**Microcontroller theory**

Microcontroller unit (MCU) is a small size, special purpose computer. It is small enough in order to be integrated on a small circuit in which will do specified tasks or applications. MCU itself comes with memory, input, output peripherals and processor. Program to run the MCU is stored in Read-only memory (ROM) and usually not change in production. A microcontroller is usually designed to run in small size and at low cost, which is compatible to be embedded in other system in order to control actions of the system automatically.

**Types**

- Intel 8051

- STMicroelectronics STM8S (8-bit), ST10 (16-bit) và STM32 (32-bit)

- Atmel AVR (8-bit), AVR32 (32-bit), và AT91SAM (32-bit)

- Freescale ColdFire (32-bit) và S08 (8-bit)

- PIC (8-bit PIC16, PIC18, 16-bit dsPIC33 / PIC24)

- Renesas Electronics: RL78 16-bit MCU; RX 32-bit MCU; SuperH; V850 32-

bit MCU; H8; R8C 16-bit MCU

- PSoC (Programmable System-on-Chip)

- Texas Instruments Microcontrollers MSP430 (16-bit), C2000 (32-bit), và

Stellaris (32-bit)

**RS485**

**Introduction**

Nowadays, there are various communication protocols can be used for the thesis, namely I2C, ISP, RS232, RS485, Bluetooth or Wi-Fi. Each protocol is designed to be suitable for specified purpose with different advantages or disadvantages, which means a perfect protocol does not exist. When making a decision to choose suitable protocols for the thesis, the author had to think about the trade-off between the stabilization and the speed of the communication protocol.

RS485 is chosen as the main way for components in the system to communicate with each other. RS485 is defined in 1983 not as a protocol but an electrical interface standard and only specifies the drivers and receivers’ characteristics. It is developed in order to make data rate and transmitting distance are inversely proportional. For instance, the data transmitting speed can reach 10 Mbps within distance of 16 meters or if the distance is extended to 1220 meters, the data rate is lower to 100 kbps. The advantage of RS485 over RS232, which is developed in 1960, is multiple nodes can be parallel connected to a bus. Additionally, the network can be extended in length and number of nodes easily by using simple connectors. Besides, Wi-Fi, Bluetooth, GSM and MQTT are also implemented in the thesis in order to take the advantages of different communication protocols in different circumstances.

**RS485 specification**

**Overview**

\table

\figure full-duplex and half-duplex

Table shows the highlight specifications of RS485. With these specifications, RS485 was a robust interface standard and was able to meet the requirements in industries, in which implemented applications that need stable, fast and reliable connection. Figure … demonstrates two ways to implement the connection with RS485, which are full-duplex and half-duplex. Full-duplex implementations require four-wire (two signal pairs) instead of two-wire in half-duplex implementations; But despite the downside of two-wire implementation is it is limited to half-duplex and needs attention to turn-around delay, in practical applications, half-duplex is most chosen. The reason is full-duplex solution depends on master-slave model, which means the slaves cannot communicate with each other. In modern designs of transceiver, the allowed number of nodes can connect to the bus is up to hundreds.