LECTURE 4

Introduction to Power Electronics Circuit Topologies: The Big Three

I. POWER ELECTRONICS CIRCUIT TOPOLOGIES
   A. OVERVIEW
   B. BUCK TOPOLOGY
   C. BOOST CIRCUIT
   D. BUCK-BOOST TOPOLOGY
   E. COMPARISON OF THE BIG THREE

II. TOPOLOGY OF L-C OUTPUT FILTERS
   A. C ALWAYS Located ACROSS $V_{out}$
   B. L LOCATED BETWEEN CRUDE UNFILTERED $V_{dc}$ AND STABILIZED $V_{out}$
      1. BUCK
      2. BOOST
      3. BUCK-BOOST
      4. LOW RIPPLE APPROXIMATION FOR OUTPUT SIGNALS AT $f_{sw}$
         a) INDUCTOR RIPPLE:
            $\Delta i = \frac{V}{L} dt(switch)$
         b) CAPACITOR RIPPLE:
            $\Delta V = \frac{1}{C} dt(switch)$
            $dt(switch) = (\text{Duty cycle}) \times T_s (\text{period of } f_{sw})$
**HARRIS PRODUCTS**

**Application**

**Typical Applications**

**Disadvantages**

**Advantages**

\[ I_C = I_R (1 - D) \]

\[ V_D = V_{IN} + V_D \]

\[ I_{MAX} = \frac{V_{IN}}{V_D} \]

\[ D = \frac{V_I}{V_D} \]

\[ V_D = \frac{S}{V_I} \]

**WAVEFORMS AND CURRENT VOLATAGE**

**Diode Voltages (VRM)**

**Diode Circuit**

- Buck (Step Down)

**Configurations**

- Converter

**Type of Converter**

- Average Drain Voltage
- Peak Drain Voltage
- Peak Drain Current
- Function Transfer Ideal
Typical Applications

Advantages

- High efficiency; simple, no transformer, low input ripple current.
- No isolation between input and output; High peak
- High output. Input to output circuits: high output ripple, input to output can be possible. Regen-

Disadvantages

- IRL = ITH
- VDS = V0 + VD
- \( \frac{1}{2} \left( 1 - \frac{I_{TH}}{I_{MAX}} \right) \)
- \( \frac{1}{2} \left( 1 - \frac{V_{IN}}{V_{0}} \right) \)

Waveforms

Volga and Current

V_{RM} = V_{0}

Circuit Configuration

Type of Diode

Boost (Step Up)
HARRIS PRODUCTS

APPLICATIONS

TYPICAL

DISADVANTAGES

ADVANTAGES

WAVEFORMS AND CURRENT VOLTSAGE

V_{RM} = V_{O} + V_{IN}

\begin{align*}
I_{CFL} &= \frac{I_{RL}}{2} \\
V_{DS} &= V_{O} + V_{IN} + V_{D} \\
I_{MAX} &= I_{1} + \frac{V_{I}}{V_{D}}
\end{align*}

CIRCUIT CONFIGURATION

SEPIC (Step Down/Up)
Extra Credit Question.

WHAT IS THE RPM OF HARD DRIVES.

<table>
<thead>
<tr>
<th>Company</th>
<th>RPM</th>
</tr>
</thead>
<tbody>
<tr>
<td>SeaGate</td>
<td>10,000RPM</td>
</tr>
<tr>
<td>Quantum</td>
<td>10,000RPM</td>
</tr>
<tr>
<td>HP</td>
<td>9,000 RPM</td>
</tr>
</tbody>
</table>

The problems that Hard drive designers have to deal with are:

- Current loss due to motor that induces the spinning
- Windage losses.
- Back emf coming from the motor.
- Very difficult to design a circuit and a motor that can produce 10,000RPM with a 5V power supply.

IBM Ultra 15 K

7500

61 or

10 K Nov
In preparation for your midterm exam, look at the attached schematic on pg. 8 of a flyback converter slowly - don’t panic. try to find only the essential power electronics portions.

1. Identify the crude dc generation in the upper left driven by 120 ac mains. this CRUDE DC IS DRIVEN BY THE SWITCH #1 INTO THE TRANSFORMER PRIMARY.

2. On the right side of the schematic notice the three secondaries of the transformers with the three dc outputs: 5, 12, and 30 v.

3. Find the cmos transistor Q1 (middle) which is the switching transistor. From the gate of this cmos-switch the gate control circuitry may also be found. We will spend the rest of the semester detailing how such circuits work.