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Domestic Battery Charge Unit Design and Production for Military Vehicle

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Abstract: As a result of increased research and development expenditures on the branding of domestic products used in the defense industry in our country, speed is given. The defense industry constitutes a large share of the inventory of military vehicles in land vehicles. At the same time, military vehicles are exported to many units of the armed forces. Domestic production of other hardware components used in these vehicles will reduce external dependency. As a result of developments in electronic communication and electro-optical technologies, such devices are widely used in fixed point surveillance and command-control tasks. With this study, original and locally designed and prototype production of battery charging units have been realized in order to meet the energy needs of the electronic systems in the fixed point services of military land vehicles from the network. Manufactured in accordance with military standards, the battery charger unit is designed to extend the cycle life of the battery by controlling its temperature. With the battery charging unit realized, defense contributes to my country economically and strategically by decreasing the external dependency by using indigenous and original resources in the industry.

Keywords: Defense industry, Battery charge, Control systems, Power electronics

Introduction

The new generation of modern military vehicles now carries many electronic and power-driven components. Previously, military vehicles were used for combat and support vehicles. These vehicles needed power for long-running radios and electronic systems. Military vehicles today include sensors, communications units, drivers and powerful weapon systems that require more energy than a conventional lead-acid battery can provide [Bogosyan, S.].

Especially during surveillance, batteries with low energy storage capacity can supply energy to demanding electrical units for a short time. This requires regular charging of the batteries [Masrur, M. A.].

New generation military armored vehicles should function as mobile power plants. Modern combat and hybrid vehicles must be capable of generating significant amounts of electrical power to provide full technology support. To meet the needs of today's vehicles, power electronics designers reassessed the built-in energy architecture. The sensor, control and communication systems of each vehicle are constantly improving [Lee, S.].

In military vehicles, 28 V batteries are commonly used with two 12 V lead-acid batteries, which are usually placed in series for military vehicles. The batteries were initially used only for loads such as lighting and ignition. However, as the complexity of vehicle systems increases, the batteries should be able to provide more power [Antoniou, A. I.].

In this study, a battery charging circuit design and production of 28 V, 60 A and 1700 W for military vehicles was realized. The battery charging circuit is designed and manufactured to meet military standards. The system was designed in Matlab/Simulink program and the results were given.

- Selection and peer-review under responsibility of the Organizing Committee of the Conference

Battery Charge Circuit

Matlab/Simulink block diagram of 28 V/60 A rectifier design is given in Figure 1. In the rectifier design, the system grid input voltage is simulated to be 220 V/50 Hz. Then 311 V DC bus voltage with the full bridge rectifier diodes is obtained. The DC bus voltage is passed through the R-L filter and then supply to the mosfet switching elements. The drive signal S3_g is applied to the mosfet switching elements S2 and S3. The drive signal S1_g is applied to the mosfet switching elements S1 and S4. The transformer in the rectifier simulation design has one primary input and two secondary outputs. The primary voltage of the transformer is 311 V and the secondary voltage is 36 V. By combining the ends of the secondary windings, 0V of the output voltage is obtained. The other end is transferred to the filter circuit by diodes and the power stage of the system design is completed.

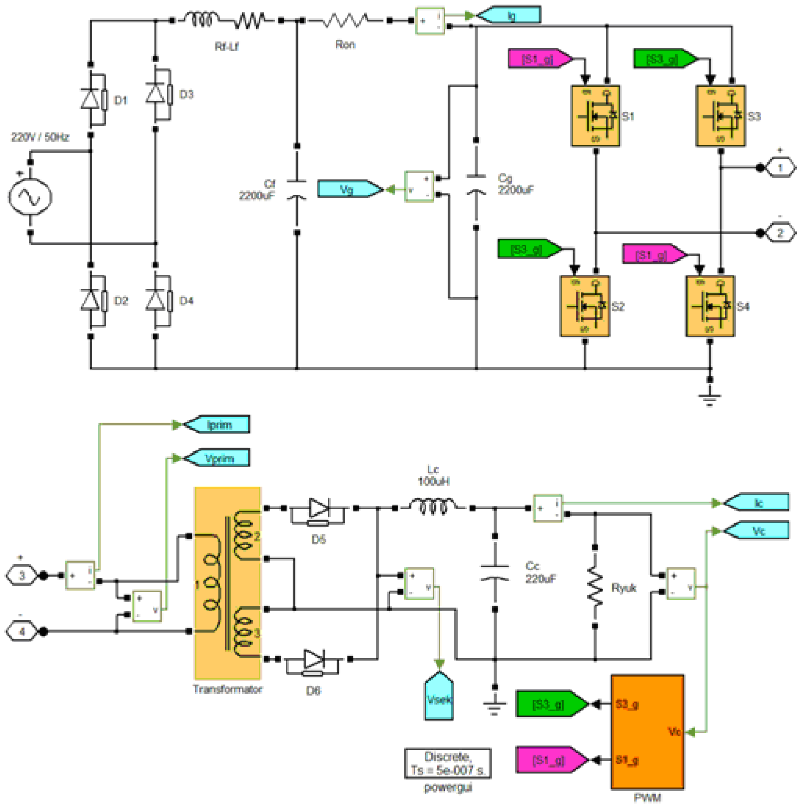

Figure 1. Battery charge circuit Matlab/Simulink block diagram

Figure 2 gives a detailed diagram of the block controlling the voltage at the rectifier output. The difference between the reference voltage value 28 V and the voltage reading at the sensor output is input to the PI controller. The PI controller produces the output by comparing the measured and reference voltage values. The switching signal is generated by comparing the error value of the PI output with the triangular wave of 55 kHz. The generated switching signal is compared with the clock generator to change the signal so that the switching elements are not simultaneously transmitting. The switching signals are then applied crosswise such that S1-S4 and S3-S2.

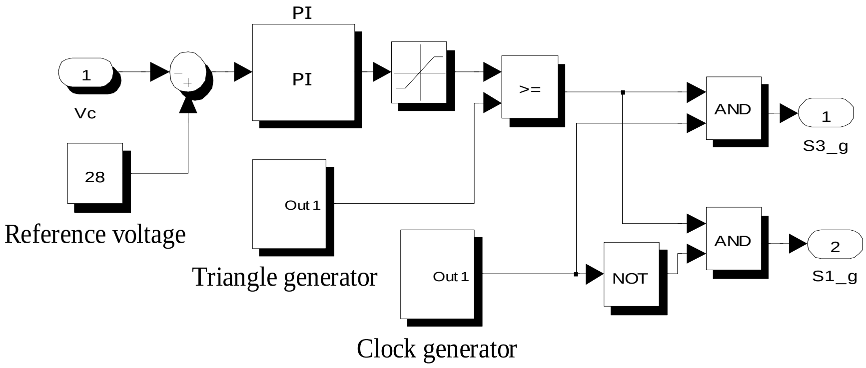

Figure 2. DC bus voltage control block diagram

Simulation Results under 60A Load

Figure 3 shows the DC bus voltage of 311 V. The DC bus voltage is provided by the full bridge rectifier circuit at the mains input. Figure 4 shows the DC bus current under 60A load. The DC bus current requires current from the grid at an average of 6 A.

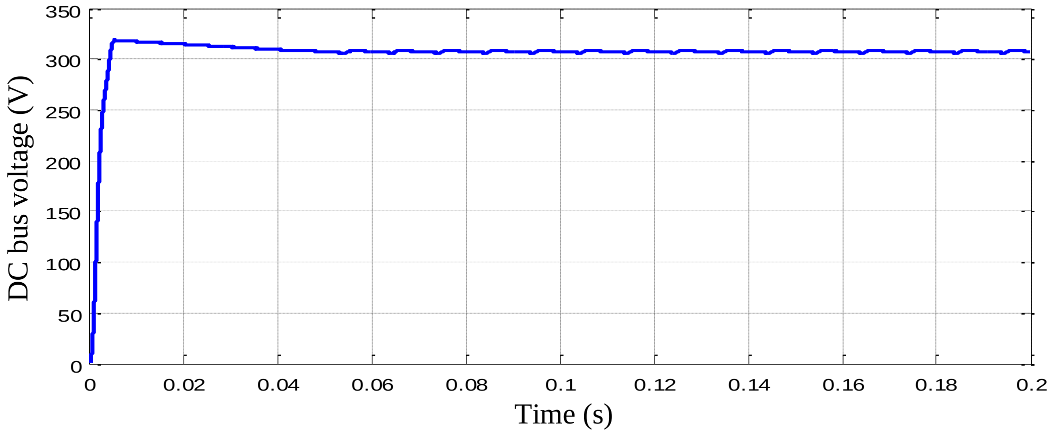

Figure 3. DC bus voltage under 60A load

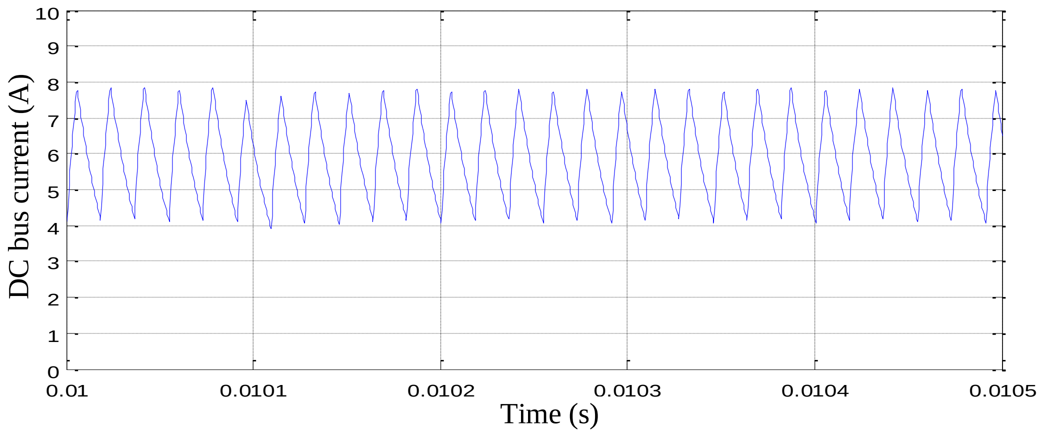

Figure 4. DC bus current under 60A load

Figure 5 shows the winding voltage at the primary terminals of the transformer under load 60A. Figure 6 shows the current change in the primary windings of the transformer for the same load current value. Figure 7 shows the secondary voltage change of the transformer in detail.

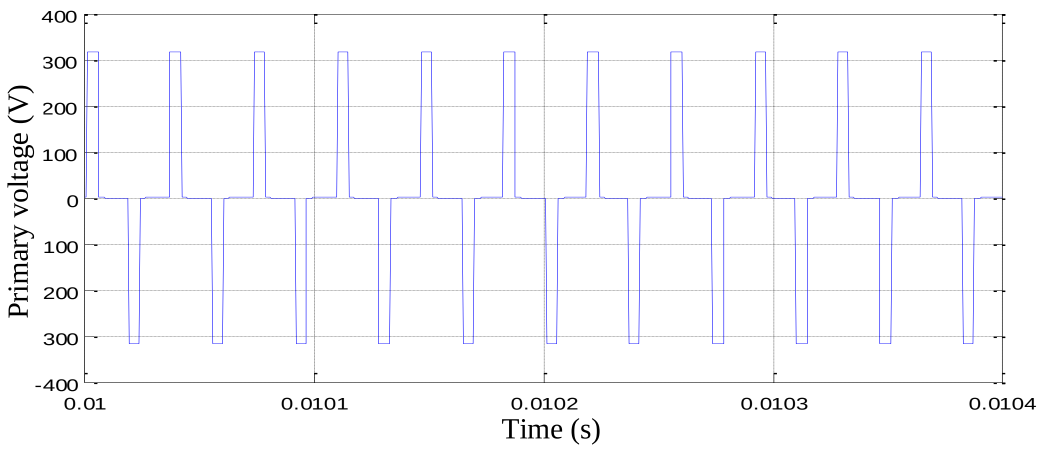

Figure 5. Transformer primary voltage under 60A load

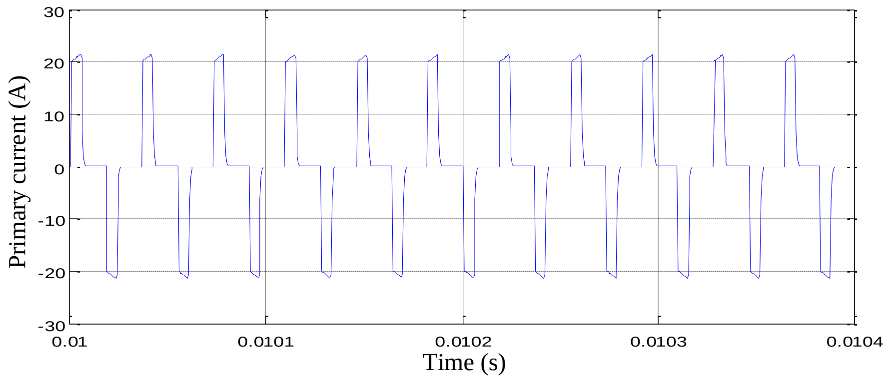

Figure 6. Transformer primary current under 60A load

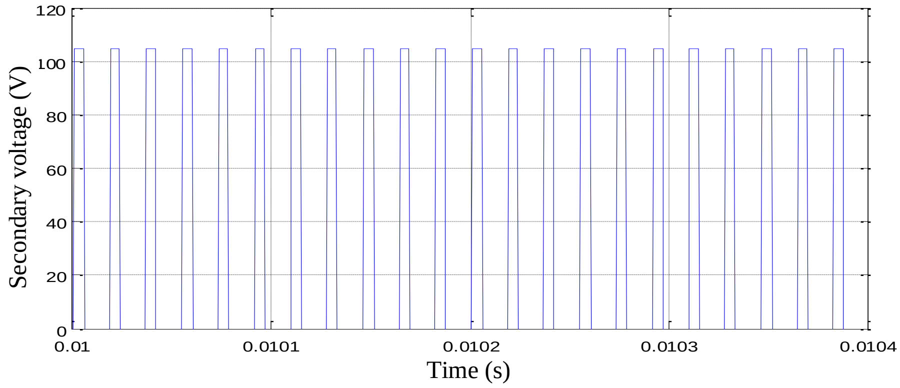

Figure 7. Transformer secondary voltage under 60A load

Figure 8 shows the change of rectifier output voltage. It is understood that rectifier output is fixed at 28 V. At the first time, the rise value is set to 0.01 s by the PI controller and drawn to the desired reference voltage. Figure 9 shows the rectifier output current value. 60 A is continuously supplied to the load connected to the system.

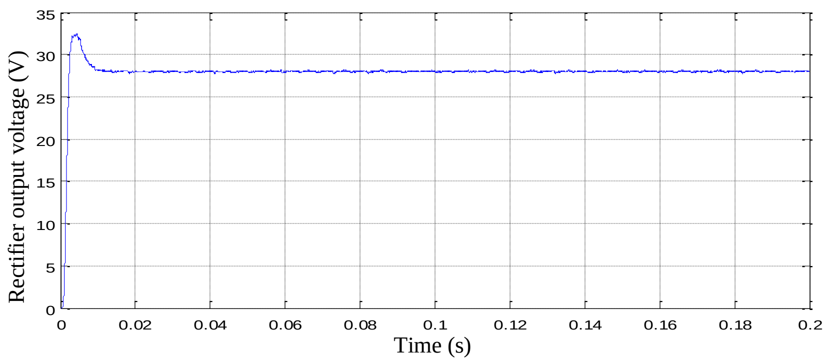

Figure 8. Rectifier output voltage under 60A load

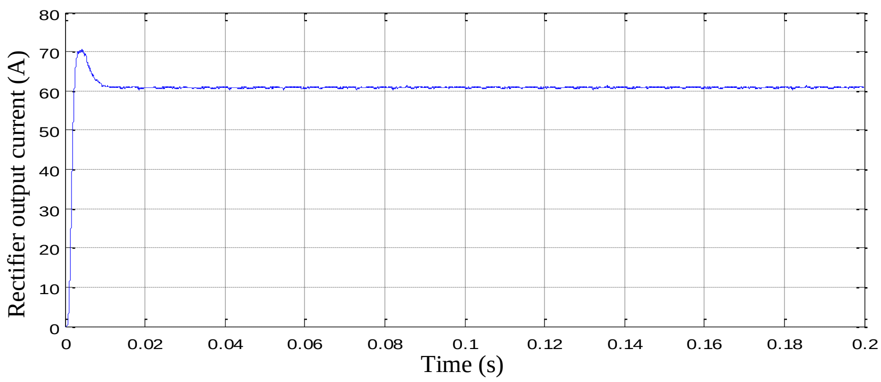

Figure 9. Rectifier output current under 60A load

Figure 10 shows the waveforms of the 55 kHz triangle wave generator. This waveform generated by the triangle wave generator is compared with the error in the PI controller output given in Figure 11. As a result of this comparison, when the PI error value is greater than the triangular wave, the comparator generates 0 when the value is smaller. This signal change produced by comparison is given in Figure 14. Figure 14 shows the output of the clock, comparator, S1_g and S3_g switching signals in detail. The frequency of the block signal is selected as half of the switching frequency.

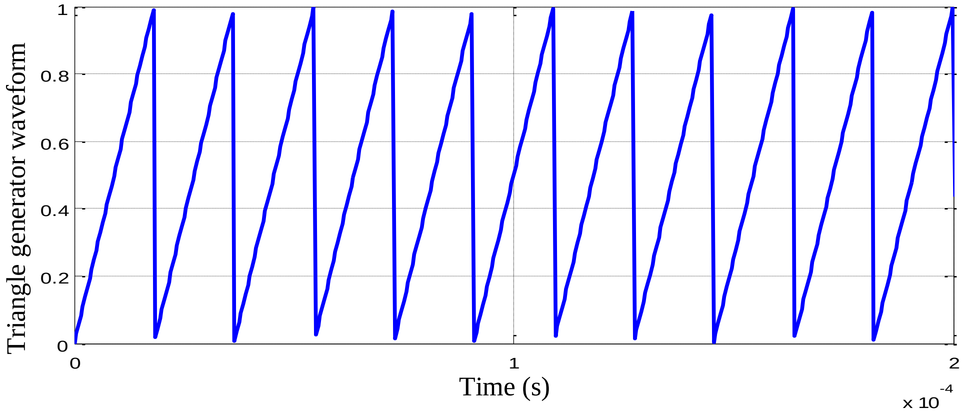

Figure 10. Triangle generator waveform under 60A load

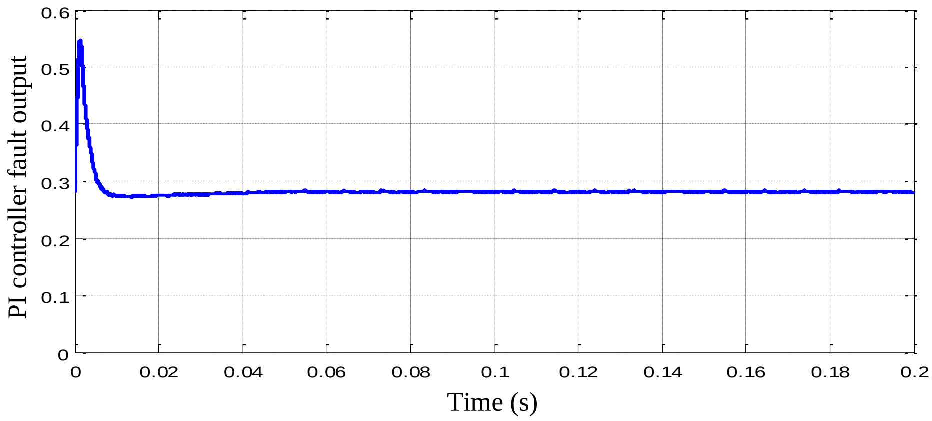

Figure 11. PI controller fault output under 60A load

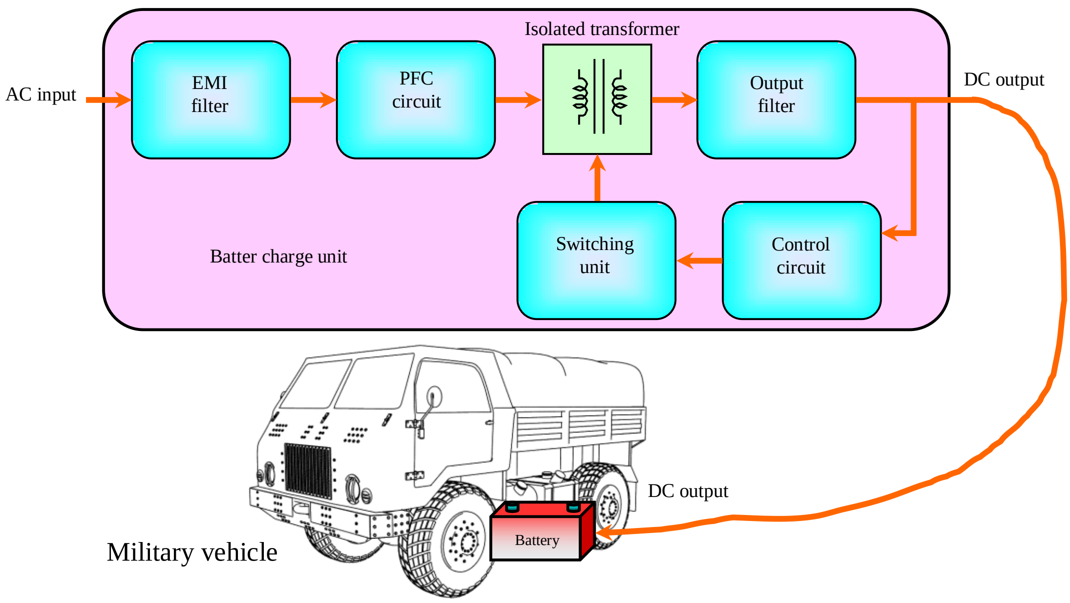

Figure 12. Diagram of military vehicle battery charge circuit

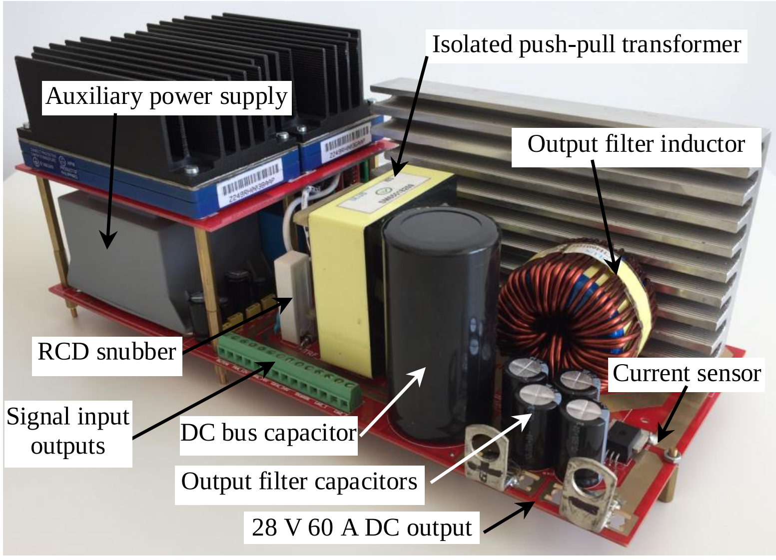

Figure 13. Photograph of battery charge circuit

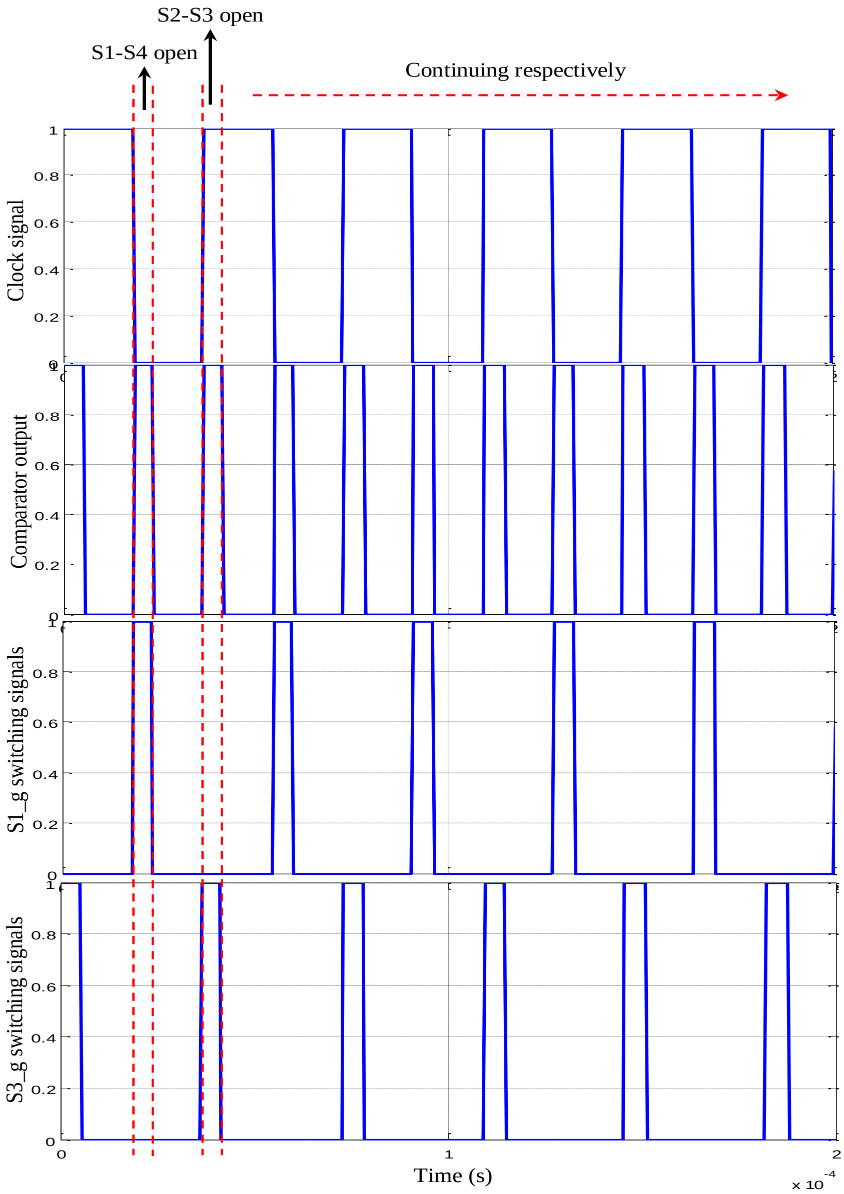

Figure 14. Comparator, S1_g and S3_g switching signals under 60A load

Conclusion

In this study, the battery charge circuit used in military vehicles was simulated with Matlab/Simulink program. The results of the circuit which has been designed with simulation program under full load are given. It is seen that the output of the battery charging circuit remains at the desired constant voltage under full load. PI voltage controller is used in the designed circuit to ensure stable operation of the system. The system designed according to the simulation results was produced.

Acknowledgments

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References

Bogosyan, S., Gokasan, M., and Goering, D. J., A Novel Model Validation and Estimation Approach for Hybrid Serial Electric Vehicles, IEEE Trans Veh Technol, vol. 56, pp. 1485-1497, 2007.

Masrur, M. A., Skowronska, A. G., Hancock, J., Kolhoff, S. W., McGrew, D. Z., Vandiver, J. C. , and Gatherer, J., Military-Based Vehicle-to-Grid and Vehicle-to-Vehicle Microgrid-System Architecture and Implementation, IEEE Trans on Transp Electf, vol. 4, pp. 157-171, 2018.

Lee, S., and Kim, J., Implementation methodology of powertrain for series-hybrid military vehicles applications equipped with hybrid energy storage, Energy, vol. 120, pp. 229-240, 2017.

Antoniou, A. I., Komyathy, J., Bench, J., and Emadi, A., Modeling and Simulation of Various Hybrid-Electric Configurations of the High-Mobility Multipurpose Wheeled Vehicle (HMMWV), IEEE Trans Veh Technol, vol. 56, pp. 459-465, 2007.

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