

Development of Programmable Inductive Voltage Divider

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Abstract: A recently developed programmable Inductive Voltage Divider (IVD) is described in this paper. The specialty is that the decade windings were replaced by the binary windings and the rotary switches are replaced by relays. The microprocessor is adopted in the IVD. The method of making binary IVD was researched. The calibration method for the binary IVD is given. The uncertainty of the binary IVD is analyzed. The calibration result shows that the programmable binary IVD has more advantage than the traditional decimal IVD.

Key words: Inductive voltage divider, Binary, Programmable, Development, Calibration Uncertainty

1.Introduction

An IVD is an instrument to offer a precise ratio of AC voltage. It has more specific property such as high input impedance, low output impedance, large ratio range, small ratio error, good stability, wide frequency band, etc. It not only can degrade the incoming error of self-exciting current but also can reduce the effect of load and parasitoid admittance. Especially it can reduce influence to the other part when it is connected in the measurement system. Usually the accuracy of an IVD can reach 10^{-6} - 10^{-7} . Therefore, it is an ideal instrument to measure AC voltage. According to the principle of reciprocity, an IVD can be changed in an inductive current shunt. So it is also an ideal instrument to measure AC current. Because an IVD has so much advantage, it is also an important part of a RLC bridge. It was studied by electrical engineer for many years in the world and the technique had been advanced thirty years ago. But nearly twenty years it was no longer advanced. Because it is still operated by manual, so it is difficult to realize automation and it does not fit with the digitization and automation. The measurement level of AC voltage, AC current and RLC was limited by the traditional IVD. So it is an urgent problem of which need to be solved.

2.Major technique problem and solution

As we know, the traditional IVD adopts decimal and operated by manual. The decade rotary switch and correlation winding was used in it. This technique has been used for many years. But it is difficult to make a programmable instrument with it. For Example, a seven decades IVD has seventy switching points. If they are adjusted sequentially with seven step-motors, the cost will be high, the structure will be complex and the program of corresponding microprocessor will be difficult. The method to realize a programmable IVD is to use a microprocessor. The rotary switches are replaced by relays. The windings of IVD were wined with binary instead of decimal. Development of binary IVD is good mode to solve problem of decade IVD. Because of binary number value vary with powers of integers, the span is large, therefore a great deal switches are reduced, and also reduce correlation winding .For example output 1~11111110, the decimal system takes 70 switch points and windings, but binary system only takes 24 switch points and winding. The number change of decimal-to-binary is convenient by using a microprocessor. The development of the microprocessor program is relatively easy. The device is simple and reliable, but new problem was brought out.

- 1) How to select the coil number of winding? If the coil number is large, the capacity of among coils will be increased. If the coil number is little, the exciting magnetism will be

lack.

- 2) The binary IVD was adapted to made with isolate IVD. But self-inductive voltage divider has high accuracy. So we must adopt self-inductive voltage divider to raise the accuracy.
- 3) A lot of relays were used in a programmable IVD. It is difficult to drive many relays at the same time for the microprocessor.
- 4) Because there is a power supply in the programmable IVD, the electromagnetic interference exists to the iron core of the IVD.

By studied the theory of IVD and practiced again and again, the problems above were solved. The convolution number of winding select 256,128,64,32,16,etc, so it not only reduce the capacity of among convolution but also ensure the exciting magnetism to iron core. This structure of IVD adopts multistage combination iron core mode. Usually the combination iron core of three stages has high accuracy. We have adopted combination iron core of four stages. The accuracy is very high from theory. The structure is shown in Fig.1.

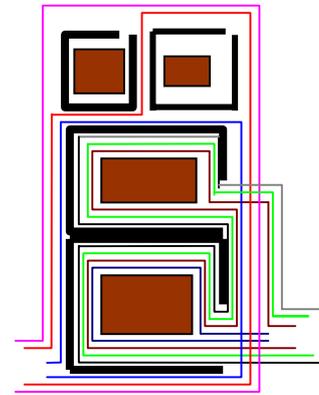


Fig.1. Diagram of winging structure

By using the multiple connection of self-inductive voltage divider and isolate IVD, the accuracy is hold with self-inductive voltage divider and the resolution is raised with isolate inductive voltage divider. In order to match a binary exciting magnetism winding, the self-inductive voltage divider adopt hexadecimal. A alternate direction relay K (Fig.2) was used and it was controlled by the software, so the quantity of isolate inductive divider was used minimum. The accuracy can be further improved. The problem how to drive many relays was solved by to driving them step by step at different time. The problem of iron core which to be interfered is solved by shield it to power supply. The circuit is shown in Fig.2.

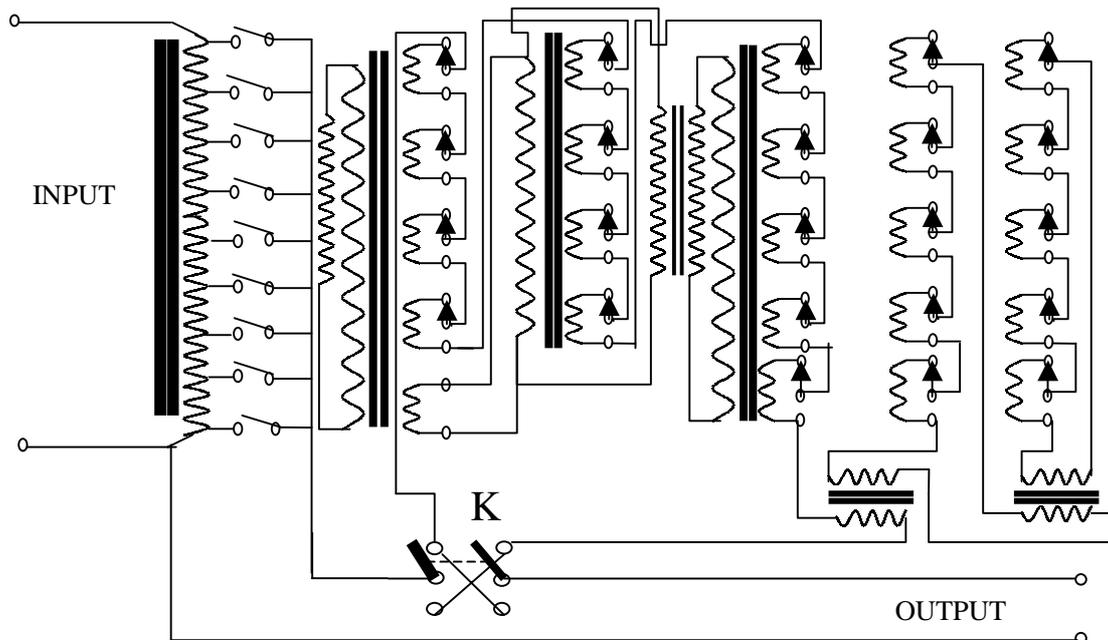


Fig.2 Diagram of the multiple connection of self-inductive voltage divider and isolate IVD

3. Control system of IVD

In order to realize the automation of IVD, the control system of which include 8031 microprocessor and GPIB was adopted. The measurement is proceeded by computer control. The system is shown in Fig.3

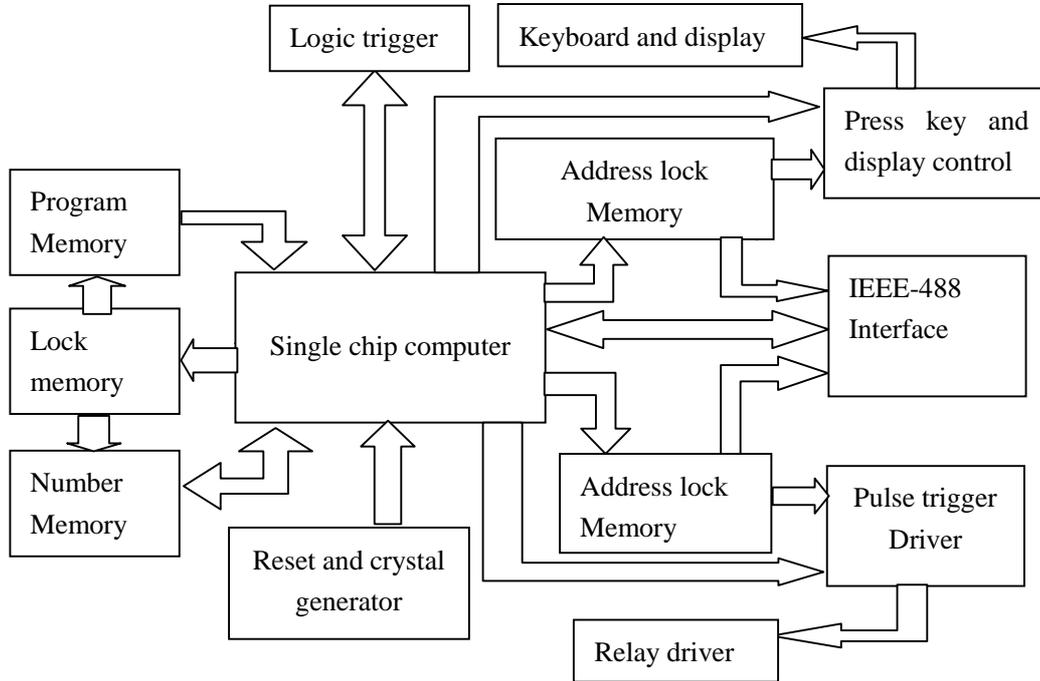


Fig.3 Block diagram of control system

4. Calibration method

The IVD was made by using multistage combined iron core, so it has high accuracy. After self-inductive voltage divider and isolate inductive divider were connected multiple series, the error of IVD is 10^{-6} in magnitude. Because the IVD is a measurement standard, so it must be calibrated. The calibration method is to calibrate IVD absolutely by using a assistance IVD and a reference winding. The assistance IVD and the reference winding must be wined with binary mode as above. The principle of calibration is that a reference voltage was offered by a binary reference winding and the voltage of reference winding is lifted by the assistance IVD. The calibration process is that the binary reference winding compare with one output segment of IVD. The first segment balance is with reference voltage and the second segment balance is without reference voltage. The display value of rate error compensate (A) and angle error compensate (B) were deducted between the two balance. The result is the deviation of one segment of IVD compared with the reference winding. All segment of IVD are calibrated with this method. The rate error and angle error of IVD is got through calculation. The accuracy of the assistance IVD is not high, the error can be eliminated in the two balance. Because the IVD is programmable, the calibration process can be performed automatically. The Block of calibration system is shown in Fig.4

Shield protection should be used in the calibration. The output terminals and lines are protected by the electrical potential by which offered the assistance winding.

Usually the calibration is taken in the 1kHz. The accuracy after calibration can be 10^{-7} magnitude. The accuracy of IVD will be reduced in other frequency.

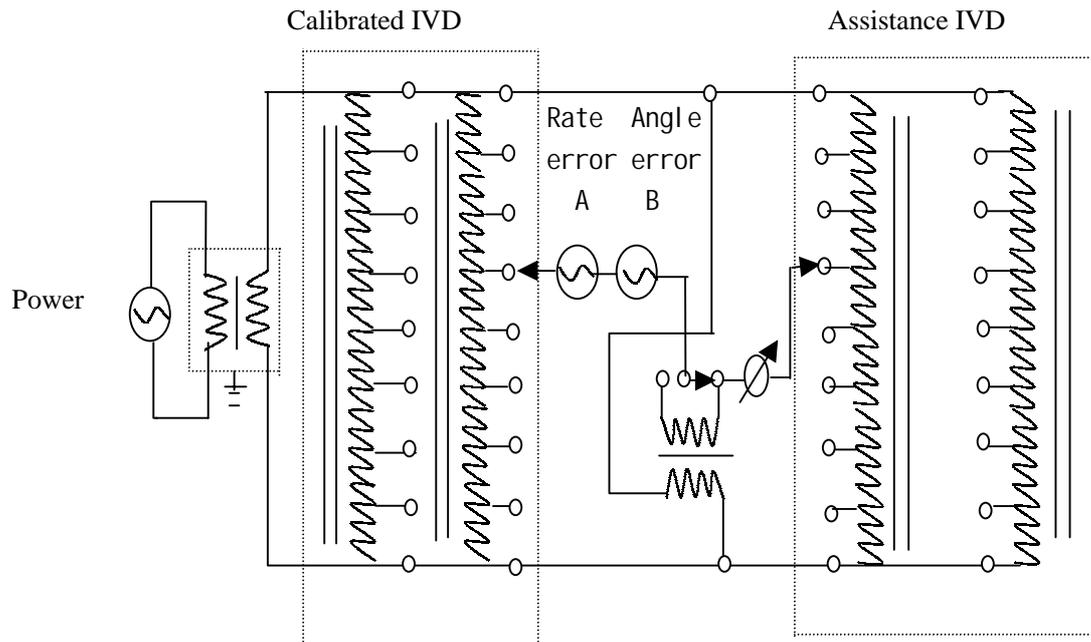


Fig.4 Block of calibration system

5.Conclusion

A new IVD of binary and hexadecimal multiple series connection was developed to realize the programmable IVD. It is a significant practice, the traditional measurement and modern technique were combined. It has been applied in the calibration system of AC standard resistance and a good result had been got. The measurement level of AC voltage, AC current, AC resistance, inductance and capacitance was also improved as well.

Reference

- [1]. Li Jidong, Huang Xiaoding, Li Zhencai, “*Research report of AC resistance calibration system*”,unpublished.
- [2]. Li Jidong, Huang Xiaoding, Li Zhencai, “*Test report of AC resistance calibration system*”, unpublished.