Design of Variable Gain Amplifier Circuit Based on Newton Rings Stress

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Abstract--On the purpose of measuring Newton rings deformation stress and the intelligentialize of the newton rings apparatus, a Variable Gain Amplifier circuit which is based on a low power, general purpose instrumentation amplifiers INA128 offering excellent accuracy was designed to amplify the low frequency and voltage signal from the Pressure sensor. The principle of circuit and the information of chips used were introduced detailedly. Intermediately, problem which appeared in the program of the design had been figured out. Finally, test the performance of the circuit and analyze the experimental data with MATLAB, results were as follws, when the gain is equal to 33.97dB(Magnified 50 times),the bandwidth is up to 599kHz; when the gain is equal to 40dB(Magnified 100 times),the bandwidth is up to 250kHz; when the gain is equal to 53.98dB(Magnified 500 times),the bandwidth is up to 39kHz.

key words-gain variable; Amplifier circuit; nstrumentation; newton rings;INA128.

I. INTRODUCTION

It is necessary that the newton rings apparatus[1] need to be made a change for the intelligentialize and research activity. Intelligent consists of the following aspects, on the one hand, the accuracy of newton rings apparatus should be improved; on the other hand, instead of reading the microscope with your eyes immediately, you can observe the picture of the microscope through the display, and you can measure the parameters of the picture by the way of image processing. An amplifier circuit must be designed to meet the needs of improving the accuracy of newton rings apparatus.

II. SYSTEM BLOCK DIAGRAM AND SCHEMATIC DIAGRAM

INA128 is chosen from all sorts of amplifiers, and high precision linear regulated power supply should be provided for it. As shown in Fig 1, The INA128 is low power, general purpose instrumentation amplifiers offering excellent accuracy[2]. For example, it can magnify the small-signal from gravity sensor.

Fig 2 shows the schematic diagram which is based on the system block diagram.

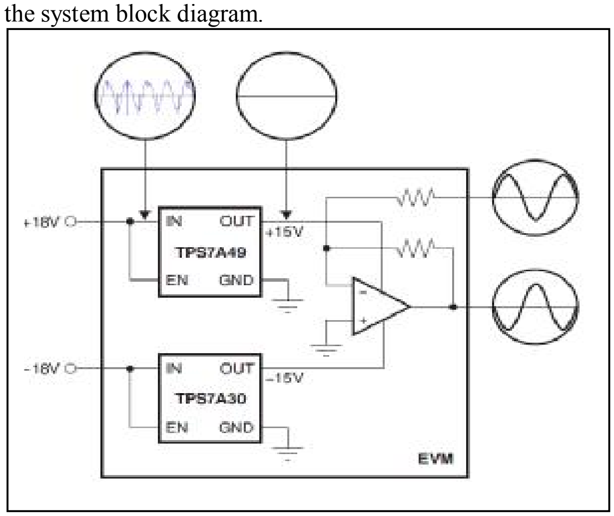

Figure 1. AMPLIFIER SYSTEM BLOCK DIAGRAM

III. THE PRINCIPLE OF THE MAIN CHIP

A. INA128

The INA128 are low power, general purpose instrumentation amplifiers offering excellent accuracy. The versatile 3-op amp design and small size make them ideal for a wide range of applications. Current-feedback input circuitry provides wide bandwidth even at high gain (200 kHz at G = 100). A single external resistor sets any gain from 1 to 10,000. RG connected between pins 1 and 8. It is easy to use the INA128, and when we put the slide rheostat to take the place of the RG, a variable gain amplifier can be designed. Gain formula[2]:

$$G = 1 + \left(\frac{50k\Omega}{R_G}\right) \quad (1)$$

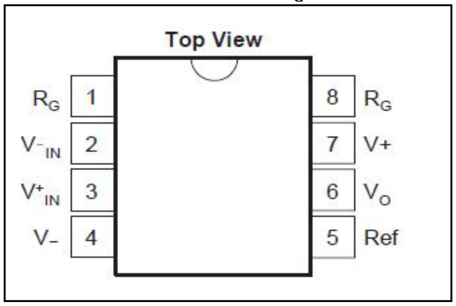

Figure 3. INA128 PIN CONFIGURATION

B. *TPS7A4901 and TPS7A3001*

The parameters and usage of TPS7A4901 and TPS7A3001 are basically same. The only difference is that TPS7A4901 is a positive linear regulator, but TPS7A3001 is negative linear regulator. For the reason, they are usually used in pairs to provide positive and negative power supply. So we will illustrate the usage of two linear regulators with TPS7A4901[3].

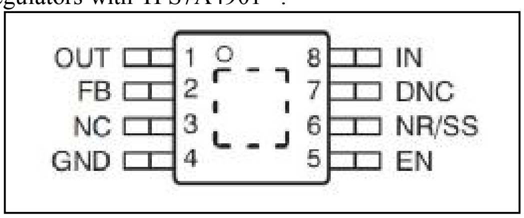

Figure 4. TPS7A4901 PIN

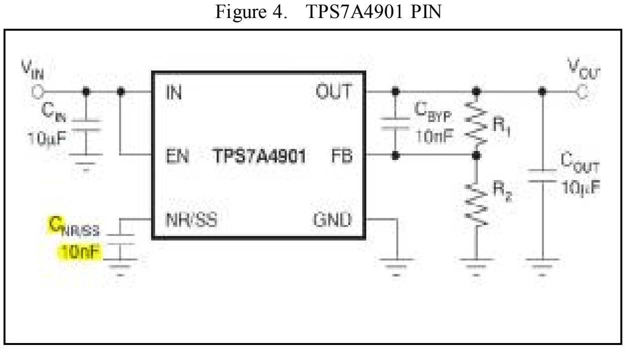

Figure 5. TYPICAL APPLICATION CIRCUIT

The TPS7A4901 has an output voltage range of +1.194 to +33V. The nominal output voltage of the device is set by two external resistors, as shown in Figure. R_1 and R_2 can be calculated for any output voltage range using the formula shown in (2) To ensure stability under no load conditions, this resistive network must provide a current equal to or greater than 5 μ A[3].

$$R1 = R2\left(\frac{V_{OUT}}{V_{FB}} - 1\right) \quad (2)$$

V_{FB} is 1.18 V because of the device characteristics[2].

IV. MODULE PERFORMANCE TEST

The test of module is mainly divided into two aspects. Firstly, test the performance of the linear power, then test the performance of the amplifier.

A. *Test of linear regulated power supply module:*

It must be sure that whether the performance of the power module is meet the requirements before testing the amplifier[4-6]. Fig 6 shown the Printed Circuit Board(PCB).

Table 1 shows the definition of the pin in the amplifier PCB.

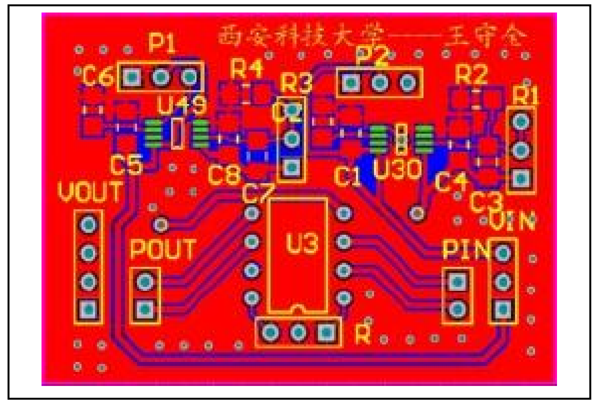

Figure 6. AMPLIFIER PCB

TABLE I. PIN DEFINITION

Sill-screen	Direction	Function
VIN	Input	Input of external power
VOUT	Output	Output voltage value of linear regulated power supply
PIN	Input	Input of external signal
POUT	Output	Output of amplifying signal

With adjusting the slide rheostat of R_1 and R_3 the output voltage can be changed to power INA128. It is important to note that the absolute value of external voltage must be bigger 2 V than what you want to get, for example, if you want to supply INA128 with ±15V, the external input voltage is ±17 at least.

B. *amplifying circuit performance test(amplitude-frequency response):*

The main instrument: signal generator, oscilloscope, several wires and voltmeter.

Here are several typical gain according to the INA128 gain formula[2]: RG=1KΩ, G=33.98dB。 RG=500Ω, G=40dB。RG=100Ω, G=53.98dB.

Using MATLAB software to draw the amplitude-frequency response curve[7-9]. As shown in figure 4.

Due to the limitation of the signal generator, the signal amplitude is set 0.05V, and frequency was gradually increased from 5Hz.

TABLE II. CUT-OFF FREQUENCY OF THE TYPECAL GAIN

Gain	Cut-off frequency
G=33.98dB	599KHz
G=40dB	250KHz
G=53.98dB	39KHz

Table 2 shows the cut-off frequency of the typical gain which obtained from figure 4. Obviously, when the gain is equal to 33.97dB(Magnified 50 times),the bandwidth is up to 599kHz; when the gain is equal to 40dB(Magnified 100 times),the bandwidth is up to 250kHz; when the gain is equal to 53.98dB(Magnified 500 times),the bandwidth is up to 39kHz.

V. CONCLUSION

According to the measured data, both magnification and bandwidth conform to the need of intelligent newton rings apparatus, and it will provide guarantee for the newton rings apparatus acquiring accurate data. Nevertheless, what we did is the beginning of intelligent newton rings apparatus, the mechanical structure of newton rings apparatus must be transform to meet the needs of measurement

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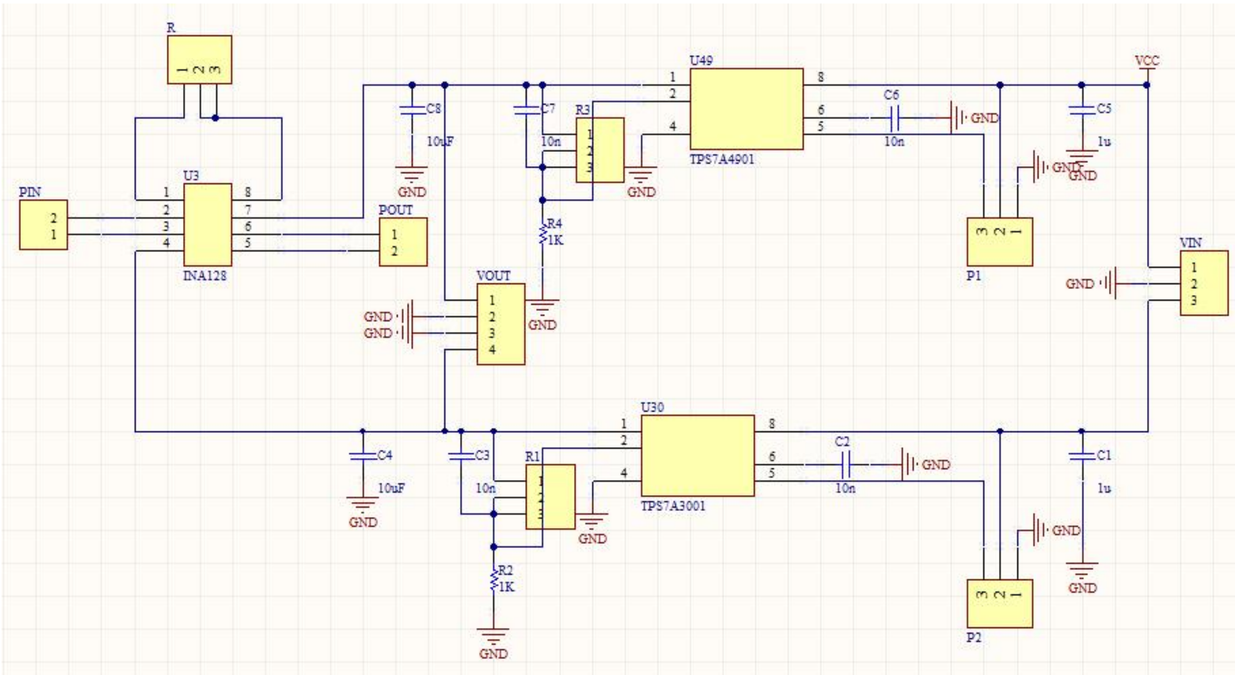

Figure 2. AMPLIFIER SCHEMATIC DIAGRAM

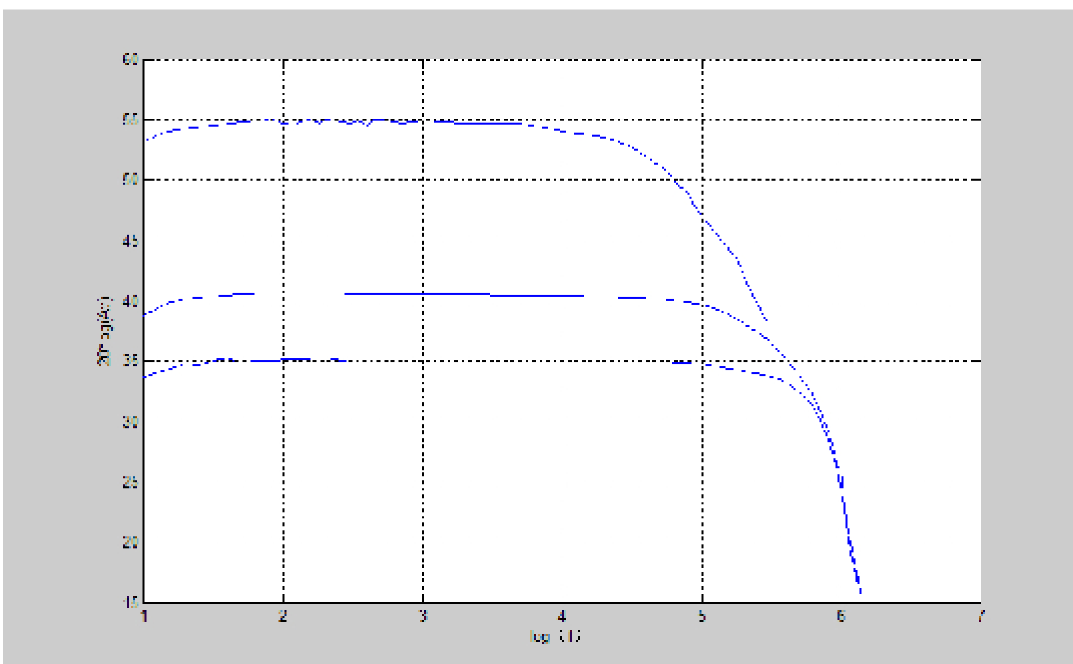

Figure 7. AMPLITUDE-FREQUENCY RESPONSE CURVE