

DC-DC Converter

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Abstract—This manual provides the design of a DC-DC Boost-Converter.

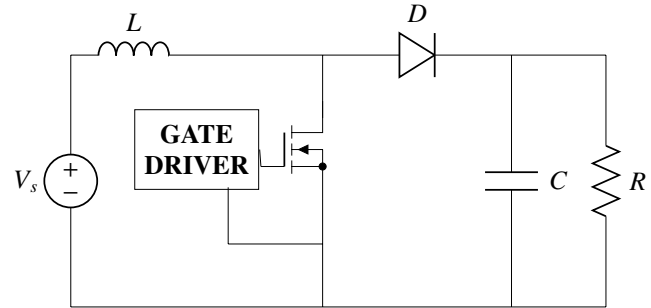


Fig. 2: DC-DC boost converter

1 COMPONENTS

Component	Value	Quantity
Arduino Uno		1
Inductor	5 mH	1
Capacitor	10 uF	1
n-MOS	IRF 540	1
Jumper Wires	M-M	20
Diode		1
Gate Driver	TLP350	1

TABLE I

2 CIRCUIT OPERATION

The boost converter blockdiagram and circuit is shown in Fig. 1 and Fig. 2.

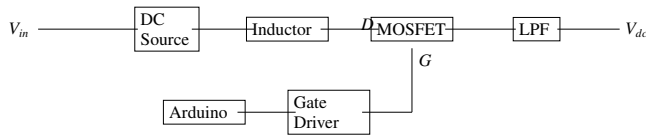


Fig. 1: Block Diagram

Problem 2.1. When the switch is ON, the circuit diagram is shown in Fig. 3. Express the voltage

across inductor in terms of V_s and V_o and current passing through the capacitor in terms of I_L and I_o when switch is ON.

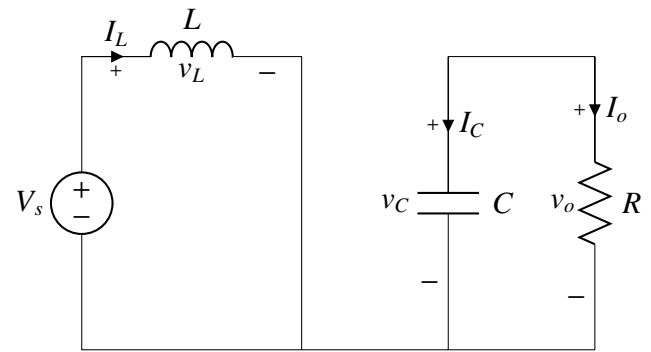


Fig. 3: Switch in ON state

Solution:

$$V_L(ON) = V_s$$

$$I_C(ON) + I_o = 0$$

$$I_C(ON) = -I_o$$

Problem 2.2. When the switch is OFF, the circuit diagram is shown in Fig. 4. Express the voltage across inductor in terms of V_s and V_o and current passing through the capacitor in terms of I_L and I_o when switch is OFF.

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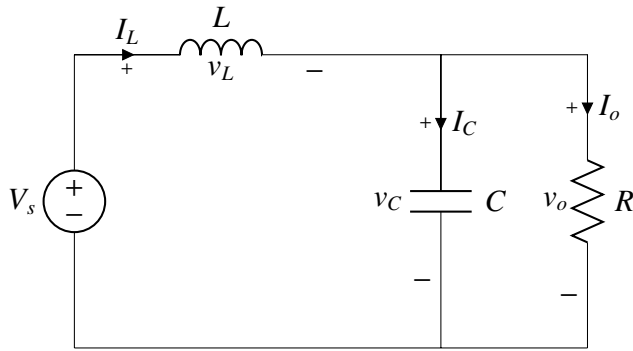


Fig. 4: Switch in OFF state

Solution:

$$V_L(OFF) = V_s - V_o$$

$$I_C(OFF) = I_L - I_o$$

Problem 2.3. Find V_o and I_o .**Solution:** From Volt-sec Balance

$$V_L(ON)T_{ON} + V_L(OFF)T_{OFF} = 0$$

$$V_s DT - (V_s - V_o)(1 - D)T = 0$$

$$V_o = \frac{V_s}{(1 - D)}$$

Where D is Duty cycle

From Amp-sec Balance

$$-I_o DT + (I_L - I_o)(1 - D)T = 0$$

$$I_o = \frac{I_L}{(1 - D)}$$

Problem 2.4. Express L in terms of D, V_s , $f = \frac{1}{T}$ and ΔI_L .Where ΔI_L is Ripple in the inductor current i.e maximum change in the inductor current from ON state to OFF state .**Solution:**

$$V_L(ON) = V_s$$

$$L \frac{di_{ON}}{dt_{ON}} = V_s$$

$$L \frac{\Delta I_L}{DT} = V_s$$

$$L = \frac{DV_s}{\Delta I_L f} \quad (2.4.1)$$

Problem 2.5. Express C in terms of I_o , D, ΔV_o and

$$f = \frac{1}{T}.$$

Solution: $\Delta V_C = \Delta V_o$ During ON state, $I_C = -I_o$

$$C \frac{dV_C}{dt_{ON}} = -I_o$$

$$\int_{V_{max}}^{V_{min}} dV_C = \int_0^{DT} \frac{-I_o}{C} dt$$

$$V_{min} - V_{max} = \frac{-I_o}{C} DT$$

$$-\Delta V_o = \frac{-DI_o}{Cf}$$

$$C = \frac{DI_o}{f \Delta V_o} \quad (2.5.1)$$

Problem 2.6. Assume,Input Voltage (V_s) = 5VOutput Voltage (V_o) = 10V $\Delta I_L = 5\%$ of I_L $\Delta V_o = 7\%$ of V_o Let $R = 10\Omega$ (for $I_o = 1A$)

Calculate L and C.

3 CIRCUIT ASSEMBLY

Problem 3.1. Assemble the Boost converter circuit according to Figs. 2, 5 and Table II.

TLP350	1	2	3	4	5	6	7	8
ARDUINO	NA	13	GND	NA			NA	
					GND			15 v
						22 Ohm		

TABLE II: Pin Connections

Problem 3.2. Program the arduino to generate a square wave with Duty Cycle $D = 0.5$ and frequency $f = 5KHz$.**Solution:**

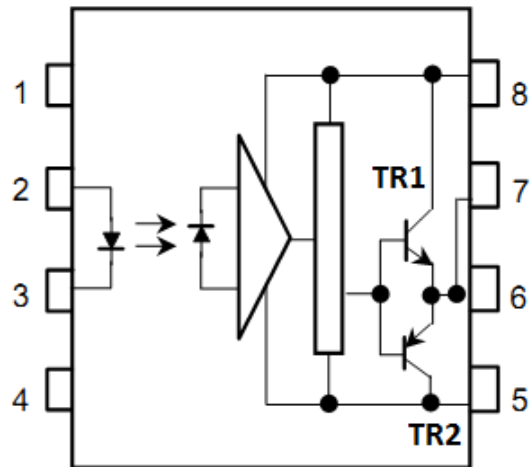
```

void setup() {
    pinMode(13, OUTPUT);
}

void loop() {
    digitalWrite(13, LOW);
    delayMicroseconds(100);
    digitalWrite(13, HIGH);
    delayMicroseconds(100);

```

Pin Configuration



- 1 : N.C.
- 2 : Anode
- 3 : Cathode
- 4 : N.C.
- 5 : GND
- 6 : V_O (Output)
- 7 : V_O
- 8 : V_{CC}

Fig. 5: TLP350

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