EEE 410 – Microprocessors I

Spring 04/05 – Lecture Notes # 19

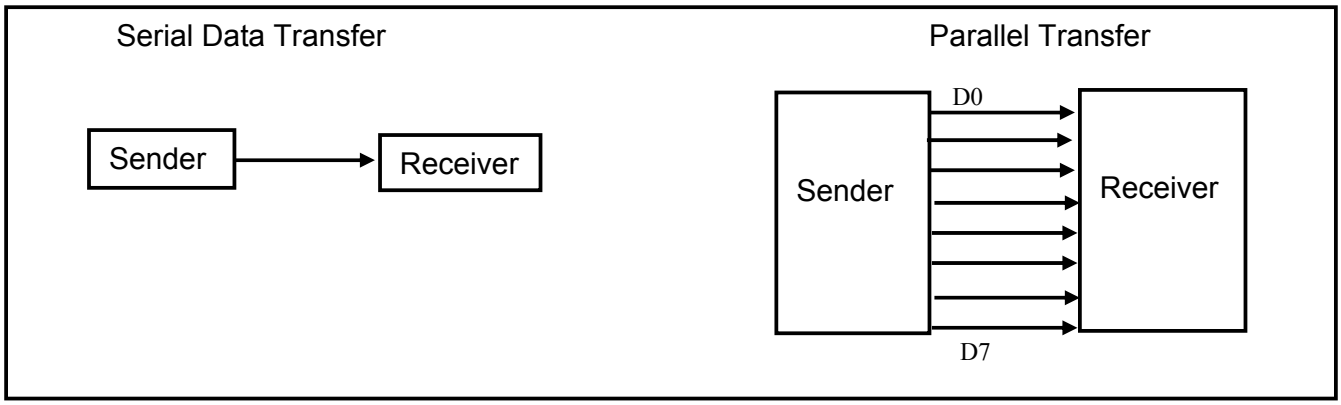
Outline of the Lecture

- **Interfacing the Serial Port**
- **Basics of Serial Communication**
- **Asynchronous Data Communication and Data Framing**
- **RS232 and other Serial I/O Standards**

BASICS OF SERIAL COMMUNICATION

- Computers transfer data in two ways: parallel and serial.

  - Parallel communication is fast and efficient. In parallel communication 8 or more lines (wire conductors) are used to transfer data to a device that only a few feet away. (e.g. printers, hard disks etc.)
  - Parallel communication provides much faster transfer of data with compared to serial communication.
  - However for long distances the number of wires required as well as the distortion on the signals in parallel wires makes parallel communication for long distances not reliable. Also the synchronization of the parallel signals is a big problem.
  - Serial communication sends 1 bit at a time, so it is slower with compared to parallel communication.
  - For long distances serial communication provides robust way of data transfer. Because there is no problem of synchronization.
  - Serial communication requires less number of wires for communication. Serial communication is used in modems, keyboards etc.



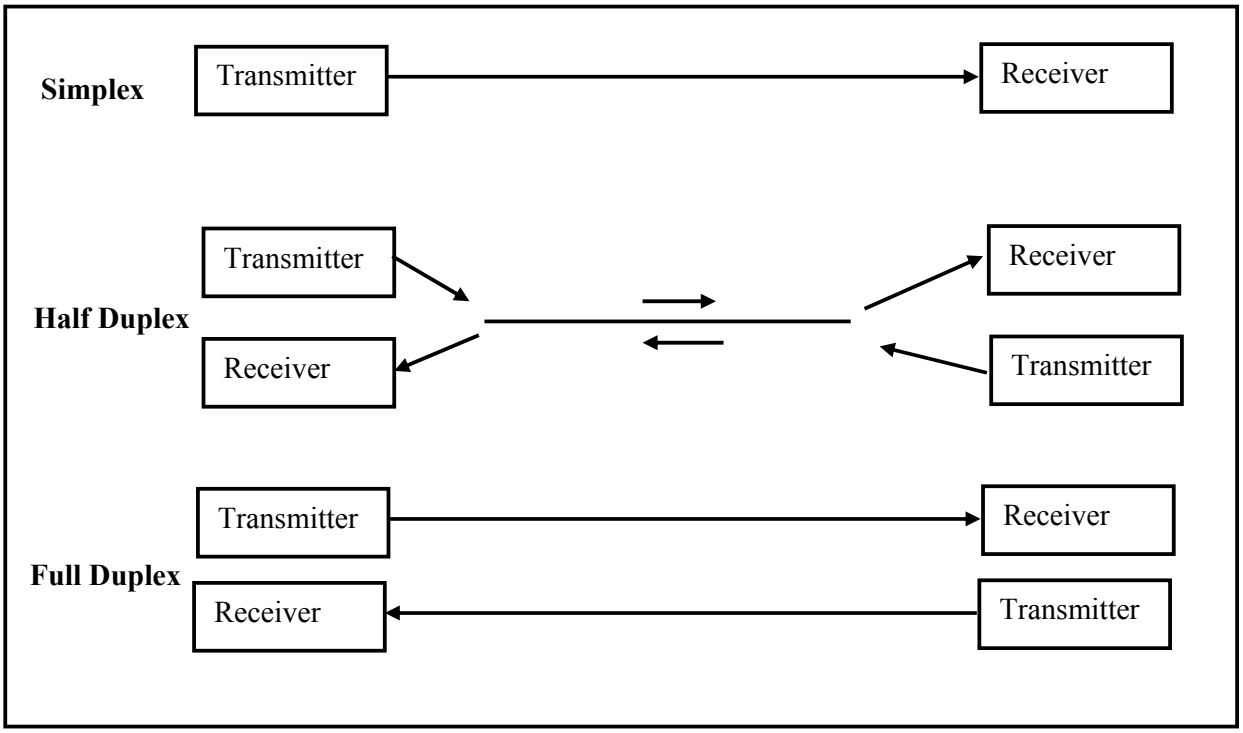
Serial versus Parallel Data transfer.

Asynchronous /Synchronous Methods

- Serial data communication uses two methods: *asynchronous and synchronous*.
  - Synchronous communication requires common timing signals and common clock for synchronization. This means that as well as the data, the clock signals must also be transmitted along. In synchronous method a block of data at a time is transmitted.
  - In asynchronous method a single byte is transferred at a time. For example, **start and stop bits** are used to indicate the receipt of a byte.

Serial Data Communication Systems

- Simplex Transmission: Transmission of data is only possible in one direction (e.g. output only-printers)
- Half Duplex Transmission: Transmission of data is possible in both directions, but in one direction at a time.
- Full Duplex Transmission: Transmission of data can be in both directions at a time. Requires to wires as data lines.



Simplex, Half and Full Duplex Transfers

UART (Universal Asynchronous Receiver-Transmitter) Chip

UART chips are used for serial communication. The 8250 series, which includes the 16450, 16550, 16650, & 16750 UARTS, are the most commonly used.

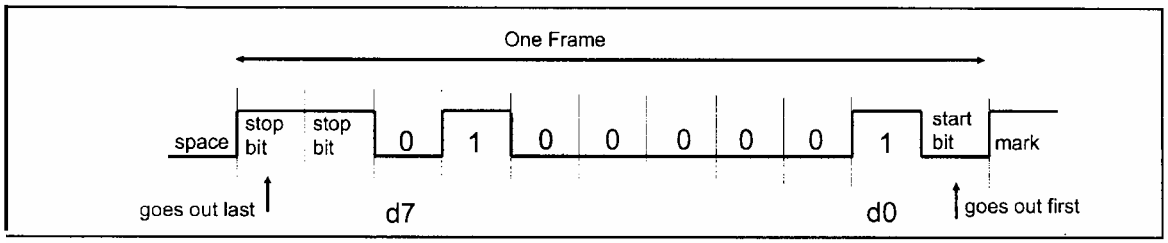
• Asynchronous serial communication and data framing

- The data coming in the receiving end of the data line in a serial data transfer is all 1s and 0s; it is difficult to make sense of data unless the sender and receiver agree on a set of rules, a ***protocol*** on how the data is packed, how many bits constitute a character, and when the data begins and ends.

Start and Stop bits

- Asynchronous serial data communication is widely used for character-oriented transmission, and block-oriented data transfers use the Synchronous method.

- In the Asynchronous method, each character is put between a start and stop bits. This is called ***framing***. In data framing, for asynchronous communications, the data such as ASCII characters are packed in between a start bit and stop bit.
- The start bit is always one bit, but the stop bit(s) can be one or two bits. The start bit is always a **0 (low)** and the stop bit(s) is **1 (high)**
- The example below gives the framing of the ASCII character "A", where, binary 0100 0001, is framed in between the start bit and two stop bits. Notice that **the LSB is sent out first**.



Framing of ASCII "A" (41H)

- Notice that the transmission begins with a start bit followed by D0, the LSB, then the rest of the bits until the MSB (D7), and finally, the 2 stop bits indicating the end of character "A".
- In asynchronous serial communication, peripheral chips and modems can be programmed for data that is 5, 6, 7 or 8 bits wide.
- In some systems in order to maintain the data integrity, the ***parity bit*** of the character byte is included in the data frame.

Data Transfer Rate (Baud Rate)

- The rate of data transfer in serial communication is stated in *bps* (bits per second). Another widely used terminology for bps is the *baud rate*.
- Typical bps values are: 2,400, 4,800, 9,600, 19,200, 28,800,… etc.

• RS232 and other Serial I/O Standards

- RS232 is the most widely used serial I/O interfacing standard.
- However the I/O voltage levels are not TTL compatible. In the RS232 a 1 is represented by –3 to –25 V, while 0 bit is +3 to +25 V, making –3 to +3 undefined.
- For this reason voltage converter such as MC1488 and MC1489 are used to convert the TTL logic levels to the RS232 voltage levels and vice versa. See Figure below.

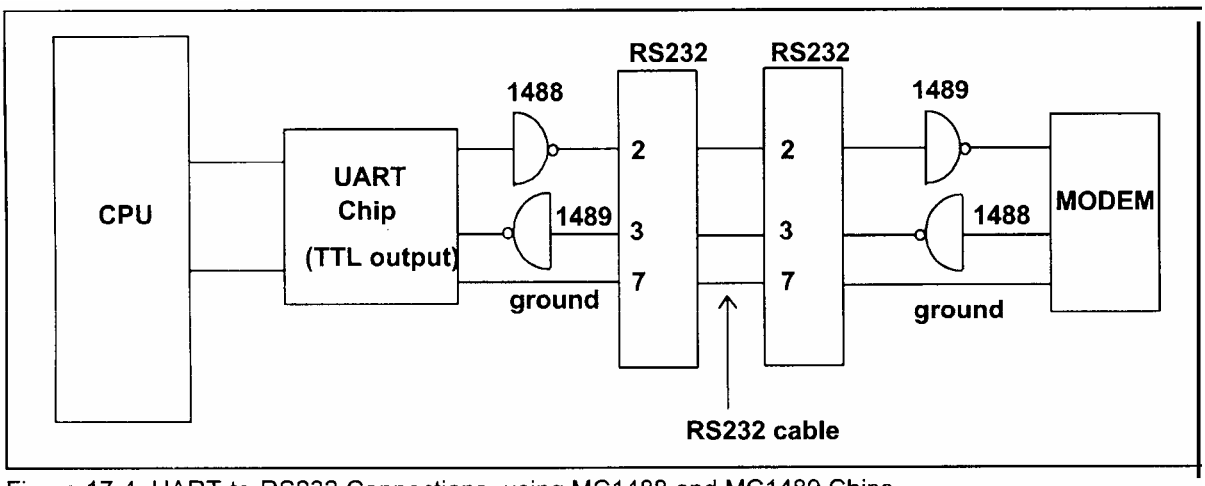
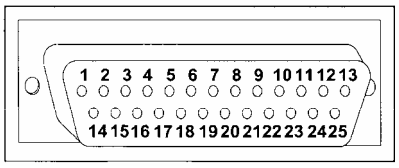


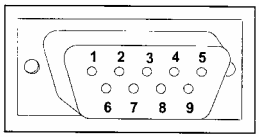
Figure 17-4. UART-to-RS232 Connections using MC1488 and MC1489 Chips

RS232 Pins

- Serial Ports come in two "sizes". There are the D-Type 25 pin connector and the D-Type 9 pin connector both of which are male on the back of the PC, thus you will require a female connector on your device. Below is a table of pin connections for the 9 pin and 25 pin D-Type connectors.



D-Type 25 pin



D-Type 9-pin

Serial Port Pinouts (D25 and D9 Connectors)

D-Type-25 Pin No.	D-Type-9 Pin No.	Abbreviation	Full Name
Pin 2	Pin 3	TD / TxD	Transmit Data
Pin 3	Pin 2	RD / (RxD)	Receive Data
Pin 4	Pin 7	RTS	Request To Send
Pin 5	Pin 8	CTS	Clear To Send
Pin 6	Pin 6	DSR	Data Set Ready
Pin 7	Pin 5	SG / (GND)	Signal Ground
Pin 8	Pin 1	CD / (DCD)	Data Carrier Detect
Pin 20	Pin 4	DTR	Data Terminal Ready
Pin 22	Pin 9	RI	Ring Indicator

Table 1 : D Type 9 Pin and D Type 25 Pin Connectors

Pin Functions

Abbreviation	Full Name	Function
TD	Transmit Data	Serial Data Output (TXD)
RD	Receive Data	Serial Data Input (RXD)
CTS	Clear to Send	This line indicates that the Modem is ready to exchange data.
DCD	Data Carrier Detect	When the modem detects a "Carrier" from the modem at the other end of the phone line, this Line becomes active.
DSR	Data Set Ready	This tells the UART that the modem is ready to establish a link.
DTR	Data Terminal Ready	This is the opposite to DSR. This tells the Modem that the UART is ready to link.
RTS	Request To Send	This line informs the Modem that the UART is ready to exchange data.
RI	Ring Indicator	Goes active when modem detects a ringing signal.

Data Communication Classification:

- Devices which use serial cables for their communication are split into two categories. These are DCE (Data Communications Equipment) and DTE (Data Terminal Equipment.)
- DTE refers to terminals and computers that send and receive data; DCE refers to communication equipment such as modems that are responsible for transferring data.