EE 432/537 Power Electronics

Laboratory Exercise #1

Objectives:

Become familiar with equipment

Examine two basic power electronic circuits

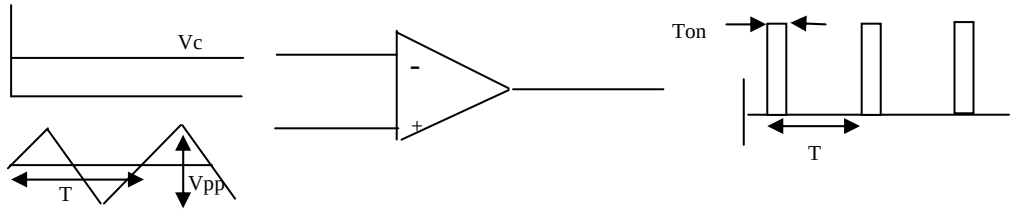
Explore PWM

Assignment 1

The concept of Pulse Width Modulation is widely used in Power Electronics. In a simple dc-dc converter the switched is turned on and off at a constant frequency f. The on time Ton is variable. The duty cycle or duty ratio D=Ton/T, where T=1/f is the period. In dc-ac inverters D is modulated to generate specific output waveshapes.

The low power control signal used to turn the switch on/off can be generated by an analog circuit or a microprocessor.

The simplest analog PWM generator compares a triangular(or saw tooth) wave with peak to peat voltage Vpp with a variable dc level Vc as shown below.



In this assignment you are asked to build such a PWM generator.

Equipment

Proto-board
LM 311

Assignment

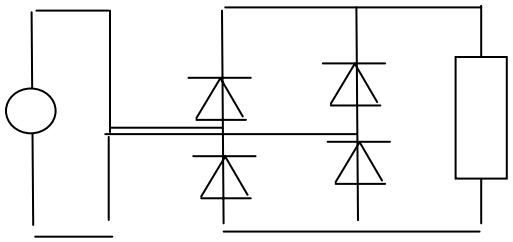
Show that D=(0.5Vpp-Vc)/Vpp

Use a comparator to realize the above circuit. Verify that you can vary D from ~ 0 to 1. Show actual waveforms for a D=0.75

Assignment 2

Single Phase Rectifier

The single phase, full wave bridge rectifier circuit below converts ac to dc with ripple. In this assignment you are asked to build this circuit and verify its performance.



Assignment

Use one phase of the 0-120V ac source and the diode bridge module connect single phase bridge rectifier. Use the isolator module and scope/DMM for measurements.

Derive a formula for the average dc voltage for a single phase bridge rectifier with resistive load.

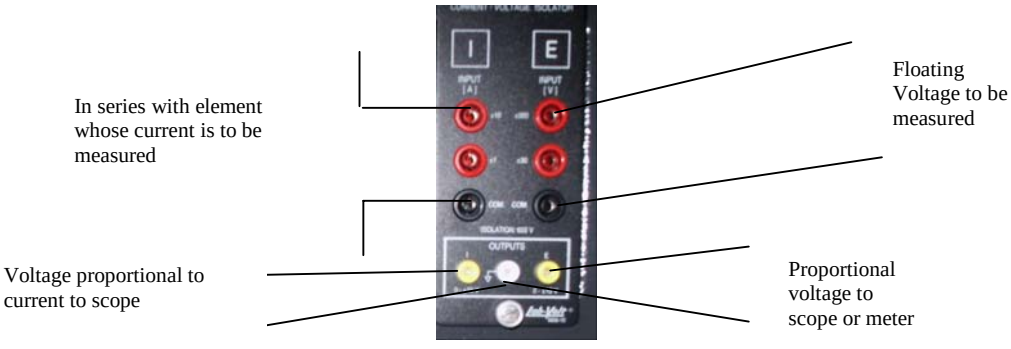
Set the input voltage to 40 V rms. Obtain the waveform for output voltage and measure the average value (dc value). Check against your formula.

Turn everything off. Connect the electrolytic capacitor provided across the resistive load. Slowly bring up the ac voltage to 40 V (Why slowly?) Obtain the waveform for output voltage and measure the average value (dc value). Explain the waveform.

Verify lab measurements using TOPSPICE simulation. Your diode should be capable of handling at least 100 V.

Equipment:

LabVolt Bench (0-120V ac source)
Power Diodes Module
Voltage/Current Isolator Module
DMM



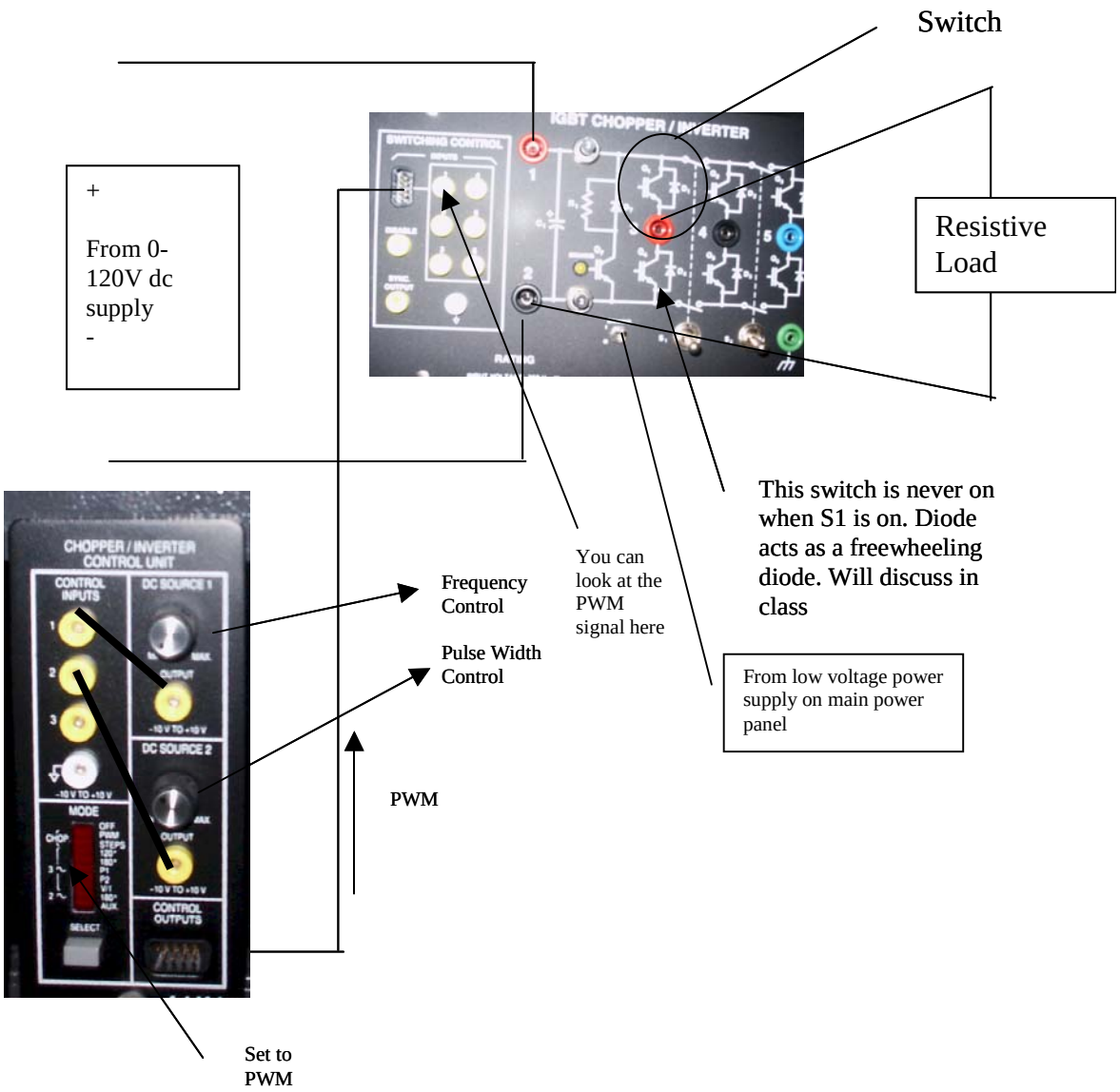
Assignment 3

PWM dc-dc converter.

In homework problem 2.1 we looked at a PWM dc-dc converter. In this experiment we will look at such a converter.

Assignment

Implement the converter as suggested below. I know it looks clumsy since we use just one switch out of six. But trace the circuit out and make sure it matches Figure P2.1



Measure the average (dc) output voltage for D= 0.2,0.5 and 0.8. Does the voltage vary linearly with D?

Display the voltage across the IGBT and the PWM signal on a scope. Make a neat sketch. Do the waveforms make sense? Now display voltage across the IGBT and the current through the IGBT. Make a sketch and identify on and off regions.

Equipment:

LabVolt Bench (0-120V ac source)
IGBT Chopper Inverter
Resistive Load Box
Voltage/Current Isolator Module
DMM

Report

1. Maintain a lab or log book and record equipment used, ratings, circuit diagrams and observations. Record everything.
2. Turn in one report per group
    a. Experiment Objectives
    b. For each assignment
        i. Objective
        ii. Procedure
        iii. Equipment
        iv. Observations / Comparison with theory and simulation/ Conclusions
3. Overall lessons learned.