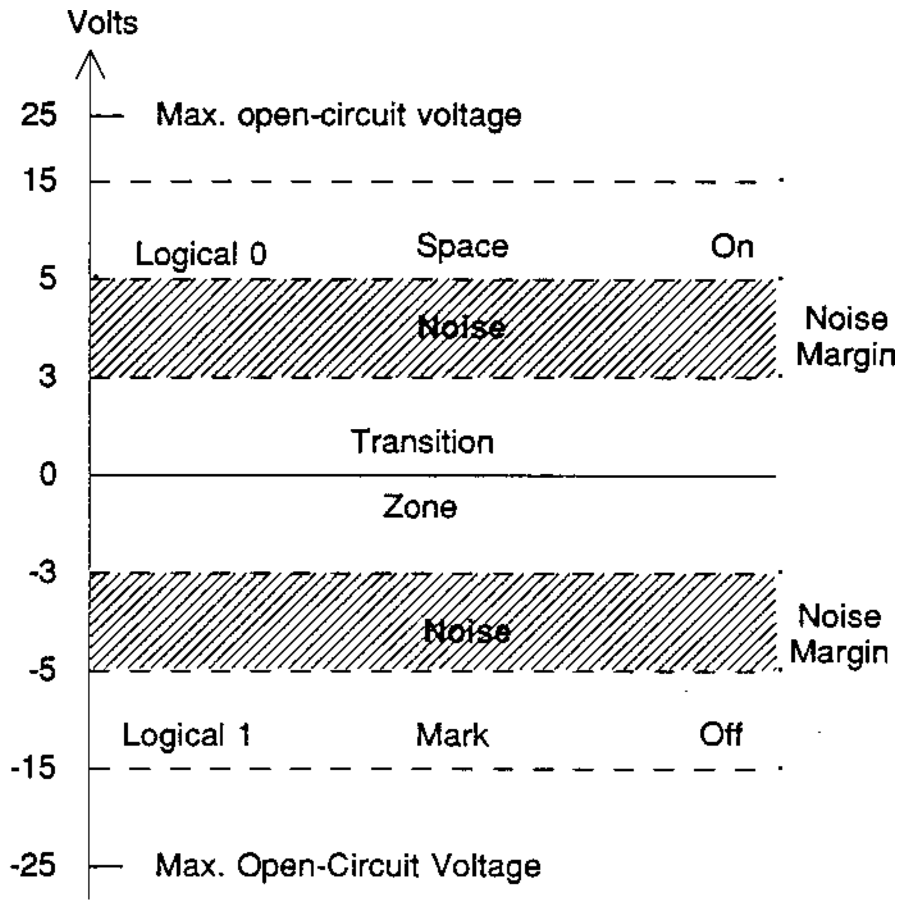
- EIA-232-D
  - -- Physical interface standard
  - -- Specifies DTE – DCE interface
  - -- Serial transmission



OVERVIEW OF THE EIA-232-D ELECTRICAL SPECIFICATION

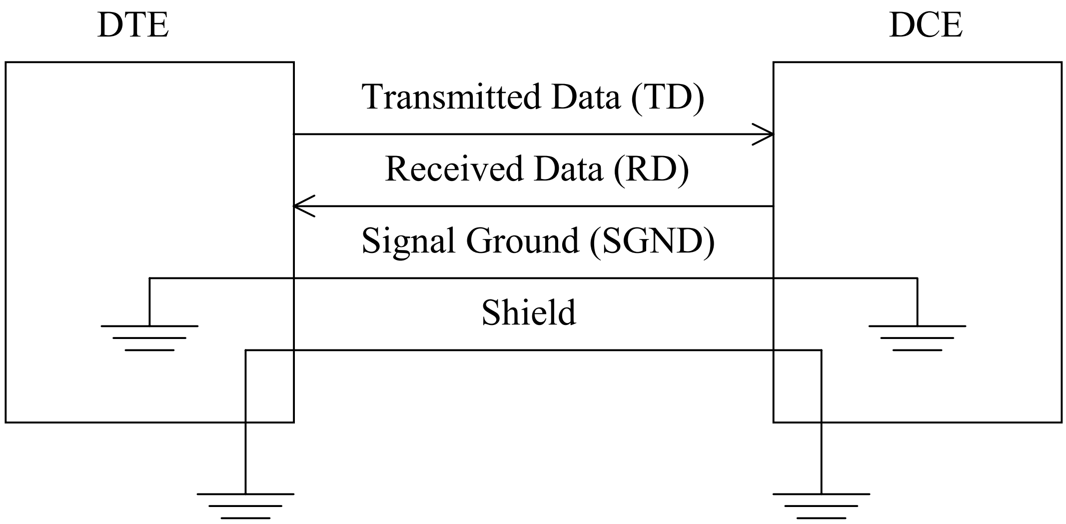
- Maximum Open-Circuit Voltage: ± 25V
- Maximum Short-Circuit Current: ± 0.5A
- Driver Slew Rate: dv/dt < 20 V/*u*s
- Maximum Capacitance: 2,500 pf
- Maximum Distance: 50 Feet
- Maximum Data Rate: 20,000 bps
- Polar Signaling

EIA-232-D VOLTAGES



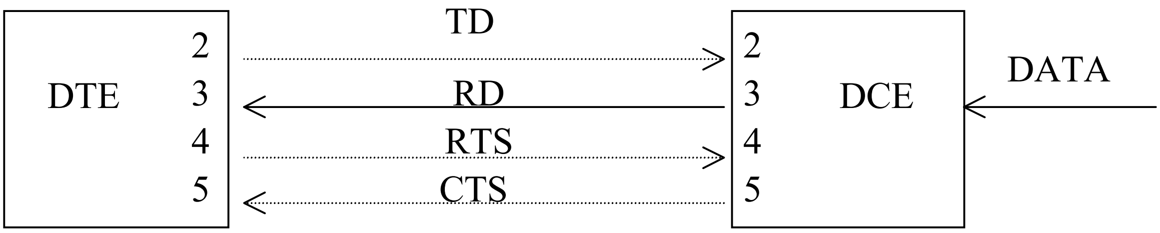
EIA-232-D INTERCHANGE CIRCUITS

- Data transfer and grounds

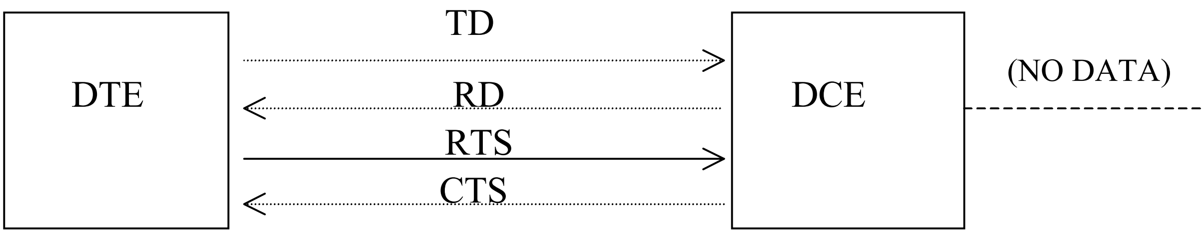


EIA-232-D INTERCHANGE CIRCUITS (cont.)

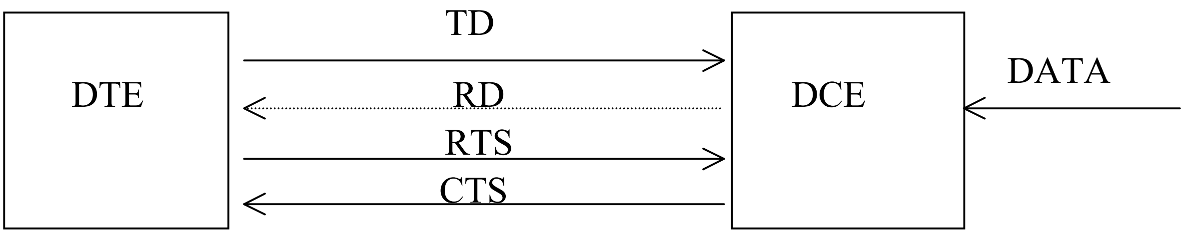
• HALF-DUPLEX APPLICATION



A) DTE RECEIVING DATA



B) DTE INVOKES RTS LEAD DCE "TURNS THE LINE" AROUND FOR TRANSMISSION



C) DCE RAISES THE CTS LEAD "PERMISSION GIVEN TO TRANSMIT"

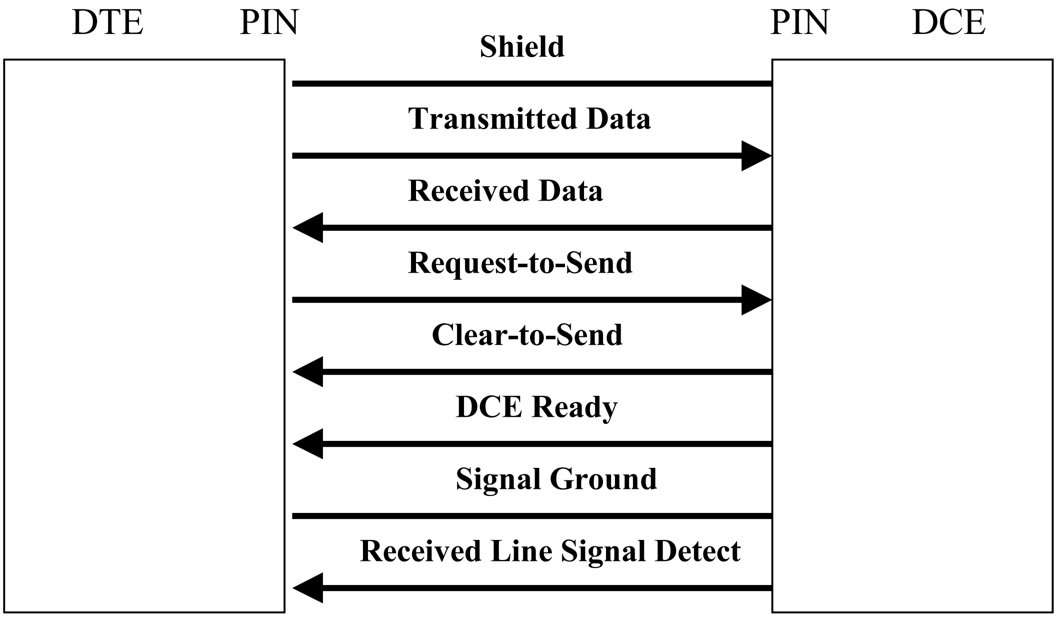
KEY

——— LINE IN USE

········· LINE NOT IN USE

EIA-232-D INTERCHANGE CIRCUITS (cont.)

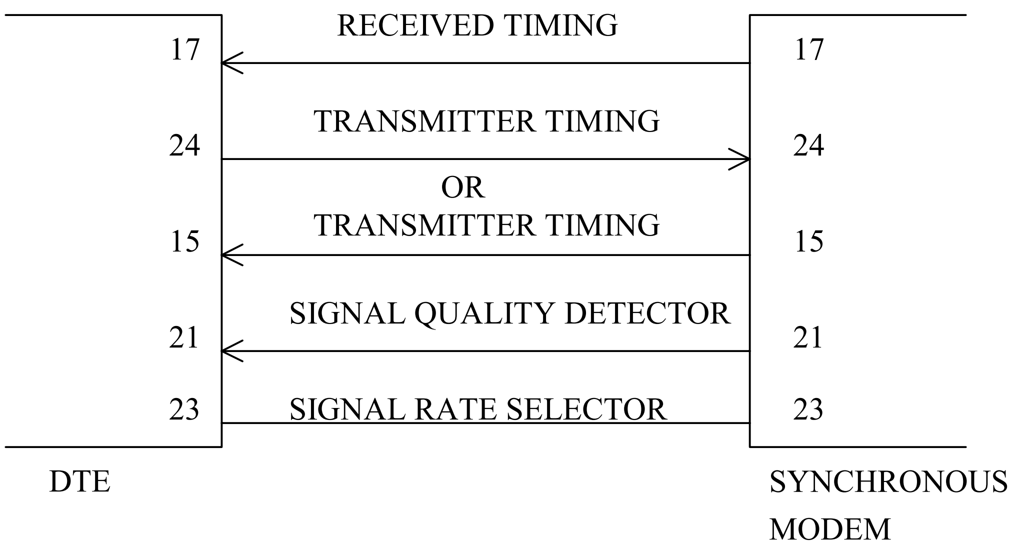
- Connections required for asynchronous leased-line application



DCE READY: In switched phone line means
"I am connected to the line"

EIA-232-D INTERCHANGE CIRCUITS (cont.)

- Additional connections required for synchronous modems



ASYNCHRONOUS NULL MODEM WIRING DIAGRAM

DTE – DTE Connection