Name:
Time:

Full Converter for a Wind Turbine

The vast majority of new wind turbines are based on permanent magnet synchronous generators. They are "direct drive" machines, which means there's no gearbox. Therefore the voltage and frequency of the generator's output can vary wildly as the wind changes. In order to connect to the grid certain voltage, frequency, and THD requirements must be met, as you've learned in previous labs. These turbines used a "full converter" to ensure all of the requirements are met. A full converter is basically this:

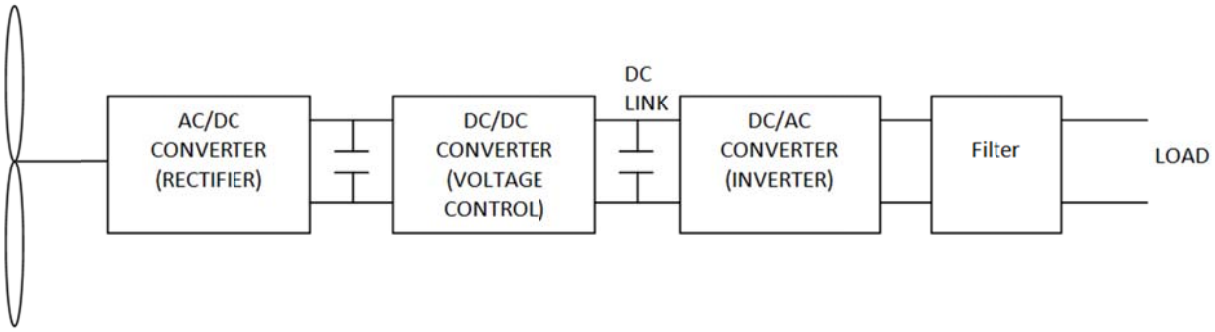


Figure 1. Full converter

For a grid-tied application the load is the grid. The DC/DC converter is optional, depending on the type of control used for the rectifier and inverter.

The goal of this project is to design and build a full converter for a wind turbine. The wind turbine will actually be a wye-connected synchronous machine. It will operate between $6V_{LN}$, 20Hz and $16.5V_{LN}$, 40Hz. Those conditions are the operating range. Your converter doesn't need to be concerned with any operating conditions outside of those, but it's can't go unstable and destroy anything either. The load will be a single 200 Ω resistor, so your inverter will be single phase. You will almost certainly need to use a microcontroller to implement your control. Shell code will be provided for an HCS08 microcontroller. It's ok to run everything from a breadboard, and to run the microcontroller from its demo board.

The design requirements are:

1. Load current THD < 30% over the entire operating range

2. Load current frequency must stay between 59Hz and 61Hz over the entire operating range.

3. Load voltage must stay between 6.5V and 7.5V over the entire operating range.

4. The Lab Volt Chopper/Inverter may only be used to implement 1 circuit.

You are free to use any circuit(s) or components you want to meet these requirements.

Name:
Time:

In order to complete the project you must:

1. Demonstrate your working circuit to your lab instructor.

2. Prepare a report that contains the following

    a. A complete schematic of your controller

    b. An operating procedure for your converter. For example: turn this on first, then turn that on…

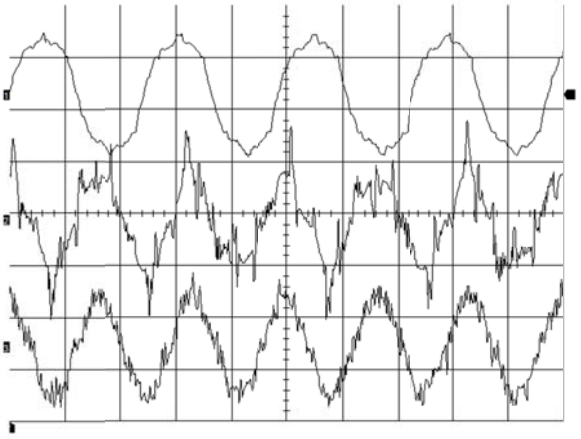
    c. Data proving that your converter meets the design requirements

    d. Screenshots of the output current wave form and spectrum for a single operating point

Good luck!

Name:
Time:

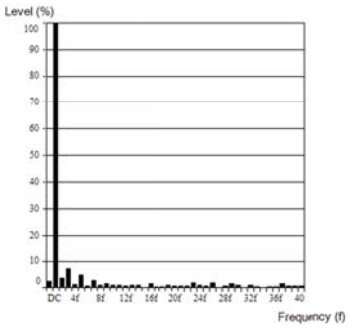
Oscilloscope



	Cur 1	Cur 2	Diff	RMS	AVG	f (Hz)
Ch 1 (V)				16.43	-0.06	41.31
Ch 2 (V)				7.09	-0.18	70.56
Ch 3 (A)				0.03	0.00	59.80
Ch 4				?	0.00	?
Ch 5				?	0.00	?
Ch 6				?	0.00	?
Ch 7				?	0.00	?
Ch 8				?	0.00	?
Time						

Time Base: 10.00 ms/div

Harmonic Analyzer



Fundamental Frequency : 60.00 Hz
Distortion : 24.1 %
DC : 3.5

Harm.	Level (%)
1 f	100
2 f	3.7
3 f	7.6
4 f	2.9
5 f	4.1
6 f	1.2
7 f	0.6
8 f	0.5
9 f	1.1
10 f	0.4

Harm.	Level (%)
11 f	0.9
12 f	1.9
13 f	0.6
14 f	0.7
15 f	1.3
16 f	0.4
17 f	1
18 f	0.2
19 f	0.9
20 f	0.4

Harm.	Level (%)
21 f	0.4
22 f	0.7
23 f	0.7
24 f	1.6
25 f	0.8
26 f	0.2
27 f	1.1
28 f	1.1
29 f	0.6
30 f	0.9

Harm.	Level (%)
31 f	0.6
32 f	0.5
33 f	1.3
34 f	0.3
35 f	0.4
36 f	2.2
37 f	0.8
38 f	1.5
39 f	1.6
40 f	0.5