Full Bridge Converter

Conversion Ratio

\[ M(D) = \frac{V}{V_g} = D_n \]

\[ \phi = D_n V_g = V \]

\[ \langle v_c \rangle = \phi = \langle v_s - V \rangle \]

\[ D \leq D_n \leq 1 \]
Transformer Saturation

\[ \langle V_T \rangle = \frac{1}{2T_s} \left( \frac{d}{dt} V_g - \frac{d}{dt} V_g \right) = 0 \]

\[ \phi = 0 \]

- Ideally, V-T balance always satisfied on Lm

- Non ideal case:
  1. Conduction loss in Q, Qy = R_{a1} - R_{a2}
  2. Timing / control error
     
     \[ D_1 = D + DD \]
     \[ D_2 = D - DD \]

\[ \langle V_T \rangle = \frac{1}{2T_s} \left[ D_1 T_s \left( V_g - n \frac{L}{L} \left( R_{a2} + R_{a3} \right) \right) - D_2 T_s \left( V_g - n \frac{L}{L} \left( R_{a1} + R_{a3} \right) \right) \right] \]

- Any nonidealities may lead to transformer saturation
- Practical implementation may use:
  1. Current control
  2. DC blocking Cap

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Push Pull Converter

![Push Pull Converter Diagram]

\[ V = nDV_c \]

\[ 0 \leq D \leq 1 \]
Half Bridge Isolated Buck

- Replace transistors $Q_3$ and $Q_4$ with large capacitors
- Voltage at capacitor centerpoint is $0.5V_g$
- $v_c(t)$ is reduced by a factor of two
- $M = 0.5 nD$

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6.3.2 Forward Converter

- Buck-derived transformer-isolated converter
- Single-transistor and two-transistor versions
- Maximum duty cycle is limited
- Transformer is reset while transistor is off
Subinterval 1 $Q_1$ on

Subinterval 2 $\rightarrow Q_2$ off
Subinterval 3

Forward Waveforms

\[ \langle V_c \rangle = \phi = D_1 V_g \frac{n_3}{n_1} - V \]

\[ \langle V_1 \rangle = \phi = \frac{V_g}{D_1} - \frac{n_3}{n_1} D_2 V_g \]

Constraints:
\[ D_2 = \frac{n_3}{n_1} D_1 \]
\[ D_1 + D_2 + D_3 = 1 \]
\[ 1 - D_1 - D_2 \geq \phi \]
\[ 1 - D_1 - D_2 \geq \phi \]
\[ D_1 = \frac{1}{1 + \frac{n_3}{n_1}} \]
Transformer Saturation When D > 0.5

magnetizing current waveforms, for $n_1 = n_2$

\[
D_1 = \frac{1}{2} \quad D_2 = \frac{1}{1 + \frac{n_2}{n_1}}
\]

- want $\frac{V_{as, \text{max}}}{V_0} = \frac{n_2}{n_1}$ (small)
- want $\frac{n_1}{n_2}$ (small)

Fundamentals of Power Electronics

Chapter 6: Converter circuits