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Electrification in Ship

Dr. Shaik Abdul Ahad, K. Thrivikram, K. Abhinay, N. Aravind
Affiliated to Jawaharlal Nehru Technological University, Hyderabad, Telangana
Department of Electrical and Electronics Engineering, ACE Engineering College, Ghatkesar, Telangana

Abstract: In ships electricity is generated by the use of alternators. These alternators are equipped with an inbuilt rectifier which gives a DC output. Depending on the speed of the alternator the output voltage will be either 48-volts or 12-volts. Now the ship generally has two different batteries with 48-volts (housing battery's) and 12-volts (Engine block battery's). These batteries are responsible for providing power for both engine block and for housing purpose as well. This battery's need to be charged. When the alternator is providing a output voltage of 48-volts the 48-volts will be directly charged and a buck convertor is used to step down the voltage from 48-volts to 12-volts and charge 12-volts battery's. when the alternators are providing a voltage of 12-volts the 12-volt batteries are directly charged and if they charge fully the the boost convertor is used to step-up the voltage and charge the 48-volts battery. Depending on speed of the alternator the output voltage varies to defined values and based on these either boost or buck operation takes place.
Keywords: Alternator, Battery, boost converter, buck converter, Engine loads, housing loads.

I. INTRODUCTION

Shipping is the backbone of today's economy, as 90% of global trade volumes is transported by sea. Much of our lifestyle today is only made possible by the existence of shipping as a cheap and reliable mean of transportation across the globe.

II. LITERATURE SURVEY

In the last years the need of high power density installation in shipboard power systems has arisen. A large amount of space for electrical equipment is required in order to feed a wide range of loads, some of which of high power (electric propulsion, radar, free electron lasers, electro-magnetic launchers, etc.). This comes up against the limited space availability, especially in military field. Moreover, innovative weapon systems (presently object of research) have proven to be difficult to manage using traditional AC distribution, as they essentially are large pulse loads to be supplied by the shipboard electrical power system. Being the electric ship power system an islanded weak grid, pulse loads represent a problematic issue: the Medium Voltage Direct Current (MVDC) distribution systems are proposed to face this problem. This technology makes it possible to use variable and high speed generators, characterized by high power density, and to integrate pulse loads, energy storage systems and innovative electric power generating systems. In MVDC power systems, energy is distributed in DC form and subsequently converted as required by supplied loads. The large amount of controlled power electronic converters allows managing system relevant variables (voltage, current and power) in a more flexible way than in AC power systems. So most of the modern ships and vessels DC power generation and utilization then AC generation and utilization.

III. BLOCK DIAGRAM

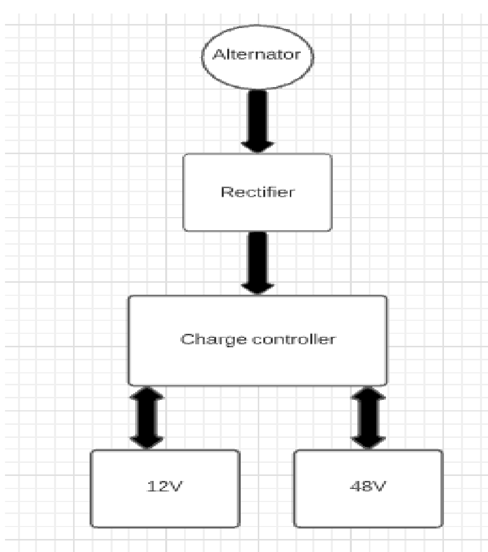

Fig 1: Block Diagram

IV. ELECTRICAL EQUIPMENT

A. Alternator

Alternator is an electrical generator that converts mechanical energy to electrical energy in the form of alternating current. For reasons of cost and simplicity, most alternators use a rotating magnetic field with a stationary armature. The major reason for using a alternator instead of a DC generator is because alternators are more efficient compared to DC generators.

B. Rectifier

Rectifier is a power electronic device which is used to convert alternating current to direct current. The alternator which we use provides an alternating current in its output so we convert the alternating current to direct current. But the output from the rectifier is a pulsating DC and we convert this Pulsating DC to steady DC.

C. Charge Controller

The charge controller is a hardwired system which control magnitude and direction of the flow of current.

D. Battery's

Batteries are a storage elements of electricity in a chemical form the battery's that we consider are lithium ion batterys.

V. FLOW CHART

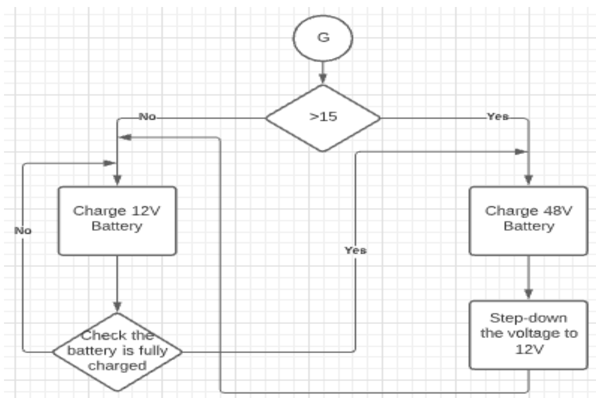

Fig 2: Flow chart

VI. WORKING

In ships electricity is generated by the use of alternators. These alternators are equipped with an inbuilt rectifier which gives a DC output. Depending on the speed of the alternator the output voltage will be either 48-volts or 12-volts. Now the ship generally has two different batteries with 48-volts (housing batteries) and 12-volts (Engine block batteries). These batteries are responsible for providing power for both engine block and for housing purpose as well. This battery's need to be charged. When the alternator is providing a output voltage of 48-volts the 48-volts will be directly charged and a buck convertor is used to step down the voltage from 48- volts to 12-volts and charge 12-volts battery's. when the alternators are providing a voltage of 12-volts the 12-volt batteries are directly charged and if they charge fully the boost convertor is used to step-up the voltage and charge the 48-volts battery. Depending on speed of the alternator the output voltage varies to defined values and based on these either boost or buck operation takes place. We have simulated the above process in Matlab Simulink and Simscape in a mathematical model.

A. Modes of Operation

Figure 2 the show the operation flow chat there are two different cases under which these system will work:

When the generator shaft is rotating at a high speed (or) when output voltage is 48V.
When the generator shaft is rotating at a low speed (or) when the output voltage is 12V.

1) Case (i): In this case the output voltage from the generator is around 48V during these time the algorithm will turn on the switch of 48V battery and step down the voltage to 12V by using a converter and charge the 12V battery simultaneously.

2) Case (ii): In this case the output voltage from the generator is around 12V during these time the algorithm will turn on the switch of 12V battery and charge 12V battery first after 12V battery is fully charged the converter will step up the voltage and charge 48V battery. Here in these case after the charging of 12V battery the 48V battery will start charging.

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Converter:

The converter that we are using in this paper is a Bi-Directional Buck-Boost converter. A Bi-Directional converter.

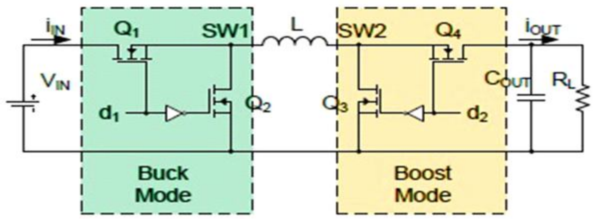

Fig 3 Bi-directional buck boost converter

V_{out}=Output voltage

I_{out}=Output current

V_{in}=Input Voltage

I_{in}=Input current

ŋ=Efficiency

Formula:

Duty cycle (D)= V_{out}/V_{in}

$I_{in}=(D/\eta)*I_{out}$

VII. OUTPUT UNDER DIFFERENT MODES

A. Case (i)

When output of the generator is 48V

Under this condition the 48V battery is directly charged through generator and simultaneously the voltage must step down and charge the 12V battery as well. the output of the batteries are shown in fig 4 and fig 5.

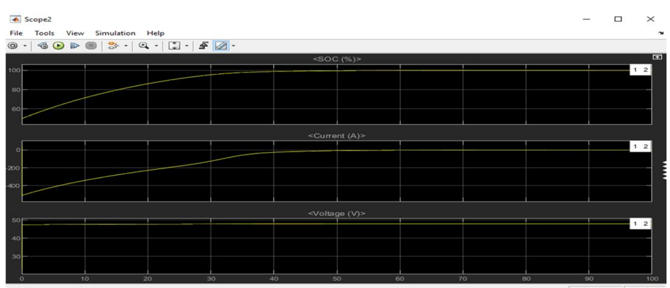

Fig4 48V Battery status.

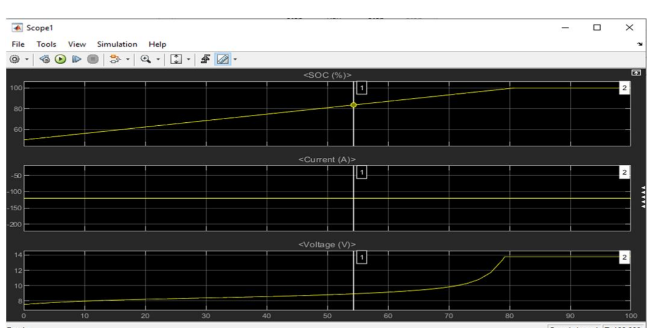

Fig5 12V Battery status.

B. Case (ii)

When output of the generator is 12V

Under this condition the 12V battery is directly charged through generator and after the battery is fully charged the voltage must step up and charge the 48V battery. The output of the batteries is shown in fig6 and fig 7.

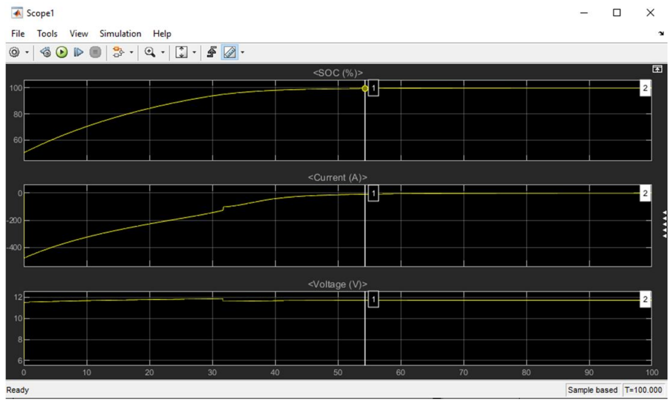

Fig 6. 12V Battery status.

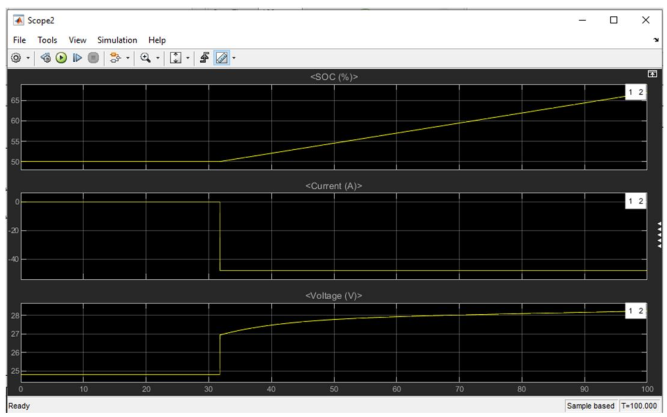

Fig 7. 48V Battery status.

In fig 4.10 there is a delay before the battery SOC percentage started increasing because it started charging after the 12V battery has reached 100 percentage of its charge.

VIII. FUTURE AND SCOPE

In this paper we designed a circuit capable of charging the battery's on board a ship. One can take this design and supply power to the different loads available on board the ship. If the loads want a A.C supply they can use a inverter circuit and provide the supply. If the loads need a 220V D.C we can use a step-up chopper or a boost converter to provide electricity to that particular electrical equipment. In this way we can provide supply to different equipment's according to their requirement.

IX. CONCLUSION

In this paper mathematical analysis of the buck-boost converters has been carried out and based on the results. Simulation of the converter has been carried out. By using these circuits we have successfully designed a system which is suitable for charging the battery on board the ship under the dynamic conditions in ship and the SOC percentages have been observed as well.

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BIOGRAPHIES

Dr. Shaik Abdul Ahad

Professor in EEE department, ACE Engineering College, India, received his B.Tech from Kakatiya University Warangal. M.Tech and Ph.D from NITK Surathkal have teaching experience of 20 years. His area of interest are Power electronics, Modular Multilevel Inverter , Dual Active Bridge Converters, Electrical Machines.

Mr. K. Thrivikram

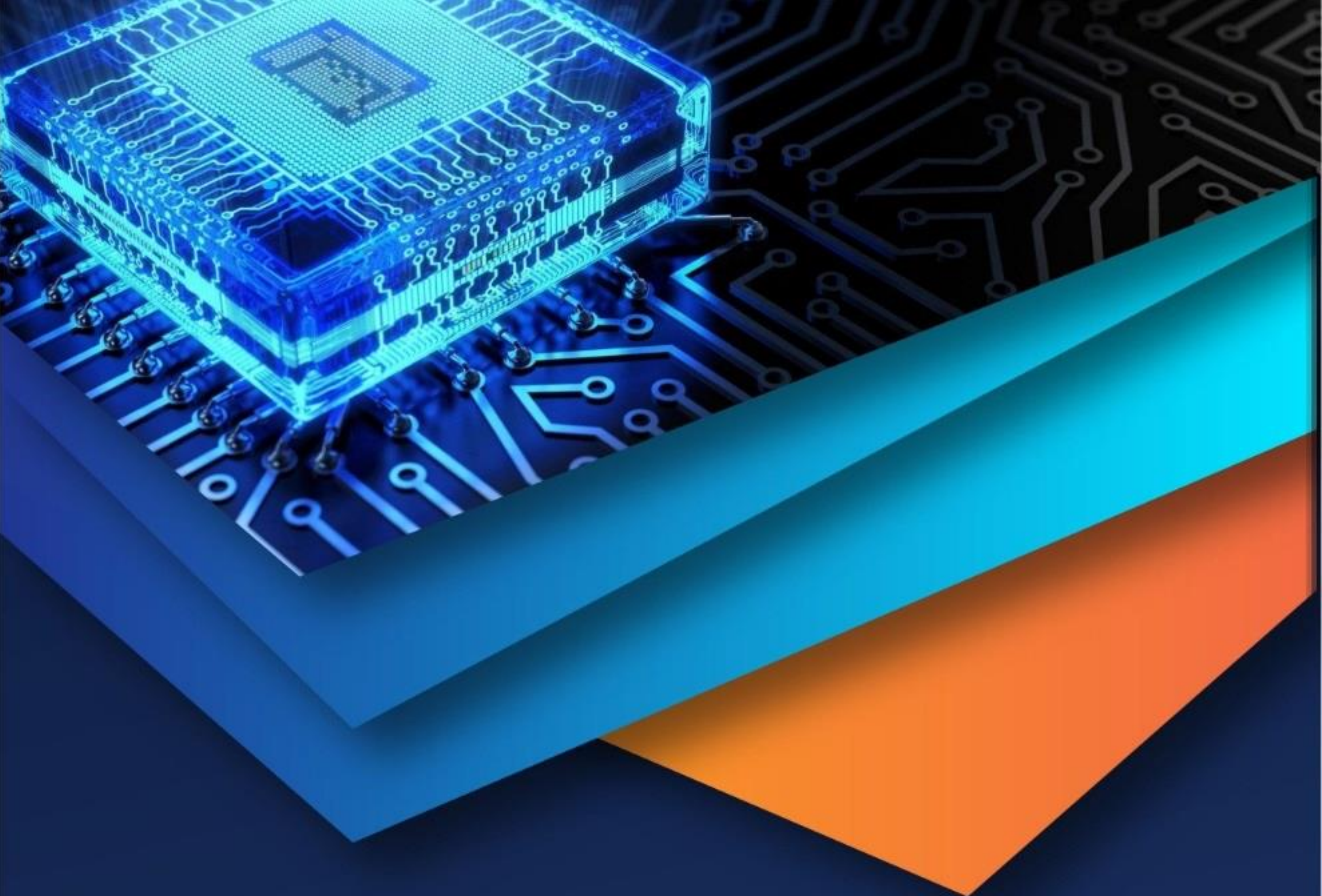
Student of EEE department. He was born in the year 2000. He did his intermediate from Sri chaithanya junior collage, Hyderabad & pursuing B.Tech from ACE Engineering college. His area of interest are Electrical machines, Power Electronics and Drives.

Mr. K. Abhinay

Student of EEE department. He was born in the year 2000. He did his intermediate from Shivani junior college, Hanumakonda & pursuing B.Tech from ACE Engineering college. His area of interest are Power system and power electronics.

Mr. N.Aravind

Student of EEE department. He was born in the year 2000. He did his intermidiat from Arjun college of technology and science & pursuing B.Tech from ACE Engineering college. Actively participate in several national hackathons. His area –of interest in power electronics.



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