Design and simulation of AC+DC Multi-Output Programmable Switched Mode Power Source

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ABSTRACT:
This study describes a unique AC+DC SMPS architecture that uses a hybrid of topologies to regulate the output type and voltage level through PWM logic. The suggested topology is widely used in current AC+DC programmable power supply on the market. The AC+DC programmable power supply architecture is designed and analyzed thoroughly using MATLAB Simulink, allowing for a thorough assessment of its performance and usefulness.

Keywords— AC+DC SMPS, PWM logic, MATLAB Simulink, programmable power supply, performance analysis

I.INTRODUCTION

With the proliferation of multiple sources/loads in engineering applications, AC+DC converters are increasingly in demand to control waveforms and regulate voltages under varying situations in order to test various DUTs such as household appliances, power supplies, and so on. Programmable power supplies are relatively expensive, which many sectors cannot afford. This work seeks to offer a programmable topology that effectively simplifies the building of AC+DC SMPS in order to provide cost-effective SMPS. Finally, an example specialized application with one input and selectable output is shown, together with detailed topology selection, design, and simulation results.

II.TOPOLOGY OF AC+DC SMPS

The topology is built by making the DC power supply constant in stage one by employing passive conversion of AC to DC using a full bridge rectifier. Although AC is used as the input source, the topology still works. After converting unstable voltage to stable voltage using a rectifier and filters, the DC supply feeds to a buck converter, which achieves the conventional technique of constant voltage and regulates the DC level, which may be set using reference pins on a microcontroller. The regulated dc supply is delivered to a single-phase inverter in step 3, which converts DC to AC using the SPWM method. We have completed the programmable ac supply up to this point. The output may be changed to DC by continually turning on required switches. As a result, the output becomes configurable using PWM logic. The entire architecture becomes an AC+DC programmable power supply by regulating the voltage and current of the buck converter. Figure 1 depicts the fundamental outline.

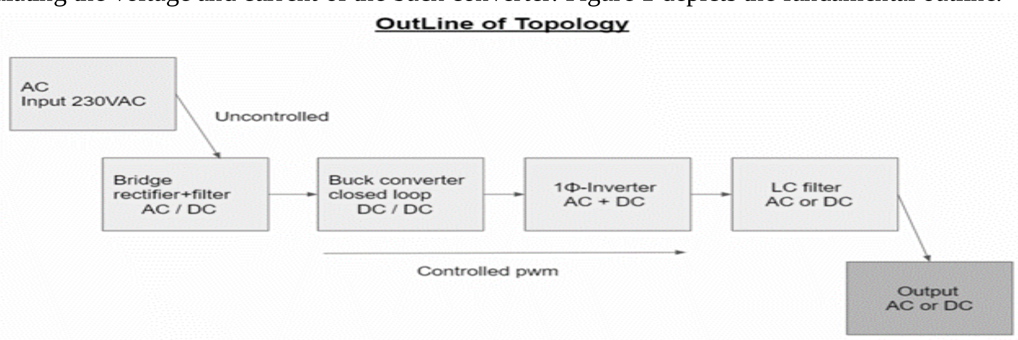

Fig. 1 A outline of AC+DC SMPS

Figure2:Topology

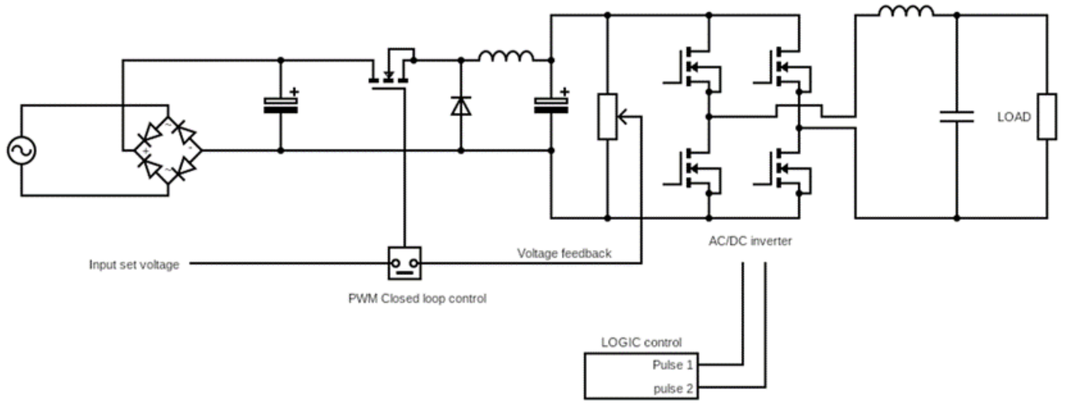

Fig.2: Topology of AC+DC SMPS

III.ISOLATED VS NON-ISOLATED TOPOLOGY

The topology described in this paper is non-isolated; however, the topology may be converted to isolated by isolating the input supply using a 1:1 transformer. Another option to improve efficiency is to replace the buck topology with isolated AC-DC SMPS such as half bridge, full bridge, flyback, and so on.

Stage 1: BUCK SMPS

As illustrated in Fig.3, the buck utilised in this architecture is a closed loop with a controlled reference voltage, which may be changed at any moment through a reference signal. Simulink and MATLAB are used to simulate and design the model.

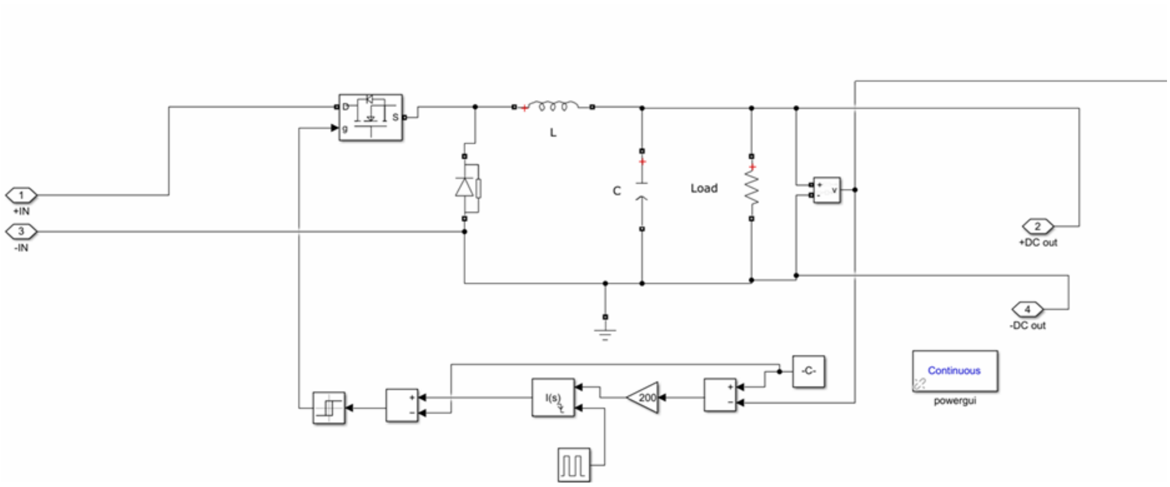

Figure.3: BUCK SMPS

Stage 2: Inverter Logic

The inverter logic employed here is basic, as illustrated in Fig.4, but the interesting component that produces the AC+DC multi output is the switching logic described in this Simulink model. The option of AC or DC is performed by altering the gating signal.

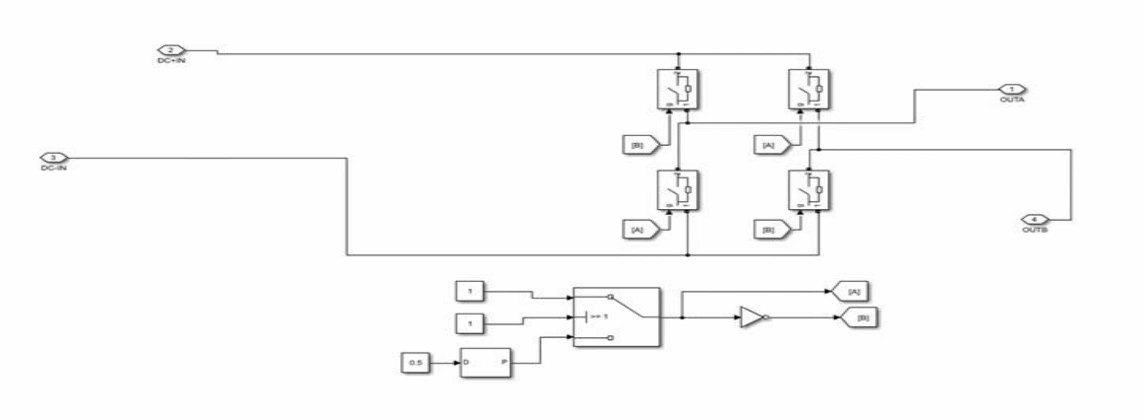

Figure.3: Inverter method

IV.SIMULINK MODEL INTERFACE

The Simulink model is simplified by the use of graphical inputs, where the set voltage may be changed using a glider by selecting the option "Current Type" AC or DC, which allows the output to be either AC or DC. The polarity changer is used to manage the DC output by switching it from positive to negative. As illustrated in Fig. 5, the DC bus Voltage level is fed from the buck output of stage 1, which affects the total amplitude of the output power whether it is AC or DC.

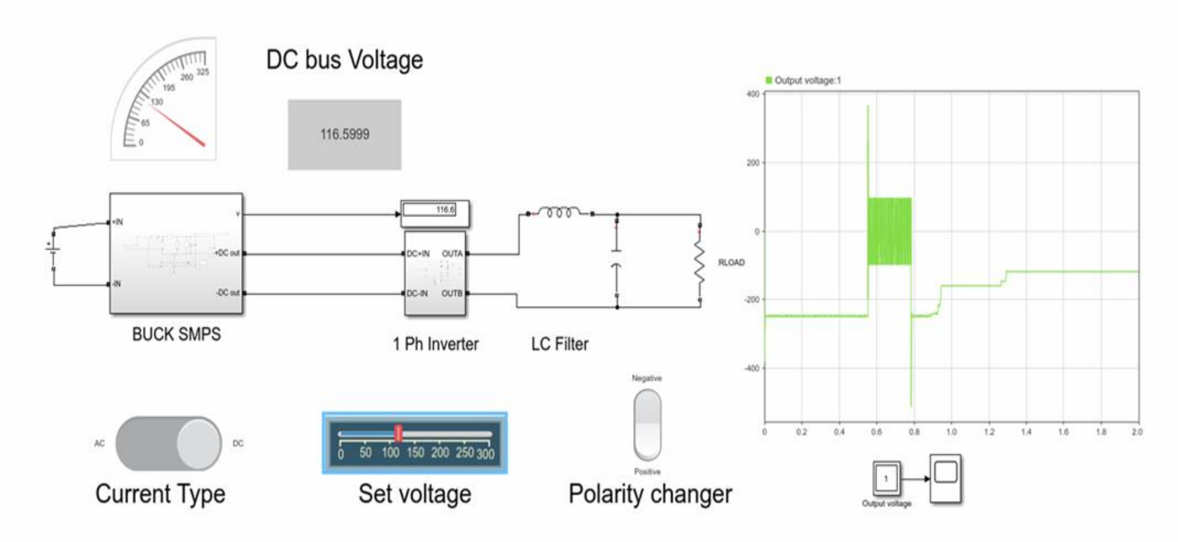

Fig. 5 Overall Simulink model of AC+DC SMPS

V.SIMULATION RESULTS

STAGE3: CONVERSION OF SQUARE TO SINE WAVE USING LC FILTER

The DC supply feeds a buck converter, which achieves the usual technique of constant voltage and regulates the DC level, which may be controlled using reference pins on a microcontroller. The AC sine wave form was fine-tuned using an LC filter and SPWM gating signals sent to a single-phase inverter, such that the DC bus voltage controls the amplitude of the AC output.

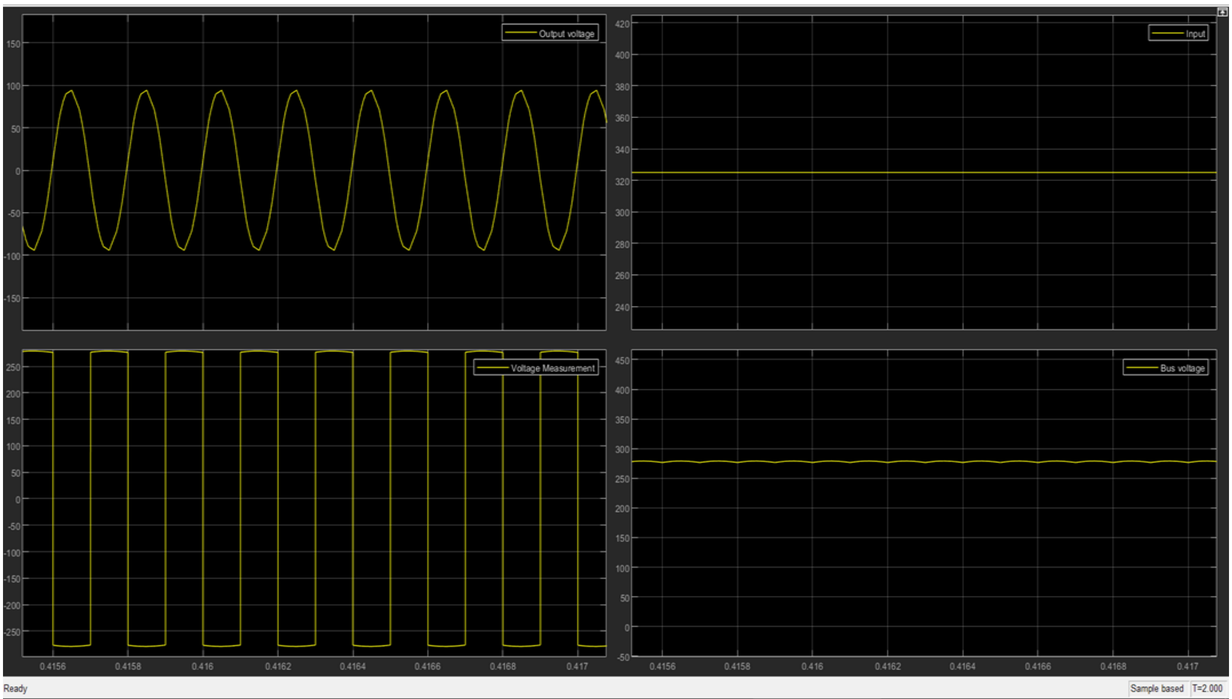

Fig. 5 SQUARE WAVE TO SINE WAVE **BUCK CONVERTER INPUT AND OUTPUT**

Stage4: DC Output Polarity Control

As illustrated in Fig. 6, this result demonstrates DC voltage magnitude control as well as polarity shifting capabilities.

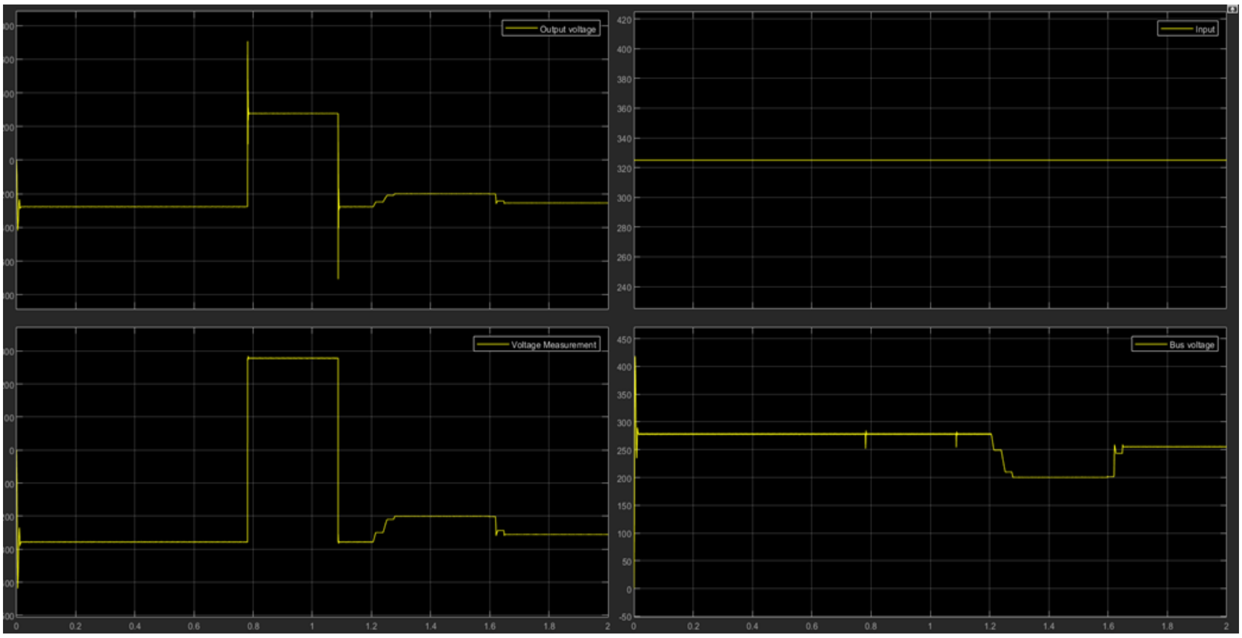

Fig. 6 Polarity Control

Stage 5: AC Output Control

As illustrated in Fig. 7, this result exhibits the AC voltage magnitude control through DC BUS voltage change.

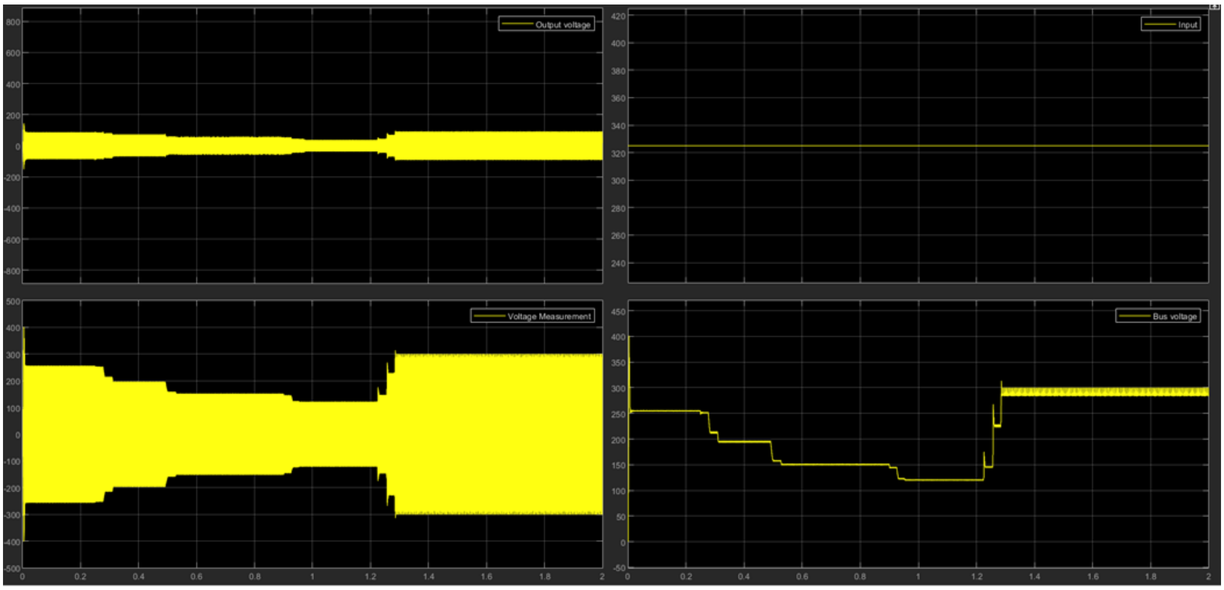

Fig. 7 AC Magnitude Change VS DC BUS Voltage change

VI.CONCLUSION

As a consequence, the simulation results reveal the topology functionality that is appropriate for the SMPS design where application is required. The functionality of the topology may be increased further by employing space vector PWM and further optimised by using a boost PFC converter. As a result, the topology application may be linked to a microcontroller-based HMI to provide a programmable power source that can give AC+DC as required by the user.

VII.ACKNOWLEDGMENT

Authors would like to thank many loyal customers who have provided information and feedback on the use of our programmable AC+DC power sources in their specific applications over a long period of time, allowing us to continuously refine and improve our products for optimal performance in a wide range of AC power applications.

VIII.REFERENCES

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