EXP 03B- Design of Buck converter

Report by:

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AIM:

Design of Buck converter for the given specifications

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)
- 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.

Circuit diagrams & Snapshots of circuit board:

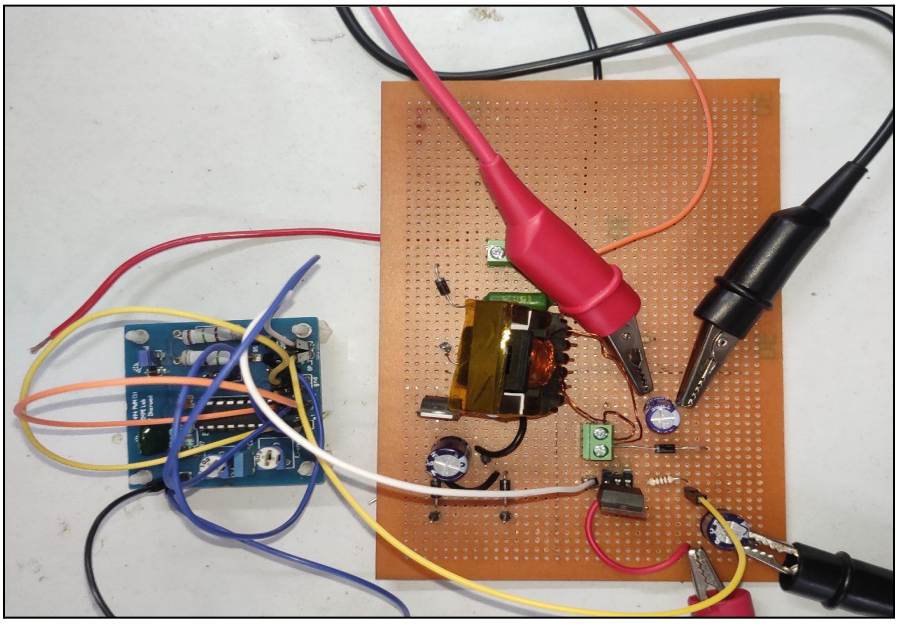
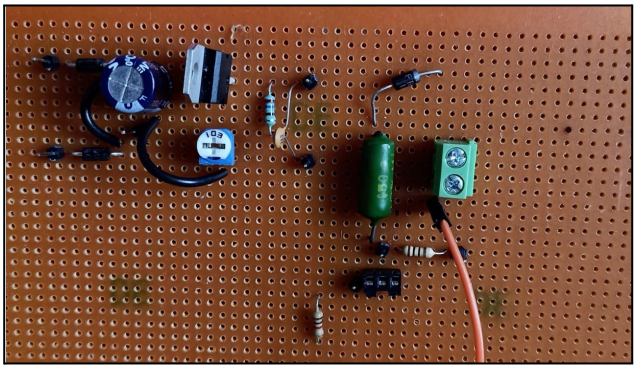


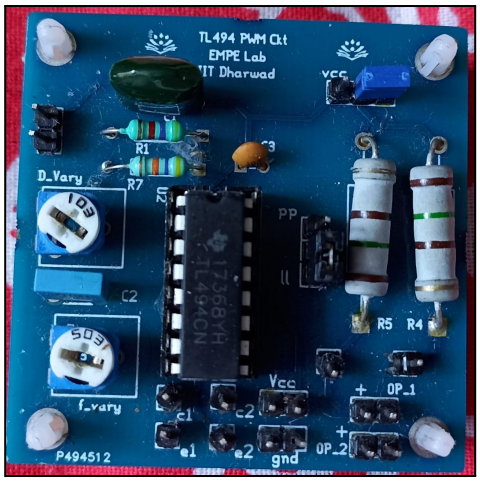
Fig3: Connection of circuit diagram according to Fig1 for making buck converter circuit.

PROCEDURES:

- Step1: We arranged the 'Circuit of the Uncontrolled Rectifier' from the previous lab experiment. This is the snapshot of PCB with LM317:



- Step2: 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:



- Step3: 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.
- Step4: 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.
- Connection of TL494 with MOSFET used in buck convertor.

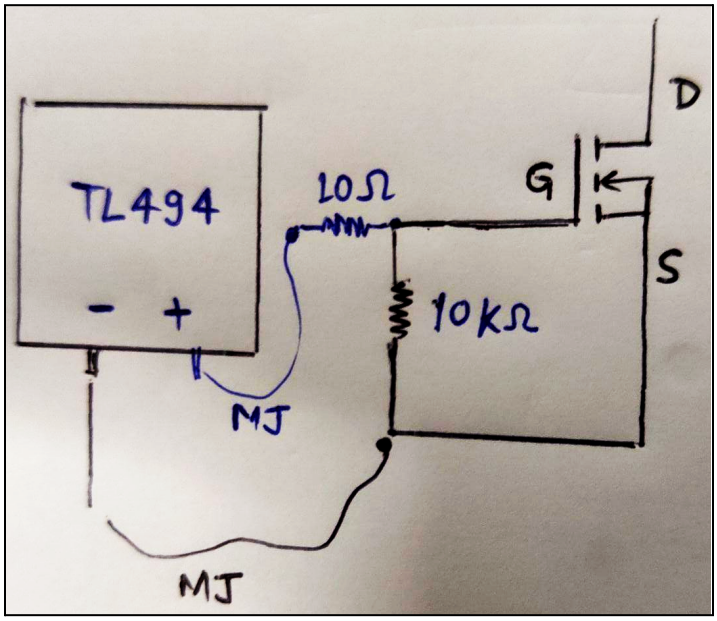


Fig2: Circuit diagram for connecting TL494 with MOSFET used in the buck converter.

- Connected all the components as shown in the circuit .
- Then we gave the 15V source voltage Vs from supply and measured Vds and observed voltage output waveform of voltage(Vds) across MOSFET in oscilloscope by varying duty cycle of TL494 .
- We also measured the Voltage across inductor 1.2mH and Output voltage waveform for the terminals of rheostat or output side capacitor in oscilloscope .

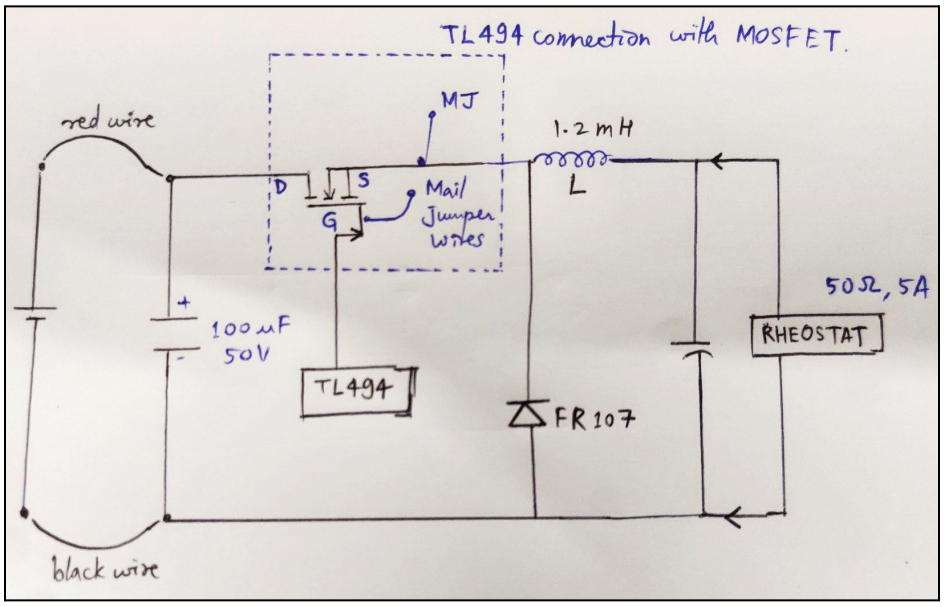


Fig1: Circuit diagram for implementing buck converter circuit(main)

Results and Outputs

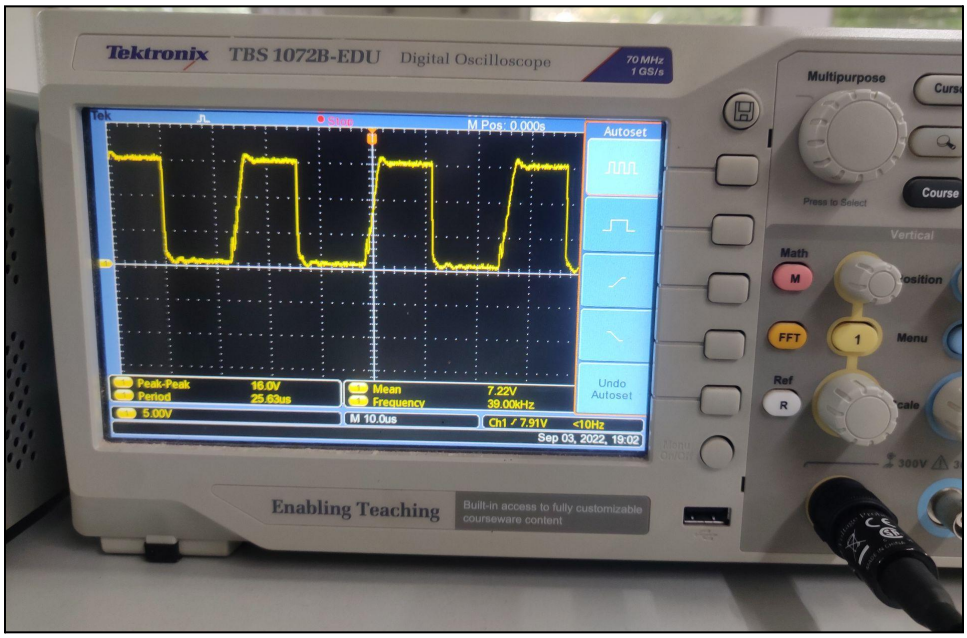


Fig4: For varying duty cycles of TL494, we observed such voltage output waveform of voltage(Vds) across MOSFET.

- **Result:** MOSFET working as a complementary switch with diode shows pulse waveform as output discontinuous due to TL494 output.

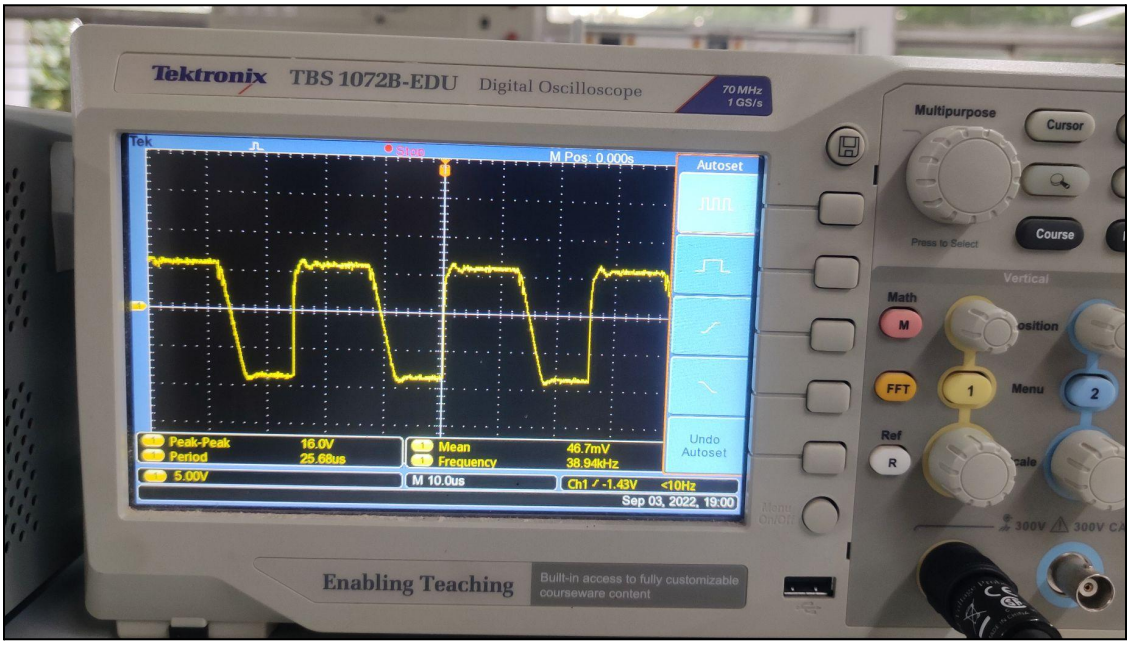


Fig5: Voltage across inductor 1.2mH showing some noise in the output waveform.

- **Result:** Although it can be a design objective, the inductor is in charge of producing and also suppressing ripples on the output waveform.

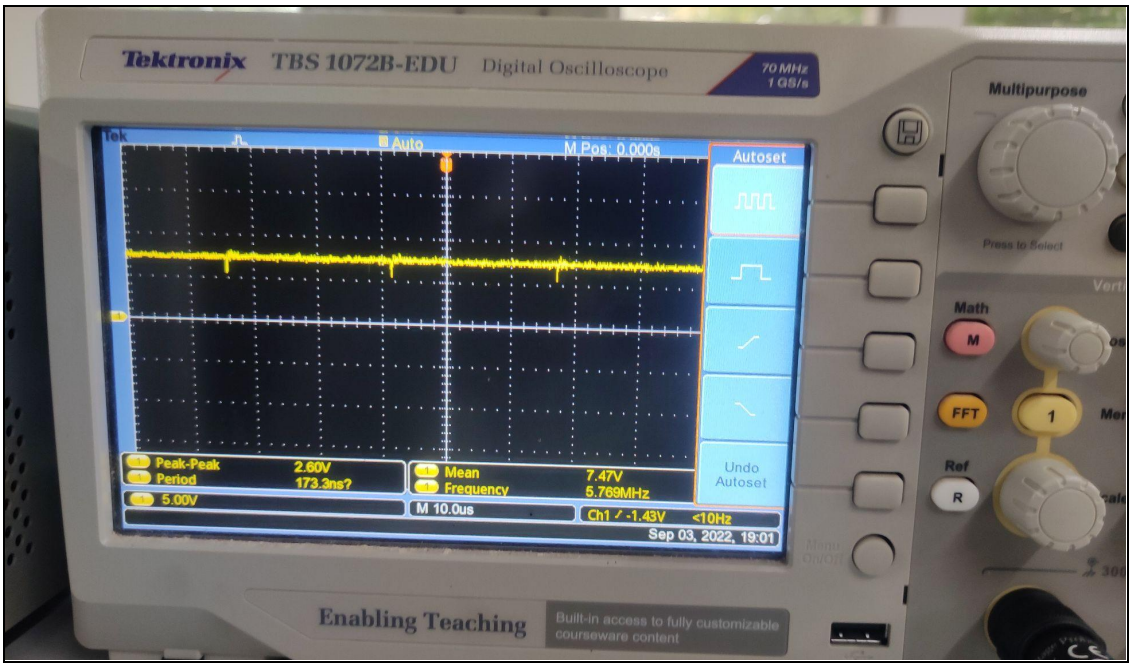


Fig6: Output voltage waveform for the terminals of rheostat or output side capacitor.

- **Result**: The output voltage in continuous mode is determined by: Vout = -D/(1-D) Vin between those limits giving DC output. The parallel inductor and capacitor combination, function as a second-order low pass filter, lowering the voltage ripple/noise at the output side.

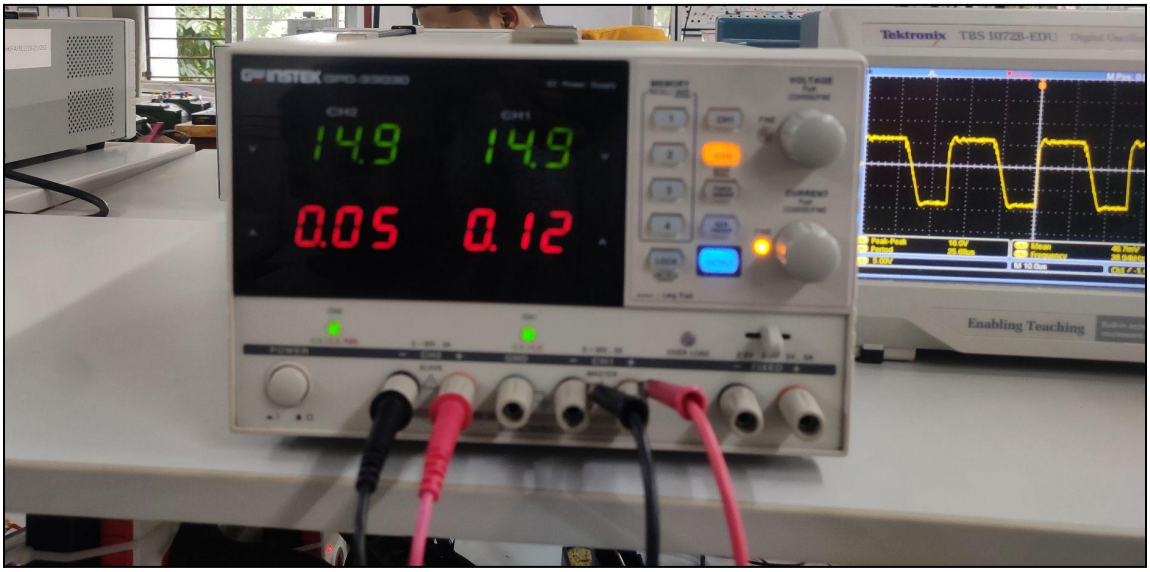


Fig7: Snapshot of regulated power supply used for DC voltage to the buck converter circuit at the input side.

- **Result:** We can see there is 0.12A of current drawn by the probe when the circuit is working.

ANALYSIS

1. The output voltage of a buck converter is never higher than the input voltage. So, as the duty cycle is set to 50%, we saw that the output voltage is also 50% of the input voltage in Fig6.
2. Buck converter circuit has a load resistor, an inductor with a capacitor on the output side that creates a low-pass filter to smooth out the voltage output, a MOSFET acting as a switch, a dc input voltage, and a MOSFET (rheostat).
3. When the switch is opened, the diode offers a channel for the inductor current, and when the switch is closed, it is biased in the reverse direction.
4. The desired output voltage can be obtained by varying the duty cycle, as illustrated in the equation below. The output voltage is increased as D goes high. The output voltage falls as D goes down.

$$V_0 = DV_{in}$$

5. The inductor's activity opposes variations in current flow and serves as an energy store. This prevents the switching transistor's output from rapidly increasing to its maximum value. When a transistor quickly switches off, the energy that has been stored is eventually released as back emf.

6. Advantages of a buck DC-DC converter:

- High performance.
- Minimal heat management and smaller hardware.
- A voltage's output might be either higher or lower than its input.
- If typical performance for a lower price is required, this converter is less expensive than the majority of the others.
