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Design of Low cost Load cell Amplification Card

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Abstract - *Whether being used for closed loop feedback, automation and assembly lines, stamping or other industrial applications, load cells provide accurate measurement of a load and convert tension or force into a proportional electrical signal. A load cell amplifier is then used for signal conditioning so the signal can be amplified and converted into an output value. Without a load cell amplifier, the signal from the load cell may be too weak to read. The amplifier simply "amplifies" the signal so it can be read and used wherever and however needed.*

As load cell can gives the output in the range of 0-20 mV. It is very low voltage so it should be amplified to -10V to +10V range so that Programmable controller or DAQ device can process the signal accurately.

In market many brand of load cell amplifier are available. But we are going to make a simple low cost amplifier which will be more accurate and also have gain adjustable feature.

1. INTRODUCTION

In this amplification card we are using three OP-Amp IC named as OP07C. The op07c is Low Noise amplifier IC. It replace Chopper Amplifiers at a Lower Cost (about ₹15 per piece). OP07 Op-amp IC have wide Input-Voltage Range: 0 to ±14 V and Wide Supply-Voltage Range: ±3 V to ±18 V.

For reducing environmental interferences and noise we are using Polyester-Capacitors. The polyester dielectric used in these capacitors also referred to as PET offers a high dielectric strength. This means that high voltage capacitors can be made relatively small. The construction and dielectric of polyester, PET capacitors means that they are able to be used in applications where sharp, fast rise time spikes are present as they are able to accommodate high dV/dt .

For making power supply for the Amplifier we are using 5 Volt regulator (LM7805), 12 Volt regulator (LM7812), -5volt regulator (LM7905) and -12 volt regulator (LM7912). A 12-0-12 step down, center tap transformer is also required in power supply circuit.

2. STUDY

2.1 Amplification Card

Now next we are going to understand circuit diagram for amplification card. The circuit diagram of the amplification is shown in figure: 1.

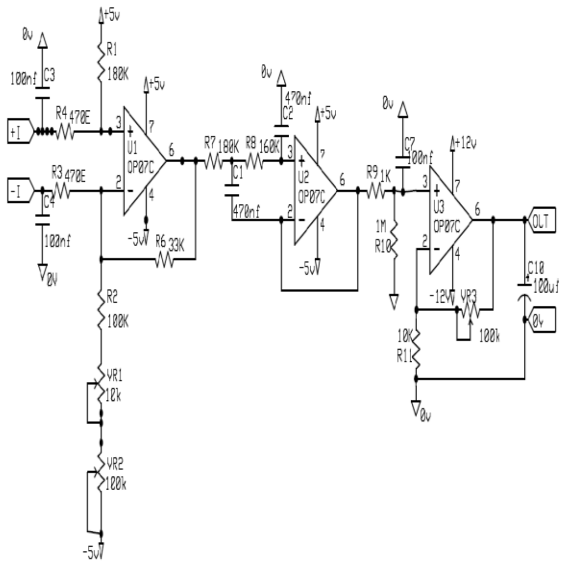

Fig.1: Circuit diagram of amplification Card

Table: 1 Component list for amplification card:

Sr.no	Component name	Specification	Quantity
1	VR1,	10k (103 W)	1
2	VR2,VR3	100k (104 W)	2
3	R1,R7,R8	180k	3
4	R2	100k	1
5	R3,R4	470E	2
6	R5,R6	33K	2
7	R9	1K	1
8	R10	1M	1
9	R11	10k	1

10	C7	100nf (.1J63)	1
11	C1,C2	470nf (470nJ63)	2
12	C3,C4,C5,C6 ,C8,C9	0.1uf (104 PF)	6
13	IC U1,U2,U3	OP07C	3

- Circuit diagram have three stages for amplification. In which middle op-amp connected such that it gives unity gain.
- In the circuit VR1 and VR2 are variable potentiometer which can be used for adjusting the offset if it will occurs.
- The VR3 is used to adjust gain of the amplifier circuit.
- The input terminal +I and –I accepts millivolt signal and after amplification we can get output between OUT and 0V leads.
- For the derivation of gain we will disconnect R1, R2, VR1 and VR2.
- Let voltage at +I is V1 and at –I it is V2.
- V01 is the output of first op-amp. V02 is the output of second op-amp.
- Vout is the output of last op-amp.

$$\frac{\mathrm{V1-V2}}{470E}+\frac{V1-V01}{33K}=0$$

$$33V1-33V2+0.47V1-0.47V01=0$$

$$V01=71.21V1-70.21V2 \qquad \text{Eq. (1)}$$

Similarly,

$$\frac{\mathrm{V01-V1}}{33}+\frac{V01-V02}{180+160}=0$$

Now put the value of V01 from Equation (1). We get

$$373(71.21V1-70.21V2)-340V1-33V01=0$$

$$V02=794.58V1-793.58V2 \qquad \text{Eq. (2)}$$

Now let Va is the voltage non-inverting terminal of last Op-amp

So,

$$\frac{\mathrm{Va-V02}}{1K}+\frac{Va}{100K}=0$$

$$101Va-100V02=0$$

Put the vale of V02 from Eq. (2) we get,

$$Va=786.71V1-758.72V2 \qquad \text{Eq. (3)}$$

Also for last op-Amp,

$$\frac{\mathrm{Va}}{10K}+\frac{Va-Vout}{R}=0$$

Now put the value of Va from Eq. (3) we get,

$$(10+R)(786.71V1-785.72V2)=10Vou_t$$

$$\frac{\mathbf{Vout}}{V1-V2}=78.67(10+R) \qquad \text{Eq. (4)}$$

The equation (4) is the input output equation which gives the gain of the amplifier.

2.2 POWER SUPPLY

Now we after this we have to need a proper power supply for the amplification card.

We know that the loadcell have four lead wires. Out of those 2 are excitation input to the Strain Gauge Bridge and other two are output of the load cell.

For the excitation to the load cell we have to apply +5V and -5V. So load cell get a differensial input of 10V.

The resistance of the load cell generly found in the range of 250E to 350E ranges.

According to load the variation of resistance is not much more.

At this resistance we get output in mv from the bridge.

So we are going to make a power supply which have +5V, -5V, +12V, -12V and 0V tieminals.

For making the pwer supply we are usnig a step-down centered tab transformer.

Table: 2 Component list for Power supply

Sr.no	Component Name	Specification	Quantity
1	LM7805	5 volt regulator	1
2	LM7812	12 volt	1

		regulator	
3	LM7905	-5 volt regulator	1
4	LM7912	-12 volt regulator	1
5	C1,C5 Electrolyte Capacitor	2200uf 25V	2
6	C3,C4,C8,C6 Electrolyte Capacitor	1000uf 50V	4
7	C2,C7	.01uf (104 PF)	2

The crcuit digram of the power supply is shon in fig.2.

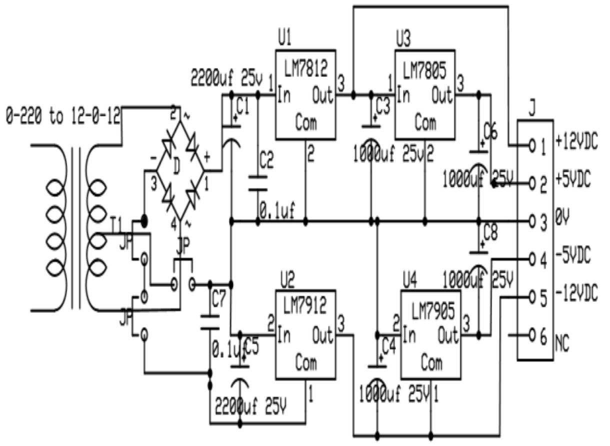

Fig. 2: power supply circuit.

3. EXPLANATION OF THE CIRCUIT:

In the first step 220VAC is stepdown to 12V AC by using transformer.

Next a bridge rectifer is used for converting AC to DC.

The centered tab wire from the transformer, is used for the 0V reference.

Now at point 1 we are getting only positive waveform of the AC waveform.

And at point 3 only negetive waveform will be found.

Now this pulseting DC have ripples. For remoing that we are using electrolyte capacitors.

Now the positive terminal 1 is connect to input of LM7812. It regulates the volatege to 12 volt.

Similarly for negetive we are using LM7912 which regulate the volatege to -12Volt.

In the circuit we can see that there is some diference in the connection of LM7812 and LM7912. In LM7912 at input we have to provide OV and at COM terminal we have to apply -volatege. Then at output we get the regulated supply -12 volt.

The same connection will be done for making +5Vand -5V.

For removing the ripples connect the capictor of 1000uf at every output of the regulator IC.

Make sure that while connecting the electrolyte capicitor, the positive terminal should be at higher potential than the negative terminal potential.

PCB Layout for Both Load cell amplifier and Power Supply.

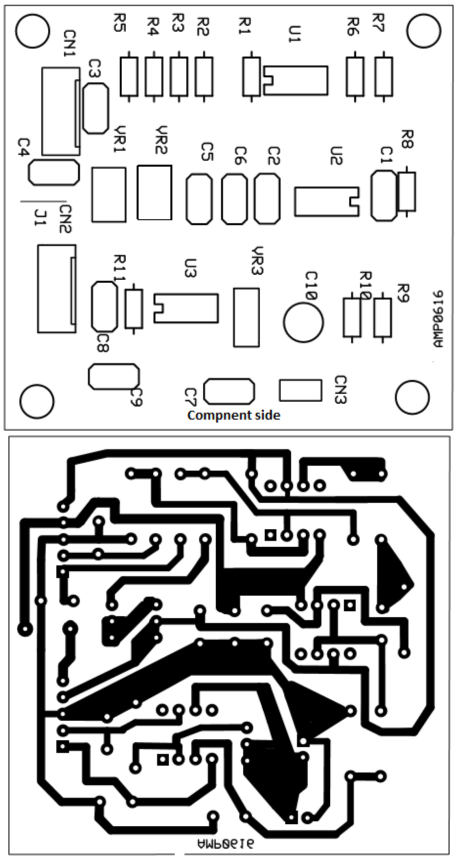

Fig.3 Amplification Card (Component side and Layout side)

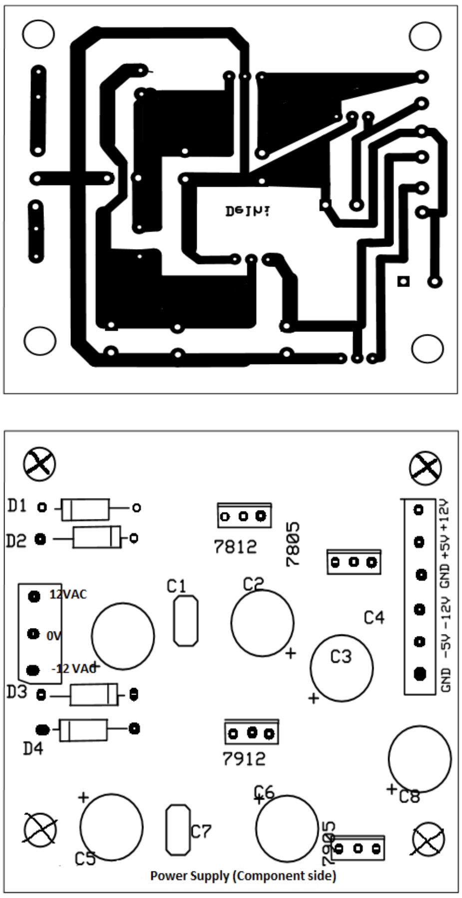

Fig.4 Power Supply (Component side and Layout side)

RESULT

If we see the gain equation of the amplification card then we can get the idea of resistance value of R.

Suppose we are applying 10mv and at ouput we have to get 10 volt.then by using the gain expression we can find the value of R.

If we calculate R then it will be about 2.8 and as in calculation we are using all values in kilo-ohm, so it will be in kilo-ohm.

Now for adjustable gain we have provide a 100k resistance potentiometer at the place of R.

This R is VR3 in the circuit diagram.

So as a result we can amplify the load cell low level voltage to high voltage for data acquisition by PLC, Arduino or other DAQ devives.

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BIOGRAPHIES

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