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Development of High Precision with suitable Hysteresis for Automatic Voltage Regulator

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Abstract-This work aimsat designing and development of a modern way of controlling the voltage. The wattage given by PCB (Power Development Board) varies from time to time. In most cases the supply voltage doesnot meet specifications.It becomes a threat to all the modern electronic devices. .So keeping an eye on the constancy of input voltage within the tolerable limits become mandatory. Systems available lack accuracy thereby resulting in surges resulting in damage.A solution to this can be got by using several tapingsand hysteresis which subsides the oscillation during level transition.

Keywords-Automatic Voltage Regulator (AVR), precision, hysteresis, auto transformer, comparator circuit, relay, PDB (Power development board).

I. INTRODUCTION

In our practical life voltage may be high or low in supply system due to fluctuations.This results in damage to electric system. To overcome this issue, we have to go for voltage regulator[1].

The control of regulators can be done either manually or automatically. Manual control can be done by tap-changing switches, a variable auto transformer, and an induction regulator.In the above case, resultantvoltage is sensed with a voltmeter connectedat output whereas decision and correcting operation is made by a human. The accuracy in controlling manually is not possible due to degree of instrument and based on its performance regarding stability[2].In large interconnected systems regulation automatically using separate regulator for each generator.

Transients, sags, swells, surges, outages, harmonics, and impulsesare the common power quality in conveniences faced by industries which results in varied magnitude of voltages.Of these voltages sag plays a major role in imparting a negative impact on industrial power regulation. The output voltage is controlled by field excitation with variable speed using AVR[3].

II. OVERVIEW AND PROPOSED DESIGN

The supply and switches are connected through multitapped transformersin primary and in secondary to obtain stabilized voltage on load side.The comparator circuit takes a lead role in decision making of controlling switches thereby resulting to a steady voltagewhich secondary tap carries from input to load.

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It is necessary to introduce two units, one to prevent hunting known as anti-hunting unit and for maintaining hysteresis named to be hysteresis circuit.Continuous fluctuation or oscillation of the regulatoris hunting and variation in voltage from one comparator to other and viceversa is hysteresis.The least difference of input voltages while switching between stages of comparators gives poor hysteresis.

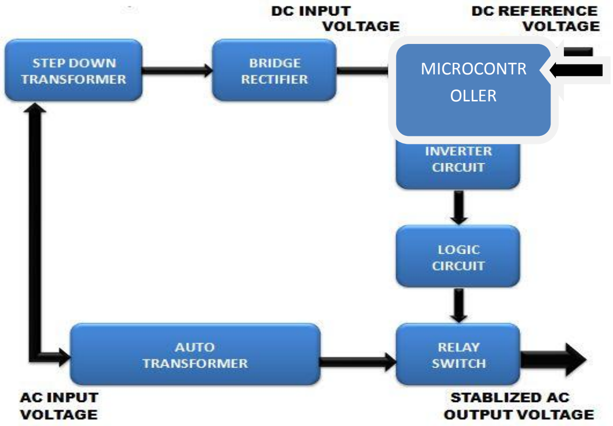

Fig.1 Block Diagram of AVR Design

The above figure clearly depicts the operation of a regulator

III. SPECIFICATION

The specifications:
Input voltage : 150V to 273V
Output voltage : 215V to 237V for the above input specifications.
Input and output frequency =50Hz
High cut feature at 274V
Low cut feature at 145V
No.of relays : 8
Auto-transformer: 8 additional tapping's: 315V, 285V, 257V, 233V, 212V, 190V, 172V, 156V

IV. EXISTING AND PROPOSED SYSTEM

A.EXISTING

In existingsystem, the operation is carried out for a single value of voltage, the voltage regulator may be automatically or manually operated The protection against excessive high, low voltage and current is confirmed which is crucial for the sophisticated electrical and electronic equipment's.Lack of precision in existing systems suffers the problem of oscillating between two output voltage and hence creating surge which can damage valuable electronics[4].

B.PROPOSED

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Regulation of 150-273V AC variation of input to the tolerable range of 215-237 volt AC output is achieved by design. Input voltage range of 80-350VAC is regulated to a stable 220VAC output voltage by increasing the turns numberson autotransformers secondary side and relays.

V. OVERALL CIRCUIT PERFORMANCE

AVR stabilizes any variable input voltage within prescribed range (100V ~ 273V) to the tolerable value of 150-240-volt AC output.A proper hysteresis is maintained. It is also maintaining a proper hysteresis with a desired level variation of voltage in switching ON and OFF.

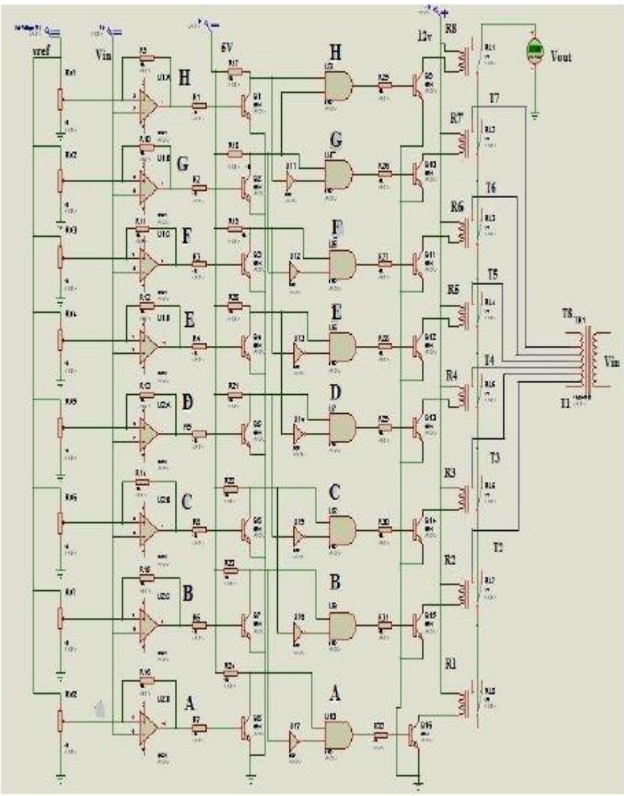


Fig.2 Practical Circuit Diagram

VI. PERFORMANCE AND RESULT ANALYSIS

Auto Transformer Tap Selection

The auto transformer used is a eight (8) tapped autotransformer, the tapings are taken from the windings of the transformer at a regular intervals i.e. 100-200 turns of the transformer. Taps are selected according to the Input voltage which is shown in the following table.

Table 1 Auto Transformer Tap Selection

Input V_{ac} (Volt)	Voltage For Tap Selection	Tap No.
100	......	T1
150	315	T2
166	285	T3
184	257	T4
203	233	T5
224	212	T6
248	190	T7
274	......	T8

VII. RELAY SELECTION

Selection of relays can be done either by logic circuit fed across inverter circuit or directly from the microcontroller.

Selection of Relay According to Logic Circuit

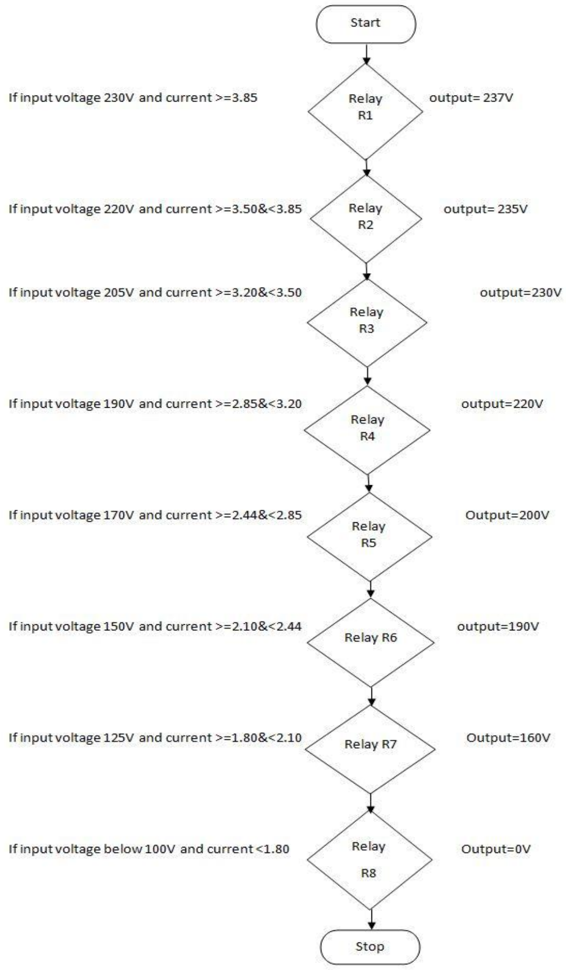
The output of the inverter circuit is feed to the logic circuit which acts as a decoder.

Relay Selection According To Micro Controller

Relays are selected by the microcontroller according to the current value.

Relay Selection Flowchart Micro Controller

The flowchart is maid according to the current value and relay selection as shown in the given flowchart:



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VIII. OPERATION OF AVR

The operation of AVR is carried out starting from the tap selection of autotransformer, based on the input voltage a specific tap is selected to bring out the required output voltage. There are eight (8) taps available beginning from T1, T2, T3, T4, T5, T6, T7 and T8 [5].

A step down transformer is used to step down the input voltage (230V) to 5V or 12V for the operation of micro controller used. Bridge rectifier is used to get fixed 5V or 12V dc feed across the micro controller. Bridge rectifier uses IC 7805 or IC 7812.

Removing the comparator circuit for purpose of higher precision of AVR and relay selection, we have used a micro controller (ATMEL 8051) in place of it.

Table 2 Relay Selection

RELAY	CURRENT VALUE	OUTPUT VOLTAGE
R1	>=3.85	230 IN – 237 OUT
R2	>=3.50 &<3.85	220 IN – 235 OUT
R3	>=3.20 &<3.50	205 IN – 230 OUT
R4	>=2.85 &<3.20	190 IN – 220 OUT
R5	>=2.44 &<2.85	170 IN – 200 OUT
R6	>=2.10 &<2.44	150 IN – 190 OUT
R7	>=1.80 &<2.10	125 IN – 160 OUT
R8	<1.80	LOW CUT-OFF

A hysteresis path is created by providing a feedback path for the micro controller. A proper hysteresis is maintained in feedback path by switching between ON and OFF which could be clearly understood from the graph.

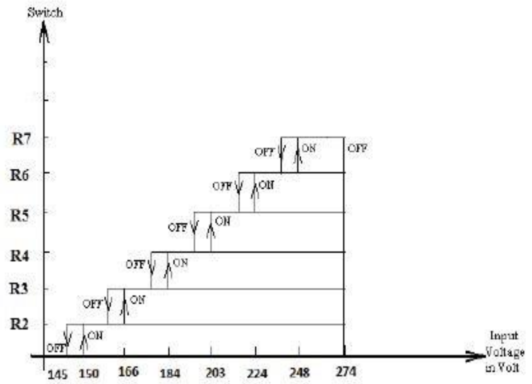


Fig: 3 Hysteresis Curve

Shortcomings Recovery

To get the Stabilized Output

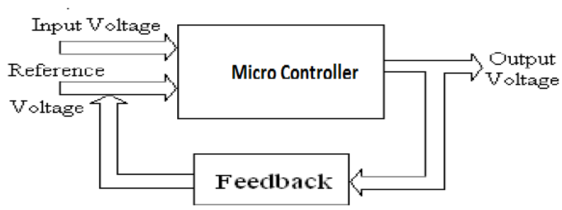
Automatic voltage regulator in general stabilises only low voltages. To overcome this a measuring circuit which drives transformer of multiple times step up secondary side from the primary side is used in [6].

To get the Precise Output

Commercially the regulators go through three to four step stabilisations of input voltages to obtain prescribed output which doesnot yield a good design.Inorder to overcome this issue in design,transformer having a many number of taps in the secondary winding side maintains a small turn difference in voltages between two adjacent taps.

Toget a Regulated Output with a Proper Hysteresis

The least difference in voltage when changing and backing from comparator leads to poor hysteresis in general AVRs causing rapid switching.This is solved bya feedback connection in the comparator from output to inverting input with variable resistance as shown below.



IX. PERFORMANCE ANALYSIS

The design is tested to get an idea about AVR output, the output is totally dependent only relay selection. After implementation we assure with proof that the design AVR can stabilize any variation in the input voltage as per the prescribed range (100V-273V) to the specified range of output voltage (150V-240V).

Table 3 Performance Analysis

INPUT VOLTAGE	OUTPUT VOLTAGE
100	00
120	150
140	180
160	190
180	210
200	230
210	235
220	235
230	237
240	229
250	238
260	227

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270	237
280	00

Overall AVR Performance

The overall performance of AVR can be studied from the given tabulation:

Table 4Overall AVR Performances

S.NO.	INPUT (V)	OUTPUT (V)	CURRENT(A)	TRANSFORMER TAP	RELAY
1	230	237	>=3.85	T1	R1
2	220	235	>=3.50 &<3.85	T2	R2
3	205	230	>=3.20 &<3.50	T3	R3
4	190	220	>=2.85 &<3.20	T4	R4
5	170	200	>=2.44 &<2.85	T5	R5
6	150	190	>=2.10 &<2.44	T6	R6
7	125	160	>=1.80 &<2.10	T7	R7
8	100	00	<1.80	T8	R8

X. CONCLUSION

Regulation of voltage is done automatically by adding many secondary taps .This design ensures to regulate 150V-273V AC variation of input to the tolerable range of 215-237 volt AC output. By increasing taps at the secondary side of auto transformer and relays we can automaticallyregulate input voltage range of 100VAC-350VAC to a stable 220VAC output voltage.

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