EXP 5- Design of Boost 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 measure duty cycle for o/p voltage 20V and Vin=15V

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
- Inductor 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 boost converter is used to step up the input dc voltage to the desired output voltage. The duty cycle of the switch (MOSFET) can be varied to change the output voltage.

Circuit diagrams & Snapshots of circuit board:

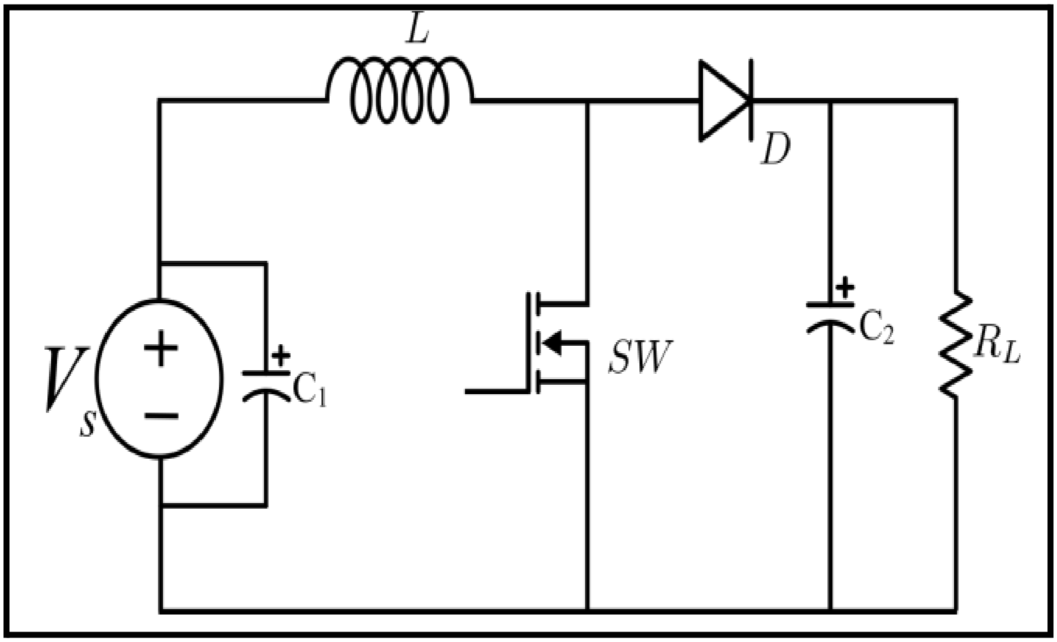


Fig: Circuit Diagram / Experimental Setup for connection of TL494 previous circuit with mosfet, resistor(load), inductor, capacitor to make boost converter.

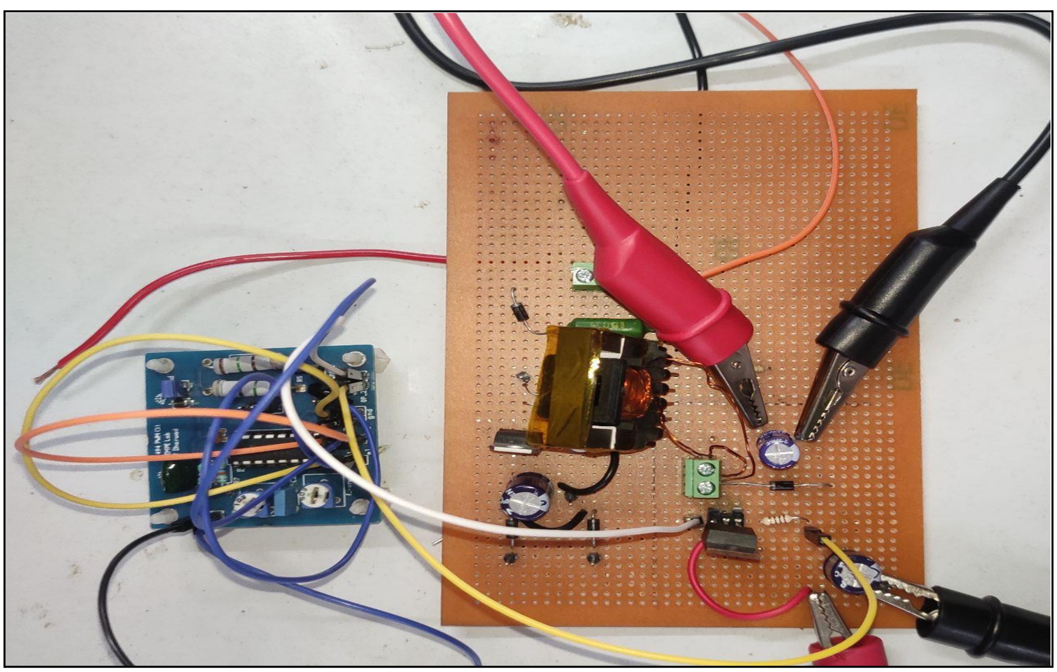
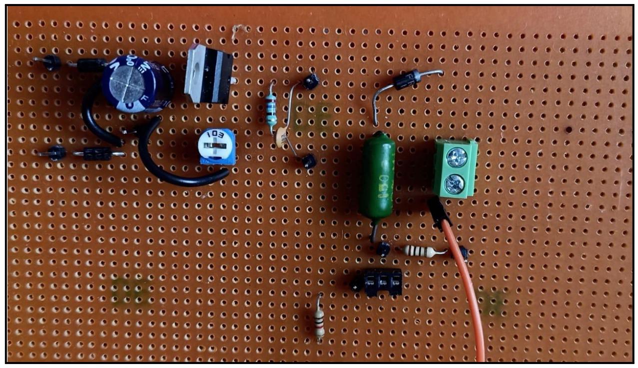


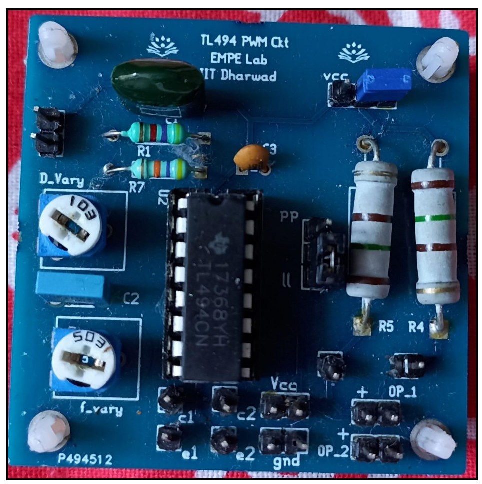
Fig: Connection and hardware implementation for making boost converter circuit.

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 converter we used TL494 as a 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.
- **Step5:**Connection of TL494 with MOSFET used in boost converter.
- **Step6:**Connected all the components as shown in the circuit.
- **Step7:**Then we calculated the required duty cycle for the 20V source voltage Vs from supply and adjusted the load to get 1.5A input current observed voltage output waveform of voltage(Vds) across MOSFE, Voltage across inductor ,and diode voltage in oscilloscope.

- **Step8:** We also measured the Voltage across inductor 1.2mH and Output voltage waveform for the terminals of rheostat or output side capacitor in the oscilloscope.

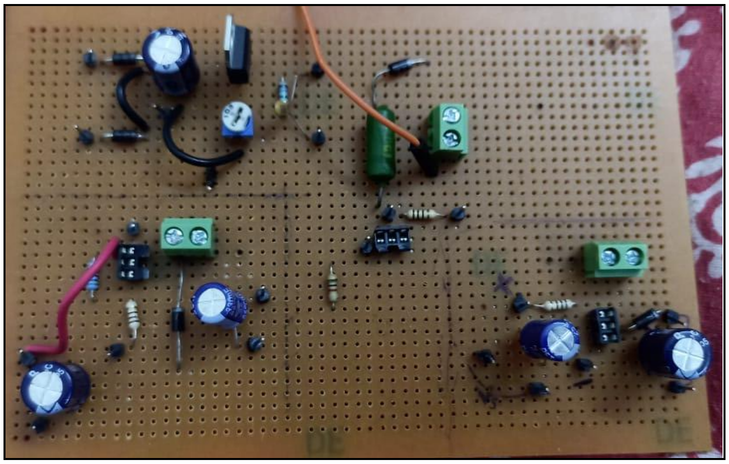


Fig: Circuit diagram for implementing boost converter circuit(main).

Results and Outputs

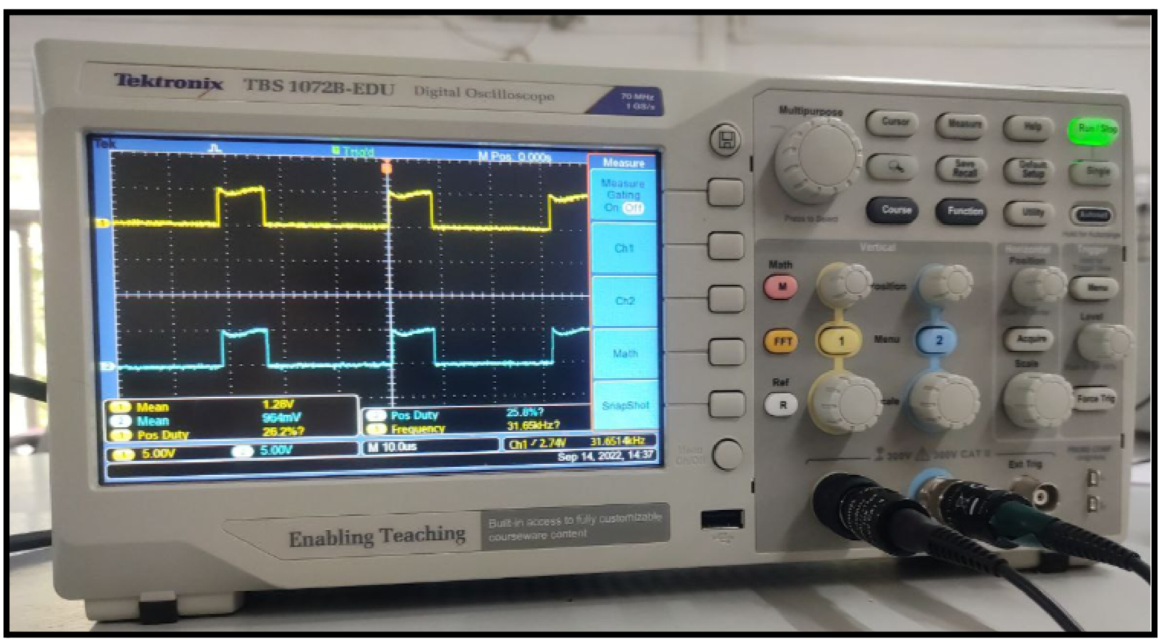


Fig4: Using the TL494 PWM generator designed earlier, we observed such voltage output waveform.

- **Result:** With a duty cycle of 25% and frequency around 31kHz we got the same phased pulses of emitter follower mode with a single-ended configuration.

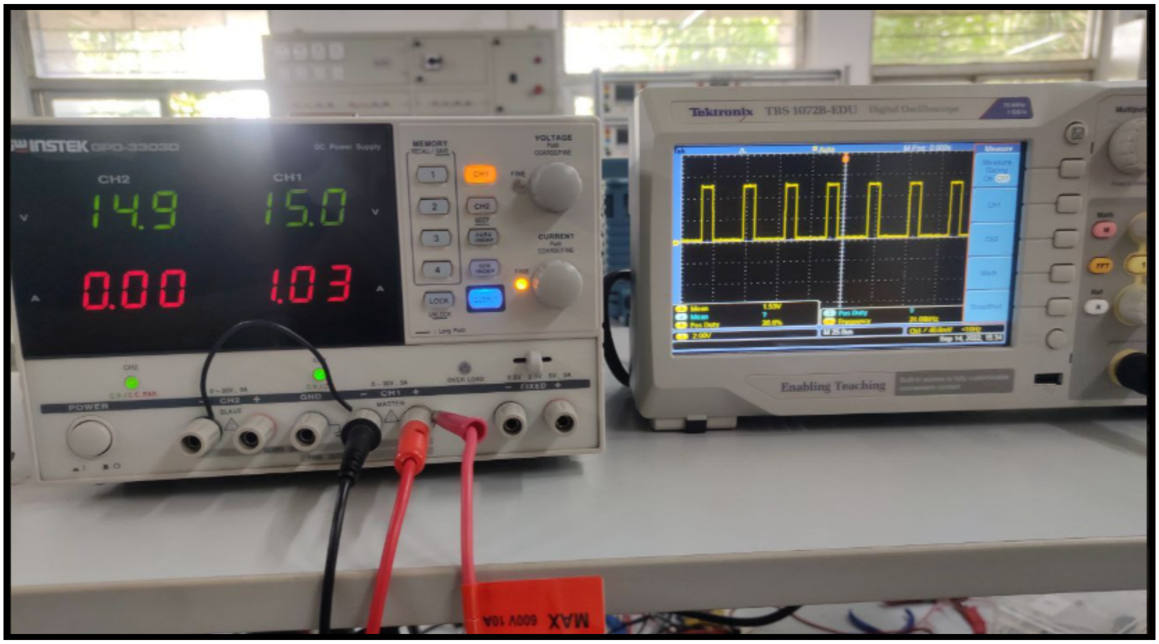


Fig5: Regulated power supply shows the load current 1.03A drawn when the circuit with TL494.

Result: We set the value of duty cycle and frequency wrt to the Vout required as per Vin given in the boost converter.

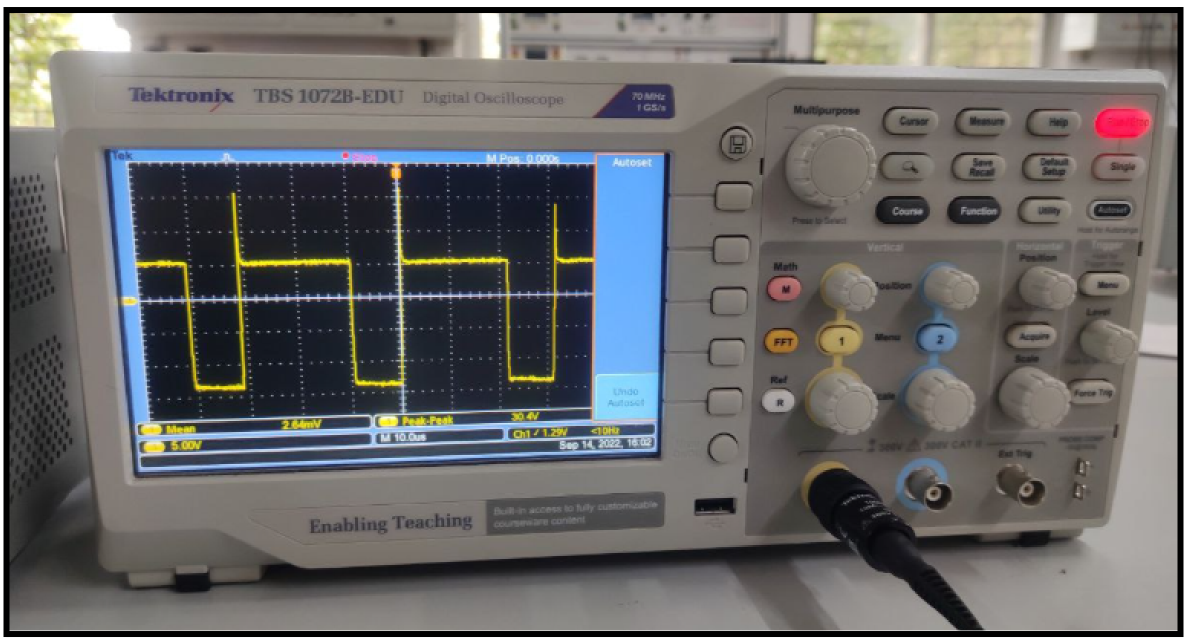


Fig6: Output voltage waveform for the MOSFET connected with TL494 and boost converter circuit.

- Result: When the pulse is low, the MOSFET is off and the voltage across the inductor is 20V. For an ON condition, there will be zero voltage across the transistor.

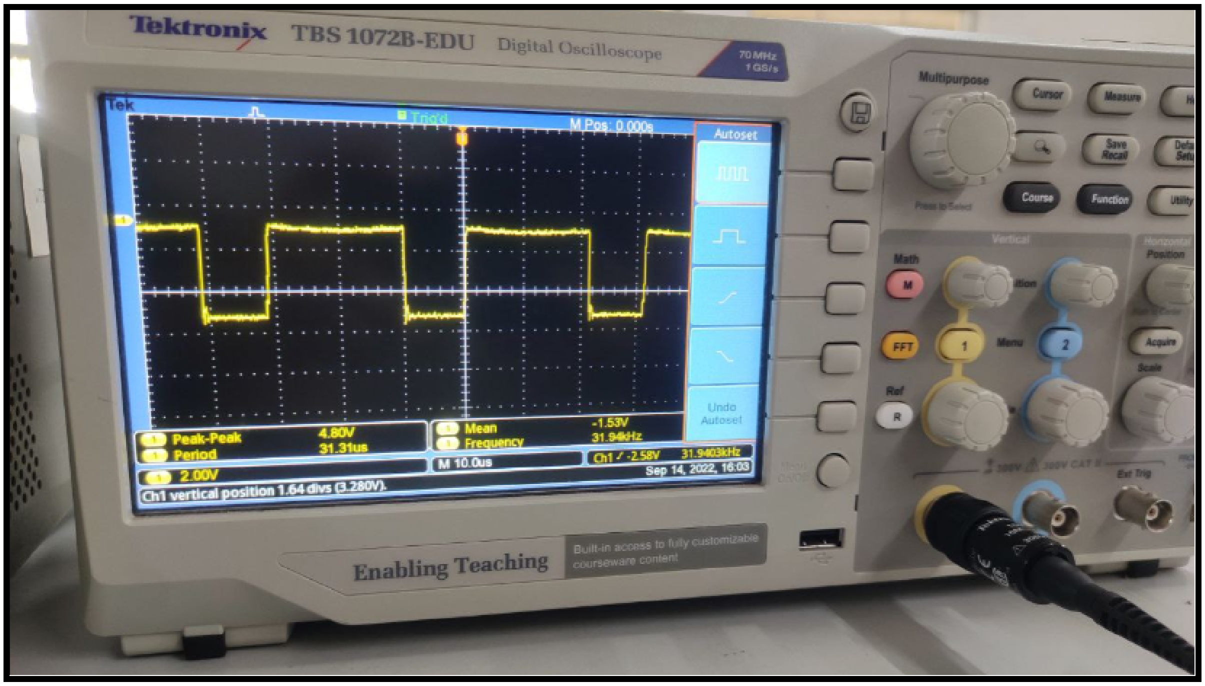


Fig7: Voltage waveform across the inductor when boost converter is in operation mode.

The propensity of an inductor to resist changes in current by either raising or lowering the amount of energy held in the magnetic field of the inductor. So we can see +15V to -5V voltage output.

ANALYSIS

1. Using a pulse width modulated (PWM) signal, the boost converter output voltage is adjusted. As The output voltage increases with an increase in D. The output voltage decreases when D goes down.

2. Since the voltage across an inductor is proportional to the rate of change of the current flowing through it, the DC (average) voltage across the inductor must be zero in the steady state for the inductor to return to its initial condition after each cycle.

3. The switch S is closed in the on-state, resulting in increasing the inductor current.

4. The switch is open in the off-state, leaving the load R, the diode D, and the capacitor C as the only paths for inductor current to travel. As a result, the energy accumulated during the on-state is transferred into the capacitor.

5. The desired output voltage of 20V can be obtained by fixing the duty cycle to 25%, as illustrated in the equation below. The output voltage is increased as D goes high. The output voltage falls as D goes down.

$$\boxed{V_o=Vin/1-D}$$

6. Advantages of a buck DC-DC converter:

- Gives the high output voltage
- Low operating duty cycles
- Lower voltage on MOSFET