A Meter-Bus Master Station Interface Circuit Based on Transistor Amplification Characteristics

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Abstract. This paper introduces a new Meter-Bus master station interface circuit based on a single power supply. By utilizing the switching characteristics and amplification characteristics of the triode, the level signal conversion and signal transmission are realized by fully combining the cut-off region of the triode to work, the linear amplification of the amplification region, and the low-voltage differential conduction of the saturation region. The M-bus master circuit of the prior art solution is usually constructed with many separate components, and the whole circuit also needs positive and negative dual power supplies, so the circuit is very complicated, the circuit failure rate is high, and the cost of the circuit is also high. The circuit described in this paper solves the above technical problems of the current Meter-BUS master circuit.

1. Introduction

Meter bus (M-Bus) is a new bus structure. The main feature of M-Bus is to simultaneously supply and transmit serial data via two non-polar transmission lines, and each sub-station with different IDs is connected in parallel on the M-Bus bus. When M-Bus is used in the energy-based intelligent management system of various meters or related devices, relevant data or signals can be collected and transmitted to the concentrator, and then transmitted to the main station through the corresponding interface. The use of M-Bus can greatly simplify the wiring and connection of intelligent management systems for energy consumption in residential quarters and office spaces, and has the characteristics of simple structure, low cost and high reliability. The intelligent energy management system consisting of M-Bus consists of terminal data or signal acquisition substation and its M-Bus transceiver circuit, M-Bus bus, master station and its M-Bus converter.

The current M-BUS main station circuit usually uses separate components to build circuits, many components, and also requires positive and negative dual power supplies. The circuit is very complicated, resulting in high failure rate and high cost technical problems. Based on solving the above problems, this paper introduces a new type of M-Bus master station interface circuit.

2. M-Bus main station interface circuit

2.1. M-Bus main station interface circuit introduction

The M-Bus main station interface circuit is shown in Figure 1[1-5]:

[Figure 1 description]
Circuit related symbols and device descriptions [1]:
- VDD is the power supply of the M-BUS bus.
- D3 is an ESD tube to prevent externally generated static electricity from damaging the circuit[4].
- D4 is a TVS tube to prevent external surge voltage from smashing the circuit[4].
- PTC is an overcurrent protection device to prevent external short circuit from affecting the circuit[4].
- D1 is a Zener diode, and the parameters are matched with VCC. Limiting the voltage on both sides of R11 is too high, affecting the life of Q1 triode.
- VCC is the working voltage of the M-bus master station.
- C1 and C2 capacitors are used for filtering.

Remark: The parameters given by the M-Bus main station interface circuit are based on the M-bus host connected to only one slave device on the M-bus bus. VDD uses 36VDC, VCC uses 3.3V, and the rest of the reference circuit diagram. If need to connect the remaining number of loads, can be recalculated according to the principle of this circuit.

2.2. Introduction to the M-Bus main station interface circuit principle:
According to EN1434-3[2]"Data Exchange and Interface" and CJ/T188-2004[3]"Technical Conditions for Data Transmission of Household Meters", the electrical characteristics of the M-bus master station are as follows:
- Send: Marking voltage:24V-36V (CJ-T188-2004: 20.8-42V).
- Space voltage: mark voltage: −12V (CJ-T188-2004: mark voltage—10V).
- Receive: mark current: ≤1.5mA, space current: 11-20mA.

2.2.1. M-bus master station position (bit) transmission:
The M-bus master station sends a logic high level through TXD[2, 3]through the current limiting resistors R8 and R10, the transistor Q4 is in the saturation region, and the emitter (E pole) and collector (C pole) of the transistor Q4 are completely turned on. That is, the voltage at the V1 point of the collector (C-pole) of the transistor Q4 is close to the reference ground. Since the voltage at the V1 point is close to the reference ground, the transistor Q2 is in the saturation region, and the emitter (E-pole) and collector (C) of the transistor Q2. The poles are fully turned on at both ends, the voltage at point V4 in the figure is close to the voltage of the power supply VDD. And since the resistance value of the resistor R13 is much smaller than the resistance value of the resistor R12, the voltage at the point V2 is close to the voltage of the power supply VDD, thereby Output a signal voltage to the M-BUS bus[5].

![Figure 1. M-Bus main station interface circuit](image-url)
The M-bus master station sends a logic low level through TXD [2, 3], and divides the voltage through the resistor R8 and the resistor R9, so that the voltage at the V5 position is about 0.533V, that is, the base (B pole) voltage of the transistor Q4 is at about 0.53V. The transistor Q4 is in the amplification region, and the emitter (E pole) and the collector (C pole) of the transistor Q4 are not completely turned on, so that the voltage of the collector (C pole) of the transistor Q4 is at 31.46V, thus obtaining a triode. The base (B pole) voltage of Q2 is also about 31.46V. The base voltage (B pole) and emitter (E pole) voltage difference of the transistor Q2 makes the transistor Q2 in the amplification region, and the emitter (E pole) and collector of the transistor Q2 (C pole) is not fully conductive at both ends. the voltage at point V4 is at 12V. Since the resistance of R13 is much smaller than R12, the voltage at point V2 is close to 12V, and the null voltage is output to the M-BUS bus[5].

2.2.2, M-bus master station position (bit) reception:
When the M-bus master station is in the receiving state, the TXD signal of the M-bus master station should be logic high. When the M-BUS bus generates the null current, that is, 1.5 mA is generated on the two lines of the M-BUS[2, 3]. When the current is flowing, the current flowing through the resistor R13 is small, and the voltage drop across the resistor R13 is also low. The voltage difference between the base (B pole) and the emitter (E pole) of the transistor Q3 can only support the transistor Q3 in the amplification region. The emitter (E pole) and the collector (C pole) of the transistor Q3 are not fully turned on, and the current is divided by the resistor R7 and the resistor R11, so that the voltage at the V3 point is lower than 0.5V, that is, the base of the transistor Q1. The voltage difference between the pole (B pole) and the emitter (E pole) is not enough to turn on the transistor Q1, and the M-bus master receiving leg RXD is judged to be high by the pull-up resistor R2, that is, the M-bus master station receives To logic high level[5].

When the M-BUS bus generates a signal current, that is, when 11 mA current is generated on the two lines of the M-BUS[2, 3], the current flowing through the resistor R13 is large, and the voltage drop across the resistor R13 is also increased. The voltage difference between the pole (B pole) and the emitter (E pole) causes the transistor Q3 to be in a saturation region, and the emitter (E pole) and the collector (C pole) of the transistor Q3 are completely turned on at both ends, and the current passes through the resistor R7 and the resistor R11 divides the voltage, so that the voltage at the V3 point is greater than 0.6V, that is, the base (B pole) voltage of the transistor Q1 is greater than 0.6V, and the voltage difference between the base (B pole) and the emitter (E pole) of the transistor Q1 makes the transistor Q1 The emitter (E pole) and the collector (C pole) are completely turned on at both ends, and the voltage of the collector (C pole) of the transistor Q1 is close to the reference ground, so the M-bus master receiving leg RXD level is pulled. Low, that is, the M-bus master side receives a logic low level[5].

2.3, M-bus data transmission:
The transmission of the circuit on the M-BUS bus through the bit (bit), combined with the EN1434-3 "Data Exchange and Interface" protocol content, thus achieving data transmission [2, 3].

3. Conclusion:
The M-Bus main station interface circuit introduced in this paper uses a single power supply, which has the advantages of simple circuit, few electronic components, low failure and low cost. At the same time, the circuit has a certain protection against overvoltage and overcurrent caused by lightning strikes.. In the embodiment, the degree of protection can be modified by mediating the parameters of the relevant device according to requirements, which is very suitable for use in a circuit for determining the number of M-BUS bus loads.

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