isrjournals

International Journal of Advanced Research in Electrical and Electronics Engineering

Volume: 3 Issue: 3 Dec,2016,ISSN_NO: 2321-4775

High Voltage Polarity Switching using Relay Based Circuit

Shubham Panchal*, Hemant Mehar**
*Student, under graduate, ** Assistant Prof.
Department of Electrical & Electronics Engineering
IPS Academy, Institute of Engineering & Science
Indore, 452012, India
Email: **meharhemant@yahoo.com

Abstract— **the relays are used as a switch for many general purpose and industrial applications. They behave like as a close and open switch. The relays can also be used as a device to change the polarity of high voltage and high current dc power with very low cost and in effective way. The method is for connect 2 relays in such a way they both works together to change the polarity as one switch of one relay remains at point A while other at point B so the current flows in clockwise direction while the first relay is closed and second is opened then the relay system changes the direction of current to anti clockwise direction .This way the power supply polarity is changed in dc using simple electromagnetic relays.**

Keywords – Relay, DC Power, Automatic Switch, High Power, Reverse Voltage

I. INTRODUCTION

THE relays are the electro mechanical devices which are used as switches for both the ac and dc power to turn them on or off. There is an interesting property of the relay; it can be used as a polarity switch to change the direction of the dc power supply by simple circuit configurations. As the default state of a simple relay has a reference terminal and two terminals to it. The reference terminal is closed to one of the two terminals and opens to the other, but when the current is applied to the pressure coils of the relay the close switch terminal becomes open while the close terminal will become open. This can be defined as the change of the states of the relay terminals. Let us assume a system of two relays in which the reference terminals are connected as each of the outputs of the dc supply and the two terminals of each relay are connected as both their closed terminal with reference are connected together with each other and to the input power supply, say to the positive terminal of the input supply. And their open terminals with reference terminals are connected to each other and to the negative terminal of the input supply. The system thus created will have a configuration as the input terminals of the relays are connected in parallel and the reference terminal will be used as the output for the system. where the direction of current is changed due to the switching action of the relays as one relay is switched at a time while the other relay stays in the same state which makes the system to supply power in a particular direction ,similarly the other relay is switched and the first relay is kept at the same state which makes the power to be transmitted to the opposite direction .in this way the relays change the power supply direction as the signals are provided to the relays pressure coils which operates the electromagnet of the relay to change the state of the switch. This system has a unique property as if the both the relays are at the same state say high or low then the current will flow in no direction as it will become short circuit at the reference output terminals while open circuit to the dc supply terminals . this property suggests the working of the system as similar to the X-OR gate as when any change is occurred in any of the input terminals the current will flow , else no current will flow in the output .There is a problem of transient state occurrence in the output which is due to sudden increase in power, which can be solved by using a inductance at the output terminal of the relay so that the solenoid (inductance) which has a property that it never lets the current to rise in a sudden so it stops the sudden increase in current at the output terminal of the system, thus the power gets filtered from transient elements to some extent and makes the system more credible in terms of switching of the polarity of large dc power using simple instruments. Another problem is faced is that the time taken in change of the polarity of the relay which will require the system to take a delay in switching of the polarity in general purpose relays but it can be reduced by using a time delay in operation of the relays or by using the relay with low operating time.

II. METHODOLOGY

The relay is electromechanical system which is used as a bi-directional switch whose function is to close or open the switch. The relay performs this work if certain signal is provided to it which activates the magnetic field as a result of that the circuit will open.

The relay the relay has 2 inputs as 1 is open to the reference while the other is closed to the reference. When the voltage signal is passed on the relay the relay switches its state and the open circuit becomes closed and vice versa.The relay

isrjournals

International Journal of Advanced Research in Electrical and Electronics Engineering

Volume: 3 Issue: 3 Dec,2016,ISSN_NO: 2321-4775

can be used as system to switch the polarity of a dc supply by connecting 2 relays as the reference is connected to the output port of the system and the common switch modes of the relays at the time t=0 (i.e. The time at which no external signal is provided to the relay).Connect the common terminals of the relayto each other and connect each pairto negative and positive respectively. Fig 01 & Fig 02 Shown the schematic design to switch the polarity of dc power using relay & PCB view of design respectively.

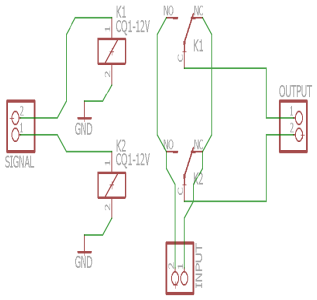

Fig. 01 The schematic of the design to switch the polarity of dc power using relay

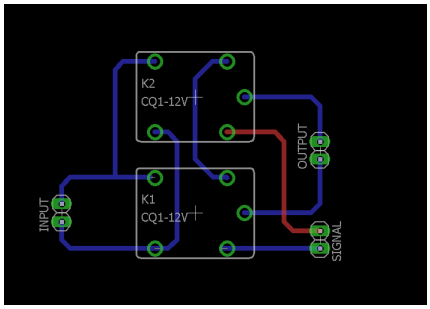

Fig. 02 The PCB view of the design showing the connections

III. THE OPERATION OF PROPOSED CIRCUIT

The relay based system has a basic design as shown in the schematic. The system is divided into two parts as relay A and relay B. at time t = 0, both the relays are at their default state as they are open circuit to the input supply and short circuit to the output terminal of the system connected to the load.

The system as mentioned as an X-OR gate analogues working so when the pressure coils of anyone of the relays is high then the current will start to flow in the specific direction as per the condition. We assume two basic conditions for the relay circuit. Case 1, when the system is connected to the input and an output source respectively. At the steady state there is no potential difference in between the terminals of the output.When a signal is passed to the relay A then it switches states between the internal terminals as a result at that time the relay A reference is at negative while the reference of the relay B is at positive which creates a potential difference between the terminals of the output and the current begins to flow in the particular direction (see Fig. 03).

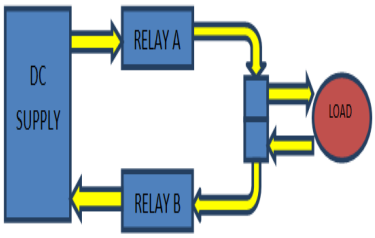

Fig. 03 Clockwise operation

Case 2, when the relay A is kept at the steady state with no signal voltage across the electromagnetic coils and the signal voltage is provided across the relay B coils the relay B position switches from close to open which create a potential difference among the output terminals where the both relays are connected and this makes the current to flow to the other direction than case 1(See Fig. 04).

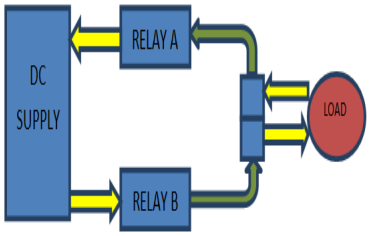

Fig. 04 Anti Clockwise operation

This is the mode of operation of the system which makes an ideal instrument to switch large dc power as the capacities of the electro-mechanical relays is very huge and they are very cost effective .

As per the design the system can be easily controlled by using a microcontroller at 5 volts and amplifying the signal to 12 volts.

The system has the following equations as

Relay A = V_a

Relay B= V_b

$$stateofflowofcurrentdirection = \begin{cases} negative, & Va < Vb \\ positive, & Va > Vb \\ neutral, & Va = Vb \end{cases}$$

The load parameters of the system for identical relays

Current = 10 amp

Voltage= 240 v

For the system the relays are parallel so voltage is 240

Current = 10+10 = 20 ampere

The net load capacity of the system (ideal) = 20*240 = 4800watts = 4.8Kwatts

The power is quite high as compared to the relay and system price

The problem of transient

The transient state which occurs due to thee switching of the relay can be minimized by using a ferrite bead (inductance) in series with the output so when the current will pass through it, it will reduce the transient affects and give a smooth DC output.

The problem of relay time response

The relay has an inherited time response property which makes it difficult to switch above a specific speed is called the threshold frequency of the relay and the system will create an error if the relays are to be operated above the threshold frequency so to overcome this problem the relay system id provided with a delay between the switching of the relays which will provide time for the relays to change state. This problem can further be solved by using high frequency switching relays with good quality of the leaf spring for better time response and low delay time.

IV. TESTING OF PROTOTYPE CIRCUIT

The relays are the devices which switch from one state to other. ideally there is no need of anything special for the system to work as the relay to switch continuously but in practice the relay circuit requires a fly back diode to prevent the transistor used as a switch for the relay pressure coil to prevent from burning due to over current and to maintain the continuous operation of the relay without any error or hysteresis. The proposed circuit also requires a high resistance connected in series to the relay pressure coil and transistor switch to protect it from excess current.

Table I. Parts of the practical system

S. No.	Part Name	Number	Quantity	Specification
1	Relay	CQ1-12V	2	5v Input 120v 10 A Output
2	Diode	1N4446	2	100V 4 A
3	Resistor		2	1K±1%
4	Terminal Connector		3	2 pin type

The fly back diode is used for the smooth operation of the system. The circuit modifications from the ideal to the practical can be seen below as in figure 05-06 it is explained the position for the diode and the resistor in the circuit to make it work smooth.

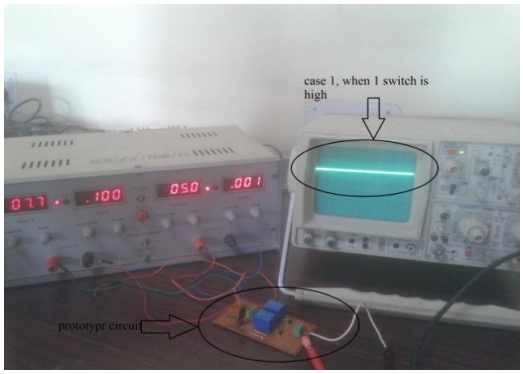

Fig. 05 testing of prototype circuit

Fig. 06 testing of prototype circuit

The results of this prototype circuit are shown in the table II.

Table II. Truth table of relay in action

Relay A	Relay B	Effect & Direction
OFF	OFF	On Current
ON	OFF	+Ve Direction
OFF	ON	-Ve Direction
ON	ON	No Current

V. ADVANTAGES AND LIMITATION OF PROPOSED SYSTEM

Advantages

1) The proposed prototype is extremely cheap as compared to others available in the market.
2) The system is simple and reliable, due to use of robust components such as electro mechanical relay.
3) The prototype can have a wide range of voltage applications from low voltages to HVDC.
4) The prototype has further advantages in AC induction motor as it can switch between primary and auxiliary coil to run the motor in both the directions.

Limitations

The system can switch the DC supply; it has no control over the magnitude of DC current. Due to switching of relay the state of transient occurs which is extremely unsuitable for electronics component as it can permanently damage but can be overcome by use of solenoid in series and filter capacitor in pi connect.

VI. Conclusion

The prototype circuit is prepared and tested for the purpose of voltage switching. This circuit is helpful to identify the different application where we need to switch the voltage immediately. Such as induction motor drive.

References

[1] Yoshinao MURATA*,Masatoshi SAKAMAKI, "Development of High Voltage DC-XLPE Cable System" SEI TECHNICAL REVIEW, NUMBER 76, APRIL 2013, Page No. 55-62

[2] Scott A. Riley, Skipp May, and Matthew P. Augustine, "High-voltage pulse switching hardware for electro-optic studies of conducting aqueous solutions", REVIEW OF SCIENTIFIC INSTRUMENTS VOLUME 73, NUMBER 8 AUGUST 2002 Page No. 3080-3084.

[3] Robert W. Erickson, "DC-DC Power Converters", Article in Wiley Encyclopaedia of Electrical and Electronics Engineering

[4] [Datasheet] (online available) www.farnell.com/datasheets/1716725.pdf

[5] [Datasheet] (onlineavailable) https://www.fairchildsemi.com/datasheets/1N/1N4446.pdf

[6] [Datasheet] (online available) https://www.panasonic-electric-works.com/pew/eu/downloads/ds_61208_en_cq.pdf