

PSERC Academy: A Virtual Library of Short Videos (4.2)

Raja Ayyanar

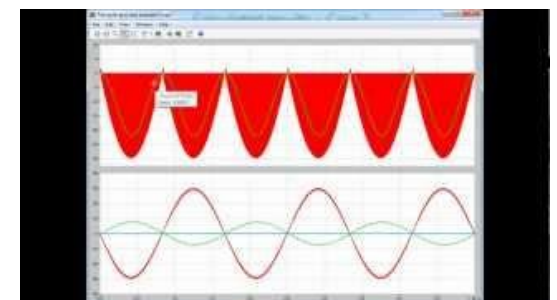
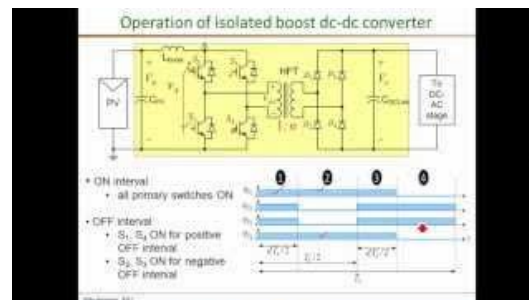
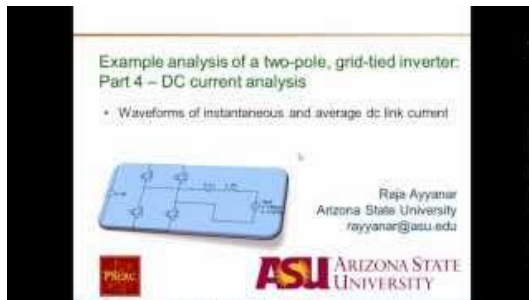
Arizona State University
(rayyanar@asu.edu)



PSERC Future Grid Initiative
May 29, 2013

Overall Objectives

- Create an online library of short (10-15 minute) videos on various topics in sustainable energy systems, power electronics, and power engineering
- The vision is to eventually develop several hundreds or even thousands of such videos that will serve as a major online reference source



Workforce Need and Target Audience

- Difficulty in offering specialized university courses in the broad area of power engineering
- Need to accommodate different paces of learning among students
- Limited flexibility in traditional course delivery
- Target audience include university students in power engineering and related fields, as well as practicing engineers

Description

- Topics cover major aspects of power engineering and sustainable energy systems in clearly defined modules, complementing university courses
- Initial modules
 - Power electronics
 - Photovoltaics systems and grid integration
 - Grid integration of wind energy
- A wide range of delivery methods including
 - Power-point lectures with audio narration
 - Interactive animations, simulations, movie clips
 - Online exercises, and online peer-to-peer correspondence, feedback

Screenecast method for videos

- Screencast techniques using *Adobe Captivate*
- Easy to use a variety of tools including power point, simulations, animations and other programs

Screenecast process

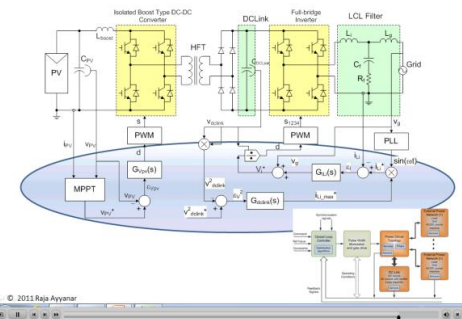
The screenshot shows the Adobe Captivate software interface. The main slide displays a diagram of a Pulse Width Modulator (PWM) and gate drive circuit. The diagram includes an 'Internal Carrier' block and three output channels labeled 'Ph a', 'Ph b', and 'Ph c'. The 'Ph a' output shows a red square wave, 'Ph b' shows a blue square wave, and 'Ph c' shows a green square wave. The slide also contains a list of bullet points:

- Generates the switching signals for driving the power devices
- Impacts switching losses and high frequency distortion
- Carrier based methods (sine-triangle comparison)
- Space vector modulation methods for three-phase

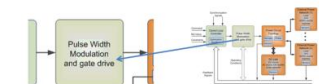
The software interface includes a 'FILMSTRIP' on the left, a 'LIBRARY' and 'PROPERTIES' panel on the right, and a 'TIMELINE' at the bottom. The 'PROPERTIES' panel shows settings for the slide, such as 'Master Slide: 1 (Master Slide 1)', 'Stage: Project Background', and 'Quality: Low (8-bit)'.

Sample outcomes of screencasting

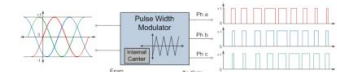
Example: Single phase PV inverter



Pulse-width modulator



- Generates the switching signals for driving the power devices
- Impacts switching losses and high frequency distortion
- Carrier based methods (sine-triangle comparison)
- Space vector modulation methods for three-phase



Sample YouTube videos

YouTube

Instantaneous and average dc link current (case 2)

ig (red, A) and duty ratio (green, scaled)

Instantaneous id (red) and CCA of id (green) (A)

Time (s)

10:54 / 12:13

YouTube

Simulation of a two-pole, grid-tied inverter: Part 2

- Waveforms of various inverter currents/voltages/power corresponding to example problem

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PSERC

ASU ARIZONA STATE UNIVERSITY

00:18 / 14:04

YouTube

Output capacitor selection

Capacitor selected should meet each of the below

- Voltage rating $> V_o = 12\text{ V}$ (margin)
- $ESR < 0.06\Omega$
- $C \gg 5\mu\text{F}$ (200 μF chosen based on ESR requirement)
- $I_{C,RMS} > 0.29\text{ A}$

Typical choice: Electrolytic capacitor

- Aluminum electrolytic
- Tantalum
- Polymer electrolytic

- Low cost
- High CV values for given size
- High ESR
- Limited RMS current rating

Other possible choices:

- Multi-layer ceramic (MLCC)
- Film capacitors
- Both have negligible ESR and high RMS current values

Raja Ayyanar, ASU

10:08 / 20:02

YouTube

Example 1: Frequency spectrum of pole voltage and its CCA

Fourier: v_AN (Green) and CCA (vAN) (Red)

Frequency (Hz)

Fourier: v_AN (Green) and CCA (vAN) (Red)

Frequency


Fourier: v_AN (Green) and CCA (vAN) (Red)

Frequency


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15:20 / 28:02

Highly User Interactive Animations



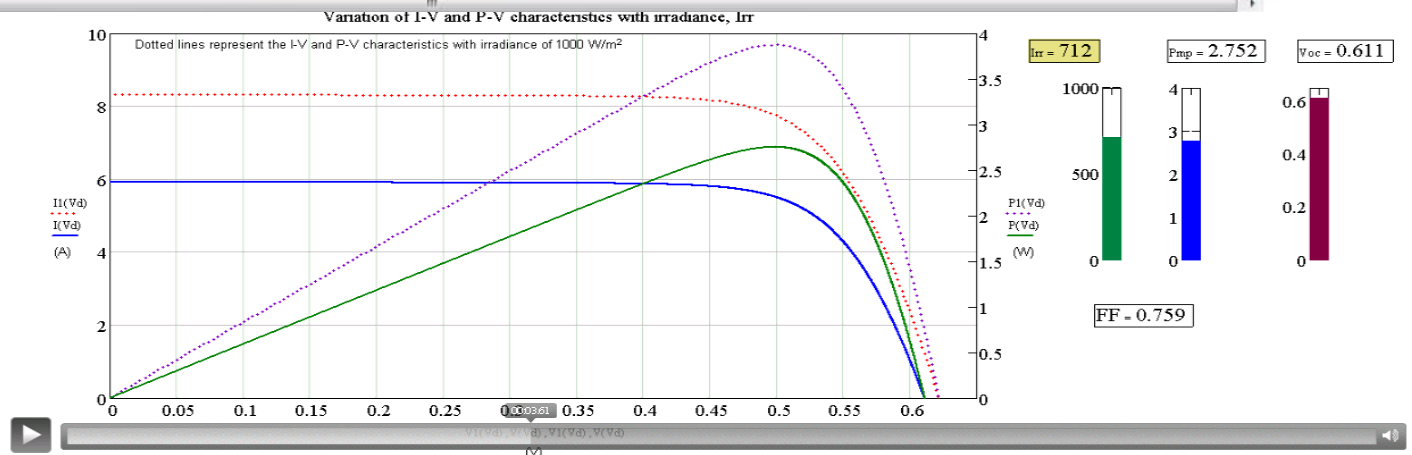
PSERC Academy



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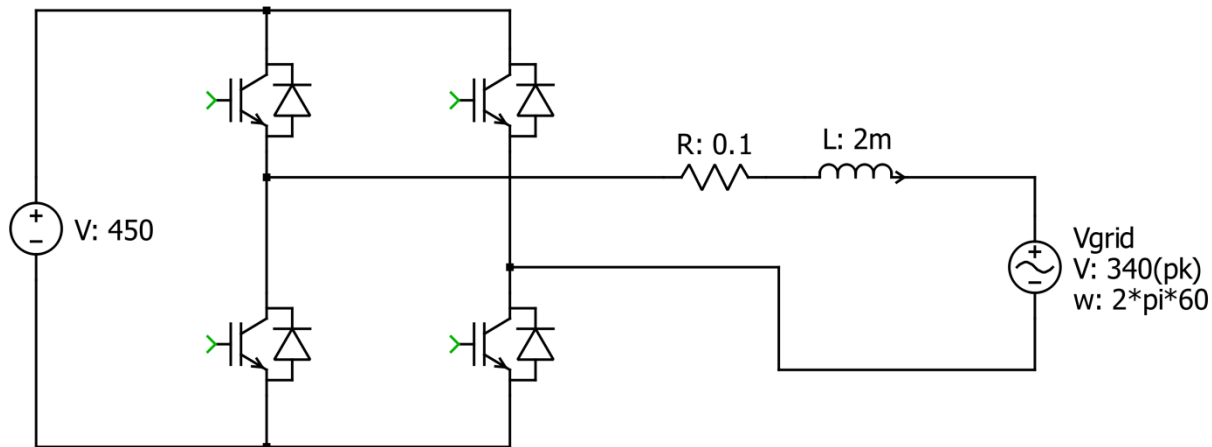
Buck converter

V_{in}
 I_o



Power Electronics and Systems Simulations

- PLECS simulation files to be made available through the PSERC Academy website
- Working with Plexim (developers of PLECS) to offer these as 'Demo files' for public use with some restrictions on circuit modifications, saving changes etc.

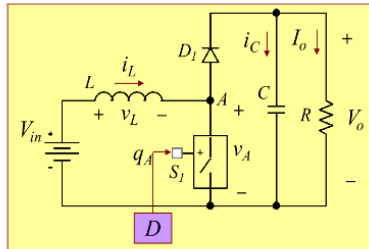


Interactive Quizzes

Multiple Choice

In a boost dc-dc converter, if $V_{in} = 10$ V, and $d = 0.75$, then $V_o = ?$

- A) 13.33 V
- B) 40 V
- C) 7.5 V
- D) -13.33 V



Correct - Click anywhere or press 'y' to continue.

Quiz Result

Your Score:	30
Max Score:	40
Questions Correct:	3
Number of Questions:	4
Accuracy:	75%
Number of Quiz Attempts:	1

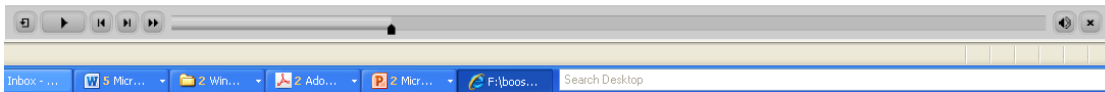
Congratulations, you passed

Continue Review Quiz



Question 1 of 4

Clear Back Skip Submit



Accessing the Materials: PsercAcademy.asu.edu

- Dedicated website with search and interactive features with the video links (YouTube), lecture material, simulations and animations

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Power Electronics

Introduction to power electronics	[pdf slides]	
Basic principles of dc-dc part 1	[pdf slides]	Simulation Quiz
Basic principles of dc-dc part 2	[pdf slides]	Simulation Quiz
Buck converter analysis part 1	[pdf slides]	Simulation Animation Quiz
Buck converter analysis part 2	[pdf slides]	Simulation Animation Quiz
Buck converter design	[pdf slides]	Simulation
Boost converter analysis	[pdf slides]	Simulation Animation Quiz
Boost converter design	[pdf slides]	Simulation
Buck boost converter analysis	[pdf slides]	Simulation Animation Quiz
Buck boost converter design	[pdf slides]	Simulation
Buck design example simulation part 1	[pdf slides]	Simulation
Buck design example simulation part 2	[pdf slides]	Simulation
Introduction to voltage source converters (VSC)	[pdf slides]	
Building blocks of VSC	[pdf slides]	Simulation Quiz
Cycle-by-cycle average	[pdf slides]	Simulation Quiz

Photovoltaic Power Conversion

PV system configurations	[pdf slides]	
PV string inverter overview part 1	[pdf slides]	
PV string inverter overview part 2	[pdf slides]	Quiz
String inverter specs part 1: IO protection	[pdf slides]	
String inverter specs part 2: Performance	[pdf slides]	
Two pole grid tied inverter example part 1	[pdf slides]	Simulation Animation Quiz
Two pole grid tied inverter example part 2	[pdf slides]	Simulation Animation Quiz
Two pole grid tied inverter example part 3	[pdf slides]	Simulation Animation Quiz
Two pole grid tied inverter example part 4	[pdf slides]	Simulation Animation Quiz
Simulation of two pole grid tied inverter part 1	[pdf slides]	Simulation
Simulation of two pole grid tied inverter part 2	[pdf slides]	Simulation
Basic principles of isolated boost dc-dc part 1	[pdf slides]	Simulation Quiz
Basic principles of isolated boost dc-dc part 2	[pdf slides]	Simulation Quiz
PV cell model part 1	[pdf slides]	Simulation Animation Quiz
PV cell model part 2	[pdf slides]	Simulation Animation Quiz

Plans for Future Use

- Open access to PsercAcademy.asu.edu by end of Q2, 2013 with initial modules on power electronics and PV systems
- Obtain feedback from PSERC community and outside, and refine the style and contents of videos and other material
- Integrate into the Power Electronics and Renewable Energy courses at ASU beginning Fall 2013
- Seek funding for sustaining the initiative
- Seek partners for developing videos on other aspects of sustainable energy systems