ECE 404 / 504

T & D Applications of Voltage Sourced Converters

Lesson 10

We can get variable voltage DC from –Vd to +Vd using two power poles in a bidirectional buck converter.

We will now get AC using this same set of ideas.

Peak value is Vd; negative peak is –Vd.

The rms value is Vd.

The amplitude of the fundamental frequency is 4Vd/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): Vd*sqrt(2*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~~ to 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.

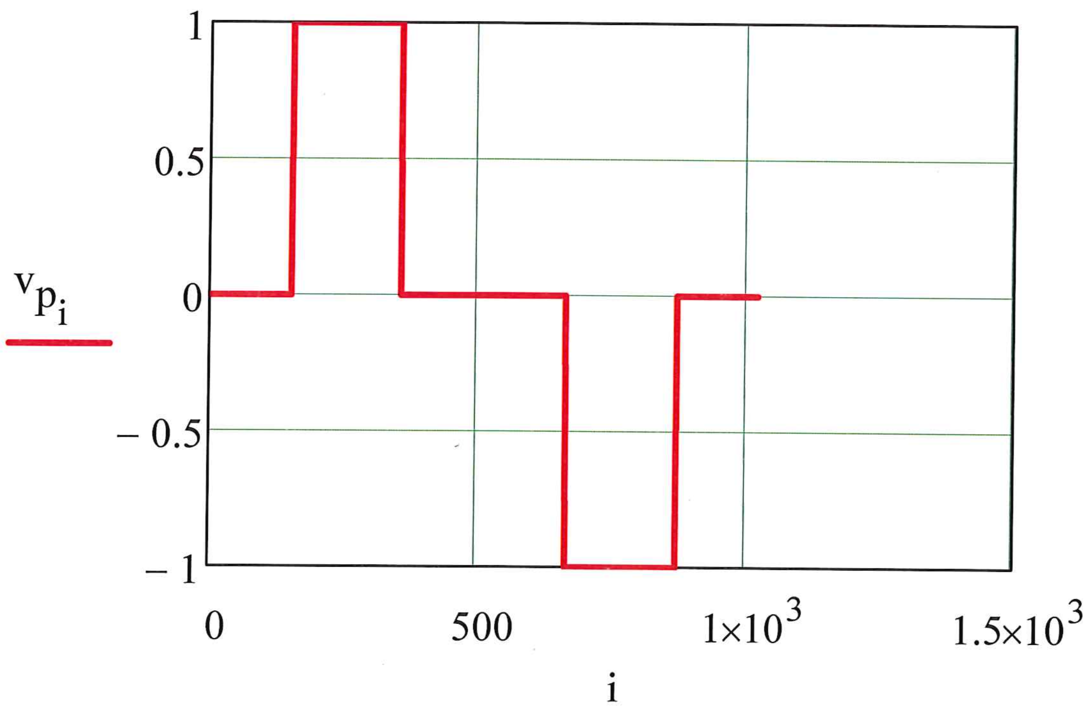
Next: Three phase waveforms

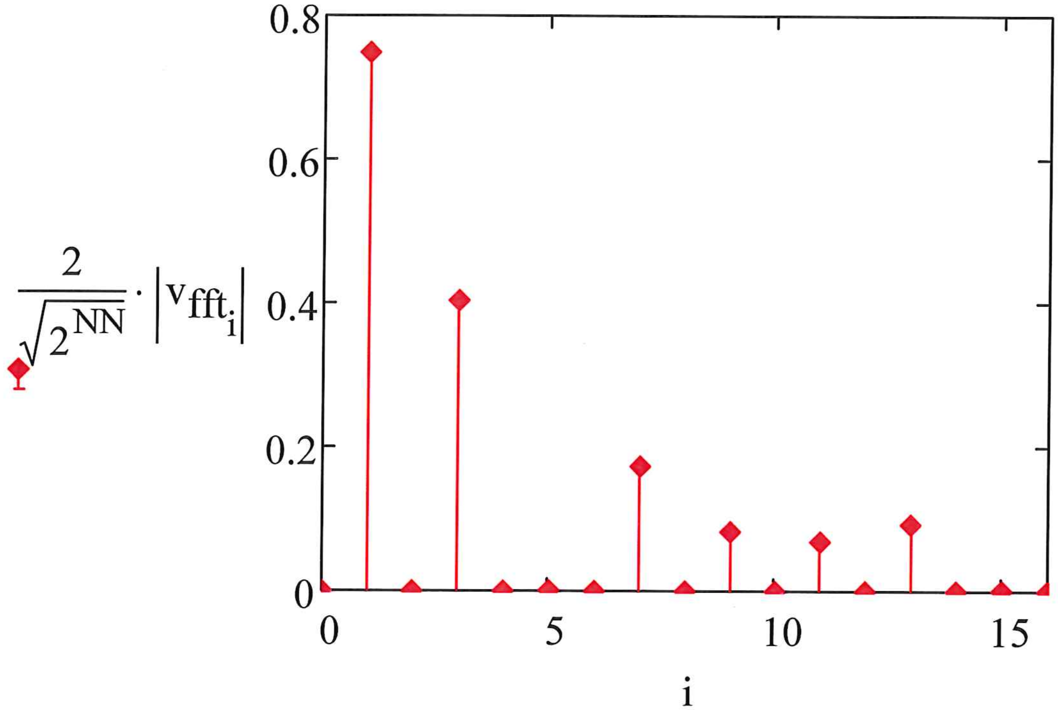
Harmonics in an AC Pulse Width Modulated Waveform: FFT Example

$d_A := 0.8 \qquad NN := 10 \qquad pts := 2^{NN} \qquad i := 0, 1 .. pts - 1$

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

$v_{fft} := \text{fft}(v_p)$




0.8
0.6
0.4
0.2
0
0
5
10
15
i
$\frac{2}{\sqrt{2^{NN}}} \cdot \left| v_{fft_i} \right|$

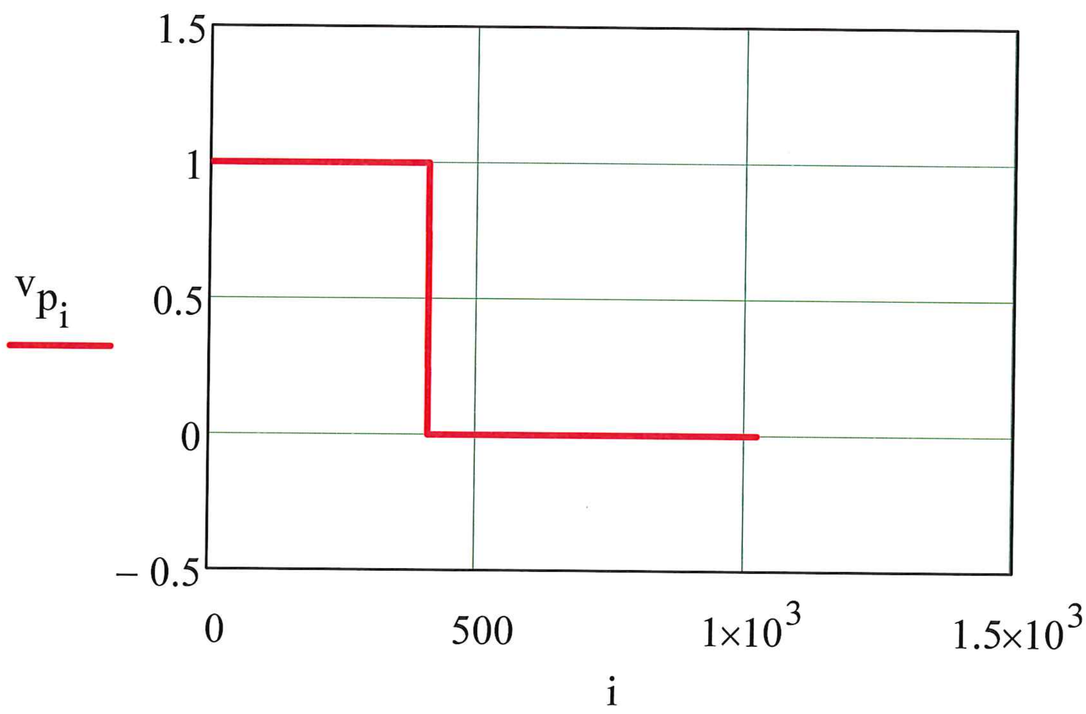
FFT Example

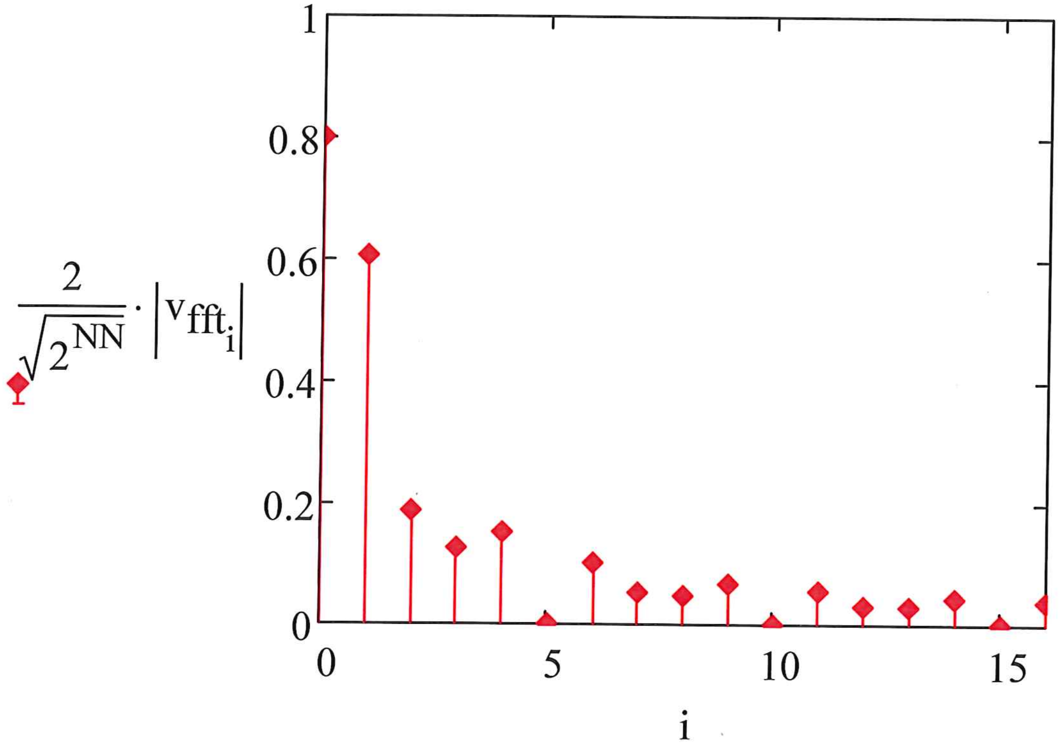
$d_A := 0.4$

$NN := 10$ $\qquad$ $pts := 2^{NN}$ $\qquad$ $i := 0, 1 .. pts - 1$

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

$$v_{fft} := fft(v_p)$$





1
0.8
0.6
0.4
0.2
0
0
5
10
15
i
$\frac{2}{\sqrt{2^{NN}}} \cdot \left| v_{fft_i} \right|$

$v_{fft_1} = 3.012 + 9.211i$

$\left|v_{fft_1}\right| = 9.691$

$\arg\left(v_{fft_1}\right) = 71.895 \cdot deg$

$\frac{\left|v_{fft_1}\right|}{8} = 1.211$

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