Chapter 5: Serial Communication

1. Serial Communication- Review

Unlike parallel communication which transmits or receives a byte of data, for an 8-bit parallel communication, simultaneously, serial communication sends or receives a single bit at a time. Although this is slower than parallel communication, which allows the transmission of an entire byte at once, it is simpler and can be used over longer distances.

Serial communication is a very common protocol for device communication that is standard on almost every PC. Most computers include two serial ports. Serial communication is also a common communication protocol that is used by many devices for instrumentation; numerous GPIB-compatible devices also come with a serial communication port. Furthermore, serial communication can be used for data acquisition in conjunction with a remote sampling device.

Serial communication has two types: asynchronous and synchronous communications.
Synchronous communication requires more complex interface and clock is sent along with data with higher rate than asynchronous communication. Synchronous communication requires that each end of an exchange of communication respond in turn without initiating a new communication. A typical activity that might use a synchronous protocol would be a transmission of files from one point to another. As each transmission is received, a response is returned indicating success or the need to resend.

On the other hand, asynchronous communication is usually for a situation where data can be transmitted intermittently rather than in a steady stream. For example, a telephone conversation is asynchronous because both parties can talk whenever they like. If the communication were synchronous, each party would be required to wait a specified interval before speaking.
The difficulty with asynchronous communications is that the receiver must have a way to find the end of talks of the other side so that one starts to speak. In computer communications, this is usually accomplished through special bits to indicate the beginning and the end of each piece of data. Asynchronous communication, therefore, has simpler interface and does not send clock, but requires `start` and `stop` bits. Asynchronous communication protocol is our main interest in this chapter.

Serial Communication Specifications
RS-232 (Recommended standard-232) is a standard interface approved by the Electronic Industries Association (EIA) for connecting serial devices. In other words, RS-232 is a long-established standard that describes the physical interface and protocol for relatively low-speed serial data communication between computers and related devices. EIA defined it originally for teletypewriter devices. In 1987, the EIA released a new version of the standard and changed the name to EIA-232-D. Many people, however, still refer to the standard as RS-232C, or just RS-232. RS-232 is the interface that your computer uses to talk to and exchange data with your modem and other serial devices. The serial ports on most computers use a subset of the RS-232C standard.

The electrical specification RS232C standard specifies many parameters such as :
1. A "Space" (logic 0) will be between +3 and +25 Volts.

2. A "Mark" (Logic 1) will be between -3 and -25 Volts.
3. The region between +3 and -3 volts is undefined.
4. An open circuit voltage should never exceed 25 volts. (In Reference to GND)
5. A short circuit current should not exceed 500mA. The driver should be able to handle this without damage. (Take note of this one!)

Above is no where near a complete list of the EIA standard. Line Capacitance, Maximum Baud Rates etc are also included. For more information please consult the EIA RS232-E standard. It is interesting to note however, that the RS232C standard specifies a maximum baud rate of 20,000 bps, which is rather slow by today's standards. Revised standards, EIA-232D & EIA-232E were released, in 1987 & 1991 respectively.

On the other hands, there are two similar standards similar to RS232: RS422 and RS485.

RS422 is a Standard interfaces approved by EIA, and designed for greater distances and higher Baud rates than RS232. In its simplest form, a pair of converters from RS232 to RS422 (and back again) can be used to form an "RS232 extension cord." Data rates of up to 100K bps and distances up to 4000 Ft. can be accommodated with RS422. RS422 is also specified for multi-drop (party-line) applications where only one driver is connected to, and transmits on, a "bus" of up to 10 receivers.

RS485 is an EIA standard for multipoint communications. It supports several types of connectors, including DB-9 and DB-37. RS-485 is similar to RS-422 but can support more nodes per line RS485 meets the requirements for a truly multi-point communications network, and the standard specifies up to 32 drivers and 32 receivers on a single (2-wire) bus.

A brief comparison of the above 3 standards is summarized in the table below.

Specifications	**RS232**	**RS422**	**RS488**
Mode of Operation	Single Ended	Differential	Differential
Max No. of Tx and Rx	1Tx, 1Rx	1Tx, 10Rx	32Tx, 32Tx
Max Cable Length	50 ft	4000 ft	4000 ft
Max Data Rate	20 kbps	100kbps	100kbps
Min Driver Output range	±5 to ±15 V	± 2 V	± 1.5 V
Max Driver Output Range	± 25 V	± 6V	± 6V

RS232 Level Converter

Almost all digital devices, including 16F877 and PIC board, require either TTL or CMOS logic levels. Therefore the first step to connecting a device to the RS-232 port is to transform the RS-232 levels back into 0 and 5 Volts. This level conversion is done by RS-232 Level Converters. The most common RS-232 Level Converter is MAX232 Multi-channel RS-232 Driver chip, which includes a charge pump which generates +10V and -10V from a single 5V supply, from Maxim Semiconductor. The package contains 2 drivers and 2 receivers: in other words, one MAX232 chip can support two serial communication ports. MAX232 needs electrolyte capacitors and whose values are determined by which device is used. For MAX232CPE, a DIP package, need 1.0 uF capacitors, while MAX232ACPE requires 0.1 uF capacitors. From the listed capacitors, capacitor C5 may be omitted. Now you better understand the minimum hardware in your PIC board especially around the MAX232 chip.