Research on Multi-master Communication System Based on RS485 Bus

Yang Cheng-ying 1*, Chen Yong 2*
1Huali College Guangdong University of Technology, Guangdong Guangzhou 511325, China.
2Sunrise Electronic Development Co., Ltd., Guangzhou 510300, China
*Corresponding author E-mail: kxcc_119@163.com

Abstract: This paper introduces an RS485 bus communication system that can support multi-host online. The communication system is based on the basic communication principle of the single chip microcomputer, combined with the function of the RS485 chip, utilizes the characteristics of the triode, and realizes the communication mode of the multi-host node on the conventional half-duplex master-slave working mode RS485 bus. This key point realization marks the fact that the RS485 bus supporting multi-host node two-way all-digital communication becomes a reality. At the same time, the communication system combines the lightning protection and surge protection requirements, and provides a solid foundation for the RS485 bus fieldbus control system FCS (Fieldbus Control System) based on RS485 bus.

1. Introduction
Fieldbus technology is one of the hotspots of technology development in the field of automation today. It is known as the computer LAN in the field of automation. Its appearance marks the beginning of a new era of automation control technology. The fieldbus is not only the instrument that is connected to the control site, but also the basis for controlling the multi-station communication network of the device. The RS485 bus is one of the representative products of fieldbus technology. RS485 bus technology adopts balanced transmission and differential reception. On the bus, +2V to +6V means logic "0", and on bus -6V~ -2V means logic "1". On the bus, two-wire communication is usually used in half-duplex communication mode. Moreover, in the RS485 communication network, the master-slave communication mode is generally adopted, that is, one host has multiple slaves [1].

The emergence of bus technology represented by RS485 bus is the basis for the intelligent control, digitization, informationization, networking and decentralization of the automatic control system. At the same time, the bus technology forms a new network integrated full distributed control system -- Fieldbus Control System (FCS), but the key symbol of all of the above is that the bus can support two-way, multi-node, bus-based all-digital communication. The conventional RS485 bus master-slave half-duplex mode determines that there cannot be multiple host devices on the bus at the same time. Otherwise, the data may be interfered and destroyed during the communication process, and even the RS485 chip and circuit may be damaged. Based on the above issues, this paper introduces a communication system that can implement multi-master communication on the RS485 bus.

2. RS485 communication circuit background introduction
The Electronic Industries Association (EIA) developed and published the RS-485 standard, which was
renamed TIA/EIA-485-A by the Telecommunications Industry Association (TIA) and was customarily referred to as the RS-485 standard. The RS485 bus data signal uses Differential Driver Mode, also known as balanced transmission, that is, using a pair of twisted pairs, one of which is defined as A and the other is defined as B. The A terminals of all nodes on the RS485 bus are connected together, and all B terminals are connected together. Normally, when there is a level greater than 200 mV between the receiving terminals A-B, the logic state "0" is output through the RS485 device; when it is less than -200 mV between the receiving terminals A-B, the logic state "1" is output through the RS485 device. Based on the electrical characteristics of the RS485 bus, the conventional RS485 bus adopts the master-slave half-duplex mode of operation. Therefore, the conventional RS485 bus architecture determines that there cannot be multiple host devices on the bus, otherwise it may cause data during communication. The interference and damage, and even damage the RS485 chip and circuit, so that the RS485 bus based on the formation of a new network integrated full distributed control system - RS485 bus fieldbus control system FCS (Fieldbus Control System) can not support multiple hosts Node two-way full digital communication[1].

3. RS485 multi-master communication circuit:

3.1 RS485 multi-master communication circuit overall introduction:

In RS-485 devices, there is typically an "enable" control signal. The "enable" signal is used to control the disconnection and connection of the transmitting transmitter and the transmission line. When the "enable" terminal is active, the transmitting transmitter is in a high-impedance state, called “third state”, which is different from logic state "1" and "0". The communication system is based on the principle of the "enable" control signal of the RS485 device, and the RS485 multi-master communication circuit shown in Figure 1 is designed [1-5]:

Description: The MCU mentioned below is the central processor of each node in the RS485 bus, such as a microcontroller, embedded processor, etc.

![Figure 1](image-url)

Figure 1  RS485 multi-master communication circuit

Circuit related symbols and device descriptions[2]:

- **EARTH**: Earth
- **485-A, 485-B**: A and B terminals of RS485 bus
- **VCC, GND**: Circuit power and reference ground
- **MCU-INT1**: Connect to the external interrupt IO port of the MCU
- **MCU-TXD**: Connect to the data send pin of the MCU serial port
- **MCU-RXD**: Connect to the data receiving pin of the MCU serial port
GDT, PTC and TVS tubes are lightning protection circuits[3]

3.2. A single node in the RS485 multi-master communication circuit sends:

When the MCU of a single node sends a logic "1"[1,4,5], the MCU-TXD of the node outputs a high level, the transistor Q1 is turned on, the enable pin of the SP3485 chip is at a low level, and the SP3485 chip is in a receiving state. The A and B two lines of the RS485 bus are pulled up and divided by the R1, R2, and R3 resistors to generate a positive voltage difference, which causes a logic "1" on the RS485 bus, and the MCU-RXD of the MCU of the node receives the logic signal "1". Therefore, through the above circuit design, the MCU of a single node realizes the transmission of logical data "1" to the RS485 bus, and realizes that the transmitted data does not have any interruption effect on the reception of the node.

When the MCU of a single node sends a logic "0"[1,4,5], the MCU-TXD of this node outputs a low level, the transistor Q1 is turned off, the enable pin of the SP3485 chip is a high level, the SP3485 chip is in a transmitting state, and the SP3485 chip receives a low level signal, so the A and B two lines of RS485 bus are controlled by SP3485 chip, output negative voltage difference, so that logic "0" is generated on RS485 bus. At the same time, because the SP3485 chip is in the transmitting state, the MCU-RXD of the MCU of the node still receives a high level signal. Therefore, through the above circuit design, the MCU of a single node realizes the transmission of logical data "0" to the RS485 bus, and realizes that the transmitted data does not have any interruption effect on the reception of the node.

Therefore, when the MCU of a single node sends data to the RS485 bus on the RS485 bus, the communication circuit realizes that the receiving port MCU-RXD of the node MCU and its external interrupt port MCU-INT1 always receive the high level function. That is, the RS485 bus does not generate an external interrupt signal to the MCU of the node.

3.3. The receiving part of the RS485 multi-master communication circuit:

When the MCU of the node on the RS bus receives data[1,4,5], the MCU of the node does not need to actively send data to the bus, so there is no need to monitor whether there is data on the bus through the external interrupt port MCU-INT1 of the MCU, so the MCU-INT1 of the MCU is turned off. According to the serial port characteristics, the MCU-TXD outputs a high level, the transistor Q1 is turned on, the enable pin of the SP3485 chip is at a low level, the SP3485 chip is in a receiving state, and the data on the RS485 bus is received through the MCU-RXD pin.

3.4. Multi-host anti-collision mechanism of RS485 multi-master communication circuit:

On the RS485 bus, through the electrical design of the circuit, the logic "1" level signal is generated by pull-up and voltage division of the resistor pull-up, and the logic "0" level signal is formed by the drive of the SP3485 chip, and the signal formed by the drive The driving capability is much larger than the driving capability of the resistor to pull up the signal. Therefore, when the logic "0" and the logic "1" exist simultaneously on the RS485 bus because different nodes transmit data at the same time, the logic "0" will forcibly change the bus signal. So that to make the bus level signal logic "0" without damaging the RS485 bus circuit. In addition, according to the characteristics of the serial data format, all data has at least a stop bit, and the stop bit is a logic signal “0” on the bus. The node will receive a logic low signal regardless of whether the node MCU on the RS485 bus sends any data. That is, the MCU of the node will receive a low level signal from the RS485 bus. When the MCU of the node needs to send data, the MCU of the node starts its external interrupt MCU-INT1. Because of the low level signal of the RS485 bus, the RS485 bus triggers the external interrupt MCU-INT1 of the MCU of the node through the circuit, so that the node MCU will monitor that the other devices on the bus are transmitting data. If the node finds that it is also sending data to the RS485 bus at this time, a data collision will occur on the RS485 bus, affecting the communication of the RS485 bus. At this time, the nodes on each RS485 bus can perform different delays through different device addresses of the RS485 bus, or can also send data to the bus after delay by random number, thereby realizing
staggered transmission of each node, and finally Multi-master communication function is implemented on the RS485 bus[1,4,5].

3.5. Lightning surge protection of RS485 multi-master communication circuit:
The circuit of the communication system realizes the protection level of differential mode 2KV and common mode 4KV according to the protection requirements in GB17626.5-2008-T “Electromagnetic compatibility test and measurement technology surge (impact) immunity test”, in implementation The degree of protection can be modified by mediating the parameters of the relevant device as required[3].

4. Conclusion:
The RS485 bus communication system introduced in this paper is based on the basic communication principle of the single-chip microcomputer, the function of the RS485 chip and the characteristics of the triode. It can realize the multi-host online communication control on the conventional half-duplex master-slave working mode RS485 bus. This key point realization marks the fact that the RS485 bus supporting multi-host node two-way all-digital communication becomes a reality. At the same time, the communication system combines the lightning and surge protection requirements, and provides a solid foundation for the RS485 bus fieldbus control system FCS (Fieldbus Control System) based on RS485 bus.

Acknowledgments
Project fund: Guangdong provincial physics experimental demonstration center (no. 179, letter of Guangdong education administration in 2018)

References
[1] ANSI TIA/EIA-485-A-1998(R2003)”Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems”.
[2] Chenyong, ”Multi-master communication circuit based on RS485 bus”, Chinese invention patent, patent number: 201610327283.X, February 2019.
[3] GB17626.5-2008-T ”Electromagnetic compatibility test and measurement technology surge (impact) immunity test”.
[4] CJ/T188-2004 ”Technical Conditions for Data Transmission of Household Meters”.
[5] (Japan) Miyake and Division ”Selection and Application of Electronic Components”, Zhang Xiu-qin, Science Press, LLC, 2017.