ECE 404 / 504

T & D Applications of Voltage Sourced Converters

Lesson 10

We can get variable voltage DC from $-V_d$ to $+V_d$ using two power poles in a bidirectional buck converter.

We will now get AC using this same set of ideas.
Peak value is V_d; negative peak is \(-V_d\).

The rms value is V_d.

The amplitude of the fundamental frequency is \(4V_d/\pi\).

What have I been able to do so far?

* Set the frequency

* I can get an amplitude; One and only one amplitude so far.
Set the phase.

Let’s go back and look at improving this amplitude. I’d like to be able to set it to something I like.

Peak value is $V_d$; negative peak is $-V_d$.

The rms value is (depends on duty cycle): $V_d \times \sqrt{2 \times d_A}$

The amplitude of the fundamental frequency is
(depends on duty cycle). Use an FFT to get the numbers.

What do harmonics do for us?

* Heat
* Torques...

How can we get the ac pulses that we saw?
*Use two levels dc and compare to a triangle wave.
*Make two buck converter controls and subtract the results.

Next: Three phase waveforms
Harmonics in an AC Pulse Width Modulated Waveform: FFT Example

\[ d_A := 0.8 \quad \text{NN} := 10 \quad \text{pts} := 2^{\text{NN}} \quad i := 0, 1 \ldots \text{pts} - 1 \]

\[ v_{p_i} := \begin{cases} 
1 & \text{if } \frac{1 - \frac{d_A}{2}}{4} \cdot \text{pts} \leq i < \left( \frac{\frac{d_A}{2}}{4} \right) \cdot \text{pts} \\
(-1) & \text{if } \frac{3 - \frac{d_A}{2}}{4} \cdot \text{pts} \leq i < \frac{3 + \frac{d_A}{2}}{4} \cdot \text{pts} \\
0 & \text{otherwise}
\end{cases} \]

\[ v_{\text{fft}} := \text{fft}(v_p) \]
\[
\frac{2}{\sqrt{2NN}} \cdot |v_{\text{fft}_i}|
\]
FFT Example

\( d_A := 0.4 \)

\[ \begin{align*}
NN & := 10 \\
pts & := 2^{NN} \\
i & := 0, 1 \ldots pts - 1 \\
\end{align*} \]

\[ v_{p_i} := \begin{cases} 
1 & \text{if } 0 \leq i < d_A \cdot pts \\
0 & \text{otherwise} 
\end{cases} \]

\[ v_{\text{fft}} := \text{fft}(v_p) \]

![Graph showing \( v_{p_i} \) values vs. \( i \)]
$$v_{\text{fft}_1} = 3.012 + 9.211i$$

$$|v_{\text{fft}_1}| = 9.691$$

$$\arg(v_{\text{fft}_1}) = 71.895\text{\,deg}$$

$$\left|\frac{v_{\text{fft}_1}}{8}\right| = 1.211$$

$$\frac{4}{\pi} = 1.273$$