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Research Article

The Design and Implementation of Operational Amplifier Wide Range Floating Power in Laser Trim Machine

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Abstract: In order to resolve the application problem of wide range voltage in operational amplifier, a method of floating power is proposed. And the design of wide range voltage circuit is implemented, which can make the input voltage range from -32V to +32V for normal amplifier. It has certain value for operational amplifier in wide range voltage applications.

Keywords: Currents, floating power, operational amplifiers, voltage followers, voltages

INTRODUCTION

The power voltage can range from ±2V to ±15V for normal operational amplifier (James and Riedel, 2005) 1. So the signal range is limited by the scope of power voltage. Practical applications sometimes require the wider signal range while the general circuit design cannot meet the requirements. For example, the output drive voltage can range from -32V to +32V for the laser trimmers machine (Yongping, 2004, 2002a, 2000) 2, 3, 4. Therefore, the precision operational amplifiers cannot operate as usual in feedback voltage loop. To solve the application problem of wide range voltage in operational amplifiers, a method of floating power is proposed, which can make the voltage of normal operational amplifiers range from -32V to +32V.

MENTALITY OF DESIGNING

Figure 1 shows that two constant flow sources are designed by using Q1 and Q2. And there is a 30V voltage regulator between two constant flow sources. We regard the voltage of stabilivolt (VQA, VQB) as the power voltage of the operational amplifier that ranges from -15V to +15V. The power voltage can float up and down with the input signal at the same time. The range of the power voltage (VQA-VQB) is 30V, and because the potential of VQA and VQB can be very high, we consider using two voltage regulars to clamp the power voltage to the input signal.

Circuit design and analysis: This part gives the circuit design, and analyzes the theory of the floating power. Moreover, the circuit of the floating power application in voltage follower is offered.

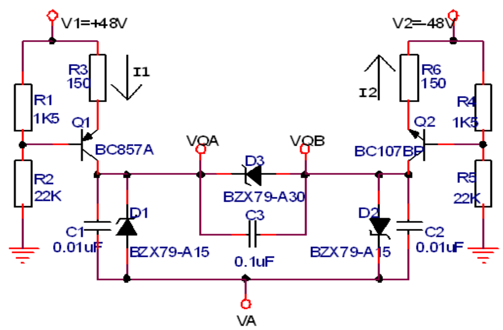

Fig. 1: Floating power circuit diagram

Floating power: Figure 1 is the floating power circuit diagram. One constant flow source consists of R1, R2, R3 and Q1, and the other consists of R4, R5, R6 and Q2. D1, D2 and D3 are three stabilivolts. The stabilized voltage of D1 and D2 is 15V. And the stabilized voltage of D3 is 30V. The B-E establishing voltages of Q1 and Q2 are 0.75V.VQA and VQB provide the power voltage of operational amplifiers that work in the wide range voltage. VA is the voltage of the driving end of the signal output. And in the diagram, C1, C2 and C3 play a role in power filtering.

According to Fig. 1, the current of the first constant flow source is formula (1):

$$I_1 = \frac{(\frac{V_1 R_1}{R_1 + R_2} - 0.75)}{R_3} \approx 16.818mA \qquad (1)$$

The current of the second constant flow source is formula (2):

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$$I_2 = \frac{(\frac{V_2 R_4}{R_4 + R_5} - 0.75)}{R_6} \approx 16.818mA \tag{2}$$

The difference between I1 and I2 approximates to the absorption current of VA. In practical circuit, there are some differences between these two currents. The two currents can be similar by adjusting R2 or R5.
We note that: the stabilized voltage of D3 is 30V:

$$VQA - VQB = 30V \tag{3}$$

VQA and VQB provide the power voltage of operational amplifiers that work in wide range voltage.

Note that the stabilized voltage of D1 and D2 is 15V, we have:

$$VQA - VA = 15V \tag{4}$$

That is:

$$VQA = VA + 15V \tag{5}$$

And we also have:

$$VA - VQB = 15V \tag{6}$$

That is:

$$VQB = VA - 15V \tag{7}$$

According to formula (3), (5) and (7), we know that, VQA and VQB swing 15V with respect to VA.

Voltage follower circuit based on floating power: Figure 2 is the floating power application in voltage follower diagram. And the point that can get the voltage of VA is shown in the diagram. VA is taken from the driver output of the other circuit U2. We put the driver output and a resistance in series for using as the signal voltage of pre-stage. The voltage drop of R2 is: (I1-I2) R2 ≈ 0, so we have: VA ≈ Vout, Therefore, Vout is always between VQA and VQB. And it will not exceed the input voltage range of the voltage follower. In laser trim machine applications, the pre-stage that drives U2 is PID mediation circuit (Yongping, 2004, 2002b) 2, 3. We make the output voltage of Vout controllable with the feedback of voltage follower in U1.

As shown in Fig. 2, the voltage of operational amplifier U1 is taken from the floating powers (VQA and VQB), which can work in the wide range voltage. The output voltage of the Voltage Follower (Vfd) is equal to Vout, and the voltage can range from -32V to +32V (the difference between the maximum and minimum is 64 V) while the maximum range of voltage of operational amplifier is 30V (equal to a range of ±15V). The actual range can be higher, but the voltage of laser trim machine only needs to range from -32V to +32V.

This design method can also be used for the amplification circuit and voltage compare circuit of wide voltage operational amplifier (Yongping, 2002a) 5.

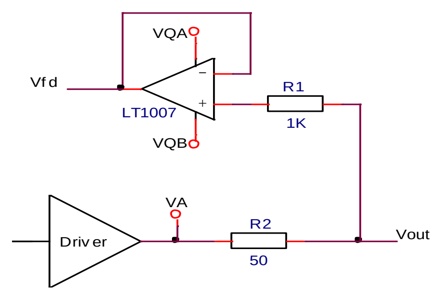

Fig. 2: Floating power application in voltage follower diagram

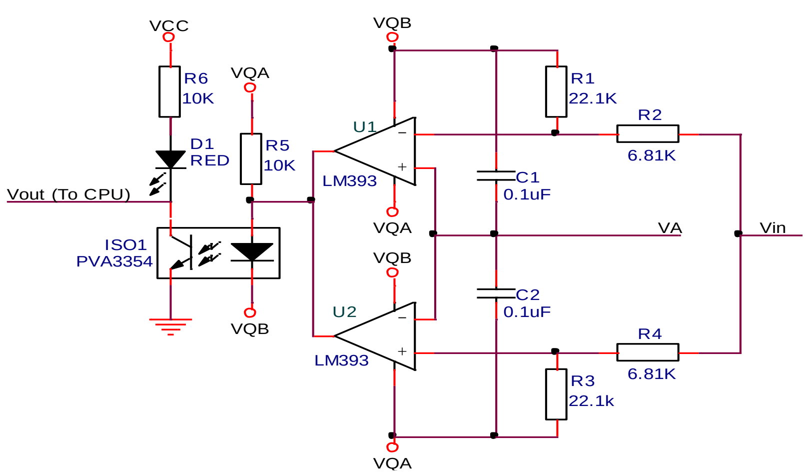

Fig. 3: Floating power voltage compare circuit diagram

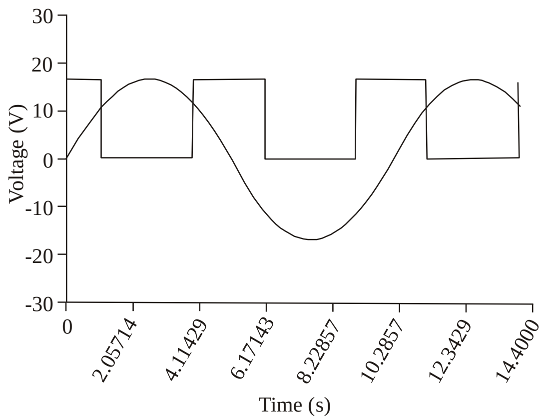

Fig. 4: Relation curve of the input of Vin and the output of voltage comparator

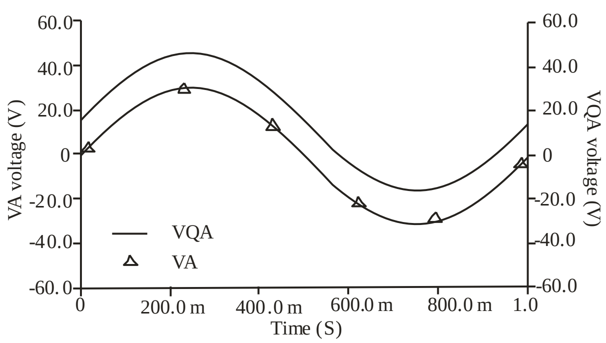

Fig. 5: VA and VQA voltage curve

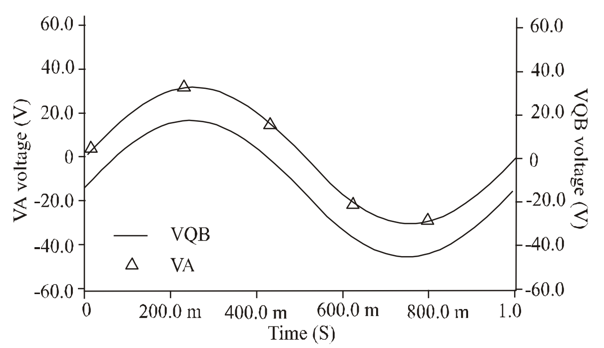

Fig. 6: VA and VQB voltage curve

Voltage overload alarm circuit based on floating power: Figure 3 is a voltage compare circuit based on floating power, which is used for detecting the input voltage Vin whether is excess or not. When Vin is within the scope of VA±10, the input voltage Vin operates normally. So the optical isolation switch is turned on, the light-emitting diode D1 is on and the voltage Vout sent to CPU for detection is low. But when Vin is beyond the scope of VA±10, the input voltage is beyond the normal scope. Then the optical isolation switch is turned off, the light-emitting diode D1 is off and the voltage Vout sent to CPU for detection is high. We can detect the input voltage

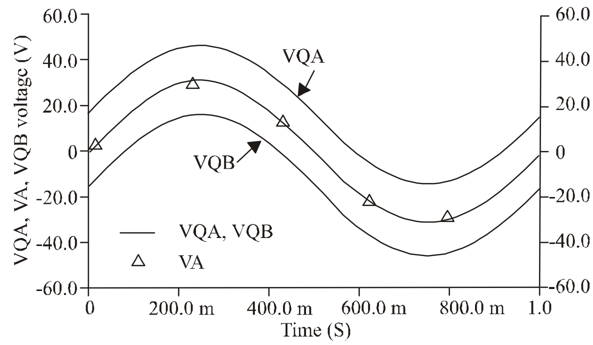

Fig. 7: VA, VQA and VQB voltage curve

whether is excess by using this circuit. Because comparators U1 and U2 work on the basis of floating power, the comparative voltages are relative to VA, which can be used for comparison of high voltages.

Figure 4 is the relation curve of the input of Vin and the output of voltage comparator when VA is equal to 0. As shown in curve, when Vin range from +10V to -10V, the output of comparator is high, the optical isolation switch is on, and Vout is low. When Vin is beyond the scope of ±10, Vout is high. When VA is not equal to 0, zero point move up and down to the VA value.

EXPERIMENTAL RESULTS

Figure 5 is the measuring voltage values of VA and VQA, and VQA is always higher than VA. According to formula (5), we note that, the difference between VQA and VA is equal to 15 V theoretically. The experiment data shown in Fig. 5 also verify the theory that VQA will float upward 15V with VA.

Figure 6 is the measuring voltage values of VA and VQB, and VQB is always lower than VA. According to formula (7), we note that, the difference between VA and VQB is equal to 15 V theoretically. Figure 6 indicates that VQB will float downward 15 V with VA.

Figure 7 is the voltage curve of VA, VQA and VQB. According to Fig. 7, we can note that, VQA and VQB float upward and downward with VA.

CONCLUSION

A method of floating power is proposed. Floating power applications in voltage follower and voltage overload alarm are implemented. And the proposed method resolves the problem of wide range voltage in operational amplifier. We also verify the feasibility of this method. It has certain value for operational amplifier in wide range voltage applications.

REFERENCES

James, W.N. and S.A. Riedel, 2005. Electric Circuits. Pearson Education, America.

Yongping, H., 2000. Measurement theory and implementation method of source wheat stone bridge in laser high speed resistance trim. Optics Precision Eng., 4: 394-396, (In Chinese).

Yongping, H., 2002b. Study and design of the real-time online measurement and control system of laser resistor trim machine. Ph.D. Thesis, Changchun Institute of Optics, Fine Mechanics and Physics, Academia Sinica, P.R. China, 2: 57-59, (In Chinese).

Yongping, H., 2002a. Time-domain analysis of high precision programmable power circuit in laser resistance trim system. J. Jilin Univ. Sci. Edn., 4: 175-178, (In Chinese).

Yongping, H., 2004. Complex frequency domain analysis of the high precision programmable voltage supply circuit of laser resistance trim system. Chin. J. Scientific Instrument, 1: 94-98, (In Chinese).