Serial Communication

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Abstract - This paper presents some observations concerning the effect of electromagnetic radiation and pulsed shapes noise one might encounter during the digital data transmission. It discusses about the serial communication, its parameters, and the serial communication protocol RS232.The noise effect on the bit stream transmitted over a channel using RS232 is demonstrated with waveforms. It also discuss about the intermittent faults in digital systems. The error detection algorithm for the digital data is briefed. A software based fault detection procedure is described and its performance is examined based on the analytical models. A numerical example is presented which illustrates the performance of the fault detection algorithm.

Keywords: Electromagnetic Radiation/Environmental noise Effect on Serial communication and the error detection in the corrupted serial packet of data.

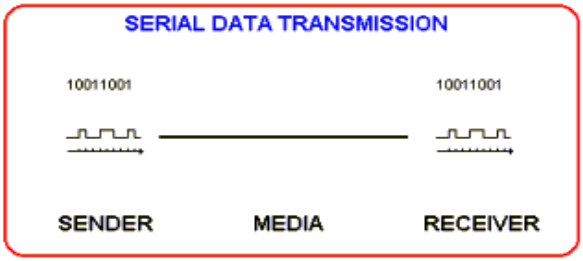
I. INTRODUCTION

Electromagnetic fields are present everywhere in our environment but are invisible to the human eye. Electric fields are produced by the local build-up of electric charges in the atmosphere associated with thunderstorms. Besides natural sources the electromagnetic spectrum also includes fields generated by human-made sources: X-rays are employed to diagnose a broken limb after a sport accident. The electricity that comes out of every power socket has associated low frequency electromagnetic fields. And various kinds of higher frequency radio waves are used to transmit information – whether via TV antennas, radio stations or mobile phone base stations. All these radiation and fields are affecting the human body and electronic equipments in different ways. The effect of the radiation on human is not in the scope of this study. The

Radiation affects the functioning of different electronic equipment in various ways; one such way is by corrupting the information present in any communication channel. Most of electronic equipment works on the digital data, which is being transferred from one device to another through wired or wireless channel. The environment noise sometimes introduces error in bit stream of serial data. The detection of generated error is essential for proper functionality of the communicating devices. So the error detection algorithm becomes the essential requirement for any serial communication channel.

II. SERIAL COMMUNICATION:

Serial communication is a popular means of transmitting data between a computer and a peripheral device such as a programmable instrument or even another computer. Serial communication uses a transmitter to send data, one bit at a time, over a single communication line to a receiver. You can use this method when data transfer rates are low or you must transfer data over long distances. Serial communication is popular because most computers have one or more serial ports, so no extra hardware is needed other than a cable to connect the instrument to the computer or two computer together.



Parameters of Serial Communication: Some parameters need to be defined for establishing the serial communication between any devices so that the reception of data is proper. The receiving device needs to know about the rate of transmitted data, the length of data packets, parity of data if any, the no of start and stop bits if any, so that the receiver can decode the received data correctly. The required Parameters are listed below as:

- Channel / Port
- Baud Rate
- Parity
- Start Bit
- Stop Bit
- No of bits

Channel / Port: A channel is a portion of the communications medium allocated to the sender and receiver for conveying information between them. The communications medium is often subdivided into a number of separate paths, each of which is used by a sender and receiver for communication purposes. In case of communication between computers the port no has to be defined for the particular transmitter and receiver. The Port used for communication as a part of this project implementation is Com Port-1 which is directly supported on the D type connector of CPU.

Baud Rate: Baud rate is a speed measurement for communication. It indicates the number of bit transfers per second. For example, 300 baud is 300 bits per second. When we refer to a clock cycle, we mean the baud rate. For example, if the protocol calls for a 4800 baud rate, then the clock is running at 4800 Hz. This means that the serial port is sampling the data line at 4800 Hz.

No of Data bits: No of data bits is a measurement of the actual data bits in a transmission. When the computer sends a packet of information, the amount of actual data may not be a full 8 bits. Standard values for the data packets are 5, 7, and 8 bits. Which setting you choose depends on what information you are transferring.

Start bits: Start bits indicating the beginning of a data stream or the start of a byte of data. In asynchronous communications, this bit that signals the receiver that data is coming. Every byte of data is preceded by a start bit and followed by a stop bit.

Stop bits: Stop bits are used to signal the end of communication for a single packet. Typical values are 1, 1.5, and 2 bits. Since the data is clocked across the lines and each device has its own clock, it is possible for the two devices to become slightly out of sync. Therefore, the stop bits not only indicate the end of transmission but also give the computers some room for error in the clock speeds.

III. PARITY

Parity is a simple form of error checking that is used in serial communication. There are four types of parity: even, odd, marked, and spaced. Of course, the option of using no parity

is also available. For even and odd parity, the serial port will set the parity bit, the last bit after the data bits, to a value to ensure that the transmission has an even or odd number of logic high bits. For example, if the data was 011, then for even parity, the parity bit would be 0 to keep the number of logic high bits even. If the parity was odd, then the parity bit would be 1, resulting in 3 logic high bits. Marked and spaced parity does not actually check the data bits, but simply sets the parity bit high for marked parity or low for spaced parity.

IV. PROTOCOL OF SERIAL COMMUNICATION RS232:

An Introduction:

Rs-232 is a three wire interface used for transferring the data between the computers/devices. The full project is implemented on this protocol. The RS232 Consist of three lines:

- **Transmit line (Tx)**: Which transmit out the stream of bits from computer (pin 3 of D type connector on the CPU).
- **Reception line (Rx):** Which receives the stream of bits from other computer(pin 2 of D type connector on the CPU)
- **Ground or common line**: A common line for ground (pin 5 of D type connector on the CPU).

RS 232 works on the a bipolar voltage level of +/- 12 V, where the bit '1' is represented with a voltage of -12V and bit '0' is represented with a voltage level of +12 V. The same is demonstrated below:

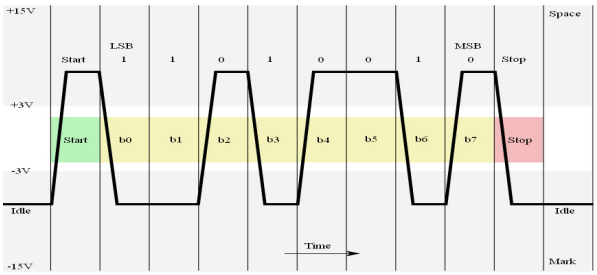


Fig-1

In the above diagram the data represented is:

- b0='1'
- b1='1'
- b2='0'
- b3='1'
- b4='0'
- b5='0'
- b6='1'
- b7='1'

start bit=additional bits for validating the accuracy of data

Stop bit= additional bits for validating the accuracy of data.

The Electromagnetic effect on serial data: The serial data is represented by the voltage pulses of different levels. The presence of environmental electromagnetic radiations may increase or decrease the level of voltage present for each bit. If the variation in voltage levels is within the permissible limits of the used protocol, the receiver can receive the bit stream correctly. If the variation in voltage is more than the specified limits, the receiver will either interpret it wrong way (that is bit'1' will be read as bit'0' and bit'0' will be read as bit'1') or if the voltage level is in the recognized voltage band the receiver may interpret the bit either way. The voltage levels for RS232 is shown in the Fig-1.The unrecognized voltage band is +3V to -3V. Any voltage level between these bands is not recognized by the RS232 receiver and it creates the error in the received data.

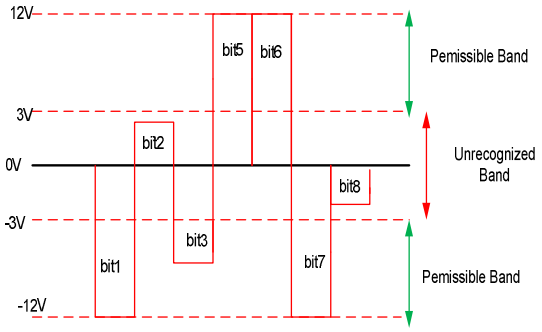


Fig-2

In the presence of noise in the data the bits may get deformed refer Fig-2. The voltage levels of bits transmitted using RS232 is shown. The corresponding voltage limits for bit'1' and bit '0' is also shown. The unrecognized band is the band where the bit reorganization is not possible by the receiver. The environmental noise has deformed the bit 2 and bit 8 and the voltage level is dropped / raised to the unrecognized band. The receiver will assume the bits either way that is either '1' or '0'.The both the bits may be considered as '0' or '1' also. In this way the data will be misinterpreted by the receiver and the functionality of the communicating devices will be affected. This intermittency in the reception of correct data will fluctuate the performance of the system.

V. INTERMITTENT FAULTS IN DIGITAL SYSTEMS:

The reliability of a system is evaluated on the basis of faults which are permanent in nature. System failures are also due to faults which are intermittent in nature, i.e., faults or errors that are occasionally present due to unstable hardware, software or corrupted data states. The

Hardware Intermittency is because of component failure, the software glitches is due to bug in the written software. The intermittency arises due to error in data is difficult to correct as the no of parameters affecting the data are large in number. The glitch/intermittency can remain for a fraction of second if the only one or two received packets are corrupted, if the no of corrupted data packets are more the intermittency will continue for a longer time.

VI. THE ERROR DETECTION ALGORITHM FOR THE DIGITAL DATA:

The general idea for achieving error detection and correction is to add some redundancy (i.e., some extra data) to a message, which receivers can use to check consistency of the delivered message, and to recover data determined to be corrupted. Error-detection and correction schemes can be either systematic or non-systematic: In a systematic scheme, the transmitter sends the original data, and attaches a fixed number of check bits (or parity data), which are derived from the data bits by some deterministic algorithm. If only error detection is required, a receiver can simply apply the same algorithm to the received data bits and compare its output with the received check bits; if the values do not match, an error has occurred at some point during the transmission. In a system that uses a non-systematic code, the original message is transformed into an encoded message that has at least as many bits as the original message.

Binary CRCs are very effective for error detection, but their software implementation is not very efficient. Thus, many binary nonCRC codes (which are not as strong as CRCs, but can be more efficiently implemented in software) are proposed as alternatives to CRCs. The one such nonCRC code used is XOR.

VII. SOFTWARE BASED FAULT DETECTION PROCEDURE:

The serial communication deals with the packet of data which is a bit stream. As explained above some redundancy is to be added to the packet of data at the end. The redundant term will be extra bit/bits to the packet. The redundant term is also called as check sum in serial communication. The serial communication data are represented in the form of bytes And each byte contains 8 no of bits. The XOR operation is to be carried out on all the bytes to be transmitted .The XORed result is called as Checksum.

Checksum = (Byte1)XOR (Byte2)XOR(Byte3)….

The checksum is transmitted as the last byte of the data packet.

The receiver will perform the same operation on the received data packet(except checksum byte) and it will compare the XORed result to the received checksum. If both the data are equal it means the received packet is correct and no noise is being added to the packet from environment. In case of mismatch between XORed value

at receiver and the checksum, the receiver will declare it as corrupted data. This way error can be detected in the serial communication.

VIII. FUTURE WORK:

The data validation procedure used on the transmitter and receiver end can detect the error present at any bit of the transmitted packet at any moment of time and the error in the packet is shown immediately even if it is for a fraction of second. This data validation scheme can be used in any serial communication protocol. It is an error detection scheme in which each transmitted message is accompanied by a numerical value based on the number of set bits in the message. The receiving station then applies the same formula to the message and checks to make sure the accompanying numerical value is the same. If not, the receiver can assume that the message has been garbled.

The data validation scheme implemented is explained as:

- At the transmitter end the first 5 bytes will be XORed and the result will be stored in the 6th byte of the packet.
- At receiver end the first 5 bytes of the received packet will be XORed and the result will be compared to the 6th byte.
- If the XORed result and the 6th received bytes are same at the receiving end it means the data reception is correct. Otherwise the received data is corrupted because of noise.

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