Voltage Detection Based on the CA1200/1300 Device

1 Introduction

Although the CA1200/1300 devices are optimized for isolated current detection, they can also be used as isolated voltage detection. This article mainly describes the attention points when these devices are used for voltage detection.

2 Circuit Description

The block diagram of the typical isolated voltage detection system is shown in Fig. 1. The values of R1 and R2 are generally determined according to the detected voltage and the power consumption requirements of the system. The value of R3 is selected according to the input range of the amplifier. Since the CA1200/1300 device uses a fully differential amplifier front-end structure, it is necessary to add a resistor R3' at the VINN end to eliminate the imbalance voltage caused by the input impedance imbalance, and to adjust the gain change caused by R3 (R3').

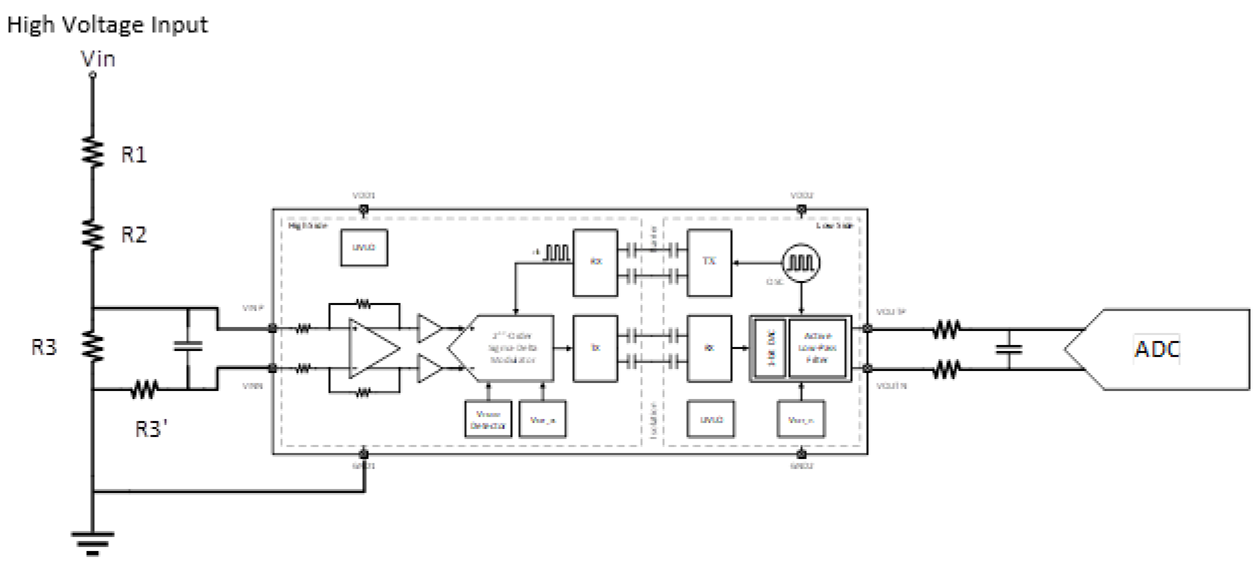

Fig. 1 CA-IS1200/1300 Isolated Voltage Detection System Block Diagram

Fig. 2 and the below derive the offset voltage if the resistor R3' is not increased. The offset voltage can be calculated by calculating the output of the front-end differential amplifier with Vin=0. Generally, the values of R1 and R2 are much larger than R3, so R3 is directly taken as the parallel of R3 and R1+R2 in Fig. 2.

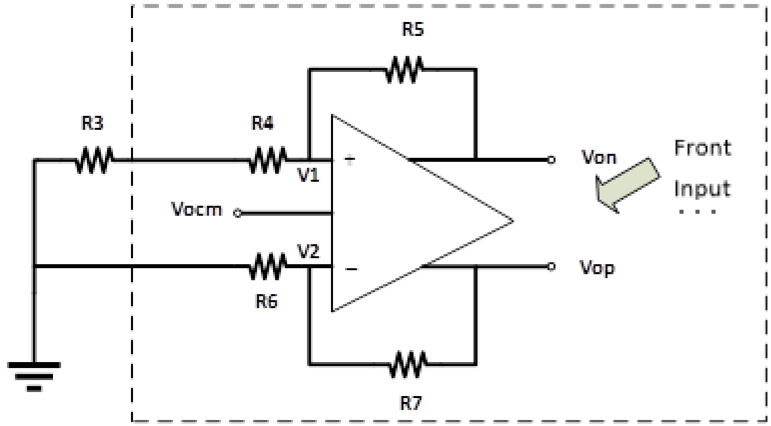

Fig. 2 Fully Differential Front-end Output Offset Voltage

Fig. 2 shows the CA-IS1200/1300 device front-end fully differential amplifier structure, R4=R6, R5=R7, and the output common-mode voltage is set to 1.875V. Then the front-end output offset voltage Vos can be calculated according to the following equations:

$$V1 = \frac{\mathrm{R3 + R4}}{\mathrm{R3 + R4 + R5}} * Von$$

$$V2 = \frac{\mathrm{R6}}{\mathrm{R6 + R7}} * Vop$$

$$V1 = V2$$

$$Von + Vop = 2 * Vocm$$

From the equations above, it follows that:

$$Vos = Vop - Von = \frac{2 * \mathrm{R3} * \mathrm{R5}}{\mathrm{R3} * (2 * \mathrm{R4} + \mathrm{R5}) + 2 * \mathrm{R4}(\mathrm{R4} + \mathrm{R5})} * Vocm$$

For example, for the CA-IS1300G25G device, R4=R6=12.5kΩ, R5=R7=50kΩ in the front-end fully differential amplifier. When R3=158Ω, Vos=18.8mV can be calculated according to the above equations, which is a non-negligible error for the system. The imbalance voltage caused by input impedance imbalance can be eliminated by increasing R3'=R3.

The voltage gain of the whole system will be calculated below, and the equivalent circuit is shown in Fig. 3:

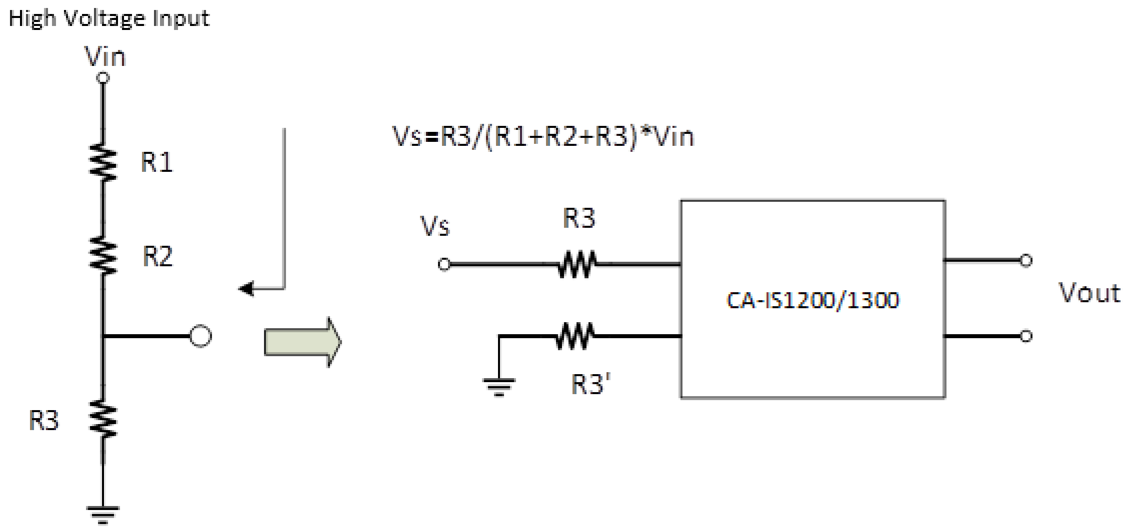

Fig. 3 System Voltage Gain

The relationship between the output of the CA-IS1200/1300 device Vout and the high voltage input Vin is as follows:

$$Vout = \frac{\mathrm{R3}}{\mathrm{R1}+\mathrm{R2}+\mathrm{R3}} * \frac{\mathrm{R4}}{\mathrm{R4}+\mathrm{R3}} * G0 * Vin$$

G0 is the voltage gain of the CA-IS1200/1300 device.

The two points mentioned above can eliminate the measurement error of the system, and on this basis, users can still determine whether further system gain and misalignment calibration is needed to obtain better system accuracy.

3 Conclusion

This article describes the technical points that should be paid attention to when the isolation current amplifiers with fully differential amplifier front-end such as CA-IS1200/1300 are used as isolation voltage amplifiers.

4 Version Information

Version	Date	State Description
Ver1.0	Apr. 2022	Initial version

5 Important Statement

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