OBSERVATION & COMPARE OF OPEN LOOP SEPIC CONVERTER AND CLOSED LOOP SEPIC CONVERTER IN SOLAR PHOTOVOLTAIC SYSTEM

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ABSTRACT:. *In this observation paper shows compare open loop and loop of SEPIC converter . if Environmental Impact on PV Cell Production of solar Photovoltaic Harvesting system described by analysis & performance using DC to DC converter, Like SEPIC converter. photovoltaic system convergence time is reduced using maximum power point tracking algorithm which responds faster to the atmospheric changes over a conventional algorithm with minimum ripple content in the output. Digital controller is used to control the dc-dc SEPIC power converter .. This has given renewable energy sources a tremendous growth potential, and recent capacity additions have come mainly from natural gas and renewable. Among renewable, solar and wind power provide most of the growth [1]. The steady and rapid growth in solar photovoltaic installation across the world has been driven by many factors including renewable portfolio standards, decreasing costs of installations and incentives [1]–[3]. The increasing capacity addition of solar PV and installation of larger power stations has led to research and development in high-power converter topologies for PV application.*

keywords - DC-DC Converter, Inverter, MPPT, open loop & closed loop SEPIC converter.

INTRODUCTION

Solar energy is the raw material and main source for several applications of renewable energy systems; thus, knowledge about the intensity of solar irradiation is essential for efficiency of these systems. Electric energy sources capable of meeting the growing demands of society with minimal impacts to the environment and high efficiency have been object of research in the last decade. In this context, the conversion of sunlight into electricity through photovoltaic cells has become one of the most encouraged and used resources in the world. However, the most unpredictable factor, which hampers capturing solar irradiation, preventing a proper conversion of sunlight into electricity, is the presence of clouds in the sky.

LITURATURE REVIEW

Somasundaram Essakiappan et. al. [4] discussed megawatt-scale PV plant is divided into many zones, each comprising of two series-connected arrays. Each zone employs a medium-frequency transformer with three secondary's, which interface with the three phases of the medium voltage grid. An insulated-gate bipolar transistor full bridge inverter feeds the MF transformer. The voltages at the transformer secondary's are then converted to three-phase line frequency ac by three full-bridge ac–ac converters. Second line frequency harmonic power does not appear in the dc bus, thereby reducing the dc capacitor size. Cascading several such cells, a high-quality multilevel medium-voltage output is generated. A new control method is proposed for the cascaded multilevel converter during partial shading while minimizing the switch ratings. The proposed topology eliminates the need for line frequency transformer isolation and reduces the dc bus capacitor size, while improving the power factor and energy yield. Paper presents the analysis, design example, and operation of a 10-MW utility

PV system with experimental results on a scaled-down laboratory prototype.

Nicolae-Cristian et. al. [5] introduces a reliability-oriented design tool for a new generation of grid-connected photovoltaic (PV) inverters. The proposed design tool consists of a real field mission profile (RFMP) model (for two operating regions: USA and Denmark), a PV panel model, a grid-connected PV inverter model, an electrothermal model, and the lifetime model of the power semiconductor devices. An accurate long-term simulation model able to consider the one-year RFMP (solar irradiance and ambient temperature) is developed. Thus, the one-year estimation of the converter device thermal loading distribution is achieved and is further used as an input to the lifetime model. The proposed reliability-oriented design tool is used to study the impact of mission profile (MP) variation and device degradation (aging) in the PV inverter lifetime. The obtained results indicate that the MP of the field where the PV inverter is operating has an important impact (up to 70%) on the converter lifetime expectation, and it should be considered in the design stage to better optimize the converter design margin. In order to have correct lifetime estimation, it is crucial to consider also the device degradation feedback (in the simulation model), which has an impact of 20–30% on the precision of the lifetime estimation for the studied case.

Abhijit V. Padgavhankar [6] solar photovoltaic system convergence time is reduced using maximum power point tracking algorithm which responds faster to the atmospheric changes over a conventional algorithm with minimum ripple content in the output. Digital controller is used to control the dc-dc boost power converter and dc-ac inverter using efficient soft switching pulses. Voltage sensor is used to vary width of the pulse to maintain the boost converter output constant level. Using current sensor frequency of the generated pulse is varied so ripple contents of the output are reduced to improve the power quality. MOSFET single phase H-bridge inverter is used to convert constant solar power into ac signal with the minimum ripple in the output and power losses. Efficient sinusoidal pulse width modulation technique is used to reduce the switching losses with the help of digital controller. For the proposed system validation Proteus 8 simulation and implemented hardware results are presented. The system has minimum switching losses, faster convergence time and high power quality.

Mr.K.Natarajan1 et. al. [7] presents the design of a Single Ended Primary Inductor Converter (SEPIC) for solar PV system. SEPIC acts like a buck-boost DC-DC converter and it allows a range of DC voltage adjust to maintain a constant output voltage. Maximum Power Point Tracking (MPPT) technique should be used to track the maximum power point continuously which depends on panel’s irradiance conditions in PV solar system. The Maximum power point has been achieved by adjusting the switching frequency of the converter. The efficiency of the converter is improved by the coupled inductor because it needs only lesser amount of magnetic core. The SEPIC converter and their various control strategies has been discussed and simulated using Simulink/MATLAB software.

Observation 1: SEPIC CONVERTER in open loop system

The SEPIC converter (Single Ended Primary Inductance Converter) is a configuration where the voltage output can be above or below the input voltage.

In fact in this particular design both Boost and Buck converter do coexist. If the duty factor is less than 50% then the circuit will behave as a buck converter. It will work as a boost converter if otherwise the duty factor is above to 50%. With the shown component values the converter works by ensuring a continuous current through the inductors, for this reason it's known as continuous mode. By reducing the inductor value the converter will move in the discontinuous mode.

The voltage output may be approximated as: Vout = (Vin*D)/(1-D) where:

D = T1/T (duty factor)

T = PWM period

T1= OFF time.

In the example for T=20us and T1=6.3us (D=31%) we have Vout is about 5V and the circuit behaving like a buck converter.

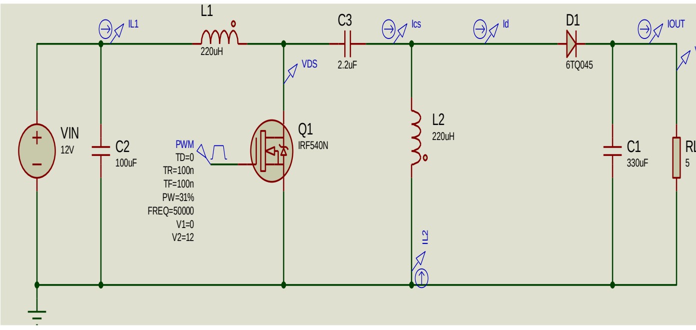

Figure 1: open loop SEPIC Converter

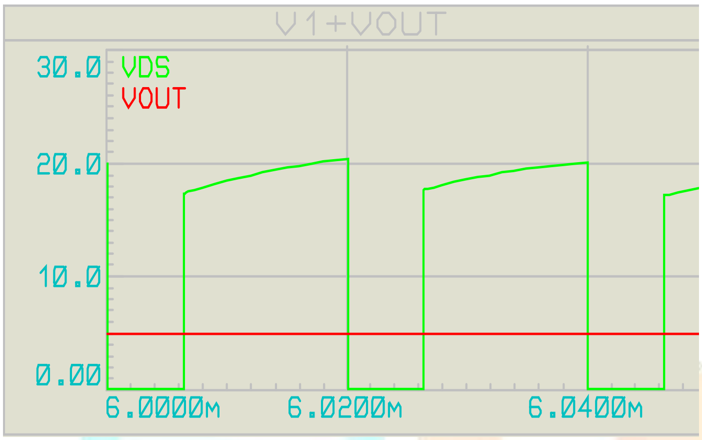

Figure 1.1: Waveform of V_{ds} and V_{out} of SEPIC converter

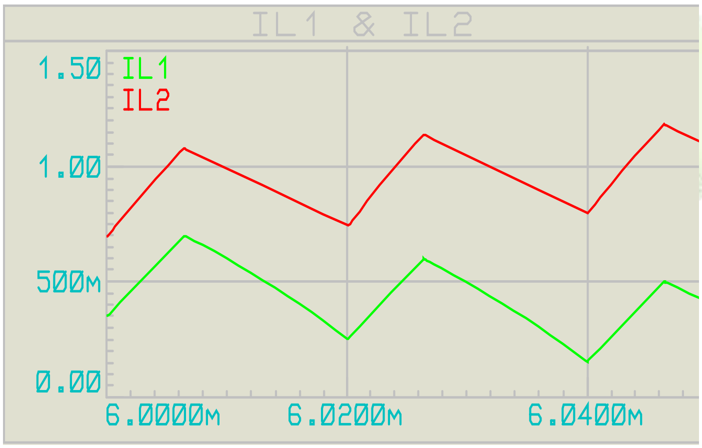

Figure 1.2: Waveform of IL1 and IL2 of SEPIC converter

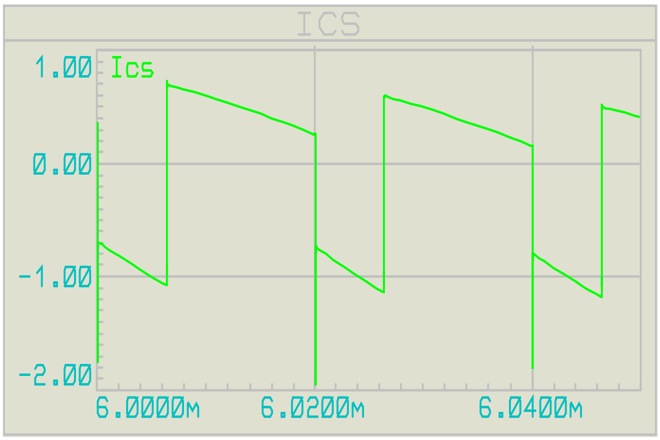

Figure 1.3: Waveform of I_{cs} of SEPIC converter

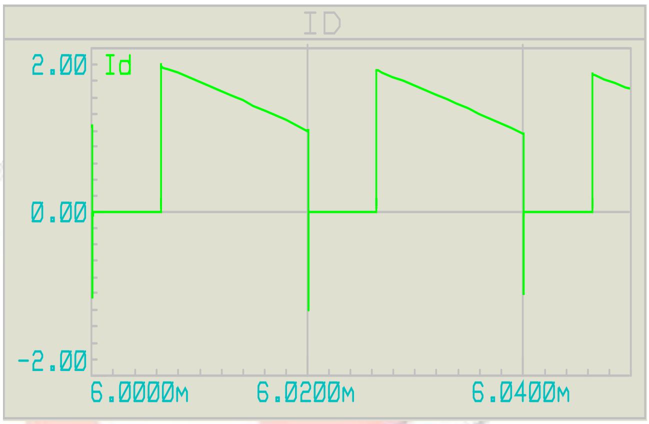

Figure 1.3: Waveform of Id of SEPIC converter

Table 1 : observation table of open loop SEPIC converter

Sr no	Vin	Duty cycle (%)	Vout	Iout
1	06	68.4	2.34	0.46
2	07	62.60	2.8029	0.50
3	08	59.25	3.26	0.65
4	09	54.36	3.74	0.74
5	10	52.35	4.18	0.83
6	11	51.14	4.64	0.92
7	12	34.87	5.0	1.01
8	13	27.28	5.55	1.11
9	14	25.11	5.99	1.19
10	15	23.89	6.44	1.12
11	16	21.30	6.91	1.30
12	17	16.55	7.38	1.42
13	18	11.09	7.84	1.56

Table1 shows the reading of different values of input voltages. from 06v to 18v with different duty cycle . if duty cycle is more than 50% then system is operate as a boost converter, and duty cycle is less than 50% then it work as a buck converter.

Different input voltages have different duty cycle .so there operation is based on duty cycle as it perform boost or buck. Input voltage 06 to 11 have duty cycle more than 50%, so they work as a boost converter. and input voltage 12 to 18 have duty cycle less than 50% so they work as a buck converter.

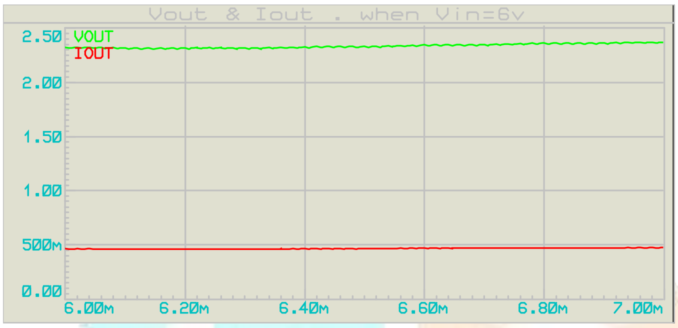

Figure 1.4: Waveform of Vout & Iout at vin =6v

When input voltage is 6v. its duty cycle is 68.4%. so it work as a boost converter at that time its Vout and Iout is 2.34&0.46 resp. figure 1.4 shows the waveform of vout and Iout response when vin is 6v.

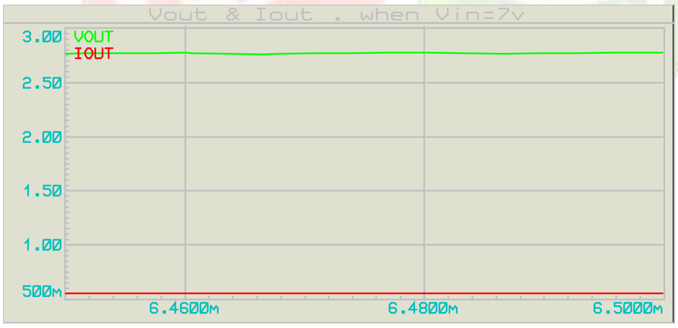

Figure 1.5: Waveform of Vout & Iout at vin =7v

When input voltage is 7v. its duty cycle is 62.60%. so it work as a boost converter at that time its Vout and Iout is 2.8029 & 0.50 resp. figure 1.5 shows the waveform of vout and Iout response when vin is 7v.

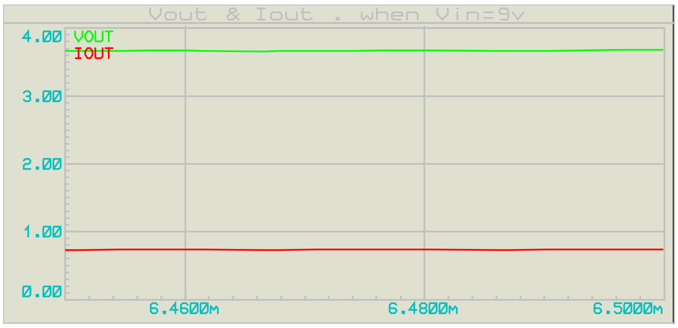

Figure 1.6: Waveform of Vout & Iout at vin =9v

When input voltage is 9v. its duty cycle is 54.36%. so it work as a boost converter at that time its Vout and Iout is 3.74&0.74 resp. figure 1.4 shows the waveform of vout and Iout response when vin is 9v.

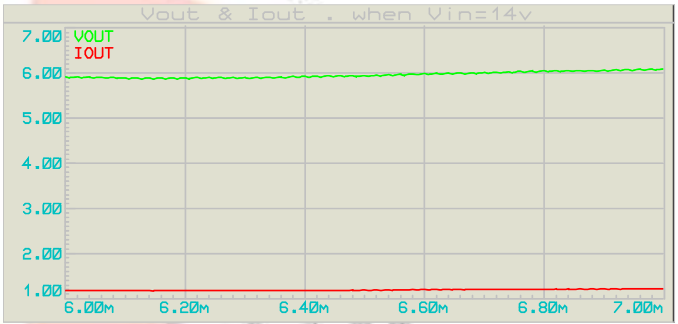

Figure 1.7: Waveform of Vout &Iout at vin =14v

When input voltage is 14v. its duty cycle is 25.11%. so it work as a buck converter at that time its Vout and Iout is 5.99 &1.19 resp. figure 1.7 shows the waveform of vout and Iout response when vin is 14v.

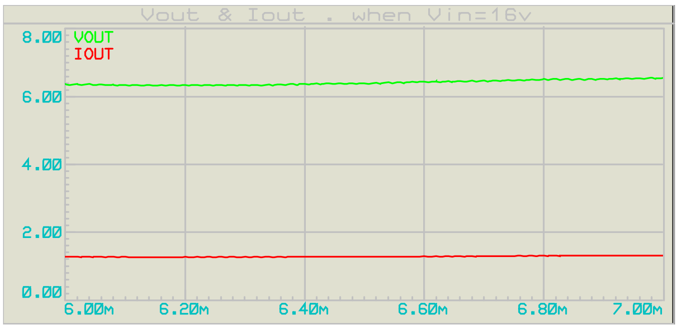

Figure 1.8: Waveform of Vout &Iout at vin =16v

When input voltage is 16v. its duty cycle is 21.30%. so it work as a buck converter at that time its Vout and Iout is 6.91 &1.30 resp. figure 1.8 shows the waveform of vout and Iout response when vin is 16v.

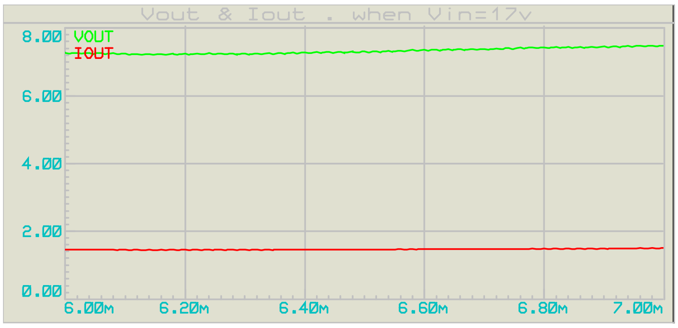

Figure 1.9:Waveform of Vout & Iout at vin =17v

When input voltage is 17v. its duty cycle is 16.55%. so it work as a buck converter at that time its Vout and Iout is 7.38 &1.42 resp. figure 1.9 shows the waveform of vout and Iout response when vin is 17v.

Observation 2: SEPIC CONVERTER in closed loop system

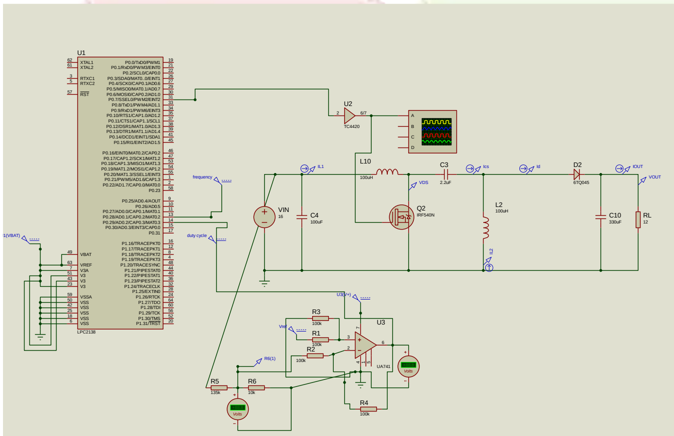

Figure 2: closed loop SEPIC Converter

The SEPIC converter with LPC2148 is designed to compatible load to achieve maximum power from photovoltaic modules. The role of SEPIC converter using microcontroller is to maintain constant output voltage. Figure 2 shows the proteus circuit diagram and concept of closed loop SEPIC converter. Proteus VSM having microcontroller programming tool, environment, with its many software features and hardware options. Many researchers and engineers use Proteus for testing and rapid prototyping for simulation.

The controller tends to maximize the output power from photovoltaic module by adjusting the duty cycle so that the solar cell module will always be at its maximum power at all times. Microcontroller will automatically increase or decrease duty cycle of the converter according to the PV module output voltage. The maximum power point loop is used to set the corresponding V_{ref} to the input, the voltage regulator loop is used to regulate the solar output voltage according to reference, which is set as maximum operating point

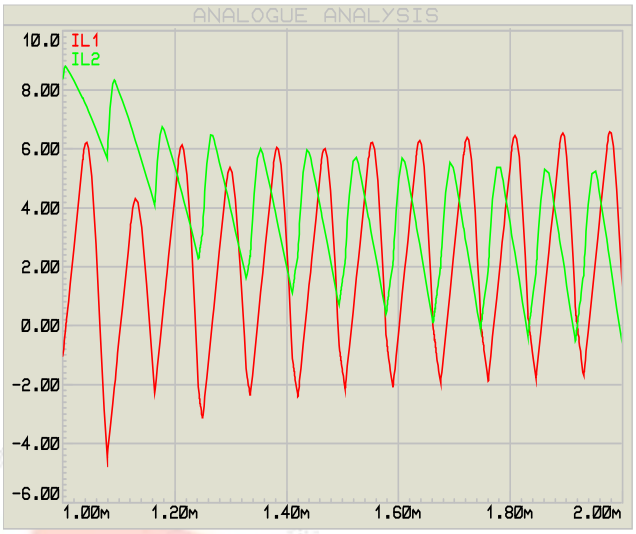

Figure 2.1: Waveform of IL1 and IL2 of Closed loop SEPIC converter

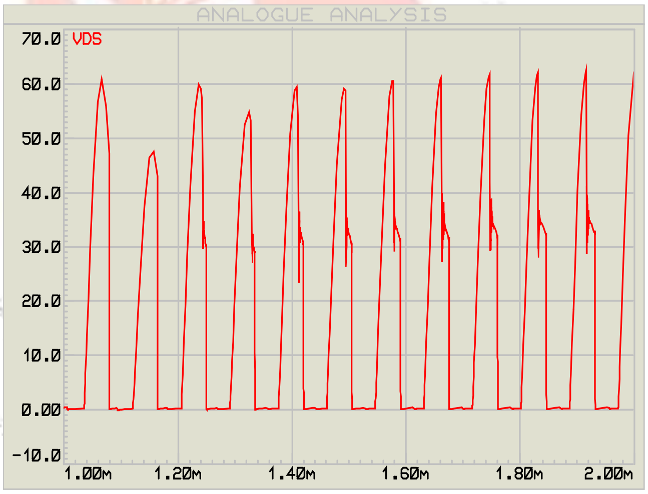

Figure 2.2: Waveform of VDS of Closed loop SEPIC converter

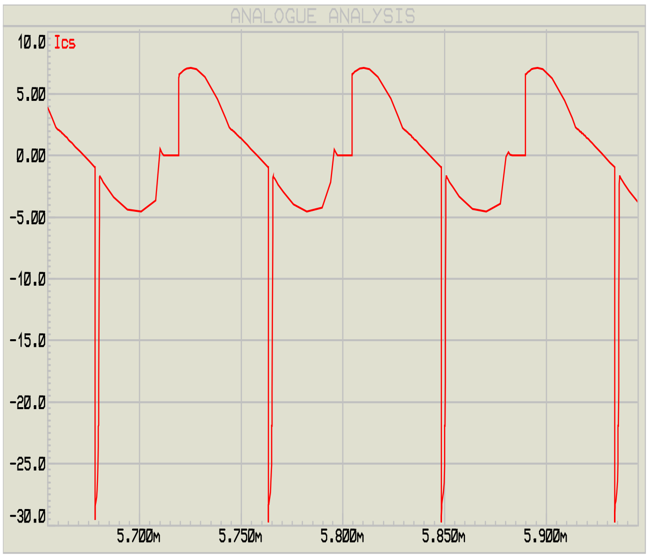

Figure 2.3: Waveform of Ics of Closed loop SEPIC converter

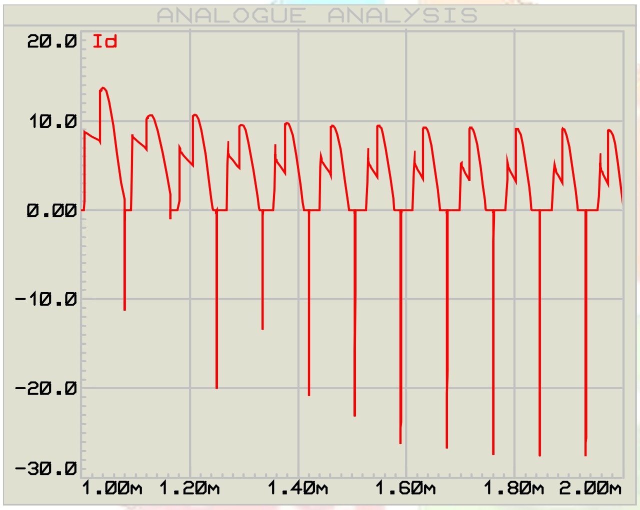

Figure 2.4: Waveform of Id of Closed loop SEPIC converter

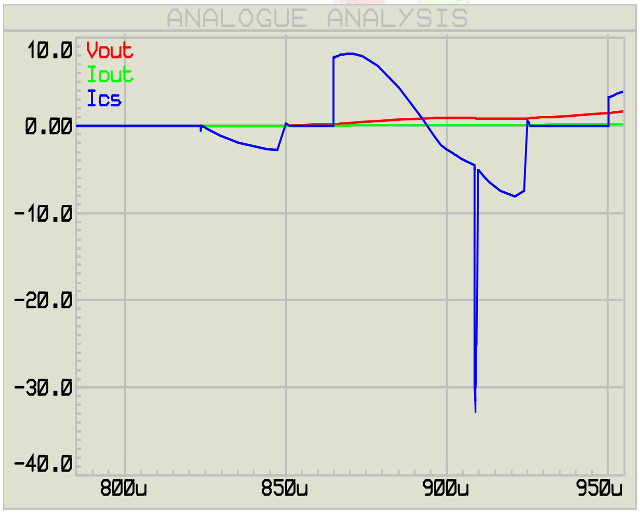

Figure 2.4: Waveform of Closed loop SEPIC converter

Table 2 : observation table of closed loop SEPIC converter

Sr. No.	Vin (V)	Duty Cycle (%)	Vout (V)	Iout (A)
1	18	49.41	25.2	1.1
2	16	55.29	25	1.1
3	14	60	24.8	1.1
4	12	65.38	24	1.03
5	10	71.76	23.9	1.0
6	8	75.29	23.7	1.0
7	6	80	23	1.0

Table2 shows the reading of different values of input voltages. from 18v to 06v with different duty cycle . if duty cycle is more than 50% then system is operate as a boost converter, and duty cycle is less than 50% then it work as a buck converter.

Different input voltages have different duty cycle .so there operation is based on duty cycle as it perform boost or buck. Input voltage 06 to 11 have duty cycle more than 50%, so they work as a boost converter. and input voltage 12 to 18 have duty cycle less than 50% so they work as a buck converter

Figure 2.5: Response of SEPIC converter when Vin = 6V

When input voltage is 6v. its duty cycle is 80 %. so it work as a boost converter at that time its Vout and Iout is 23 &1.0 resp. figure 2.5 shows the waveform of vout and Iout response when vin is 6v.

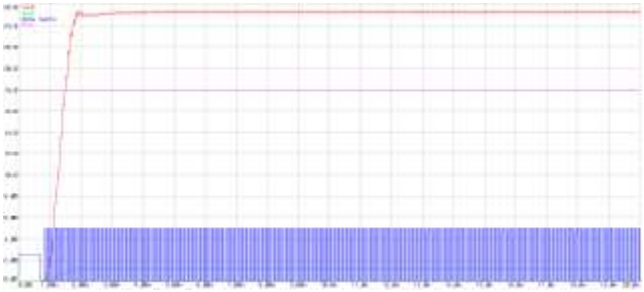

Figure 2.6: Response of SEPIC converter when Vin = 18V

When input voltage is 18v. its duty cycle is 49.41%. so it work as a buck converter at that time its Vout and Iout is 25.2 &1.1 resp. figure 2.6 shows the waveform of vout and Iout response when vin is 18v.

SEPIC Design					
Vin min	5.6	V			
Vin max	16	V			
Vd	0.5	V			
fsw	15000	Hz			
Vout	12	V	Pout	6	W
Iout	0.5	A			
Dmax	0.690608	69.06077	%		
Dmin	0.438596	43.85965	%		
del iL	0.428571				
L	0.000602	601.5961	uH		
iL1peak	1.339286	A			
iL2peak	0.6	A			
iQ(MOSFET)	1.939286	A			

Figure 2.7: value of SEPIC converter component

CONCLUSION

The proposed work is for maximum power operating point to adjust the photovoltaic operating voltage close to maximum under changing atmospheric condition. In first observation, we observed open loop SEPIC converter . its Vout and Iout waveform with different input voltages and different duty cycle. In second observation, we observed closed loop SEPIC converter . its Vout and Iout waveform with different input voltages and different duty cycle. a digitally controlled SEPIC converter for solar PV with voltage and current sensing is presented. Maximum power point is estimated by sensing voltage and current which varies the duty cycle and frequency respectively of the pulse to minimize the power loss caused by switching losses and hence improvement in overall performance of the system. The overall observation shows that if input voltage of PV module has been changed due to environmental changes so there is no changes in Vout and Iout because of closed loop SEPIC converter.

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