

1. Introduction

In recent years, with the development of wireless communication technology and microelectronics technology, non-contact IC card (RF card) technology has flourished and has been rapidly popularized in many fields

And promotion, such as bus ticketing systems, resident ID cards, phone cards, bank cards, etc. Passive power supply technology is one of the key technologies for RF cards, and currently the main

It is solved through the principle of electromagnetic induction and integrated voltage stabilizing circuits. When the RF card enters the reader's magnetic field, energy is obtained from the magnetic field through electromagnetic induction, i.e

The two ends of the coil induce AC current, which can be rectified and stabilized to obtain DC voltage. This article discusses a self designed RF card using 0.35um CMOS technology

Feedback switch type voltage stabilizing circuit.

2. Structural design and working principle of voltage stabilizing circuit

Integrated voltage regulator, also known as integrated voltage regulator, maintains its output voltage when the input voltage or output current changes within a certain range. It has been widely used

Used in various electronic devices to replace the assembly of discrete components in regulated power supplies.

2.1 Circuit structure design

The integrated voltage regulator circuit mainly includes the following parts: reference source circuit, voltage regulation circuit, and power switch circuit.

The reference source circuit consists of a two-stage CMOS differential amplifier circuit and a bandgap reference source composed of a transistor circuit. Its structure is shown in Figure 1.

The active resistor P0 and polycrystalline resistor R7 form a bias circuit to provide bias current for the circuit. The two inputs of the two-stage differential amplifier are connected at the Q1 and Q2 terminals by the reference

The source principle shows that only when the Input offset voltage of the amplifier circuit is very small and is not affected by temperature, the output of the reference source can maintain good performance. According to the amplifier

The function and principle of the bandgap reference source can be obtained as follows:

$$I_1 R_6 = I_2 R_4 \quad (1)$$

According to formula (1), the Input offset voltage of the amplifier in the circuit is close to zero. Therefore, the voltage value of the REF point after stabilization is as follows:

$$V_{REF} = V_{Q1} + V_{R6} = V_{Q1} + R_6 I_1 = V_{Q1} + R_4 I_2 \quad (2)$$

Due to the connection between the base and collector of PNP transistors, the V_{Q1} value is equivalent to the forward voltage drop V_{BE} value of the BE junction diode in the transistor, which is generally 0.6~0.8V.

The temperature coefficient of the BE junction diode in the transistor is negative, while the temperature coefficient of the resistor is positive. In equation (2), V_{Q1} and V_{R6} can compensate for each other with changes in temperature, so the base

The output V_{REF} of the quasi source is not sensitive to temperature changes.

The voltage regulation circuit is the core part of the voltage regulation circuit, including two primary CMOS differential amplification circuits COMP and voltage regulation and feedback circuits, as shown in Figure 2.

The inputs of the two differential amplifiers are obtained from the voltage divider resistor, and after comparison and amplification, feedback regulation and current limiting protection circuits are used to obtain MA1 and MB1 in the control power switch circuit

Opening and closing of switch tubes.

The power switch circuit consists of a rectifier composed of energy storage capacitors, NMOS transistors, and a switch circuit, as shown in Figure 3. P1 and P2 are directly connected to both ends of coil L0 through electromagnetic coupling

When combined with P1 and P2, AC power is induced, and after rectification, a DC voltage VDD is generated at the C0 end of the energy storage capacitor. The voltage regulating capacitor C5 forms a discharge circuit after conducting the N2 tube

Start charging C5 and stop charging C0 with the current on P1 and P2, keeping the voltage at both ends of C0 stable, providing a stable power supply voltage for the load circuit.

2.2 Working principle:

When the RF card enters the magnetic field of the reader, it undergoes electromagnetic coupling through the coil and generates AC induced current on P1 and P2, which is converted into DC current through a rectifier, while also storing energy

Charge the capacitor C0 and voltage regulating capacitor C5. The C5 capacitor is very small and can be instantly filled with current through the rectifier. Due to the N2 tube being cut off on both sides of C5, there is no discharge

Circuit, therefore, the current on P1 and P2 will only charge capacitor C0, and a power supply voltage VDD will be generated at both ends of C0. VDD will continue to rise as the capacitor charges. In the rectifier

The effect of active resistors and diodes increases the voltage amplitudes at both ends of P1 and P2, leading to an increase in the potential at point a; At the same time, the output of the voltage sampling circuit also follows

Elevated with the increase of VDD. When the VDD voltage reaches V0 (as shown in Figure 4), the sampled output voltage is greater than the reference voltage VREF, and at this time, the voltage regulation circuit outputs

The voltage values of MA1 and MB1 can enable the opening of N1 and N2 pipes in sequence. Due to the grounding of the source end of the N2 tube, the voltage on A begins to decrease after the N2 tube is connected, causing

P1 and P2 charge C5 again. Due to the continuous conduction of the N2 tube, C5 also began to discharge at the same time, and since then, C5 and N2 tubes have been charging on one side

The state of edge discharge, and the voltage at point a oscillates within a certain range. The charging and discharging of C5 maintains the voltage peak on P1 and P2 at a certain potential through feedback, and it also does not

Continue charging the capacitor C0, so the voltage difference between the two ends of C0 remains stable. The VDD obtained at this point is the working voltage we need. During normal operation of the RF card

Due to the consumption of the load circuit, the voltage on the energy storage capacitor C0 will decrease accordingly. When the VDD value is less than the V0 value, the N2 tube will cut off and the C5 capacitor will not discharge back

After fully charging C5, P1 and P2 will continue to charge C0, causing an increase in the pressure difference

between the two ends of C0, i.e. an increase in VDD. In this way, a self feedback stability is formed in the circuit

Voltage supply.

3. Simulation results

In the normal working environment of RF cards, the coupling coefficient between the card and the reader is generally small, ranging from 0.1 to 0.35, and the signal voltage of the reader is generally 12V. In simulation verification,

Add 12V, 13.56MHz test excitation to obtain induced current on inductor L0. Using a 0.35um SPICE model with a coupling coefficient of 0.25, VDD stability is obtained

The fixed voltage is 3.35V, and the Hspice simulation results are shown in Figure 4:

4. Conclusion

Through the above design and simulation analysis, it can be seen that this voltage stabilizing circuit can obtain stable voltage in a short period of time and can be automatically adjusted; Basic and simulation of multi-objective chip testing results

The results are consistent and meet the design requirements, so it has good practicality and reference value.