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THE PERFORMANCE COMPARISON BETWEEN COMMERCIAL AUTOMATIC VOLTAGE STABILIZER AND PROGRAMMABLE AUTOMATIC VOLTAGE STABILIZER

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Abstract

This paper compares the performance of AVS (Automatic Voltage Stabilizer) that has been on the market with PAVS (Programmable Automatic Voltage Stabilizer) designed by researchers. In practical terms, the AC power used in electronic devices experiences variations over time. This can cause major damage to electronic devices. To avoid this, it is necessary to stabilize the power voltage, minimizing the output wave rate. To adjust the entire system automatically, a microcontroller is used with several protection devices to detect errors. The circuit in this system is simpler and easier to understand than commonly control circuits. Simulations for circuits and programs have been carried out using the PIC IDE language. The results showed that PAVS is better performance and lower cost than commercial AVS.

Keywords: AVS, Input voltage, Microcontroller, Output voltage, PAVS.

1. Introduction

In practice, the AC power supply used in electronic devices can variate at any time. This can cause major damage to electronic devices. For this reason, much important electrical equipment can be damaged. The problem posed such as power quality, voltage, surge and brownout can have a major impact on negative productivity industry. In addition, this problem also causes problems with everyday electrical equipment such as fans, laptops, coolers and refrigerators. To eliminate this problem, practitioners usually use voltage stabilizers to secure electronic devices [1, 2].

AVS (automatic voltage stabilizer) is an electronic device that automatically regulates input voltage variations at the specified level. The main power supply voltage can be affected by a variety of disturbing physical factors, so special regulatory equipment is needed to keep the voltage stable. AVS functions primarily to regulate the input voltage to produce stable output and to provide protection against sudden voltage shrinkage, voltage surges, impulses, notches, over-voltage, under-voltage, power supply surges, and over current to sophisticated equipment and machinery [3]. The market, which has existed system as servo stabilizer, continuously variable transmission, Ferro resonance regulator, thyristor AC regulators, transformers and electronic regulator [4]. All systems are devices that are available for voltage stabilizer. However, in these systems, there are still shortcomings in terms of flexibility, efficiency, etc.

In this modern era, it is very important that an AC voltage supply is needed to automatically operate interconnections between systems. The electronic control circuit can be used to get the desired output, which is flexible, simple, and economical [5, 6]. For system automation and make the system more precision, microcontroller-based voltage stabilizers are designed. A microcontroller is a hardware that functions as an electronic circuit controller and can store programs on inside it [7]. The microcontroller will help to control the input and output voltage on the voltage stabilizer. Microcontroller here performs all actions in accordance with the program maintaining proper precision as we desire and the undesired input transitions are regulated by the AC protection devices.

Many studies had been carried out to analysed the performance of voltage stabilizer. In our previous study, the performance of voltage stabilizer based on *Q*-factor values was analysed using the *R* programming language [8]. This study will compare the performance and the economic value of the AVS (Automatic Voltage Stabilizer) circulating in the market, with PAVS (Programmable Automatic Voltage Stabilizer), which was done by LT Spice XVII.

2. Methods

2.1. PAVS design flowchart

The purpose of the design is to automatically stabilize the variation of the input voltage with a range (150 V - 230 V) at the output voltage normal level specified with high precision. For this new input voltage setting automatically designed such that when the input voltage is in compilation varies, the output voltage will keep stable at a constant value. The method used in this study is described by Fig. 1.

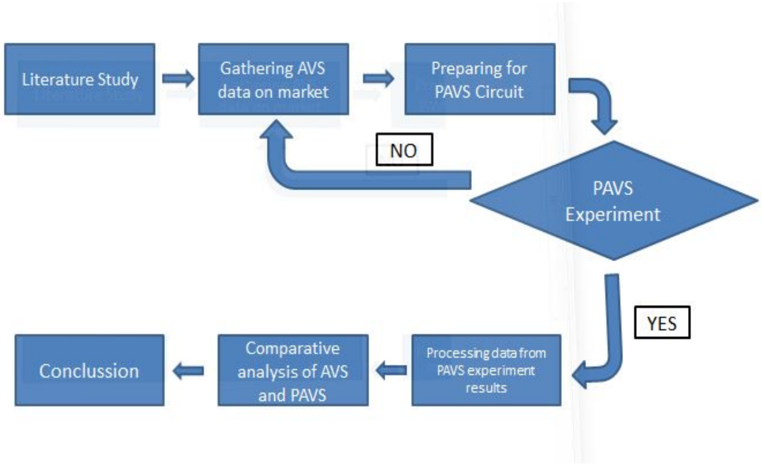

Fig. 1. Flowchart design of PAVS.

2.2. Commercial stabilizer performance data that has been circulating

For commercial AVS data that has been circulating, we use data from Akinlolu Adediran Ponnle's research [9] taken from 12 different AVS brands. The output voltage is generated in Fig. 2 and Table 1.

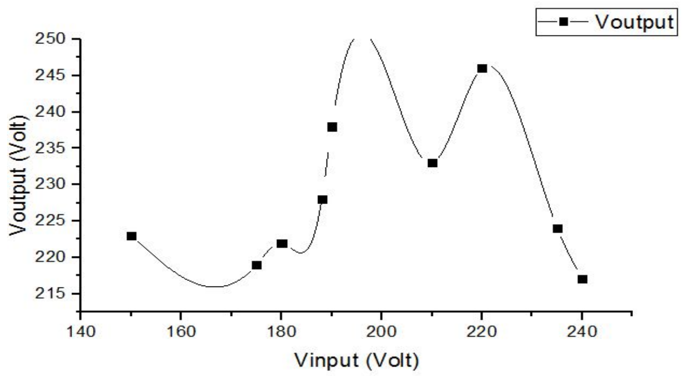

Fig. 2. AVS performance based on input and output voltages.

Table 1. AVS performance based on input and output voltages.

Vinput (volt)	Voutput
150	223
175	219
180	222
188	228
190	238
220	246
210	233
235	224
240	217

3. Design and workings of PAVS

The measured performance of the PAVS is based on the design that was made, as shown in Fig. 3. The working step of this circuit energizes one relay at a time from 150 V AC upwards, and all relays and energies when an AC 230 V input is reached. Similarly, if the supply input voltage drops gradually from 230 V, the relay is deactivated automatically one by one so that the output voltage remains constant at 230 V AC. Then, the prototype of PAVS was made to measure its performance (as shown in Fig. 4).

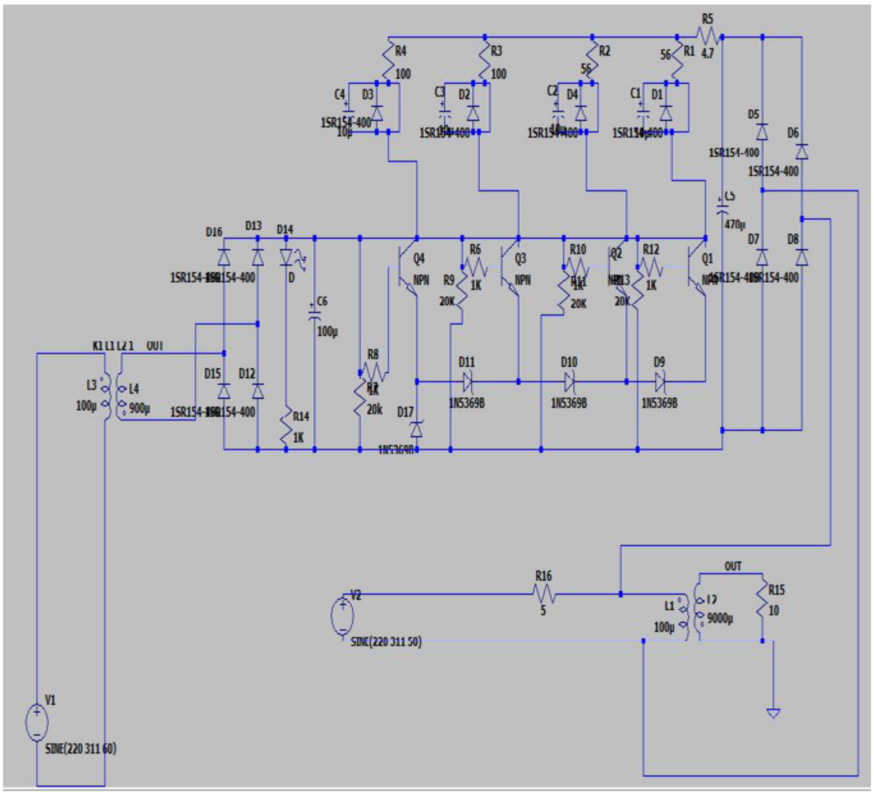

Fig. 3. Programmable automatic voltage stabilizer circuit.

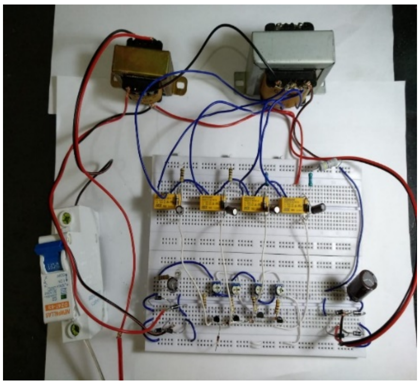

Fig. 4. PAVS prototype.

The power supply to the circuit is given from the transformer *X*2 secondary coil. Because the voltage between the two intercepts is 20 V, it is directly corrected using the Bridge Rectifier using diodes *D*1 to *D*4. The corrected output is then filtered using *C*1 electrolytic capacitors. The voltage from the source is detected by transformer *X*1 and repaired with the help of a bridge rectifier made from diodes *D*5 to *D*8. The repaired output is then filtered by capacitor *C*2 and given to the base of transistor *T*1 to *T*4 through the variable resistor, *VR*1 to *VR*4. Ponnle [10] mentioned that for the Zener diode, *ZD*1 to *ZD*4 reference voltage is used. To control the incoming voltage, we use the PIC 16F873A microcontroller. The circuit will not differ much because the circuit and relay will function to regulate the voltage. The incoming AC voltage is converted to DC with the help of a rectifier and then the capacitor filters it. Decoupling capacitors are also used and placed close to the microcontroller.

4. Results and Discussion

From the experiment carried out by supplying a device with a voltage input range of 150-240 V, the output voltage in Fig. 5 and Table 2 is generated. PAVS performance will be analysed based on input and output voltages. From Fig. 5, we can analyse that the change in output voltage of PAVS is relatively more stable, and there is no significant difference in each change in input voltage. when the input voltage drops, PAVS regulates so that the input voltage rises and approaches 220 V.

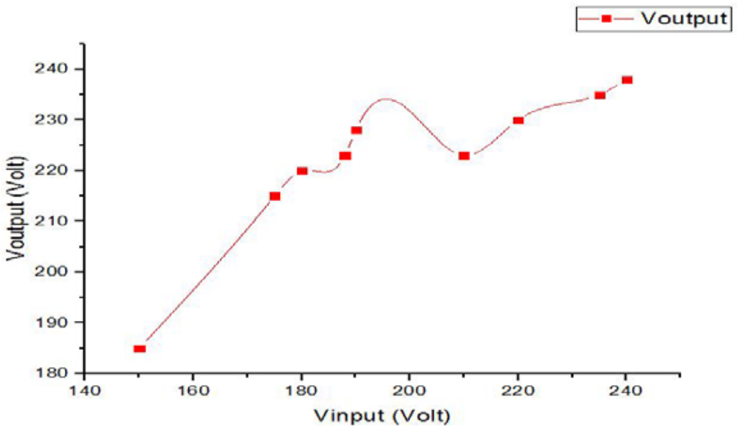

Fig. 5. PAVS performance based on input and output voltages.

Table 2. PAVS performance based on input and output voltages.

Vinput (volt)	Vout (volt)
150	185
175	215
180	220
188	223
190	228
220	223
210	230
235	235
240	238

From the experimental results of AVS and PAVS measurements, a comparison is made in Fig. 6. From Fig. 6, it can be seen that the output voltage of PAVS (red line) is more stable than AVS (black line). We can also increase the voltage faster when a sudden shrinkage of voltage occurs. We suspect that the stability level of output voltage generated by PAVS is due to the use of microcontrollers.

In addition, the PAVS circuit is simpler and easier to be designed, therefore, PAVS is cheaper than AVS because we can design it before we make it. Based on a study in the market by Sukumar and Castagnet [11], the commercially available AVS has a many step stabilization of the input variable voltage where the output becomes a major changes stable value within a specified range that is not an absolute design to get an output precise.

Therefore, in my research, the methods have been used to create a system to obtain precision output in large input variations is a design of the main transformer, which has many taps on the side of the transformer secondary winding, which maintains a small bend distinction between two adjacent beats [12].

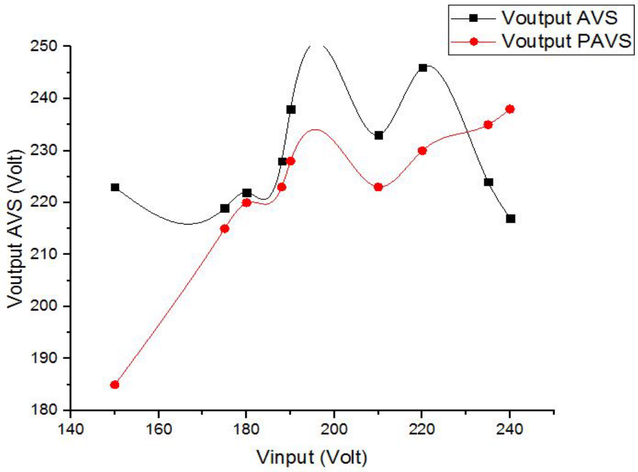

Fig. 6. Comparison of the performance of AVS and PAVS.

5. Conclusions

From the research that has been done, PAVS has a better and more stable performance than AVS that has been on the market. That is because PAVS use a microcontroller, therefore, that it can be programmed and produces more precise output voltage at predetermined inputs. The microcontroller performs all actions based on with the program, which maintains the exact precision as desired and the unwanted input switchover is regulated by the AC protection device.

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References

1. Standler, R.B. (2002). *Protection of electronic circuits from overvoltages*. New York: Courier Corporation.
2. Katalin, A. (2019). Voltage monitoring and supply controlling system. *Procedia Manufacturing*, 32, 380-384.
3. Venkatesh, S.; and Muthiah, K. (2011). Power fluctuations-usage of servo voltage stabilizers in industries. *International Journal of Applied Engineering Research*, 2(1), 283-289.
4. Yukita, K.; Kobayashi, Y.; Duy-Dinh, N.; Matsumura, T.; and Goto, Y. (2019). Suppression of PV output fluctuation using EV in an electric power system. *IFAC-PapersOnLine*, 52(4), 93-98.
5. Hoque, M.M. (2014). Design, implementation and performance study of programmable automatic voltage regulator. *Journal of Electrical Systems*, 10(4), 472-483.
6. Rasheduzzaman, M.; Hoque, M.M.; Das, N.K.; and Chakrabarty, J.P. (2008). Design and implementation of an automatic voltage regulator (for ceiling fan) using temperature sensor. *International Journal of Engineering*, 5(1), 207-211.
7. Microchip. (2003). *PIC16F876A data sheet. 28/40/44-Pin enhanced flash microcontrollers*. Chandler, Arizona, United States of America: Microchip Technology Incorporated.
8. Hamidah, I.; Solehudin, A.; Abdullah, A.G.; Sriyono; Shieddique, A.D.; and Muttaqin, M.R. (2019). Q factor simulation on voltage stabilizer with RLC circuits. *Journal of Engineering Science and Technology* (*JESTEC*), 14(1), 489-497.
9. Yamazaki, S.; Miyake, H.; Tsubuku, M.; and Noda, K. (2015). Voltage regulator circuit comprising transistor which includes an oxide semiconductor. *United States Patent No. 8963517*.
10. Ponnle, A.A. (2015). Performance of domestic AC voltage stabilizers in meeting low voltage problems in Nigeria: A case study of 12 different brands. *International Journal of Engineering and Technology*, 5(6), 358-367.
11. Sukumar, V.; and Castagnet, T. (1995). An automatic line voltage switching circuit. *Application Note*, 6 pages.
12. Tomioka, T. (2017). Voltage regulator and semiconductor device. *United States Patent No. 9798341B2*.