# EXP 04- Dynamic analysis of a Buck Converter

Report by:

*Shivam Kumar(200020044)*

*Shashi Prabha(200020043)*

## AIM:

Perform the Dynamic analysis of a Buck Converter

Vin = 15V, Vout=7.5V, Iavg = 1A, fsw=30kHz and duty cycle of 50%

## COMPONENT USED:

- TL494 PWM Controller with IC Base
- Resistors - a) 47kΩ, 4.7kΩ; 0.25W b)2, 150Ω; 2W
- Rheostat (50kΩ; 10kΩ)
- Rheostat (50Ω; 5A)(wire wound)
- IRF480 MOSFET
- Indctor 1.2mH
- Diode (BY399)
- Circuit of Uncontrolled Rectifier (using LM317 or IC7815)
- Shorting pins
- Capacitor(100nF, 10nF, 100nF,220uF,47uF)
- PCB Board
- Wires(M & F), Wire stripper
- Regulator IC 7815 & LM317
- Soldering Equipment
- Oscilloscope
- Regulated Power Supply

## SUMMARY:

The buck converter is used to step down the input dc voltage to the desired output voltage. The duty cycle of the switch (MOSFET) can be varied to change the output voltage. To smoothen the output voltage and current the LC filter is used, Dynamics obtained during the load change, line voltage change and duty cycle change can be observed in the experiment

.

## Circuit diagrams & Snapshots of circuit board:

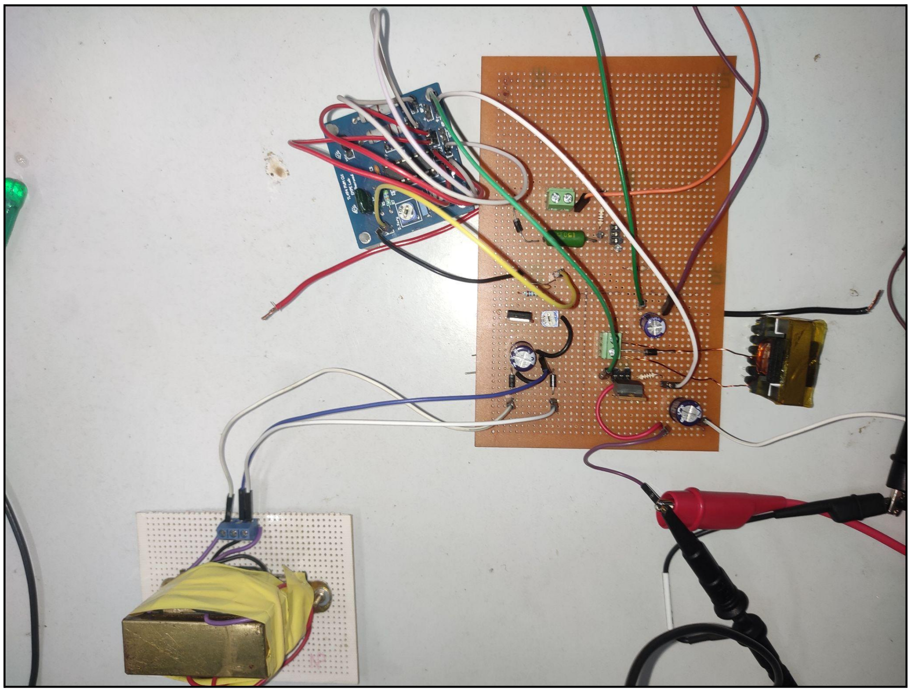
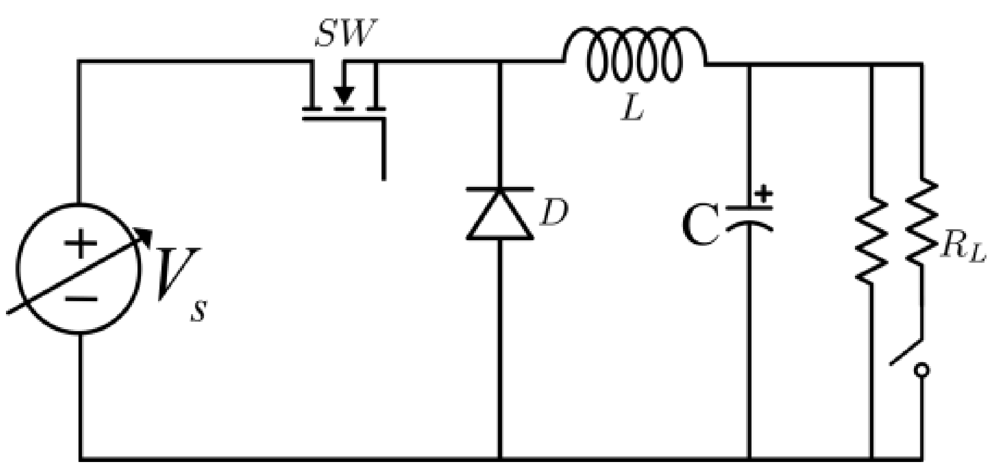


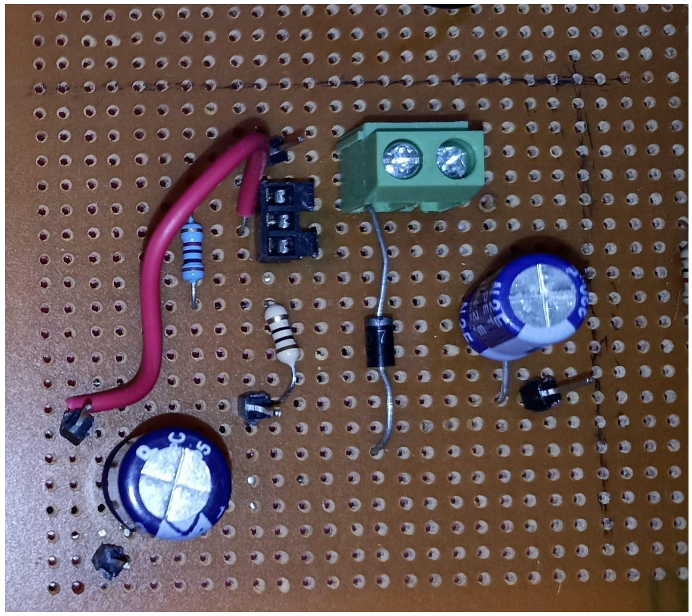
Fig1: Connection of circuit diagram according to Fig1 for making buck converter circuit.

## PROCEDURES:

- **Step-1:**Connected all the components as shown in the circuit .

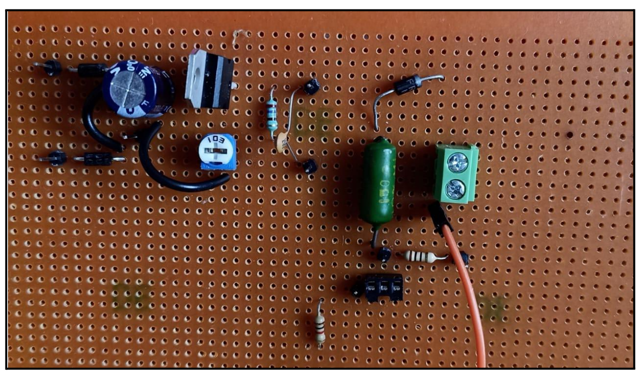



-

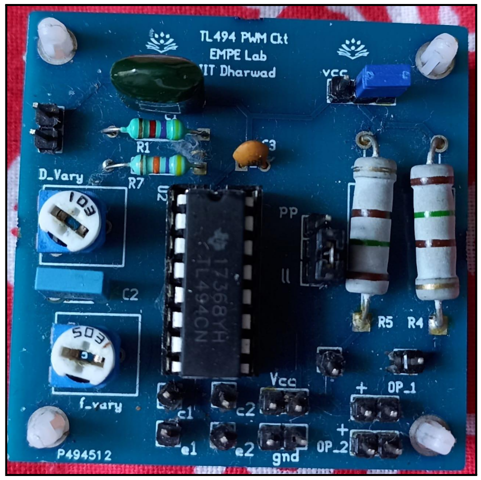


❖ Fig2: Circuit diagram for implementing buck converter circuit(main)

❖ **Step-2:** We arranged the 'Circuit of the Uncontrolled Rectifier' from the previous lab experiment. This is the snapshot of PCB with LM317:



❖ **Step-3:** Soldered the base pins and resistors, capacitors, potentiometers, IC base pin, and male jumper pins with desired refdes on the blue PCB for TL494. Below is the snapshot of the PCB of TL494:




- **Step-4:** After connecting the circuit of an uncontrolled rectifier LM317 board and TL 494 PCB circuit to get a 15V input supply, also we obtained a sawtooth waveform from CT(PIN5) of TL494.
- **Step-5**: To design Buck convertor we used TL494 as controllable switch,for this we implemented the EF(Emitter Follower)) configuration of the MOSFET in single ended mode, ie., we gave pins C1, C2 to +Vcc [15V] and E1, E2 to resistor R5 and R4, and o/p 1 and o/p 2 probes are connected to an oscilloscope.
- **Step-6**:Connection of TL494 with MOSFET used in buck convertor.

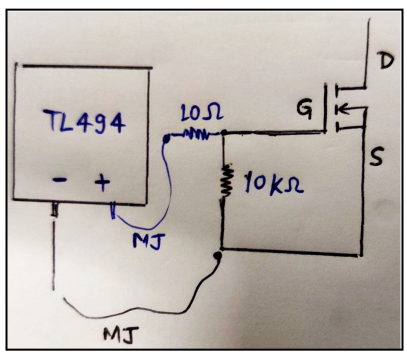



Fig3: Circuit diagram for connecting TL494 with MOSFET used in the buck converter.

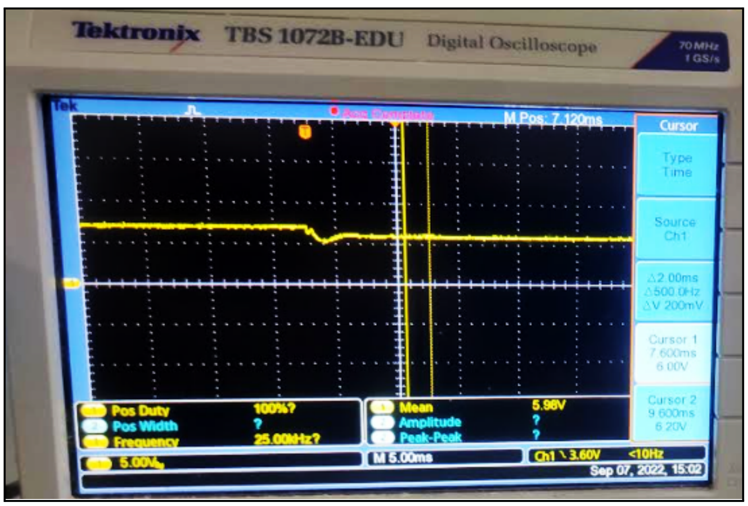
---

- **step-7:**Then we gave the 10V fixed source voltage Vs from supply and touched the other nob of 15V to measure the transient change in buck convertor output voltage and measured Vds and observed voltage output waveform of voltage(Vds) across MOSFET in oscilloscope by varying duty cycle of TL494 .
- **step-8:**We also measured the Voltage across inductor 1.2mH and Output voltage waveform for the terminals of rheostat or output side capacitor in oscilloscope.

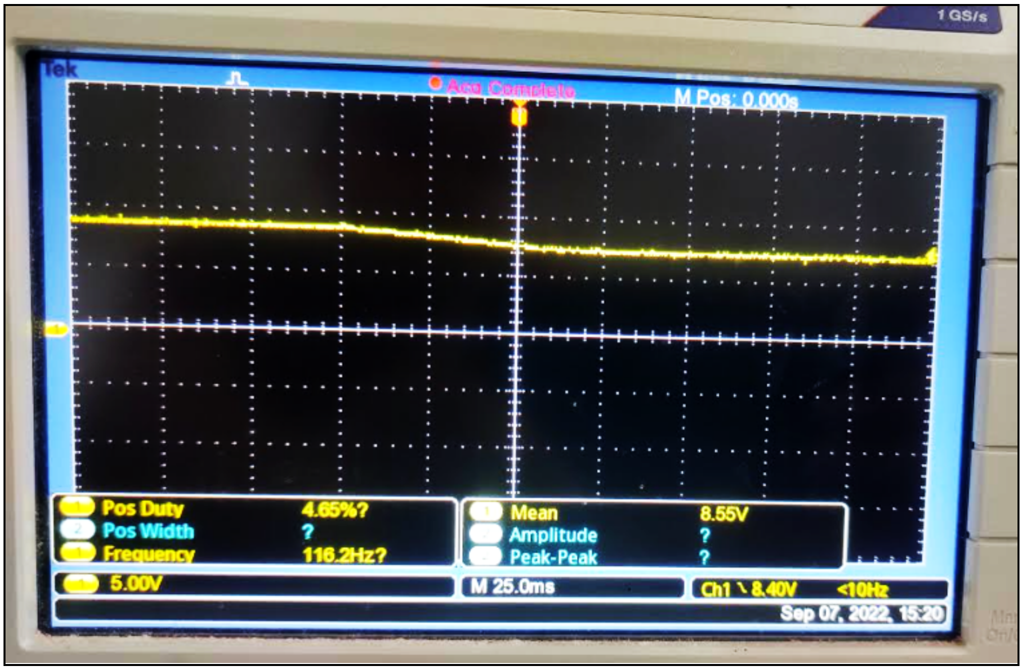
OUTPUT WAVEFORMS


**FigA : While varying the input voltage we can observe the transient graph of the buck converter's output.**

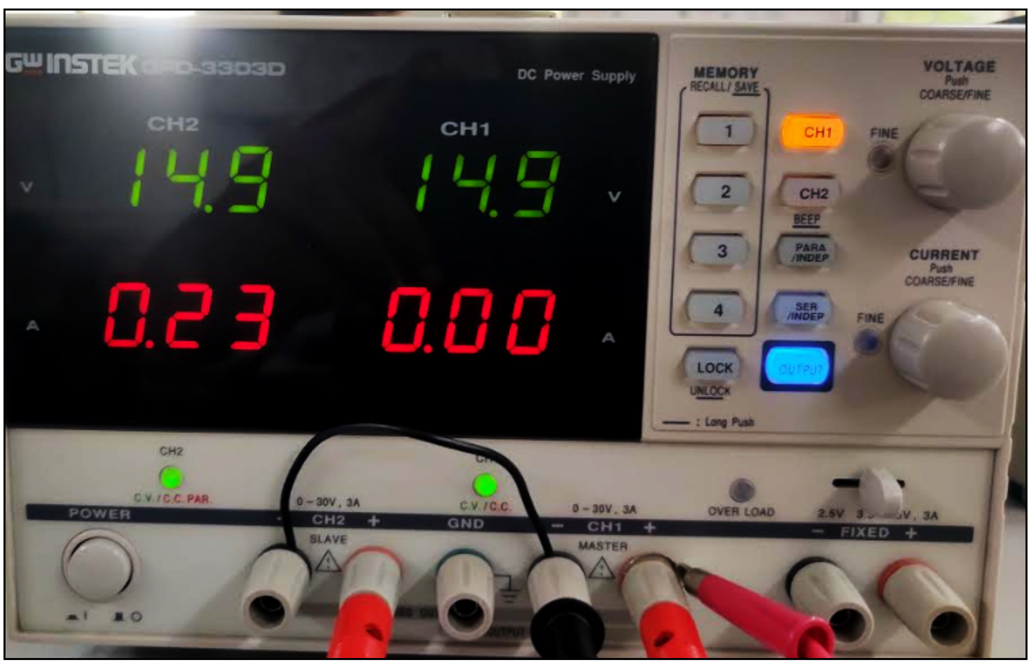
**Explanation:-we can see output voltage is not getting changed as we are changing input voltage from 10 to 15 there is certain delay.**




**FigB : While varying the load resistor(rheostat) we can observe the dipping graph of the buck converter's output.**




**FigC : Altered the duty cycle from the TL494 pot. and observed the output voltage change using the oscilloscope.**




**FigD: Observed the current drawn while varying the load resistance using the regulated power supply.**

## RESULTS AND ANALYSIS

1. In figA: Buck converter regulatory behavior when the input voltage is changed from lower to higher.
2. In figB: It is clear that the converter maintains the reference voltage despite changes in the circuit's load.
3. In figC: Varying duty cycle creates such a dip in a waveform which can result in an uncontrolled variation of the output voltage (due to the existence of inductor current oscillations.)
4. The output of this circuit should be completely DC and less powerful than the input voltage. As a result, the fundamental circuit was changed to incorporate a filter to create the DC output voltage, such as an LC low pass filter: *"When the switch is turned ON, the diode will enter reverse bias and give electricity to the load and inductor. When the switch is off, the diode becomes forward biassed and an inductor current passes through it. It will contribute some of its energy reserves to the load. Both high ranges step down converters and low load connections from high-level voltage can use this circuit configuration."*
5. An inductor maintains a constant voltage across the load R when the switch is OFF. It is helpful to maintain a consistent current across load R when there is no supply voltage. Additionally, the switch controls sudden changes in current when it is ON.
6. By altering the duty cycle, the DC buck converter's output voltage can be modified accordingly.
7. Low pass filtering and harmonic removal are done by the capacitor in the buck converter circuit. It must be chosen to be big enough to handle ripples, overshoots, and voltage variations when the switch is getting on and off.