DEVICES AND COMMUNICATION BUSES FOR DEVICES NETWORK– Lesson-4: RS232C and UART COMMUNICATION

Exemplary Protocol – RS232C

- For asynchronous communication between two data serial links on a network ─ Between a data communication equipment and data terminal equipment
- RS232C ─ a standard protocol used in IBM PC COM ports, keyboard, computer-mice and
- For the data serial link network in UART bit format

DTE and DCE

- RS232C communication is between a DTE (computer) COM (communication) port and a DCE (modem) port.
- DTE stands for 'Data Terminal Equipment'.
- DCE stands for 'Data Communication Equipment'.
- RS232C is a standard for interfacing signals between DCE and DTE.

Sequence of serial bits in an RS232C Byte

- Data Bits─ RxD and TxD lines
- As per UART standard formats on RxD and TxD lines

Voltage Levels at TxD and RxD lines in RS232C

- logic 1—Receiver end voltage level
  from – 3 V to – 25 V
- logic 0 — Receiver end voltage level
  from + 3 V to + 25 V
- logic 1— Transmitter end voltage level
  from – 5 V to – 15 V
- logic 0 — Transmitter end voltage level
  from + 5 V to + 15 V
- opposite to that of TTL logic
- wider noise margin to enable long distance communication

RS232C Connector

- 9 pin and 25-pin in case of IBM COM port
- Can be simpler

Handshaking signals on 9 Pin connector

- Handshaking signals– RI, DCD, DSR, DTR, RTS, CTS, DTR

Voltage levels at Handshaking signals

- TTL standard

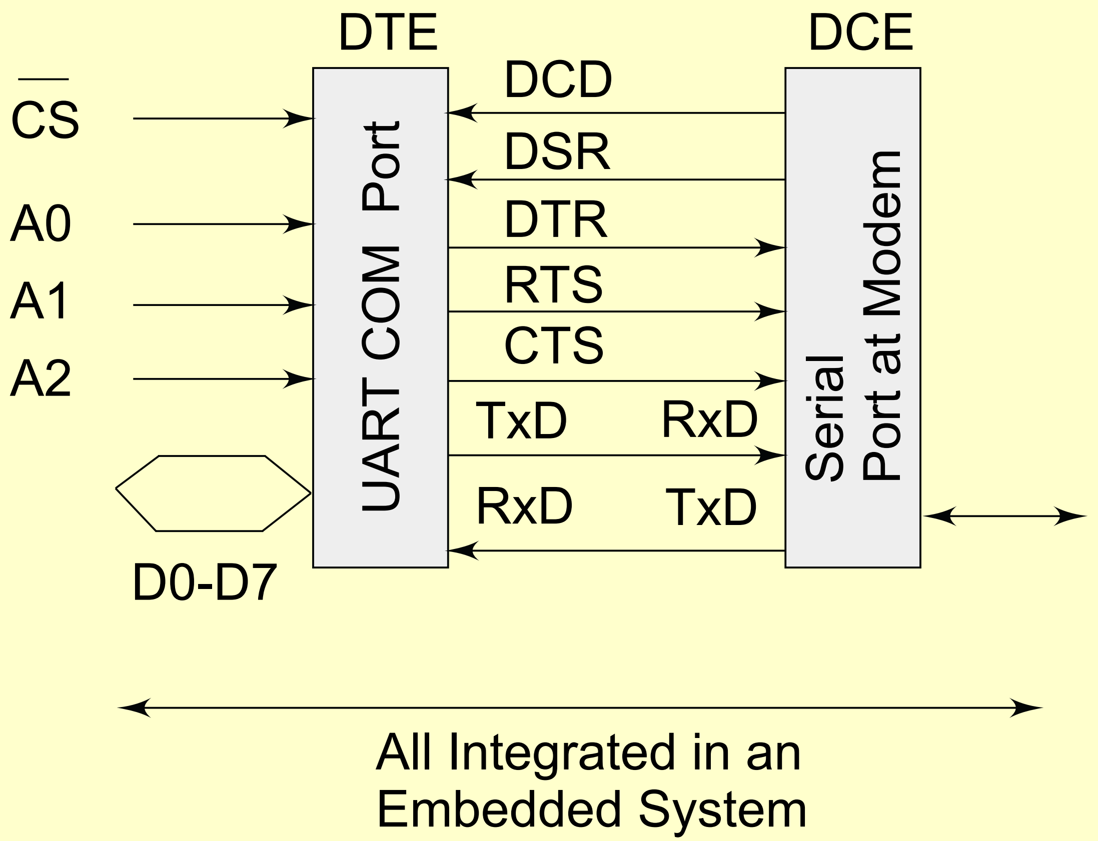
Example: 9-pin Connector Handshaking signals

- RI to indicate ring available at data communication equipment receiving end
- When a modem connects, modem sends *data carrier detect* DCD signal at an instance t0.
- Communicates *data set ready* (DSR) signal at an instance t1 when it receives the bytes on the line.
- Receiving end responds at an instance t2 by data terminal ready (DTR) signal.

Example: COM port and Modem Handshaking signals

- After DTR, *request to send* (RTS) signal is sent at an instance t3
- Receiving end responds by *clear to send* (CTS) signal at an instance t4. After the response CTS, the data bits are transmitted by modem from an instance t5 to the receiver terminal.
- Between two sets of bytes sent in asynchronous mode, the handshaking signals RTS and CTS can again be exchanged. This explains why the bytes do not remain synchronized during asynchronous transmission.

RS232C port at DTE and DCE handshaking and data Signals



RS232C port in a computer

- Used up to 9600 baud per s asynchronous serial transmission rate with UART mode communication.
- Generally baud rates set at 300, 600, 1200, 4800 and 9600.
- When transmitting upto 0.25 m or 1 m on cable (untwisted) the maximum baud rate can be 115.2 k or 38.4k baud per s, respectively

RS232C port for keyboard serial communication

- Communication at 1200 baud per s asynchronous serial transmission rate with UART mode communication at IBM PC COM port.
- The signals used are RTS, CTS, TxD and RxD for keypad communication.

A mice port RS232C COM in the computer

- A mice port can also be RS232C COM port in the computer (Alternative USB)
- Handshaking bits are RTS, CTS and data bits are at TxD
- Draws power from RTS and ground line
- Voltage levels: TTL logic 1 derived from RTS line itself ground

COM Port Emulation

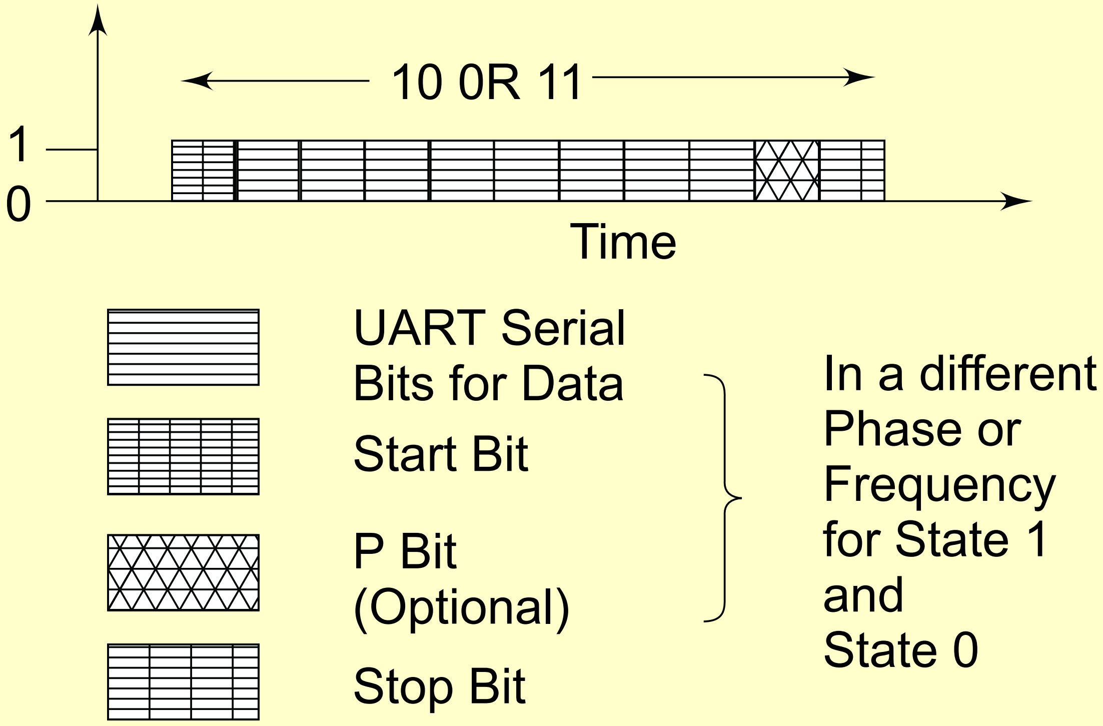
- Assume a mobile smart phone Bluetooth device for personal area wireless network.
- Bluetooth device protocol provides for emulation as DCE serial port, which can now communicate in UART mode – When computer on the other hand has a serial port called COM port (Example 3.1)

Mobile device placed on a cradle

- . The mobile device port data-pins connects the cradle pins. The cradle connects the computer or laptop COM port.
- The mobile emulated COM Bluetooth and computer serial port communicate. The data (for example, pictures or address book data) between them synchronizes between COM and emulated Bluetooth serial device ports

2. UART

UART Bits



UART Serial Bits for Data

Start Bit

P Bit (Optional)

Stop Bit

In a different Phase or Frequency for State 1 and State 0

Idle State

- A line— non-return to zero (NRZ) state. It means in idle state the logic state is 1 at the serial line.

Byte start signaling flag bit

- Compulsory- Start bit 1 to 0 transition, which receiver detect at the middle of bit interval T [T^{-1} = prefixed baud rate.]

Data bits

- After start bit; *8* bits transmitted on TxD line and received on RxD line during period of 8 T (receiver detect at the middle of each bit interval T), In earlier circuits, the number of data bits could also be set 5, 6 or 7 in place of 8
- Full or half duplex

Address bits for destination

- Not provided
- Can be indirectly sent by setting a programmable bit P = 0 or 1 as per receivers’ processing circuit or programming

Control or error detect bit

- One bit- P-bit optional
- Present in 11T mode
- P bit can be used to detect parity error
- P-bit can be used to interpret the preceding byte not as data but as address or command or parity as per the processing circuit for serial bits at receiver

Byte end flag bit

- Compulsory- Minimum one stop bit at Logic 1 [In earlier circuits, the number of stop bits could also be set 1½ or 2 in place of 1]

Disconnected State

- Zero (Z) state
- Disconnected serial line logic state is 0

UART 8250

- UART 8250 includes a 8-bit one byte buffer only and was used earlier in original IBM PC COM port, which had 8-bit register UART port and did not include any FIFO buffer for the receiving or transmitting bytes.

UART 16550

- UART 16550 includes a 16-byte buffer and is nowadays used more commonly as compared to earlier original IBM PC COM port, which had 8-bit register UART port, was based on 8250 and did not include FIFO buffer.

Multi-processor communication using UART mode from SI in 8051

- TTL logic 1 and 0
- No handshaking signals

Summary

We learnt

- RS232C serial port_communication usually in UART 10-bits or in 11-bits format full duplex using TxD and RxD lines
- RS232C voltage levels for 0 and 1 opposite to that of TTL logic, Opposite to that of TTL logic, wider noise margin to enable long distance communication
- Handshaking signals– RI, DCD, DSR, DTR, RTS and CTS

We learnt

- 9 or 25 pin connector at IBM PC COM ports using RS232C standard
- UART serial port_communication is usually either in 10-bits or in 11-bits format:
- one start bit, 8 data bits, one optional bit (P-bit) and one stop bit.
- UART communication can be full or half duplex using TxD and RxD lines

End of Lesson 4 of Chapter 3