Instrumentation Amplifier with Shift Register As a Robot

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Abstract
The article presents a concept of designing a Instrumentation Amplifier Circuit supporting efficient and more reliable Amplification processes with some additional features of Amplification (as compared to Operational amplifier and Isolation amplifier) and further that voltage uses by multidirectional shift Register (acts as a Robot) to shift the value in different directions. The purpose of the system is to design and develop technique in making efficient amplification with added features and further support to develop technique to shift data value of voltage with provision of selection lines (robot concept based) in different directions based on requirements. Basic purposes and assumptions regarding the design and development of this system as well as a description of its operation have been presented.

Keywords: *MUX, Shift register, Instrumentation Amplifier Circuit, Latches and Flip-flop, Interfacing, Voltage gain, CMRR, OPAMP.*

INTRODUCTION
In 21st Century, Traditional concept of selecting Amplifier device for amplification purpose assumed to time consuming, one of the tedious process and comes under the categories of impracticable applications. Thus Instrumentation Amplifier circuit is an efficient solution for; to accomplish task of amplification with added virtues. Circuit designers are faced with challenge of developing system with increasing functionality and complexity while under demanding power and time-to-market constraints. Such system often requires Instrumentation Amplifier circuit to allow interfacing among MUX, Instrumentation Amplifier circuit, and Shift Register built from different process technologies. It helps to find exact solution you need. The choice of proper "Robotic device concept" depends on many factors and will affect the performance and efficiency of the circuit.

METHODOLOGY OF DESIGN PROCESS

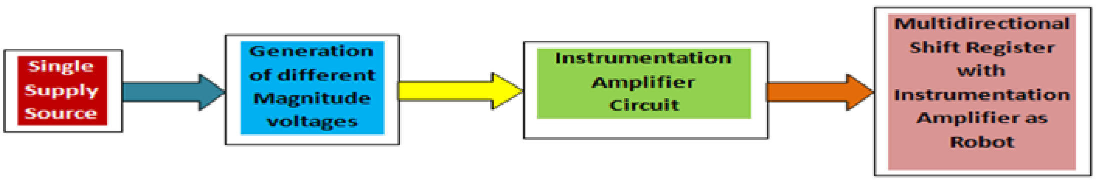


Figure 1*: Illustration of Methodology adopted in design process*

The methodology process involves in first phase; the circuit is designed to generate different magnitude voltages that act as input to Instrumentation Amplifier circuit. In second phase, these magnitudes of different voltages are transmitted via different OPAMP used within Instrumentation Amplifier circuit. Further in the third phase, A shift register circuit with Instrumentation Amplifier is designed to act as Robot wherein amplified form of voltage used by shift Register becomes capable of shifting the value in different directions up, down, east, west, north, and south based on system requirement with provision of selection line and ultimately acts as a Robot.

CONCEPT OF DEVELOPING A DIFFERENT MAGNITUDE VOLTAGE

A concept is developed to generate different magnitude voltages from a single voltage source. Three step up transformers are used to generate three different magnitude voltages by using the concept of transformer relation as

V1/V2 = N1/N2 = I2/I1

Where

V1 = Voltage at primary side.
V2 = Voltage at secondary side.
N1 = Winding at Primary side.
N2 = Winding at secondary side.
I1 = Current at primary side.
I2=Current at secondary side

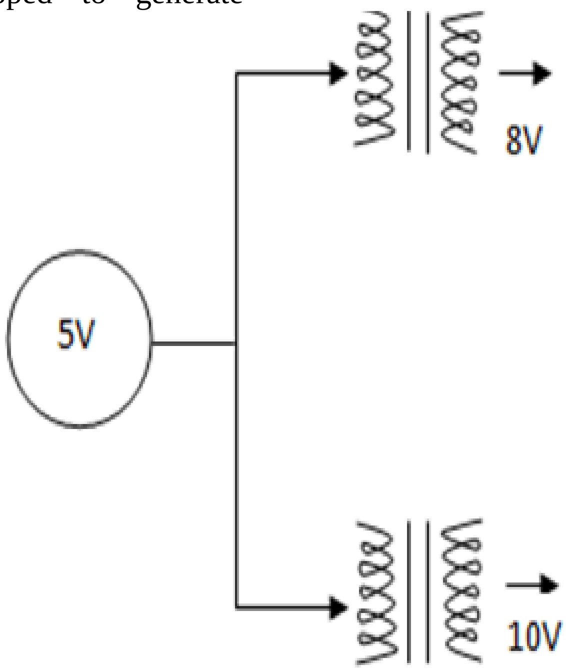


***Figure 2**: Steps up transformers for generating different magnitude voltages*

CONCEPT OF DEVELOPING INSTRUMENTATION AMPLIFIER CIRCUIT

A concept is developed to design Instrumentation Amplifier circuit wherein different magnitudes of voltages are passed via different OPAMPS that is used within an Instrumentation Amplifier circuit. The circuit "Amplified form of signal" further transfer to next stage of OPAMP within Instrumentation Amplifier circuit; and after amplification further signal becomes available at output line [1].

The important characteristics of an Instrumentation Amplifier that set it apart from other amplifier are:

- The instrumentation amplifier has finite gain selectable within precise value of range with high gain accuracy and high gain linearity.
- The instrumentation amplifier has a high impedance differential input.
- The instrumentation amplifier has high common mode rejection ratio (CMRR) and a high common mode voltage range.
- The instrumentation amplifier has high stability of gain with low temperature coefficient.

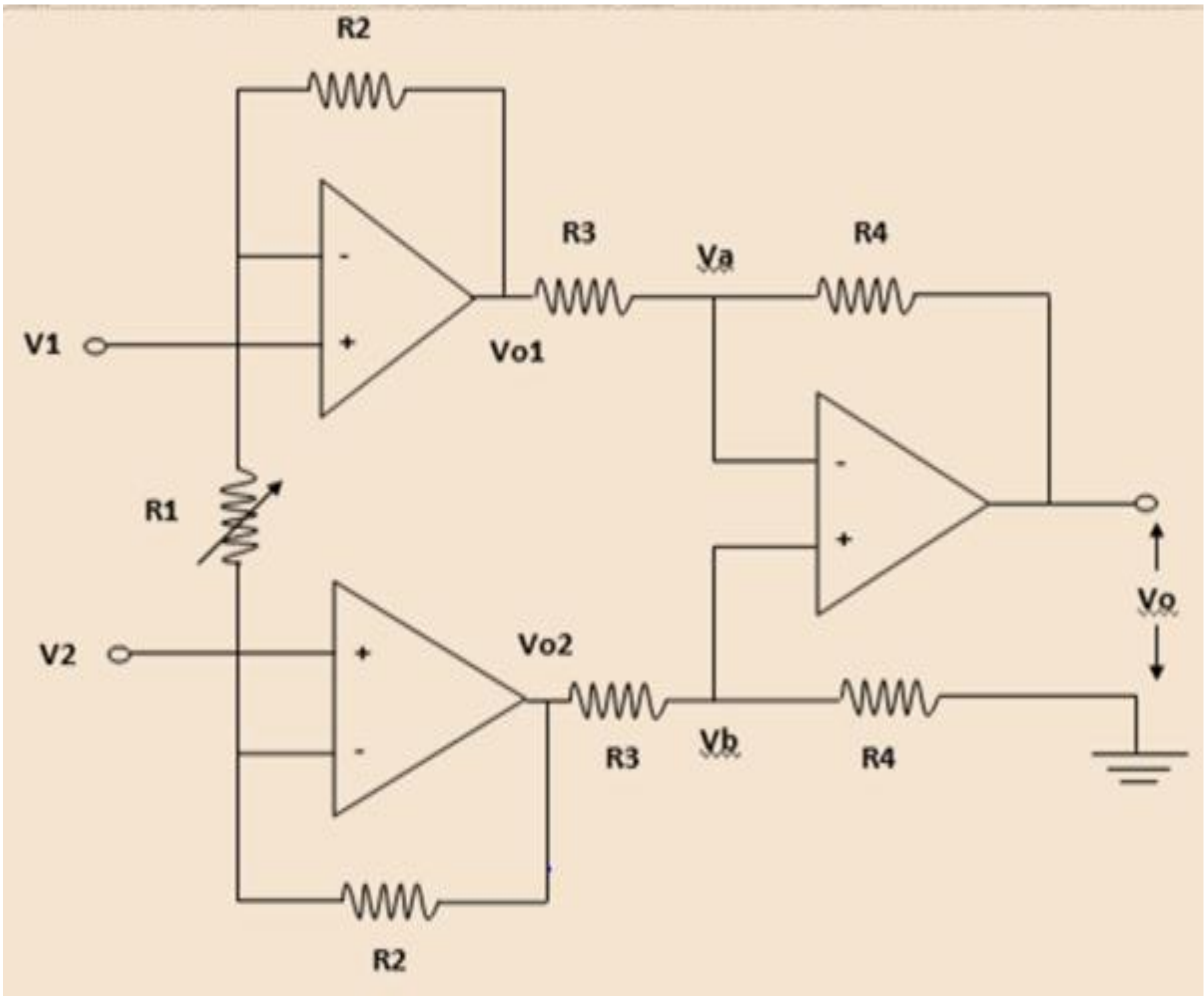


Figure 3: *Instrumentation Amplifier Circuit.*

Analytically computing the Instrumentation Amplifier output Voltage (Vo) as well as gain (Av):

From diagram, we can write

(V01 – V1)/R2 = (V1 –V2)/R1 (3.1)

{Vo1/R2} = {V1/R1} + {V1/R2} – {V2/R1}

Vo1 = [{R2/R1} V1 + V1 – {R2/R1} V2]

Vo1 = [V1 + {R2/R1} (V1 – V2)] (3.2)

Similarly, we can also write

(V2 – Vo2)/R2 = (V1 –V2)/R1

- {Vo2/R2} = {V1/R1} - {V2/R2} – {V2/R1}

{Vo2/R2} = {V2/R2} + {V2/R1} – {V1/R1}

Vo2 = [V2 + {R2/R1} V2 – {R2/R1} V1]

Vo2 = [V2 + {R2/R1} (V2 – V1)] (3.3)

From eq. (3.2) & eq.(3.3)

(Vo1 – Vo2) = [V1 + {R2/R1} (V1 – V2)] - [V2 + {R2/R1} (V2 – V1)]

= (V1 – V2) + {R2/R1}V1 – {R2/R1}V2 – {R2/R1}V2 + {R2/R1}V1 (3.4)

= (V1 - V2) + 2{R2/R1}V1 – 2{R2/R1}V2

= [(V1 – V2) + 2{R2/R1} (V1 – V2)]

(Vo1 – Vo2) = (V1 – V2) [1+ 2{R2/R1}] (3.5)

Applying KCL at node Va,
[{(Va – Vo1)/R3} + {(Va – Vo)/R4}] = 0.
[{Va/R3} + {Va/R4} – {Vo1/R3} – {Vo/R4}] = 0.
{Vo/R4} = [{Va/R3} + {Va/R4} – {Vo1/R3}]
{Va/R3} + {Va/R4} = [{Vo/R4} + {Vo1/R3}]
Va [{(R3+R4)/(R3R4)}] = [{Vo/R4} + {Vo1/R3}]
Va = [{R3/(R3+R4)}Vo + {R4/(R3+R4)}Vo1] (3.6)
Similarly, Applying KCL at Vb.
[{(Vb – Vo2)/R3} + {Vb/R4}] = 0.
[{Vb/R3} + {Vb/R4} – {Vo2/R3}] = 0.
Vb [{(R3+R4)/(R3R4)}] = [{Vo2/R3}]
Vb= [{R4/(R3+R4)}Vo2] (3.7)
At perfect balance, Va must be equal to Vb.
Va = Vb
[{R3/(R3+R4)}Vo + {R4/(R3+R4)}Vo1] = [{R4/(R3+R4)}Vo2]
{R3/(R3+R4)}Vo = [{R4/(R3+R4)}Vo2] – [{R4/(R3+R4)}Vo1]
{R3/(R3+R4)}Vo = {R4/(R3+R4)} (Vo2 – Vo1)
Vo = {R4/R3} (Vo2 – Vo1)
Vo = - {R4/R3} (Vo1 – Vo2) (3.8)
From eq. (3.5) & eq. (3.8), we can write
Vo = - {R4/R3} (V1 – V2) [1+ 2{R2/R1}]

Vo = {R4/R3} (V2 – V1) [1+ 2{R2/R1}] (3.9)

The gain can be expressed as

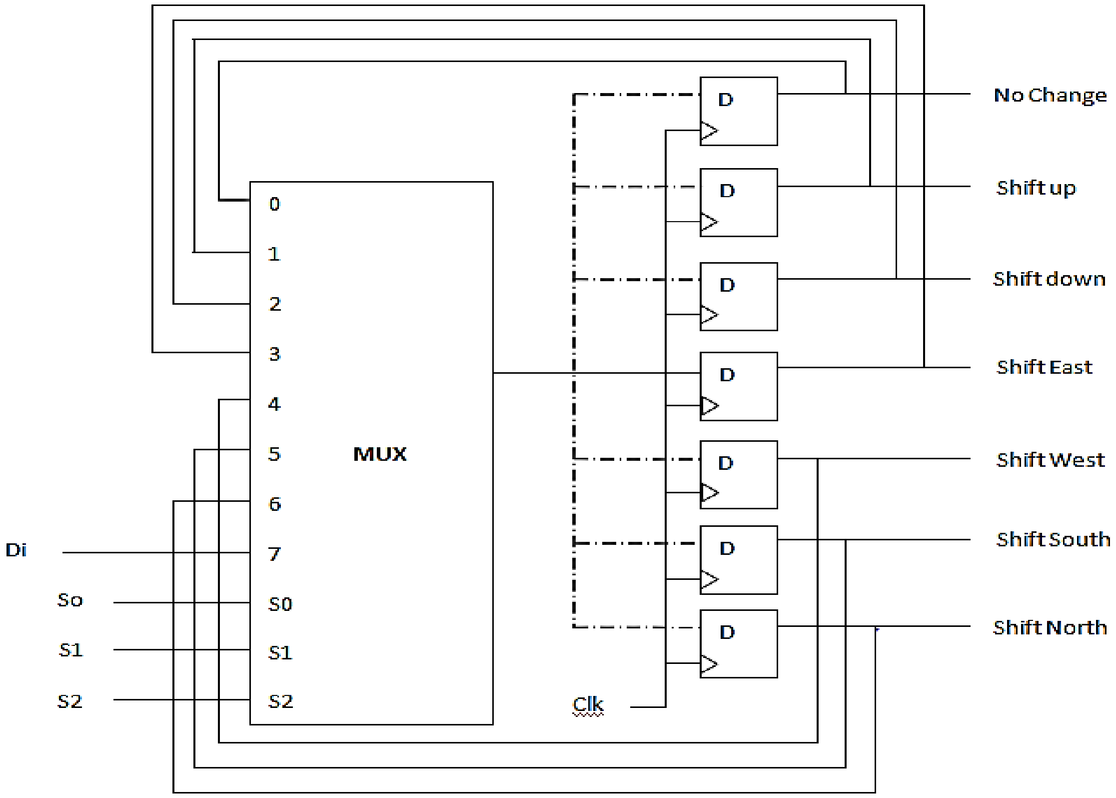
Av = [Vo/(V2 – V1)]

Av = {R4/R3} [1+ 2(R2/R1)] (3.10)

Table 1: *Conceptofdeveloping multi directional shift register*
A concept is developed and accordingly a system is designed wherein A Registerbecomes capable of shifting binary data in multiple directions.

Mode Control			Register Operation
S2	**S1**	**S0**	
0	**0**	**0**	No change
0	**0**	**1**	Shift up
0	**1**	**0**	Shift down
0	**1**	**1**	Shift East
1	**0**	**0**	Shift West
1	**0**	**1**	Shift South
1	**1**	**0**	Shift North
1	**1**	**1**	Parallel Load

Diag.4 Function for typical stages. The three selections inputs S2, S1, and S0 select one of the multiplexer inputs for the D Flip-flop. The selection line controls the mode of operation of the Register according to function table 4. When the mode control S1, S1, S0 = 000, the multiplexer input 0 is selected and this form path each flip-flop output into its own input. The next clock transition transfer into each flip-flop the binary value it held previously and no change of state occurs [2].



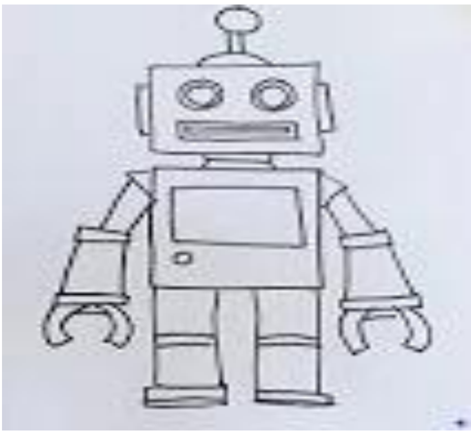


Figure 5: *Multidirectional Shift Register*

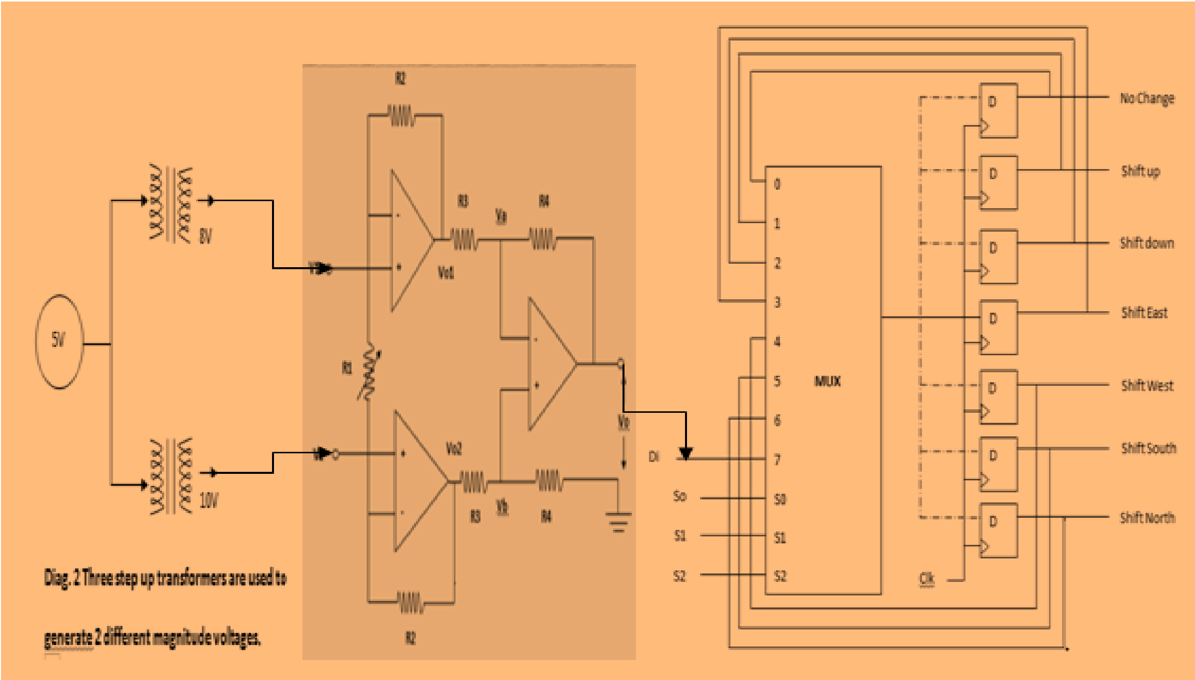
When S2, S1, S0 = 001, the terminal marked 1 on the multiplexer has a path to the D input of each flip-flop. These paths cause a shift up operation.

Similarly, the process is repeated for different values of S2, S1, S0 as 010, 011, 100, 101, and 110, ultimately results into shift operations as shift down, shift East, Shift West, Shift South, and shift North [3].

When S2, S1, S0 = 111, the binary information on each parallel input line is transferred into the corresponding flip-flop, resulting into parallel load [4].

COMPLETE CIRCUIT DESIGN VIA INTERFACING

The complete circuit design for **"Instrumentation Amplifier circuit with Shift Register as a Robot"** is obtained through interfacing of three circuit as i) Single source to multiple voltages generating circuit, ii) Instrumentation Amplifier circuit, and iii) Multi-directional shift Register circuit [5].



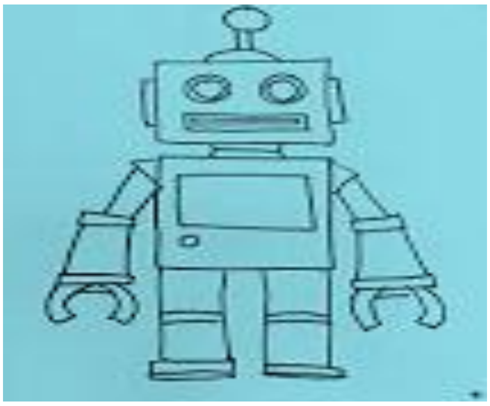


Figure 6: *Instrumentation Amplifier with shift Register circuit as Robot*

CONCLUSION

The complete circuit design results into successfully converting "A Instrumentation Amplifier Circuit with shift register acting as a Robot" capable of amplifying signal with Instrumentation Amplifier and Shifting the data value by Multidirectional Shift Register in different directions based on requirement within the system. This design concept to shift data in different direction based on requirement within a system is one of most relevant applications, to meet Circuit designer's challenge of developing system with improving performance, smooth and reliable functioning speed to shift data in different direction and act as a Robot.

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