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A Review on Industrial Battery Charger by Thyristor Firing Angle Control

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ABSTRACT: This project is designed to charge batteries using DC from AC power supply. The DC power is obtained from a rectifier system that is controlled by a thyristor. Whereas the AC power is deployed on a bridge rectifier composed of diodes and a triac to achieve required control from microcontroller (of 8051 family). The system requires detection of zero crossing point of waveform by a comparator and its output is fed into microcontroller. Then the expected delayed triggering control is provided by microcontroller to the triac through opto-isolator interface. Eventually, the power is provided to load through triac in series with bridge rectifier. Now the rectified and controlled DC output is applied to load (here we have used resistor instead of a battery). With the use of a multimeter output DC is measured. The microcontroller is connected with push button switches using which the DC voltage can be increased or decreased for appropriate charging.

KEYWORDS : Transformer, Battery, Converters...

I.INTRODUCTION

The projectis intended for charging battery(s) by DC from AC supply of power. DC power supplied for a battery's charger is a derivative from a thyristor controlled rectifier mechanism. AC supply of power is useful to a link rectifier consisting of diodes and a TRIAC achieving preferred power from the micro controller.

This project of industrial battery charger brings into use zero crossing point of the waveform which is sensed by a comparator whose productivity is then supplied to the micro controller. The micro controller endow with necessary delay in triggering control to a TRIAC via opto isolator edge. As a final point the power is supplied to the load via triac in succession with the linking rectifier. The DC output which is rectified and controlled is provided to the load i.e., a resistor employed in our project as a substitute of a battery. The DC voltage thus produced is calculated by utilizing a multi-meter. In this industrial battery charger project we have used a microcontroller which is from 8051 family which is edged via push button keys employed for rising or lessening the DC voltage for appropriate charging reasons.

This particular project can be improved further by employing direct 230 volt power supply rather than 12 volt AC to the linked rectifier for obtaining high voltage to control for charging numerous of batteries connected in a sequence.

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II. METHODOLOGY

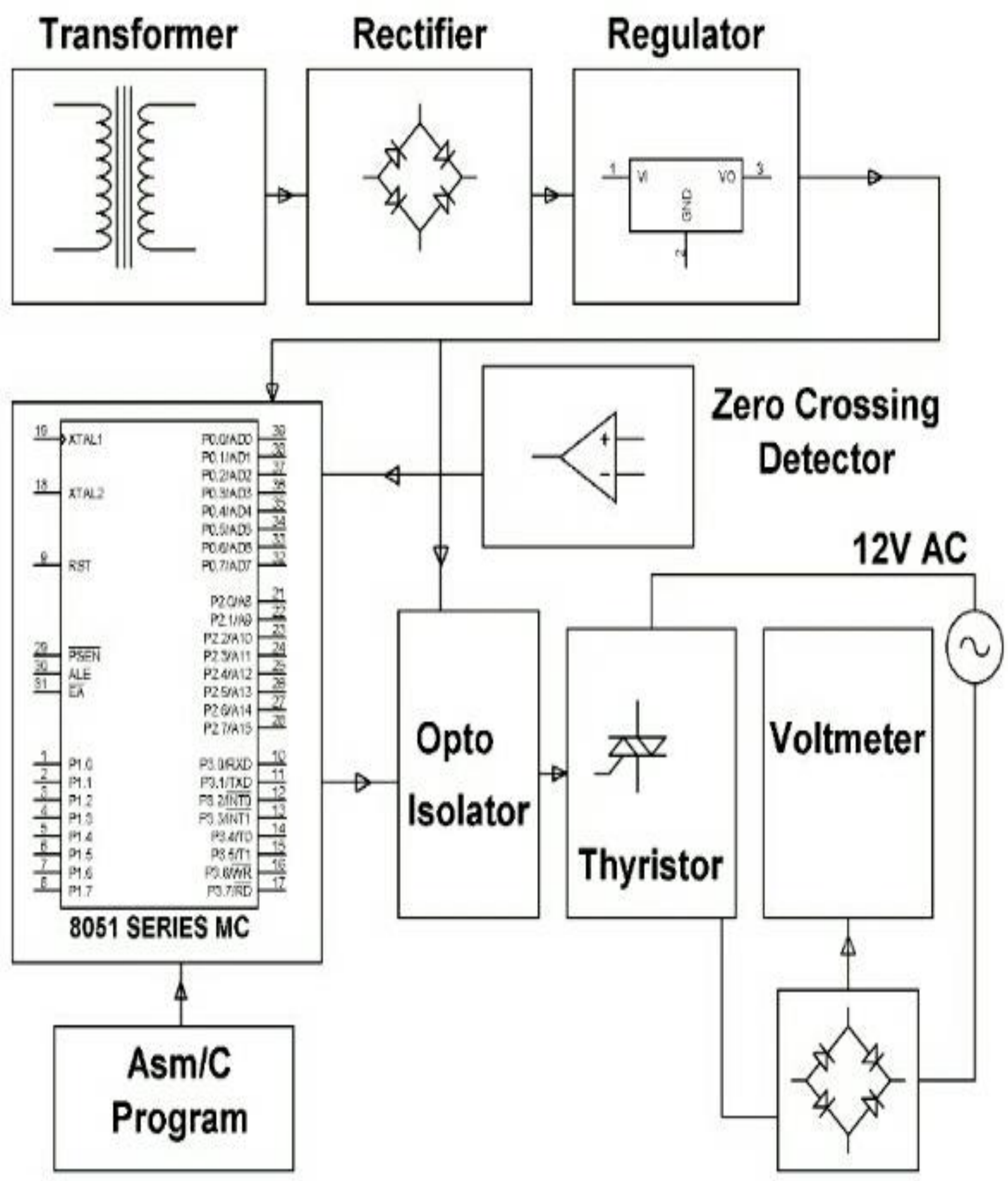

FIG 1: BLOCK DIAGRAM OF INDUSTRIAL BATTERY CHARGER BY THYRISTOR

The block diagram of the thyristor based emergency battery charger using DSP controller is shown in Fig.4.The 1Φ, 230V, 50Hz supply is fed to the 230/133 V transformers. The 133 V AC input to semi-controlled converter is rectified to obtain a 110 V DC. The DSP processor is programmed using CCStudio to obtained required duration gate pulse.

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A TI device AMC1100EVM is used to sense the output voltage and provide voltage feedback to the DSP controller. The passive LC filter at the output reduces the ripple content in the output voltage and the output current.

III. OBJECTIVE

The major objectives of the presented work are as listed:

- To design a 2.5KW, 110V,70AH Thyristor Based Emergency Battery Charger for railwayapplication
- To obtain a regulated output of 110V DC with output regulation ≤2.5%
- To obtain an overall system efficiency ≥80%
- To supply the load and charge the primary battery in the case of failure of the mainbattery.

IV. COMPONENTS

The various components of the thyristor controlled emergency battery charger are chosen to fulfill all the stated objectives.The valve regulated lead acid battery (VRLA)battery is charged in the constant voltage mode.The selection process of the various blocks that has been incorporated in the thyristor controlled emergency is as:

Transformer

A rectified output of 110V is required.Considering the voltage drops across the diode , thyristor,inductor resistance and electrostatic resistance(ESR) in capacitor , a 230/0-133-139V centre tap transformer is selected.The double winding transformer has EI core.

Rectifierbridge

A thyristor –diode bridge module SKKH 57/16E is used.The thyristor has 150 mA holding current (I_H) 300mA latching current (I_L).The minimum gate to cathode voltage (V_{AK}) for turning on the thyristor is 3V.

Passivefilters

The capacitor and inductor is selected to minimizethe ripple content in the output voltage and the output voltage and the output current

Capacitor

A 4700µF, 350V DC, Large Can Electrolytic Aluminium Capacitor is used is used to minimize the ripple content in the outputvoltage.

Inductor

A 18mH allowing maximum permission current of 30A is used.It is of Type 43 with single core EI laminations. The ripple content in the output after using the LC filter circuit is calcuted using equation -

Ripple factor (RF) =

$$\frac{1}{6*\sqrt{2}*w^2*L*C}*100$$

RF= 1.411 % ≤ 2.5%

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Output Voltage ErrorDetector

R1 and R2 at the output forms the potential divider circuit.The resistance values are selected as 45.3kΩ and 100Ω repectively.

The voltage across R1 is 109.75V and that across R2=0.24V if an output of 110V is obtained.

The voltage across R2 (V_{R2}) vary in the range of 0.25V to 3.3 V as the output varies between 106V to 112V due to fluctuations in the AC supply.The voltage $V_{R2}$is fed to AMC1100EVM , a TI device generating the error voltage in the output and feeding it as input to the ADC as shown in Fig.6.

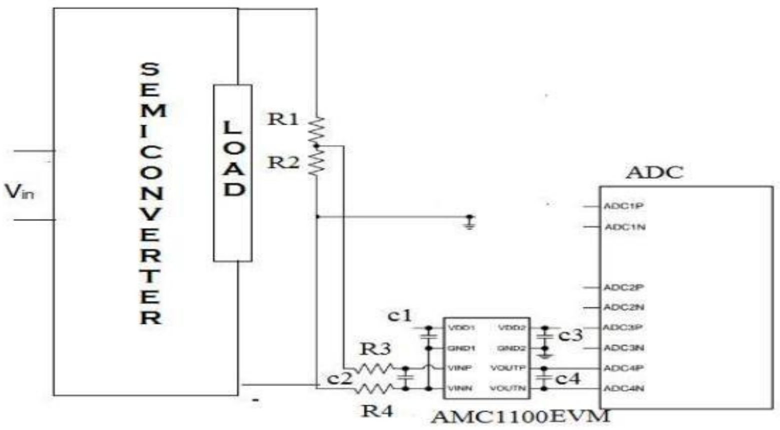

Fig.6 AMC1100EVM detecting the error in output voltage

DSPProcessor

TMS320F28335 processor is used to generate the required gate pulses to fire the thyristor.The block diagram is shown in Fig. 7.

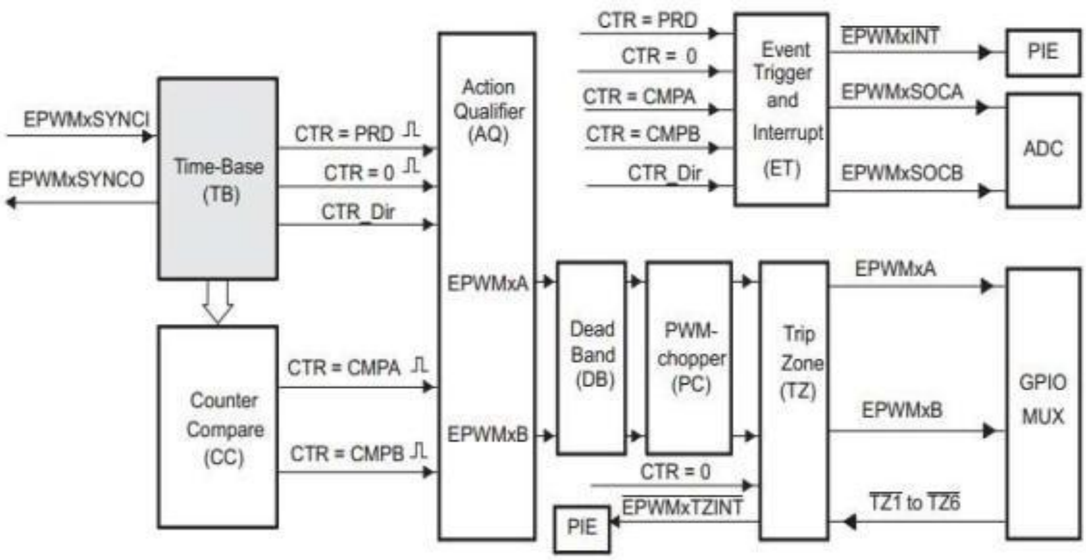

Fig.7 Block diagram of TMS3220F28335

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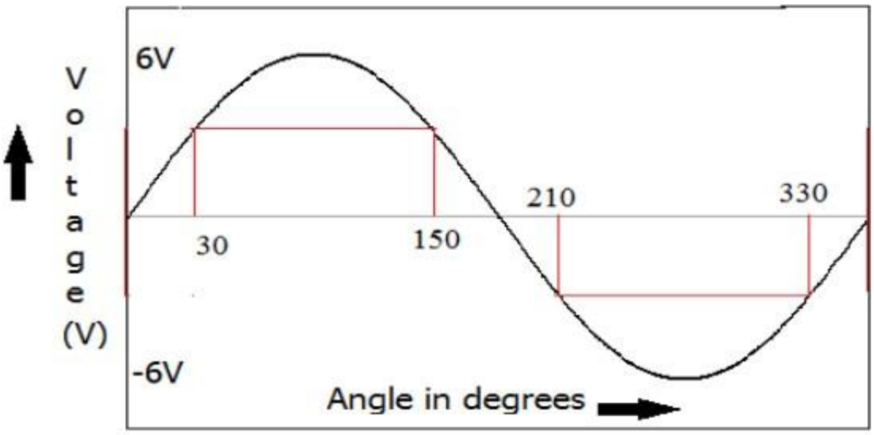
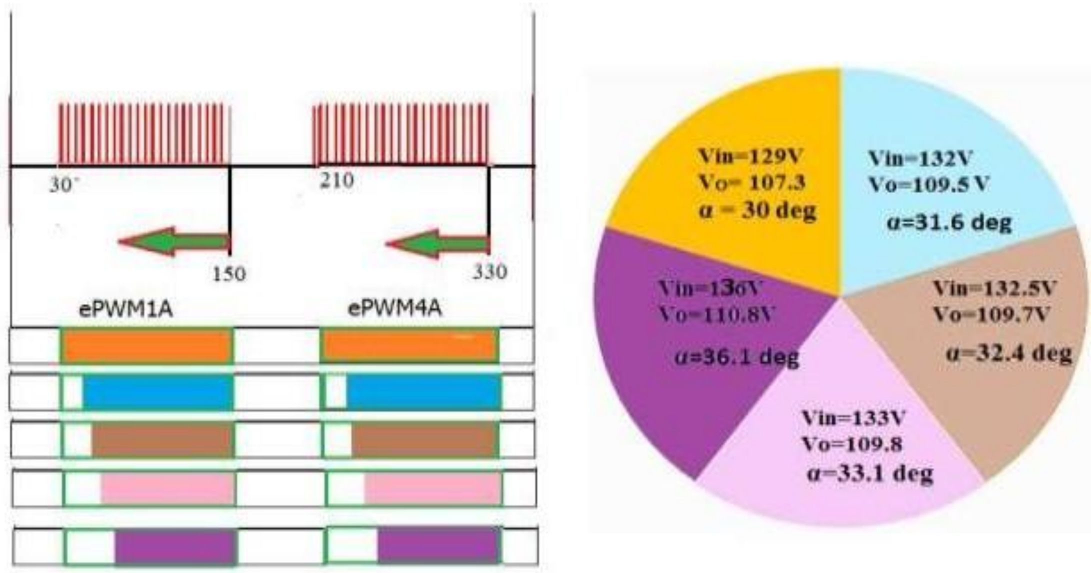
The phase angle control logic is implemented as shown in Fig.8.The thyristor firing angle gets adjusted based on the error voltage input to the ADC.The slave ePWM signals ePWM1A and ePWM4A corresponds to the firing angle of thyristor T1 and T2 respectively where as ePWM6A is the master ePWM controlling the generation of ePWM1A during the positive half cycle and generation of ePWM4A during the negative half cycle.





(b)Fig.8ThyristorFiringLogic(a)DeadBandGeneration(b)Firingangleadjustment

Firing Control Circuit

The ePWM1A and ePWM4A is fed to the firing and control circuit shown in Fig 9.The IR2121 IC limits the inrush of huge current and shuts down the circuit in case of any fault detection.The high switching frequency MOSFET is synchronised with the ePWM pulses.A transient voltage suppresser diode BZW50-33 and a fast recovey diode UF4007 is used on the transformer primary for preventing the voltage from exceeding 15V.

Battery

The thyristor controlled emergency battery charger is used to charge nine 12V valve regulated lead acid (VRLA) batteries connected in series..

VI. CONCLUSION

The emergency battery charger is connected in parallel to the main based battery charger. The DSP controlled firing circuits is more efficient , accurate and reliable compared to the analog firing circuit based battery charger used in the conventional bogies oftrains.The DSP controller based battery charger consume lesser power and losses are also minimised to a greater extent.

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