TERM ROJECT REPORT

Designing of ZETA converter and it's thermal modelling

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Objective:

Design a Zeta converter of 1.5 Kwatt . Input voltage variation (80V-150V) current ripple 1% voltage ripple 5% and Fsw is 80 kHz. Develop a thermal model and evaluate the conduction and switching loss . Validate this in PLECS software.

Introduction:

Zeta converter is a different topology to get buck-boosting. It is evolved as dual of Sepic Converter. It contains two inductor, two capacitor and one diode.The Zeta converter is a type of power electronics converter that combines features of both buck (step-down) and boost (step-up) converters. It is designed to operate in both modes, allowing it to handle input voltages that can be either higher or lower than the desired output voltage. This bidirectional capability makes the Zeta converter versatile in various applications where the input voltage may vary.

Advantages:

1. It is a buck-boost type converter. It means you can step up the voltage and step down as well.
2. It provides better efficiency and better voltage gain than the regular buck-boost converter.
3. The output voltage is positive in reference to the ground which makes the sensing circuit simple and easy to implement in PCBs.

Disadvantages:

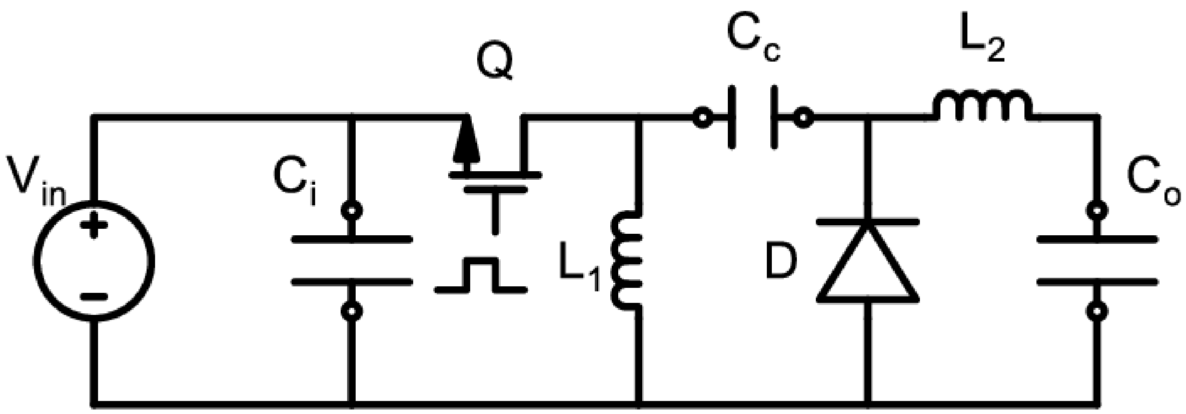
1. The input current is discontinuous, which is not desired for some applications.
2. The passive element requirement is more.
3. It is a fourth order nonlinear converter, which makes the control difficult. Some control techniques get difficult to implement in this converter, like sliding mode control (Hysteresis Control).

Software used:- PLECS

PLECS tools can be applied to many disciplines of power electronics engineering. Conceived with a top-down approach in mind, PLECS facilitates the modelling and simulation of complete systems, including power sources, power converters, and loads.

Included with PLECS is a comprehensive component library, which covers the electrical, as well as the magnetic, thermal, and mechanical aspects of power conversion systems and their controls. Power electronics circuits are captured with a schematic editor in a way that is familiar and intuitive for electrical engineers. Typical power electronics components such as semiconductors, inductors and capacitors are placed on the circuit diagram and simply connected by drawing wires.

Topology:



Zeta Converter

Formulas we have used:-

Component	Zeta
$\frac{V_O}{V_{In}}$	$[\frac{D}{1-D}]$
L_1	$L_1 \geq \frac{1}{2}[\frac{V_{In}.D}{F.\Delta I_{L1}}]$
L_2	$L_1 \geq \frac{1}{2}[\frac{V_{In}.D}{F.\Delta I_{L1}}]$
C_1	$C_1 \geq [\frac{D}{V_{In}.F.\Delta I_{L1}}]$
C_2	$C_2 \geq [\frac{D}{8.F.\Delta V_{c2}}]$

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$$V_o = \left(\frac{D}{1-D}\right) V_{in} = \frac{0.6}{0.4} \times 150 = 225 V$$

$$P_o = \frac{V_o^2}{R}$$

$$\Rightarrow R = \frac{V_o^2}{P_o} = \frac{225^2}{1.5 \times 10^3} = 33.75 \Omega$$

$$I_{L_1} = I_o\left(\frac{D}{1-D}\right) = 10A$$

Current Ripple $= 1\% = 0.01$

$$I_{L2} = I_{L1}\left(\frac{1-D}{D}\right) = 6.67$$

$$\Delta I_{L1} = 0.01(10) = 0.1$$

$$\Delta I_{L2} = 0.01(6.67) = 0.067$$

$L_1 \geq 5.6\, mH$;

$L_2 \geq 8.39\, mH$;

$C_1 \geq 5 \times 10^{-7} F$;

$C_2 \geq 8.33 \times 10^{-8} F$;

<u>We have Taken</u>

$L_1 = 6\, mH$

$L_2 = 9\, mH$

$C_1 = 5.5 \times 10^{-7} F$

$C_2 = 9 \times 10^{-8} F$

Sr. No.	COMPONENT	Values
1	Input voltage	150 V
2	Output voltage	225 V
3	Output current	6.67 A
4	Switching frequency	80,000 Hz
5	Capacitor C1	5.5×10^{-7} F
6	Capacitor C2	9×10^{-8} F
7	Inductor L1	6 mH
8	Inductor L2	9 mH
9	Duty ratio	0.6

Switch Selection:

From Model:

$V_{sw}|_{peak} = 419.65V$

$I_{sw}|_{peak} = 16.8A$

Rating of Switch Taken:

$V_{sw}|_{peak} = 650$ V

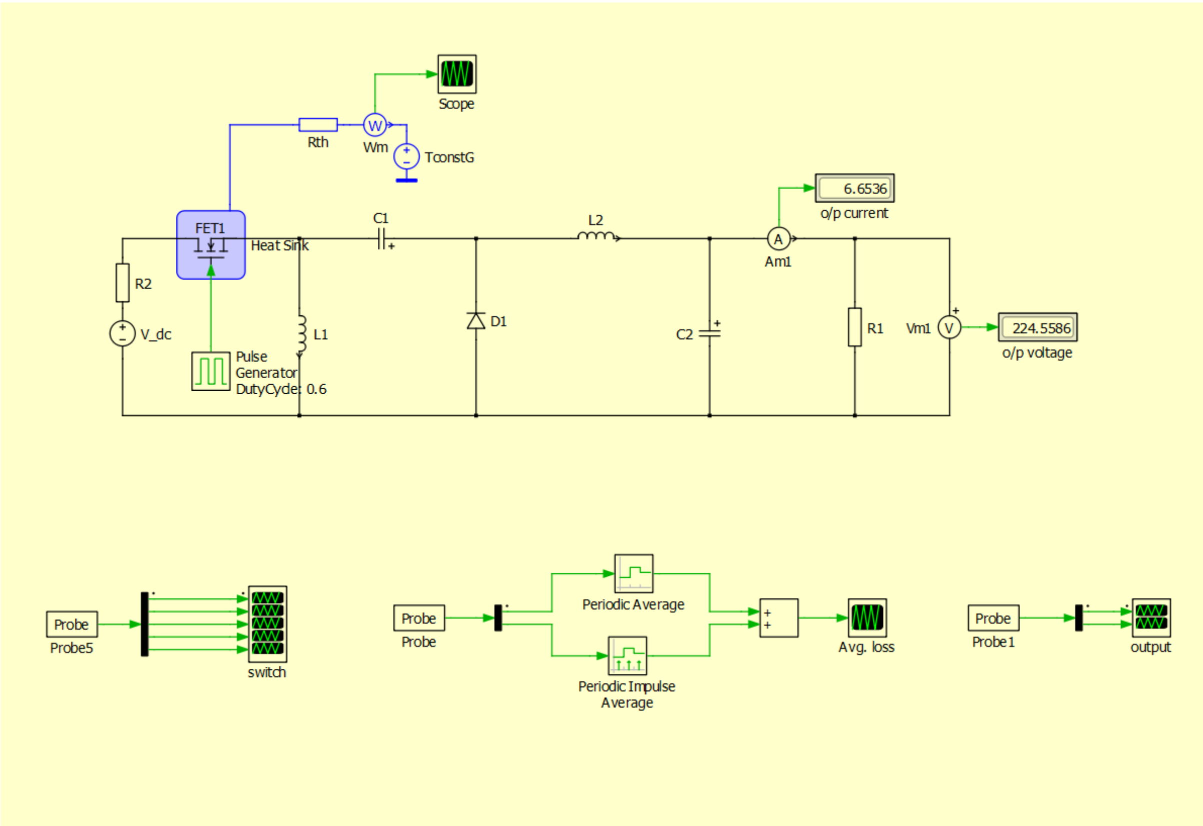
$I_{sw}|_{peak} = 22$ A

We have taken **Discrete SiC-MOSFET switch(C3M0120065D).**

Part Number	Package	Marking
C3M0120065D	TO-247-3	C3M0120065D

V_{DS}	650 V
$I_{D\ @\ 25^{\circ}C}$	22 A
$R_{DS(on)}$	120 mΩ

PLECs Model:-



Simulation Results:

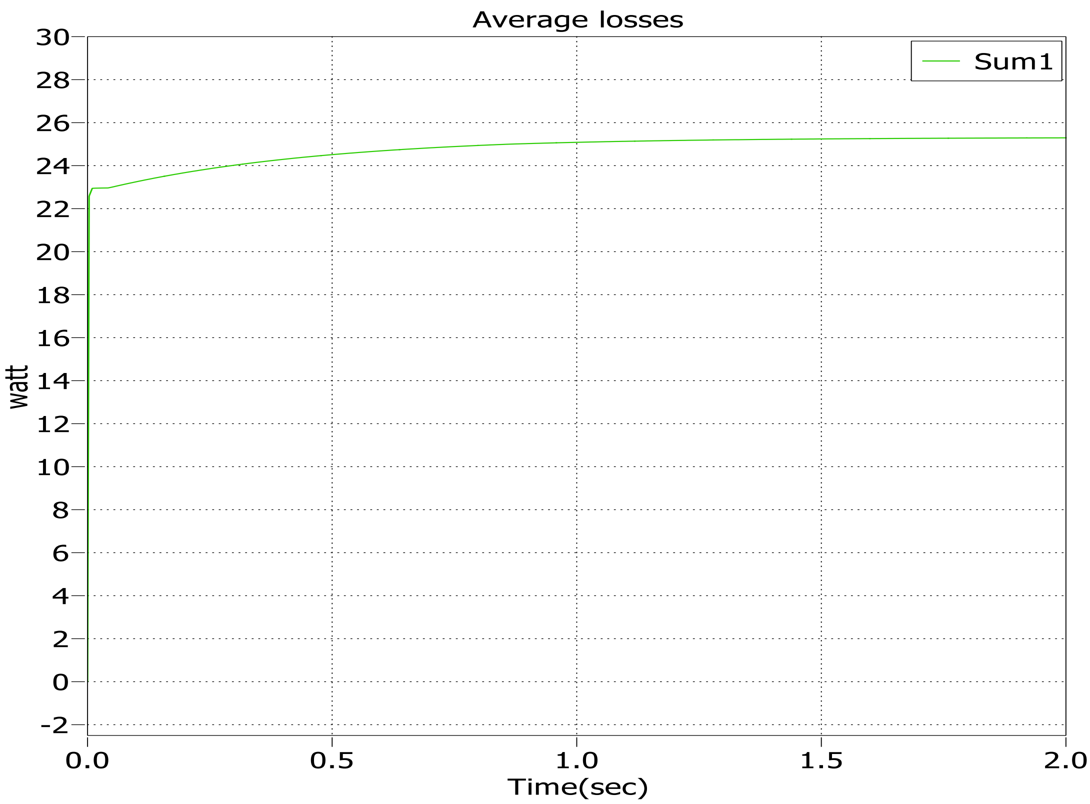


Figure:- Average Losses

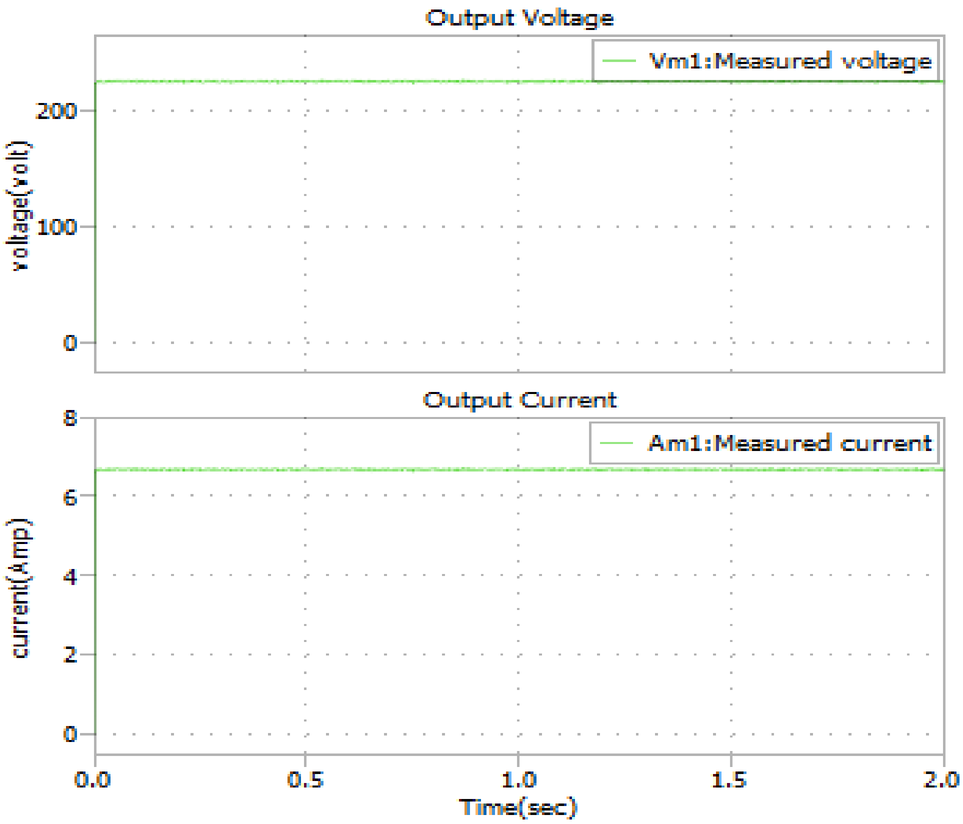
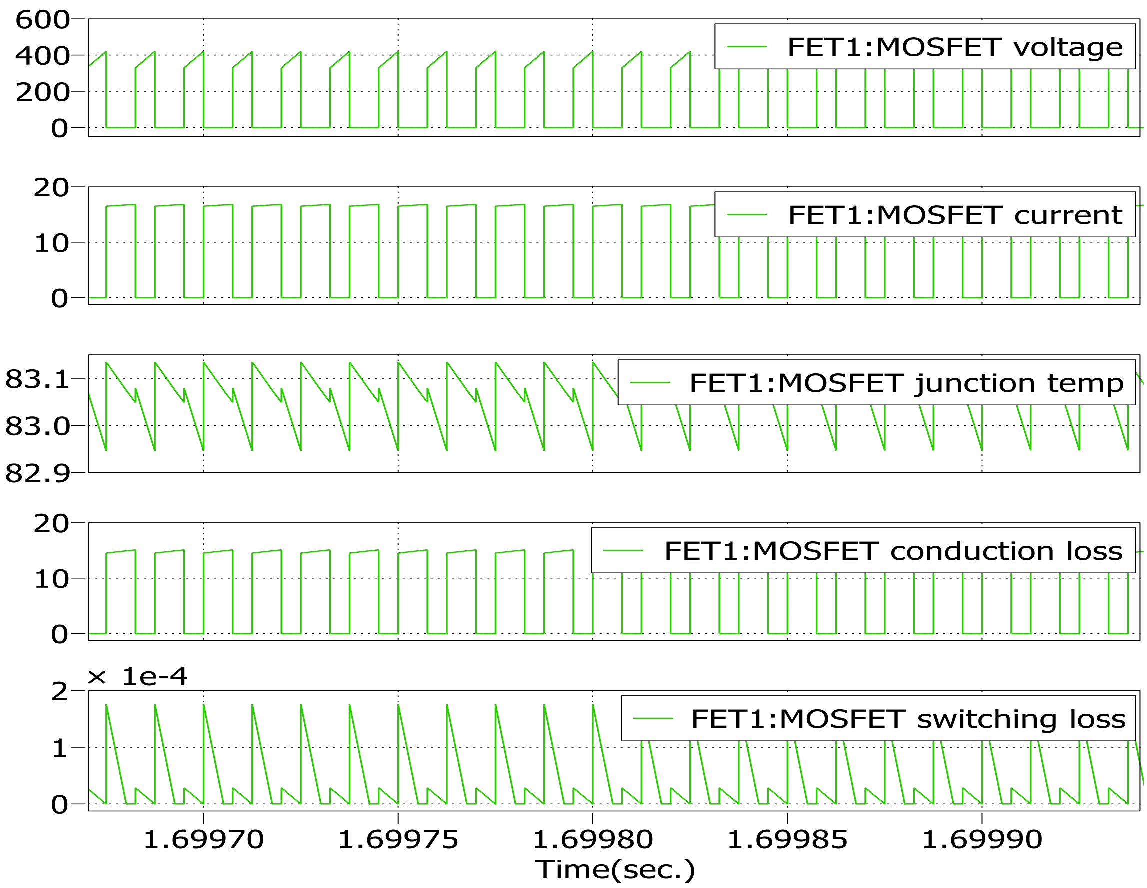


Figure – output voltage and current



Conclusion:-

In summary, the Zeta converter is a versatile DC-DC converter with applications in both step-up and step-down scenarios. Its unique topology and energy exchange mechanism make it a valuable tool for power electronics engineers.

In PLECs we have made Zeta Converter. After using our Calculated Values It is giving outputs perfectly. Then we have made thermal model such that switch will operate at 80° C. We have calculated switching and conduction loss and validated through PLECs Model.