POWER FACTOR CORRECTION FOR THREE-LEVEL RECTIFIER

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***Abstract* — A high-efficiency bridgeless three-level power factor correction (PFC) rectifier is proposed. The circuit configuration of the proposed rectifier consists of four metal oxide semiconductor field-effect transistor (MOSFET) switches, and the reverse recovery problems of the switches are eliminated. Also, the proposed rectifier with three voltage levels reduces the power losses, harmonic components, voltage ratings, and electromagnetic interference. To control the grid current and the output voltage effectively, a feed-forward nominal voltage compensator with the mode selector is developed; by presetting the operating point of the grid voltage, this compensator improves the control environment. Thus, the proposed three-level PFC rectifier with developed control algorithm provides high power quality and high efficiency of 99.05%. Experimental results based on a 1-kW prototype are provided to evaluate its performance and verify the analysis.**

***Index Terms* — MOSFET, PFC, AC-DC, CAPACITOR.**

I. INTRODUCTION

In recent years the demand for electric power and its conservation have prompted the use of alternative energy sources, especially the renewable energy sources. The renewable energy sources like photovoltaic arrays and fuel cells produce output voltages at low level. In order for efficient use of low level voltage, it must be stepped up for the purpose of practical utilization or stepped up and inverted before connecting to grid. Global energy consumption tends to grow continuously. To satisfy the demand for electric power against a background of the depletion of convectional, fossil resources the renewable energy sources are becoming more popular.

In electronics, a chopper circuit is used to refer to numerous types of electronic switching devices and circuits used in power control and signal applications. A chopper is a device that converts fixed DC input to a variable DC output voltage directly.

In power electronics applications, since the switching element is either fully on or fully off, its losses are low, and the circuit can provide high efficiency. However, the current supplied to the load is discontinuous and may require smoothing or a high switching frequency to avoid undesirable effects.

A DC power supply is used in most of the appliances where a constant voltage is required. DC stands for Direct Current, in which the current flow is unidirectional. The process of DC conversion can be done by DC Converters.

II. LITERATURE SURVEY:

1.Jun Seok Kim, Sung Ho Lee proposed A high-efficiency bridgeless three-level power factor correction (PFC) rectifier is proposed. The circuit configuration of the proposed rectifier consists of four metal oxide semiconductor field-effect transistor (MOSFET) switches, and the reverse recovery problems of the switches are eliminated. Also, the proposed rectifier with three voltage levels reduces the power losses, harmonic components, voltage ratings, and electromagnetic interference. To control the grid current and the output voltage effectively, a feed-forward nominal voltage compensator with the mode selector is developed; by presetting the operating point of the grid voltage, this compensator improves the control environment.

2.MiaosenShen proposed, A multilevel dc–dc power conversion system with multiple dc sources proposed in this paper. With this conversion system, the output voltage can be changed almost continuously without any magnetic components. With this magnetic-less system, very high temperature operation is possible. Power loss and efficiency analysis is provided in the paper. Comparison results show that the system does not require more semiconductors or capacitance than the traditional boost converter. Experimental results are provided to confirm the analysis and control concept.

III.METHODOLOGY:

The requirement of solid state ac-dc converter for the improvement of power quality from the power factor correction point of view it reduces the total harmonic distortion at input in ac mains. And gives the smooth dc output and this need motivate the several topologies based on the power electronics converter. i.e buck, boost and buck-boost. The mode of operation of boost converter is continuous current mode (CCM) is become popular due to reduction of electromagnetic interface (EMI). The evolution of the traditional boost converter is elaborated in terms of enhanced characteristics achieved by other topology based on boost converter. The conventional boost converter for the power factor correction is not more reliable and efficient because of losses and complex construction generates a need of new invention for the power factor correction which will more efficient and simple in construction, faster in switching and the most important beneficial in terms of economy and now for this a new concept is introduced called single inductor three-level bridge.

IV. HARDWARE USED:

1.IRF840 MOSFET: It is a third generation power MOSFET with the best combination of fast switching, ruggedized device design, low on-resistance and cost-effectiveness.it is preferred for industrial applications where power dissipation levels is approximately 50 W. The low thermal resistance and low package cost contribute to its wide acceptance throughout the industry.

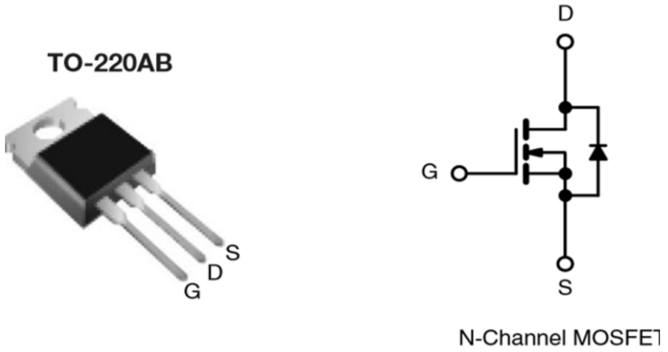


Fig .1 IRF840 MOSFET

I am using MOSFETs as a switch because of its characteristics which are given below:

- MOSFET is majority carrier device.
- It is a voltage control device. Output is controlled by controlling the gate voltage.
- Drive circuit is simple it should provide constant gate voltage.
- Fast switching.

2.DRIVER CIRCUIT:

The purpose of a driver circuit is to switch a power semiconductor device from OFF-state to the ON-state and vice versa. To reduce instantaneous power dissipation during switching, the turn-on and turn-of must be minimized. So, that power device spends little time in the active region. In the on-state the drive circuit must provide adequate drive power to keep the power switch in the on state where the conduction losses are low. The drive circuit is needs to provide reverse bias to the gate to minimize turn of times and to ensure that the device remains in the off state and is not triggered on by stray transient signals generated by the switching of other power devices. The features of properly designed gate-driver circuits are as follows:

- It interfaces between the control circuit and the power switch.
- It amplifies the control signals to the levels required to drive the power switch.
- It also provides electrical isolation between power and control circuits.
- The gate drive circuit required to provide protection to the power device.

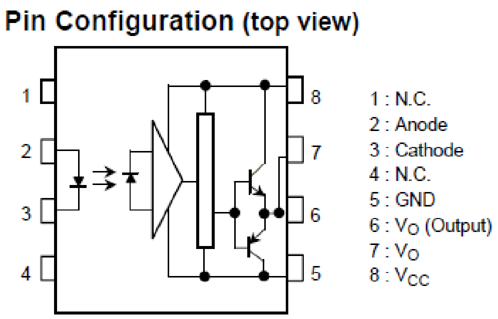


Fig2 Pin configuration of isolated MOSFET driver TLP250

Parameters of TLP 250:

1. Input current is 5mA
2. Supply current is 11mA
3. Supply Voltage range is 10-35V
4. Output current is ±1.5A

I have used TLP250 opto coupler and driver circuit to provide isolation between MOSFET and control unit. TLP250 is a 8 pin IC which provide both isolation and amplification. MOSFET Driver TL250 like other MOSFET drivers have input stage and output stage. It also have power supply configuration.

3. ARDUINO MEGA 2560:

Arduino is an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software An Arduino board consists of an 8-bit Atmel AVR microcontroller with complementary components to facilitate programming and incorporation into other circuits

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal Oscillator, a USB connection, a power jack, an ICSP header, and a reset button.

4. PFC CONTROL CIRCUIT:

It is a control circuit to Control the voltage and current**.** It consists of PLL, Voltage controller, current controller and mode selector. IR1152PFC Control circuit IC is used.

SPECIFICATION:

AC Input Voltage	85-24VA
Maximum output power	350W
Frequency	46-63 Hz

V.IMPLEMENTATION:

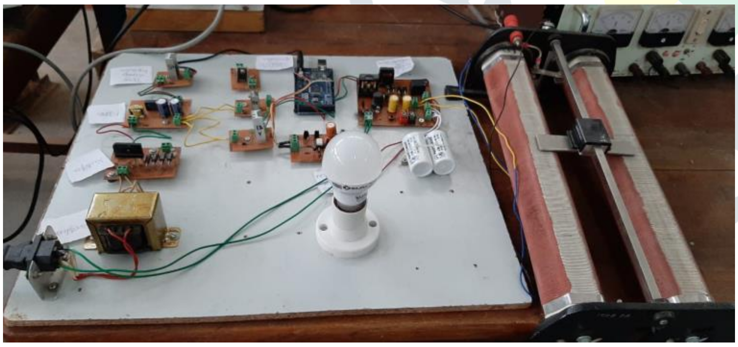
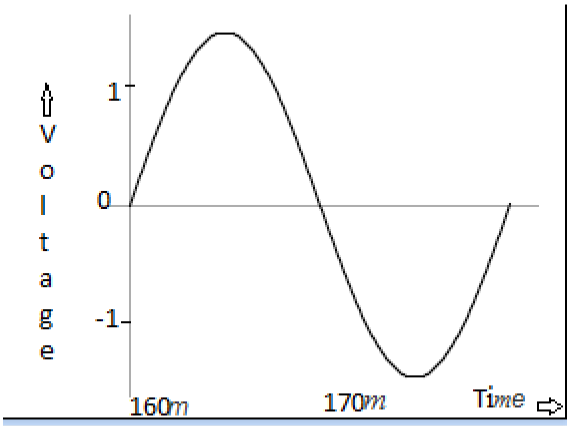


Fig 5 Three Level PFC Rectifier

OUTPUT WAVEFORM



A bridgeless PFC rectifier that further improves the low-line efficiency of the front-end by reducing the conduction loss through minimization of the number of simultaneously conducting semiconductor components is introduced. Because the proposed bridgeless rectifier also works as a voltage doubler, it can be designed to meet harmonic limit specifications with an output voltage that is twice that of a conventional PFC rectifier. As a result, the proposed rectifier also shows better hold-up time performance. Although the output voltage is doubled, the switching losses of the primary switches of the downstream dc/dc output stage are still significantly lower than that of the PFC counterpart

VI .Results:

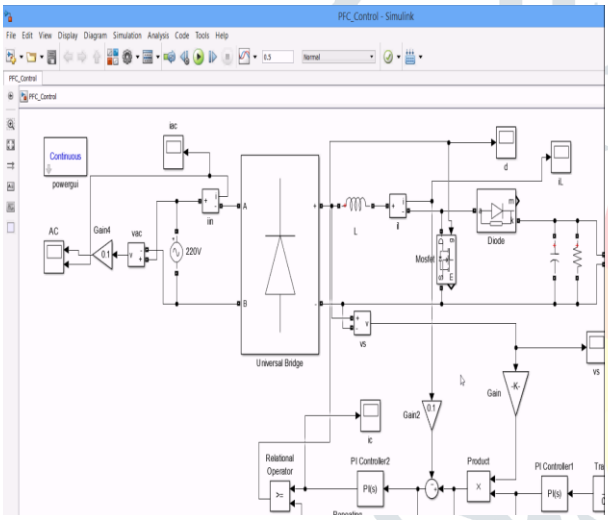


Fig 6.1 Simulink circuit

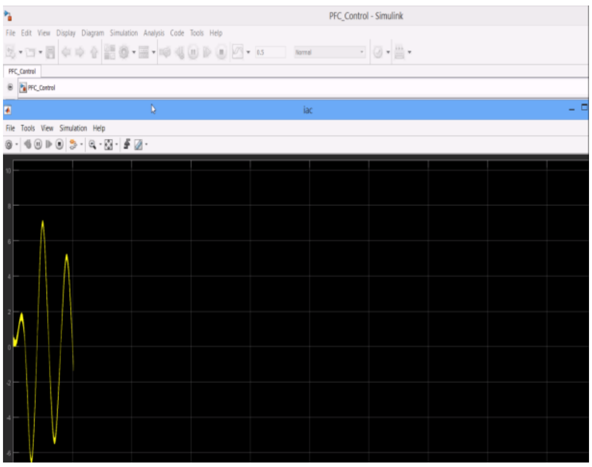


Fig 6.2 Simulink output

VII. Future scope:

This control technique can be adaptable to various topologies for leading edge and trailing edge modulation by simply changing the reference and control input. These results reveal that adding the notch filter, the dynamic response of the output voltage can be improved by four times faster compared by without notch filter. The output voltage is sensed by the output voltage sensor and it is given to the voltage amplifier, which amplifies the error voltage and this voltage is integrated by the externally resettable integrator to produce a variable slope ramp voltage in a switching cycle.

Conclusions

As the Bridgeless PFC boost converter eliminates the input rectifier bridge and the range switch, most of the conduction loss and switching losses are reduced so we can achieve higher efficiency than the conventional PFC boost converter and high power density, it can be used for high load applications. This paper proposes a boost PFC AC/DC converters, including analog peak current mode control with digital voltage loop control. The effect of hysteresis band of the comparator implement in analog circuit is analyzed for current loop. In digital voltage loop, notch filter is used to eliminate double line frequency on output voltage to improve dynamic and reduce input line current THD. The proposed PFC control scheme has been verified by using simulation.

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