LOW POWER AUTOMATIC VOLTAGE REGULATOR FOR SENSITIVE EQUIPMENTS BY USING AUDIO AMPLIFICATION TECHNIQUE

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Degree of Master of Science in Industrial Automation

Department of Electrical Engineering

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DECLARATION OF THE CANDIDATE & SUPERVISOR

I declare that this is my own investigation and this dissertation does not incorporate without acknowledgement any material previously submitted for a Degree or Diploma in any other University or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

…… ……..

Signature: Date:

The above candidate has carried out research for the Masters Dissertation under our supervision.

……. ……

Signature of the supervisor: Date

DEDICATION

To my parents for earning an honest living for us and for supporting and encouraging me to believe in myself. I dedicate this thesis to my family for nursing me with affections and love and their dedicated partnership for success in my life.

ACKNOWLEDGEMENT

Thanks are due first to my supervisor, Dr. D.P Chandima, for his great insights, perspectives, guidance and sense of humor. My sincere thanks go to the officers in Post Graduate Office, Faculty of Engineering, University of Moratuwa , Sri Lanka for helping in various ways to clarify the things related to my academic works in time with excellent cooperation and guidance. Sincere gratitude is also extended to the people who serve in the Department of Electrical Engineering office.

Lastly, I should thank my parents, friends and colleagues who have not been mentioned here personally in making this educational process a success. May be I could not have made it without your supports.

ABSTRACT

In the market there are many choices for Automatic voltages regulators such as auto transformers with relays, servo-mechanism types, Thyristor used types and power inverters type with varying degrees of quality, efficiency, and power output capability. But they cannot be used for low power sensitive applications such as biomedical instruments etc. due to high harmonic content, wave distortions and RFI/EMI issues etc.

The High-Frequency Inverter is mainly used today in uninterruptible power supply systems, AC motor drives, induction heating and renewable energy source systems. The simplest form of an inverter is the bridge-type, where a power bridge is controlled according to the sinusoidal pulse-width modulation (SPWM) principle and the resulting SPWM wave is filtered to produce the alternating output voltage. This can be achieved by using a High-Frequency Inverter that involves an isolated DC-DC stage (Voltage Fed Push-Pull/Full Bridge) and the DC-AC section, which provides the AC output.

My objective to overcome the said problem is to design a simple Low power Automatic Voltage Regulator for sensitive equipment by using audio amplification technique giving an output waveform as similar to the main supply without moving parts (electro-mechanical devices). It would be a linear mode operating electronic amplifier circuit using bipolar junction transistor (BJT) for 50Hz operation of the main supply.

The noise free low signal obtained from the main supply is used as an input signal, having supply frequency (without oscillator) and low voltage. To obtain a controlled noise free standard supply voltage and frequency at the output terminals by the process of power amplification, which could be used for the sensitive equipment in nature such as medical equipment etc.

This is done by passing the main supply through the RFI/ EMI filters (radio frequency and electromagnetic interference) and utilizing the very low voltage “signal” of frequency 50Hz via step down process. The signal as said is filtered using low pass filters and amplified by utilizing audio amplification method. Since 50Hz or 60 Hz frequency is within the audible range, the amplifier is almost the same as audio amplifier which has the push pull output which inverts the noise free DC supply, obtained after the rectification and filtered from the main supply and converts back to AC supply at the same frequency and at the same RMS value.

The sample input signal is calculated (by graphical method) with voltage fluctuation expected and is augmented via preamplifier stage to get a higher amplitude signal. This is done for the various amplitude of input signals to the preamplifier and from its output signals. The fraction of the augmented signal is used for amplification by the stages following the preamplifier. Any variation in the main supply would not interrupt this signal but provide the variation in amplitude by fraction and this is used to control the output voltage. Also the output voltage from the push pull transformer is kept at higher value, expected drop plus normal supply voltage, (by step up winding) and is brought to the supply voltage by electronically. And even supply voltage goes up, it will bring down to the normal supply voltage automatically. As this circuit is operative with the supply frequency, it may be easy to synchronize with the main supply voltage whenever needed. The general effects of voltage regulation on semiconductors and transformers characteristics were also considered with the guidance of IEC 60146-1-1,Semiconductor converters and IEC 60146-1-3 , IEC 60076 converter transformers.

Calculations have been done based on practically obtained data to determine the voltage regulation introduced by the normal loading with the voltage variation between 260V and 180V. The subsidiary Legislation under the Electricity Act defines a maximum voltage variation is ±6% of the nominal voltage (216.2- 243.8V) to the consumer. Our system response approximately±2%

For the future development, high power transistors are used in the driver circuit and for the better response integrated circuits may be used instead of discrete circuit which I have used. There are lots of IC's available. The circuit also could be used with MOSFET in the output stage. The circuit should be modified when using MOSFET as it is capacitive and voltage control device at the input as compared to BJT, which is current operative device.

Key words

Thyristor, Radio Frequency Interference /Electromagnetic Interference (RFI/EMI) filters, Root Mean Square (RMS), Bipolar Junction Transistor (BJT), Metal Oxide Semiconductor Field Effect Transistor (MOSFET), Sinusoidal Pulse-Width Modulation (SPWM), Inverter, signal.

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LIST OF ABBREVIATIONS

Abbreviation	Description
BJT	Bipolar Junction Transistor
MOSFET	Metal Oxide Semiconductor Field Effect Transistor
MMF	Magnetomotive force
PWM	Pulse width modulation,
RFI/EMI	Radio Frequency Interference /Electromagnetic Interference
SMPS	Switch mode power supply system
SPWM	Sinusoidal Pulse-Width Modulation

LIST OF APPENDICES