

CONSTANT DC TO DC CONVERTER USING SEPIC TOPOLOGY FOR BATTERY CHARGING

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Abstract: This Paper proposes an analysis of simulation on closed loop DC-DC SEPIC (Single ended primary inductance converter) converter. SEPIC converters are considerably used converters when the input voltage gets ample variation around rated voltage. The proposed closed loop implementation of the converter maintains the constant output voltage in spite of variations in input voltage and significantly reduces the overshoot and there by improves the efficiency of the converter and provide a non-inverting voltage. The simulation of the SEPIC converter has been validate the method and shown the effectiveness of design using MATLAB/SIMULINK environment.

IndexTerms - SEPIC converter, PWM control, DC-DC power conversion.

INTRODUCTION

The renewable source of energy like solar, wind etc., has wide scope in future compared to non-renewable source of energy. Photovoltaic (PV) conversion depends on the PV effect to convert the sun energy into electricity this conversion has low efficiency but it is pollution free. In order to obtain high solar conversion efficiency implementation of DC-DC converter or DC-AC converter is needed. The research carried out by many researchers in the field of PV conversion proposes new converters like ZETA converter [1], AC-DC SEPIC converter [2], other converters like Buck, Buck Boost, CuK converters were also came the elements of research for improving the solar conversion efficiency.

Wind energy is also a form of renewable energy present in abundance and it is free from pollution hence, some of the researchers have work upon hybrid system of renewable energy using solar and wind energy system [3]. The converters like Buck Boost and CuK cause enormous electrical stresses on the components of the energy system which may result in failure of the system. SEPIC converters can reduce the problems due to Cuk and Boost converters [4]-[8]. To overcome problems like sudden voltage drops and voltage raise and to obtain the fixed constant output with minimal overshoot, ripple, harmonics and to get improved efficiency at load this system is designed. In this system to obtain DC voltage from AC source a bridge rectifier and later to achieve the DC-DC voltage balance SEPIC converter is utilized. Here SEPIC converter is also used to boost up the unregulated low dc voltage and along with SEPIC converter PID controller is also utilized to remove the harmonics and to improve the operation of the system. This system can be utilized in charging stations, electric vehicle battery charging, industries applications and many more.

I. PROPOSED METHOD

The basic block diagram of the proposed system is shown in Fig.1. In which the AC-DC rectifier is connected to SEPIC converter. The reference voltage V_{ref} is compared with SEPIC converter output voltage, if there is any error then it is fed into the tuned PID controller circuit, which is then compared with the ramp voltage to produce the necessary gating pulses needed to switch the active switch Q1.

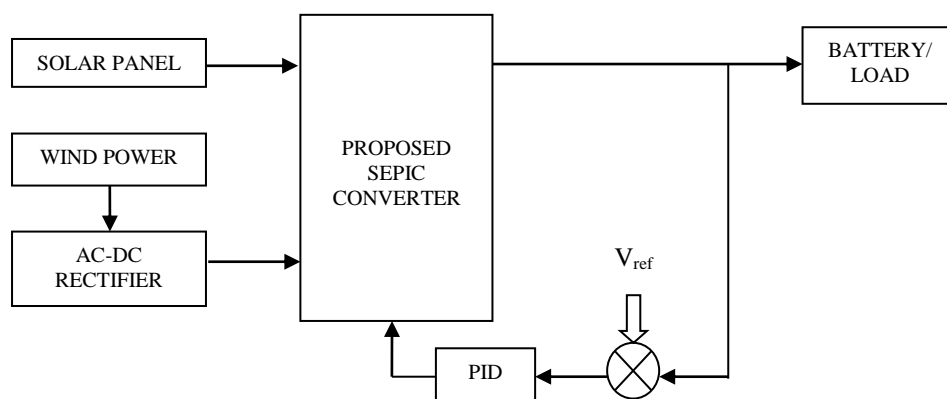


Fig.1 Block diagram of the proposed system

II. DESIGN ANALYSIS

The simplified basic circuit diagram of SEPIC converter is shown in Fig.2.

When Active Switch Q1 is ON: Diode D1 is in reverse biased, the voltage V_{L1a} is approximately equal to V_{IN} and the capacitor voltage across C_p is approximately $-V_{Cp}$. During Q1 ON state, the energy in inductor L1a is stored from the input voltage V_{IN} and in the inductor L1b, energy is stored from coupling capacitor C_p and the voltage across it is V_{L1b} . The equivalent circuit when Q1 is ON state is shown in Fig.3.

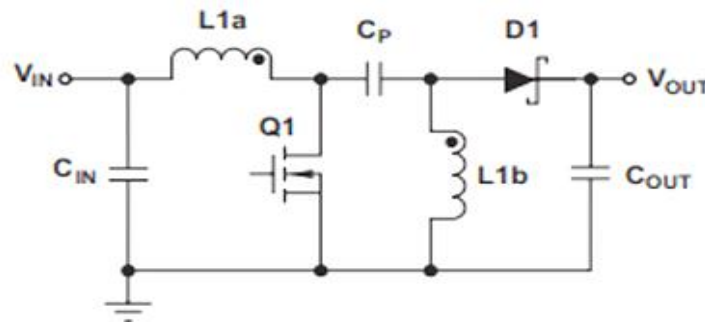


Fig.2 Simple basic circuit diagram of SEPIC converter

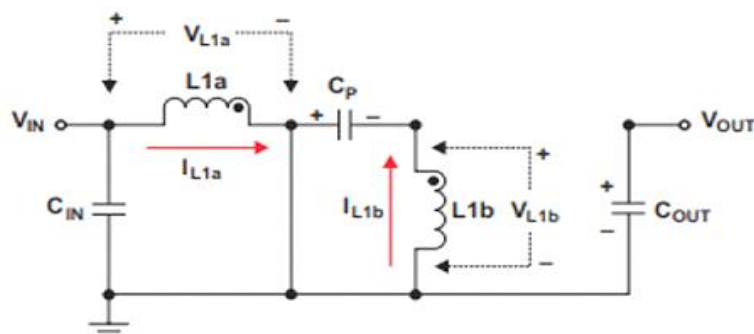


Fig.3 Equivalent circuit diagram, when Q1 is ON state

When Active Switch Q1 is OFF: During this state of operation, current I_{Cp} through C_p , will be same as that of current I_{L1a} and the current I_{L1b} will flow in same direction as it was flowing during Q1 ON state condition as shown in Fig.4.

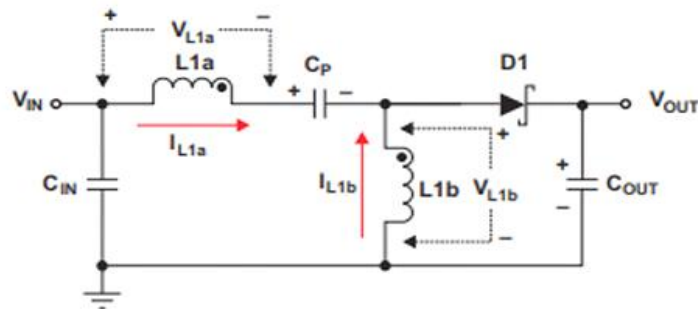


Fig.4 Equivalent circuit diagram, when Q1 is OFF

The design of different parameters is mentioned as given in the equations (1) – (8).

Duty cycle of the circuit, $D = (V_{OUT} + V_D)/(V_{IN} + V_{OUT} + V_D)$ (1)

Average inductance current, $I_{L1} = P_s / V_s$ (2)

Average inductance current, $I_{L2} = P_s / V_o$ (3)

Inductance, $L_1 = (V_s D) / (f \Delta I L1)$ (4)

Inductance, $L_2 = (V_s D) / (f \Delta I L2)$ (5)

Load resistance, $R = V_o^2 / P$ (6)

Capacitance, $C_1 = (V_o D) / (R f \Delta V c1)$ (7)

Capacitance, $C_2 = (V_o D) / (R f \Delta V c2)$ (8)

The design parameters of the proposed system are calculated as shown in Table 1.

Table 1: Design parameters of the proposed system

PARAMETERS	VALUES
Source voltage	9V
Duty cycle	0.67
Time	1/100000s
L1	151μH
L2	151μH
C1	45μF
C2	45μF
R	27Ω

III. SIMULATION MODEL AND RESULTS

The simulation model of the closed loop SEPIC converter in MATLAB/ SIMULINK environment is shown in Fig.5. An AC input voltage of 9V from solar panel while a rectified voltage from wind power is directly fed to the SEPIC converter. These waveforms are respectively shown in Fig. 6 and Fig. 7 and the output from the SEPIC converter obtained is shown in Fig. 8. It can be observed that the voltage obtained from SEPIC converter is a constant value of 18 volts for an input of 9 volts fed to it. PID controller is used in the design to reduce the overshoot, increase the efficiency and minimize the steady state error with respect to the reference voltage V_{ref} .

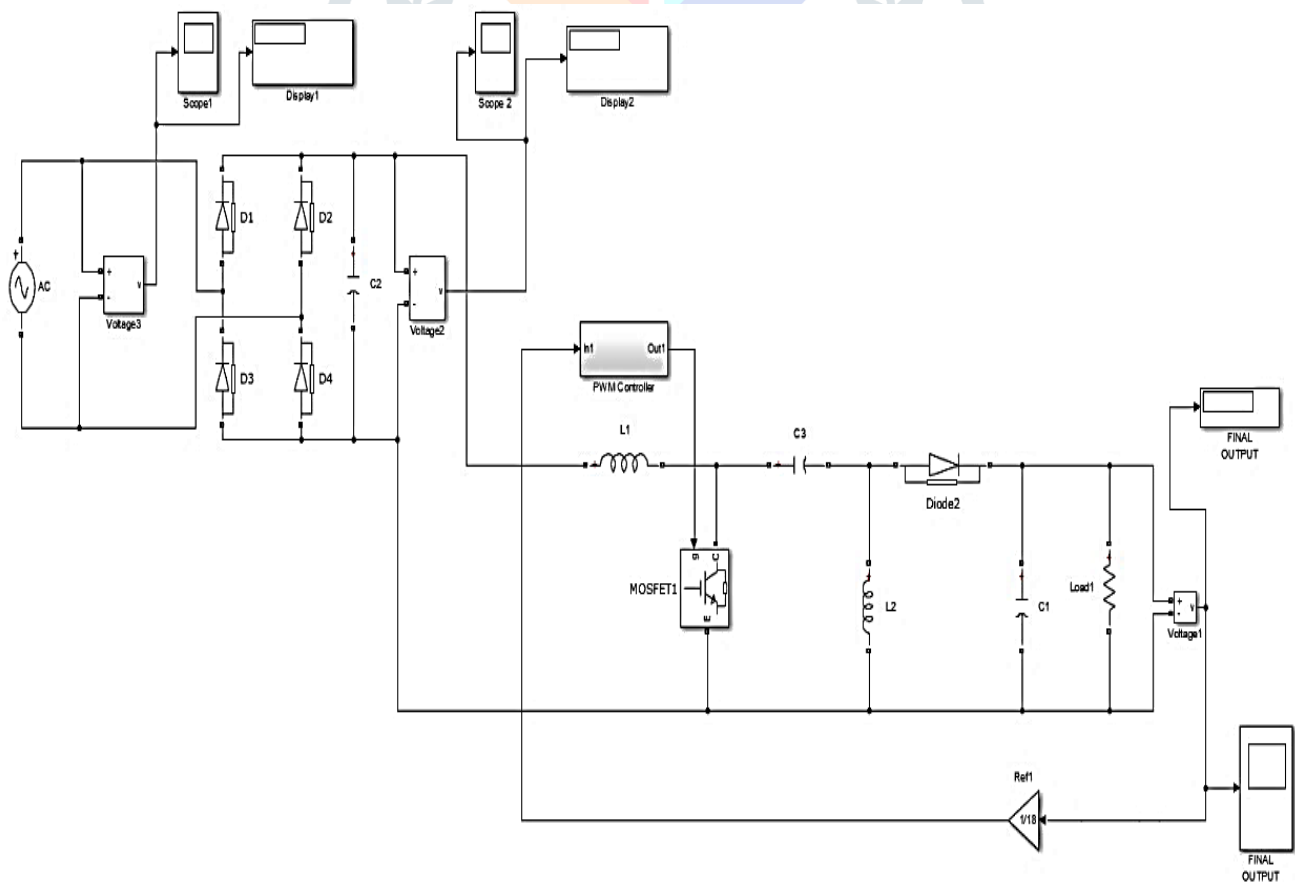


Fig.5 Simulation model Closed Loop SEPIC converter

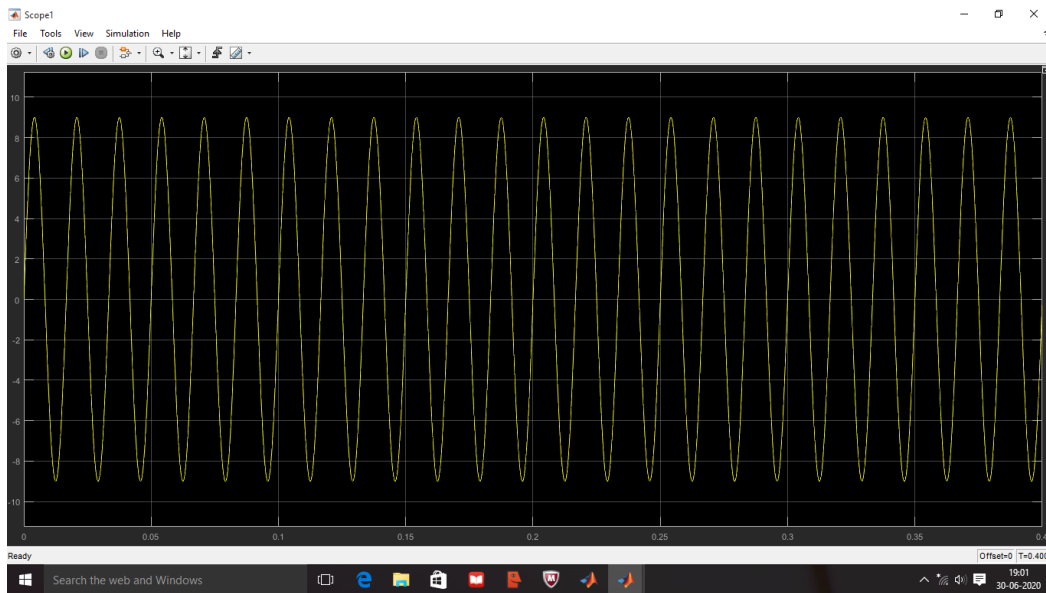


Fig.6 Input ac voltage waveform for 9V

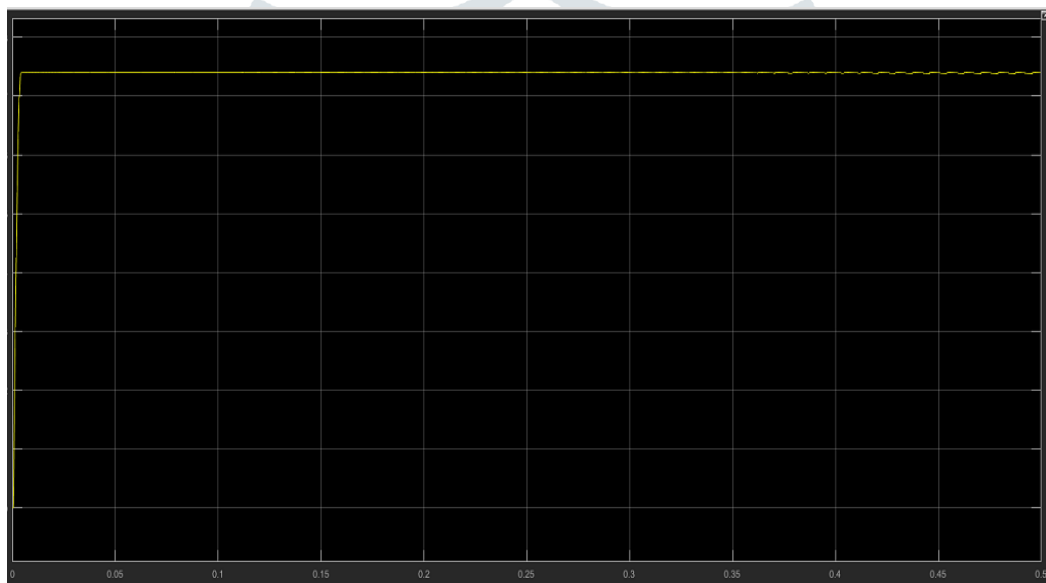


Fig.7 Rectified waveform fed to SEPIC converter for 9V

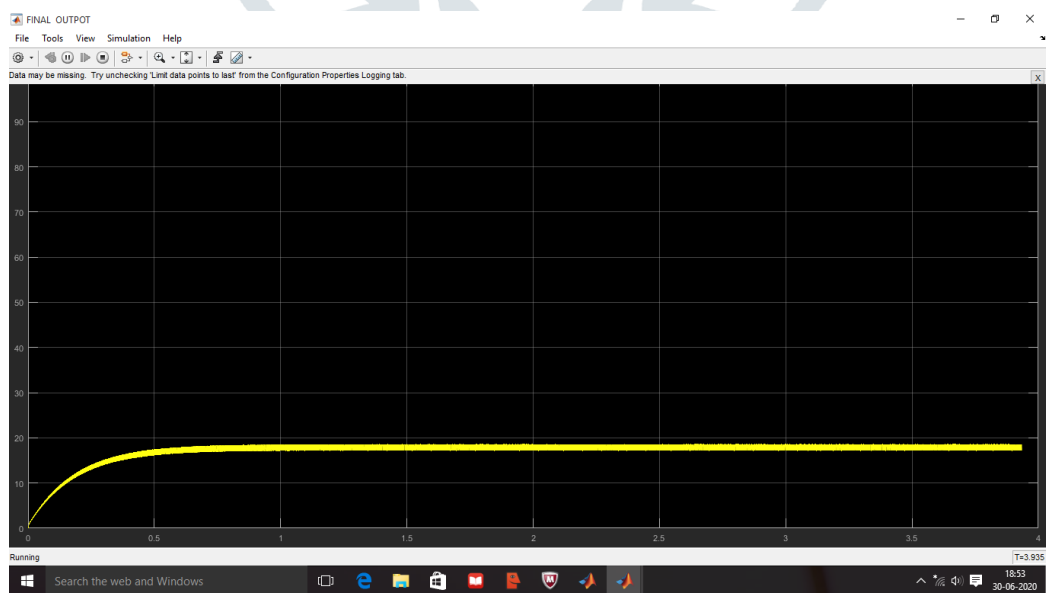


Fig.8 Output voltage waveform of closed loop SEPIC converter for 9V

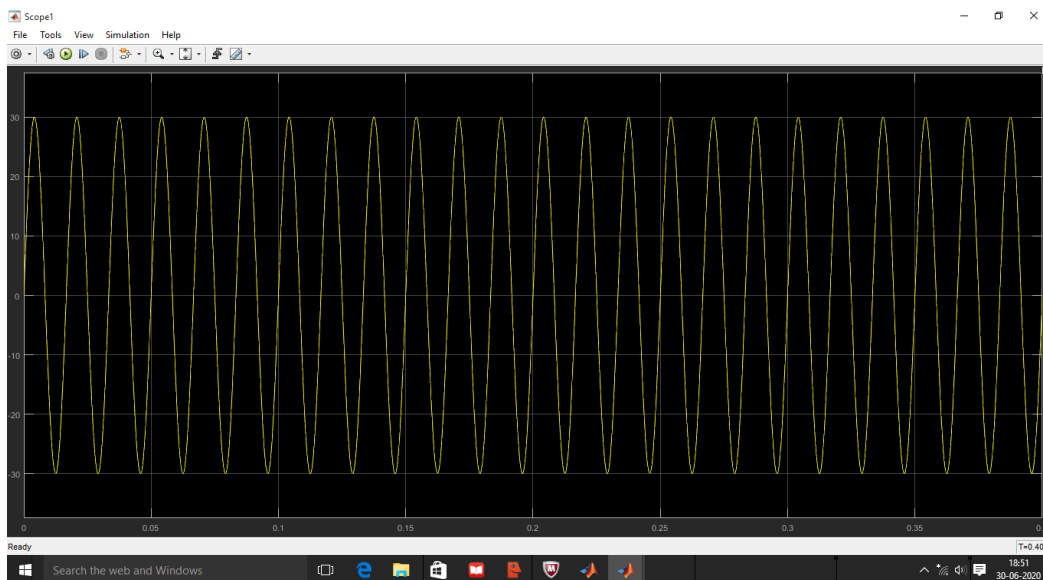


Fig.9 Input ac voltage waveform for 30V

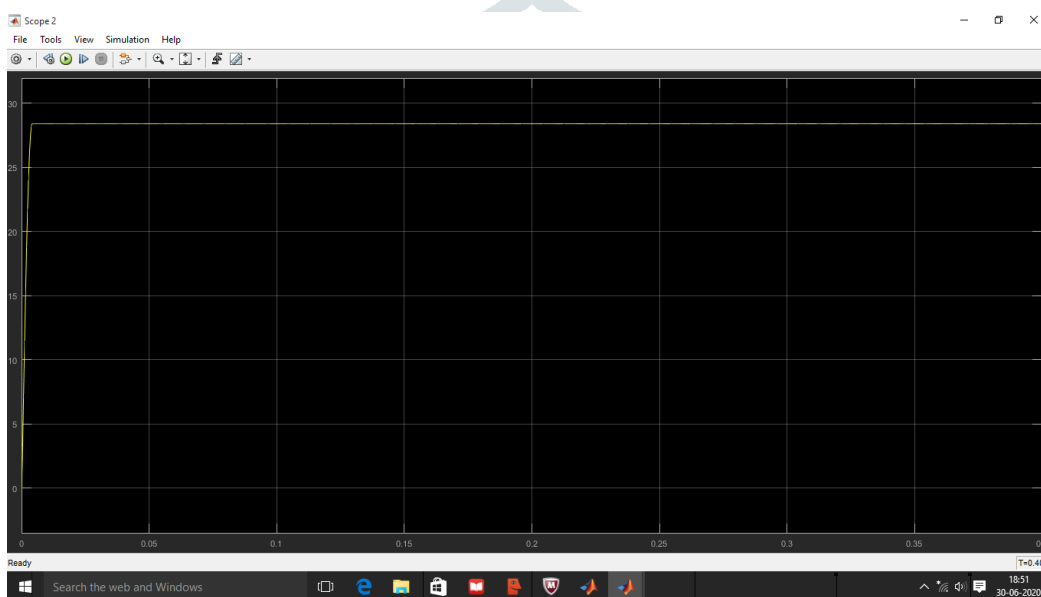


Fig.10 Rectified waveform fed to SEPIC converter for 30V

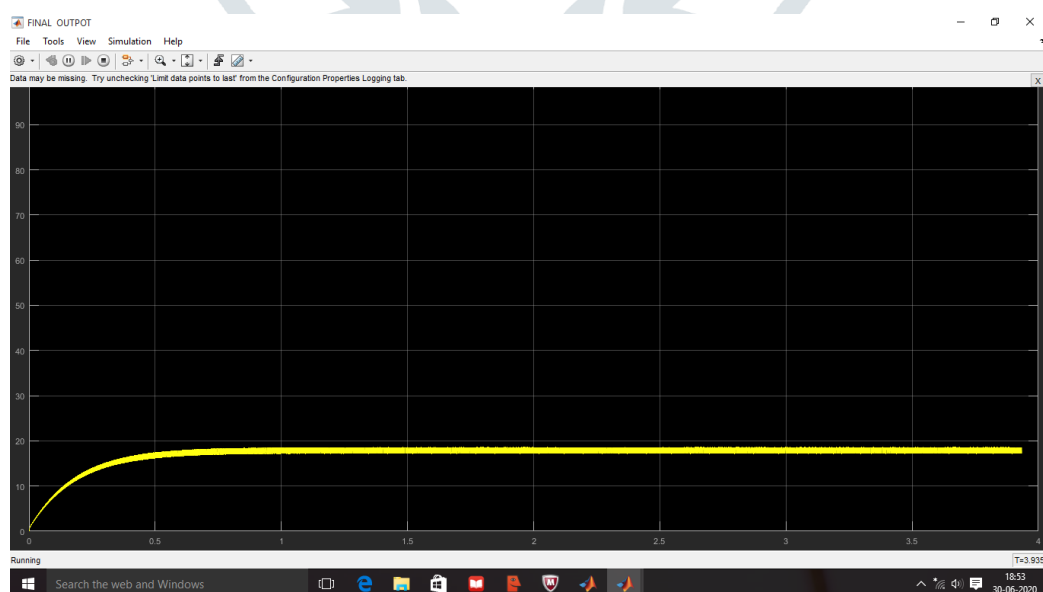


Fig.11 Output voltage waveform of closed loop SEPIC converter for 30V

IV. CONCLUSION

This thesis gives complete detail on using closed loop SEPIC converter for steady DC to DC conversion. From this propound work, the frame work keeps up the constant output however variation at input i.e., for 12V input, yield will be 18V regardless of whether there is raise ex: 20V, 30V or fall ex: 10V, 9V yield remain steady and can achieve better

efficiency along with SEPIC converter PID controllers gives least overshoot, better voltage regulation and converter operation. The propound organization is simple, easy and expense of production is in sensible range.

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