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IGBT Chopper

Lab excercise #5

Metropolia University of Applied Sciences

Bachelor of science

Electronics

IGBT chopper

19/20/2018

Author(s) Title Number of Pages Date	Yoon YeongJin, measurement manager Seo Dong Geon, install manager You Deok Ki, safety manager Kun Zhu, reporter IGBT Chopper xx pages + x appendices 5 May 2010
Degree	Bachelor of science
Degree Programme	Electronics
Specialisation option	Power electronics
Instructor(s)	Ahoste

Keywords	

Contents

1 Introduction

This laboratory work provides a walkthrough of a four quadrant chopper with four contolled semiconductor (IGBT) switches. In the first part of the work the chopper acts as a DC power supply with variable output voltage, and in latter part as a pulse-widthmodulated (PWM) inverter. This type of inverter provides a variable frequency from a DC source, and is a key component of any frequency converter that are used commonly in variable speed AC motor drives (VSD). The work is done with the LabVolt laboratory

2 learning equipment.Chapter Heading

2.1 Subheading

Setup and connections

Operating voltage and data connections

Connect the 24VAC operating voltage to the modules:

· DACI

· IGBT Chopper / Inverter

Connect USB cable(s) from the DACI to the computer

Control and measurement connections (miniature banana plug leads)

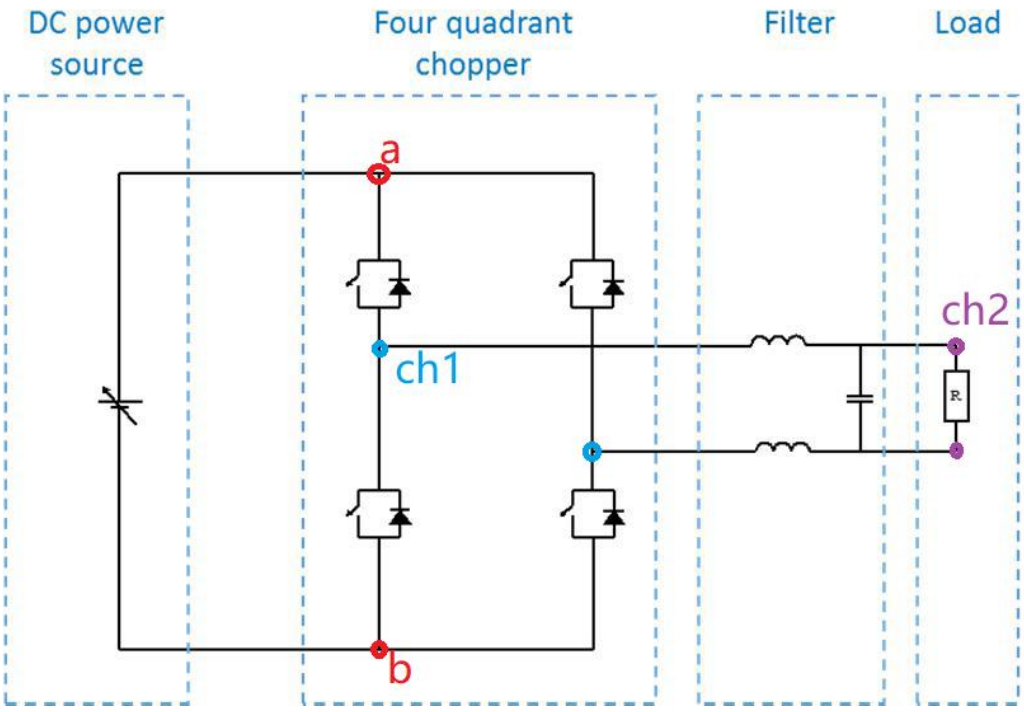


Figure 1, main circuit

Main circuit measurement setup
Apply following voltage measurements:
- Multimeter:
  - supply DC voltage
- Oscilloscope:
  - chopper output voltage (Ch1)
  - load resistor voltage (Ch2)

measurement for part I:

1.1 as shown in Fig1, Vab is the supply DC voltage

Chi1 is the chopper output voltage (Ch1), ch2 is the load resistor voltage (Ch2)

1.2

duty cycle	actual meas	ch1/ RMS	ch2/ RMS	ch2/ pk-pk
10%	10%	-32.09	-29.501	5.8
50%	50%	-2.27	-0.181	6.4
70%	70%	13.12	14.928	8.8

1.3 duty cycle is defined as

$$\mathrm{D} = \frac{t_{on}}{T}$$

Where t_{on} is switch turn on time, T is the period.

1.4

The chopper changes output voltage direction by increase and decrease duty cycle. Meanwhile the output voltage changes dependently, and values reaches smallest when duty cycle reaches 50% (0V theoretically), and increases to both sides away from 50%.

1.5

The average voltage after the filter has small drops, but much smoother and close to a sinusoid wave.

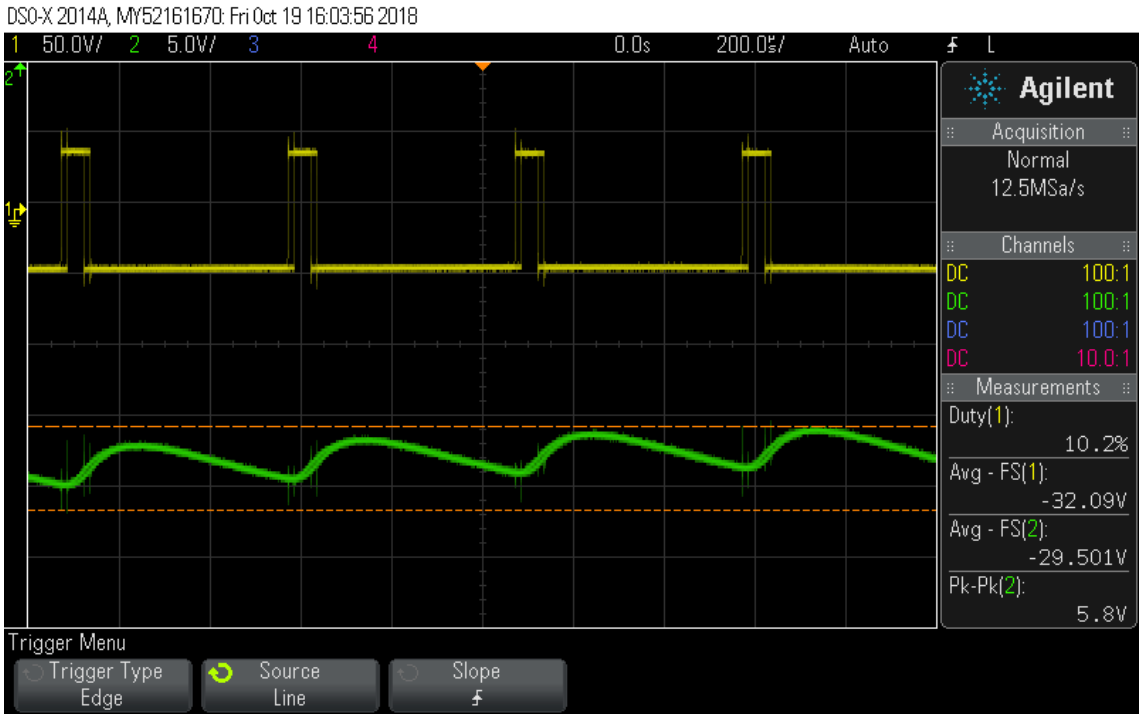
1.6

$$V_{out} = V_{in} \times (2\alpha - 1)$$

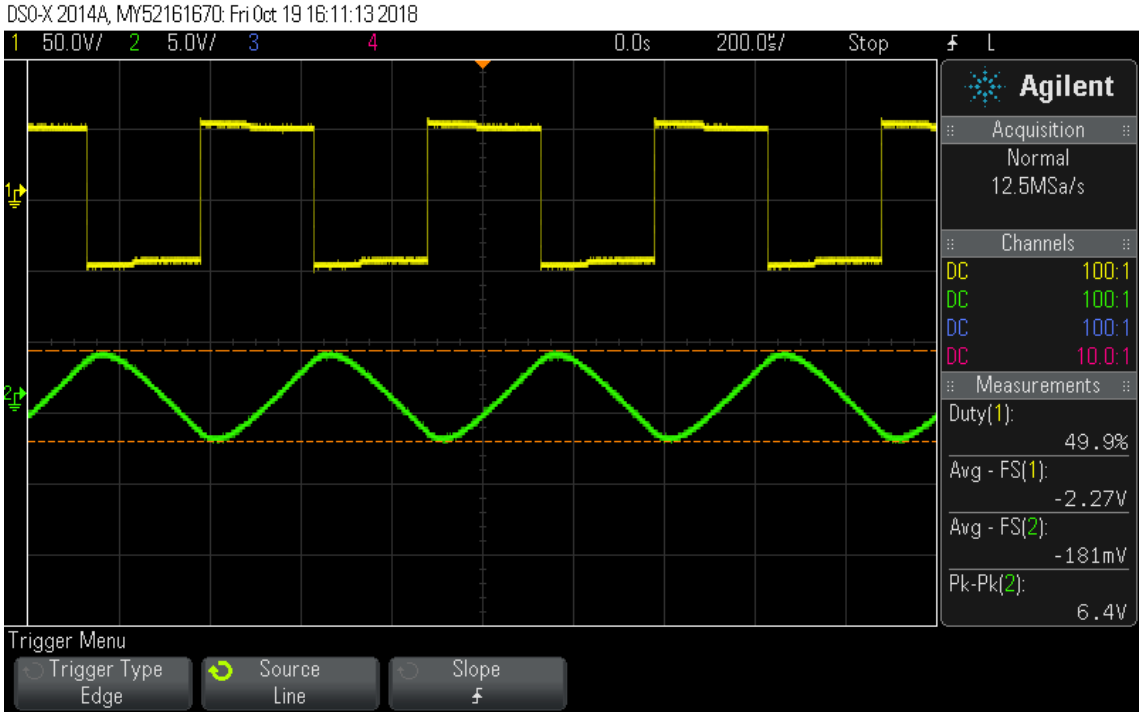
Where V_{out} is the output voltage, V_{in} is the input voltage, α is the duty cycle.

1.7

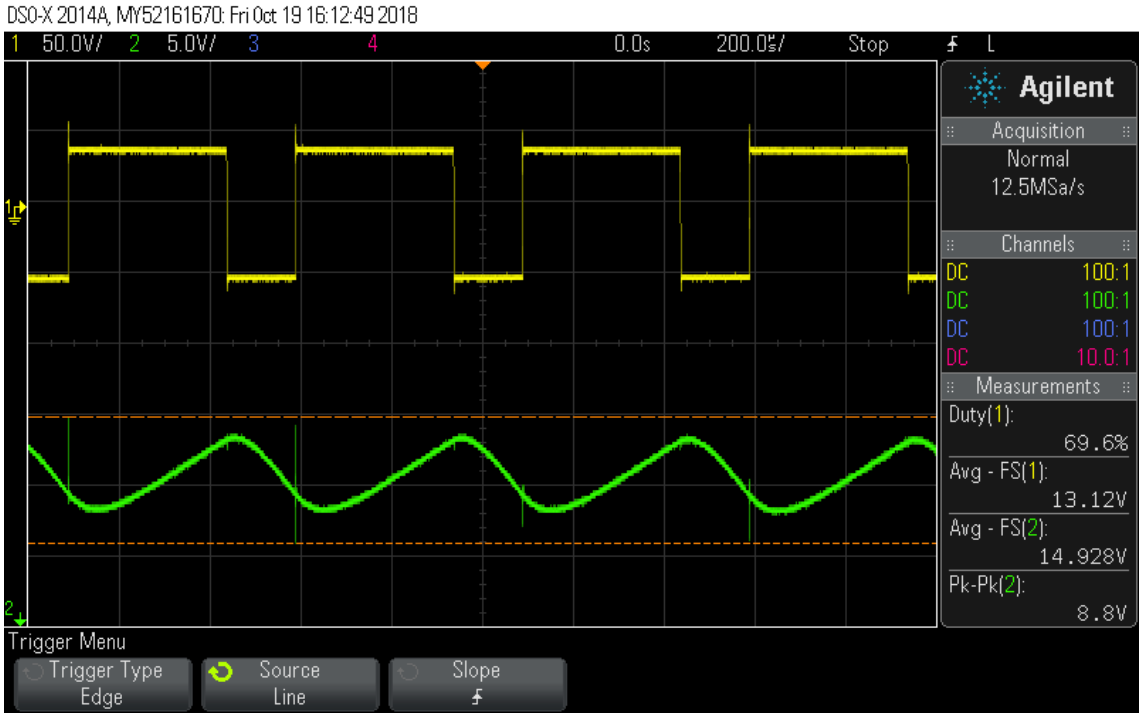
Duty cycle at 10%



Duty cycle at 50%



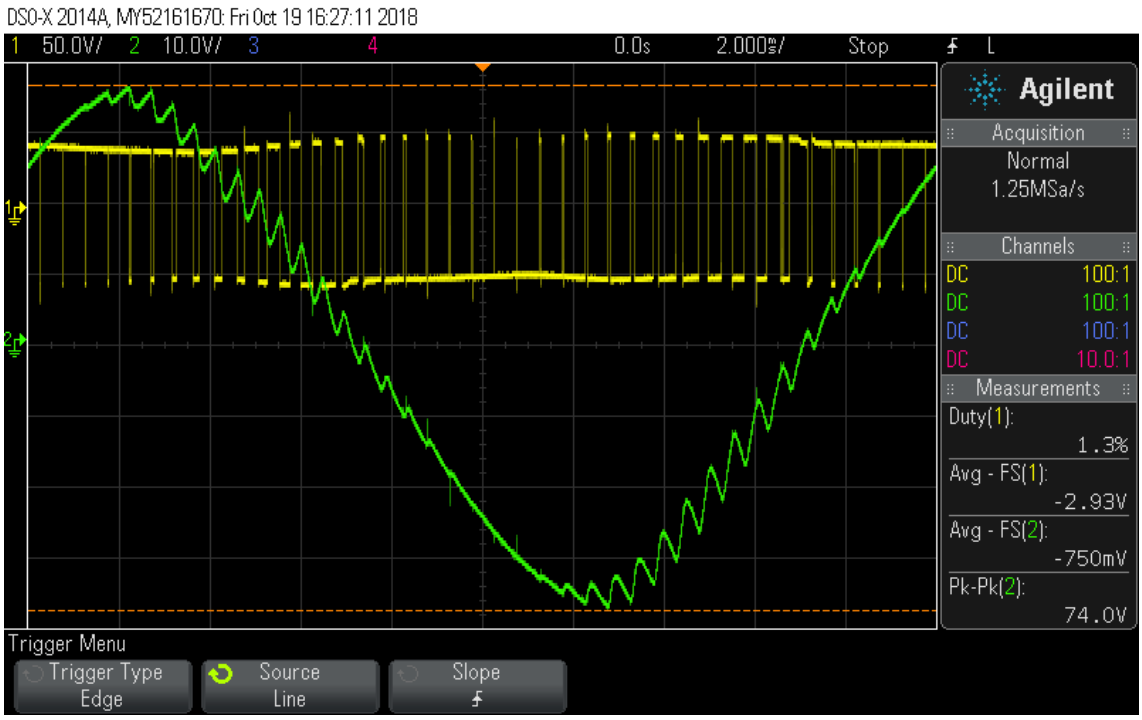
Duty cycle at 70%



Part II

2.1 duty cycle changes in range of 0-100% as frequency increases, the rate of duty cycle fluctuation increases at the same time.

2.2



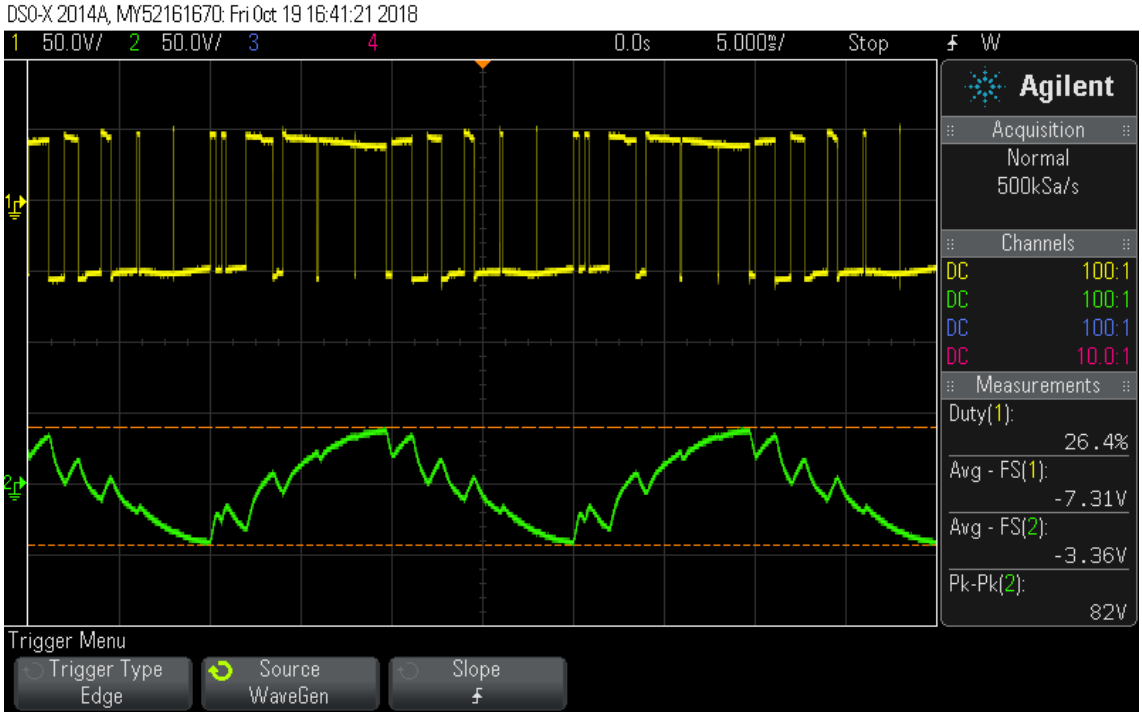
The controllable switches can change current flow direction, so to change the DC polarity. Further by adjusting the duty cycle, the output voltage value and rate of change will be changed accordingly. Thus, switches produce pulses to the output.

3.1

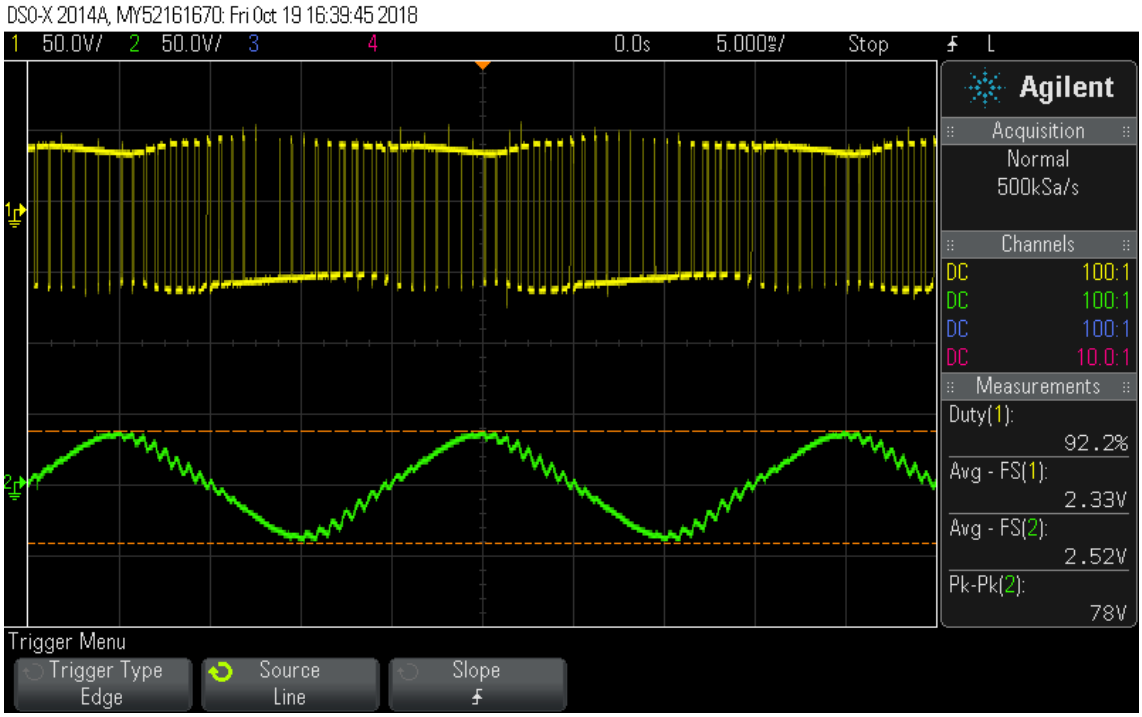
The switching frequency impact output voltage level to its smoothness. The higher the switching frequency the smoother the output voltage level.

3.2

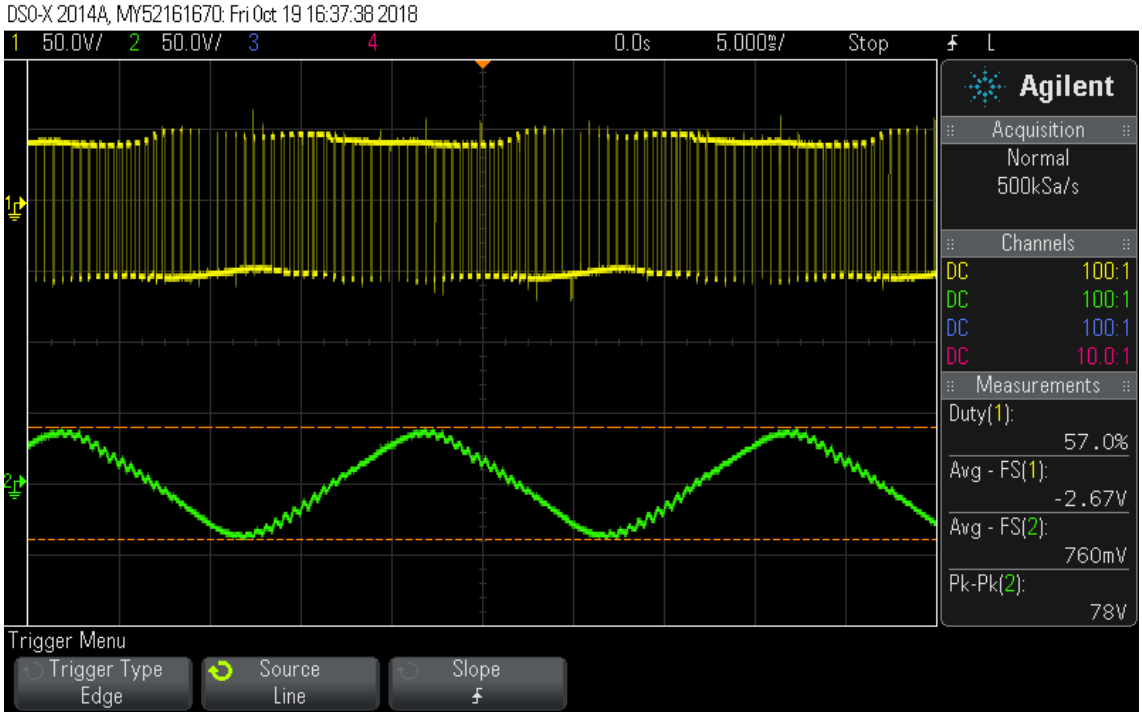
50Hz inverter frequency, at 500Hz switching frequency



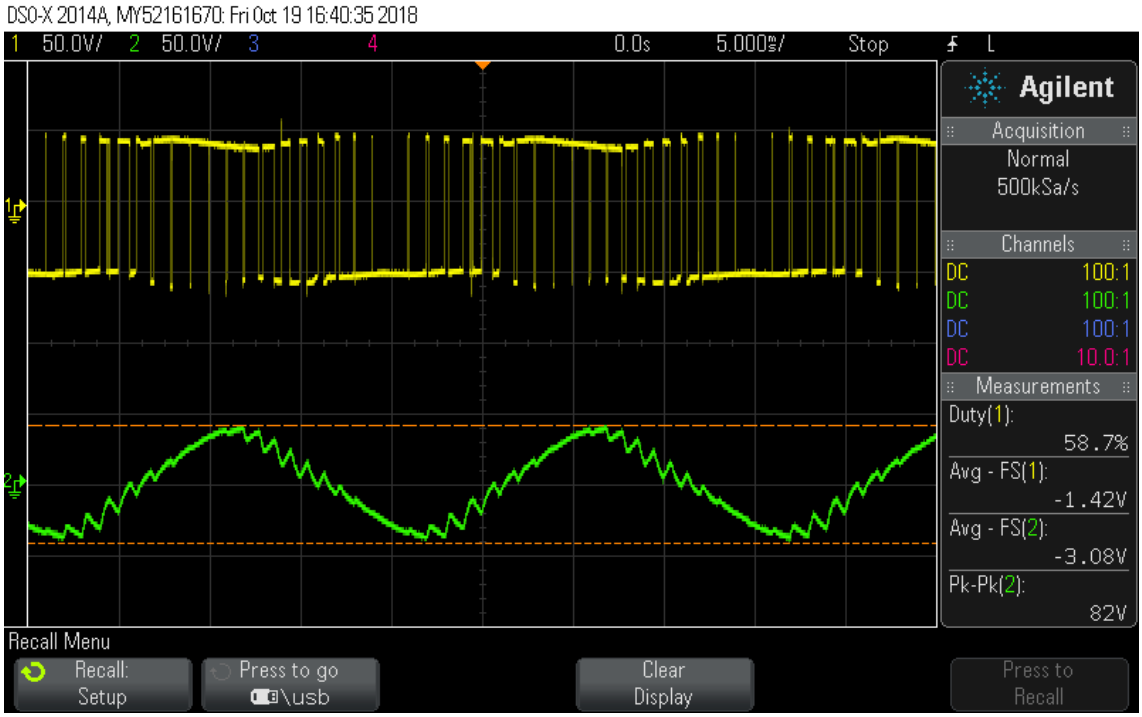
50Hz inverter frequency, at 1500Hz switching frequency



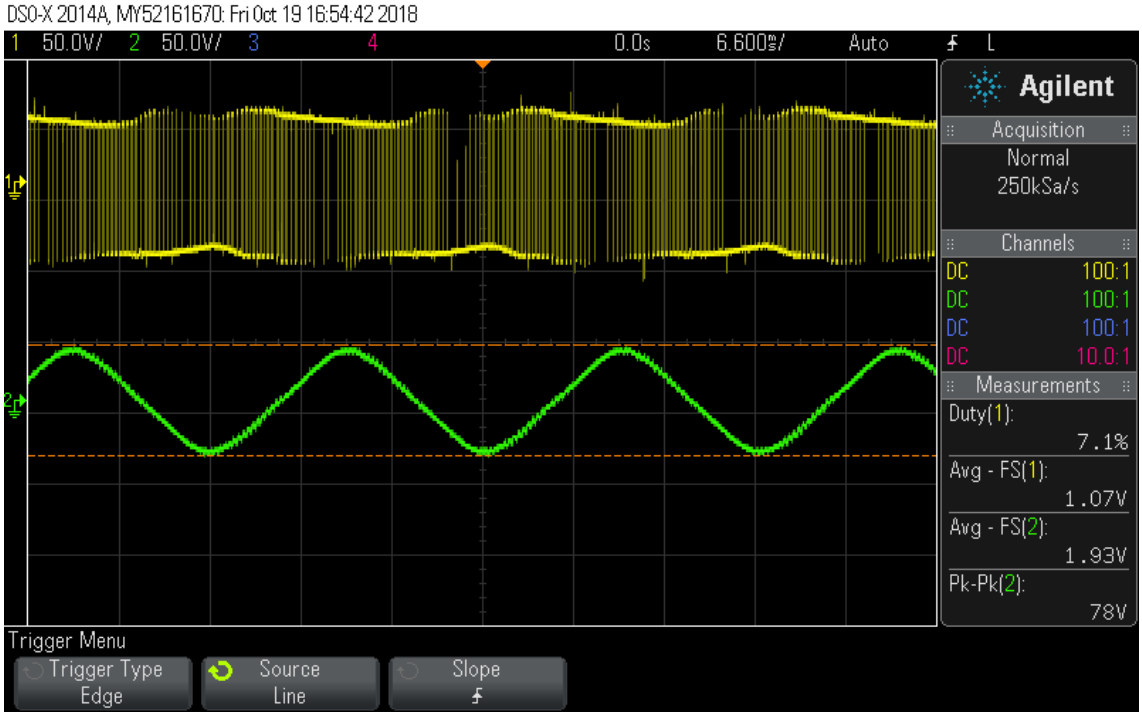
50Hz inverter frequency, at 2000Hz switching frequency



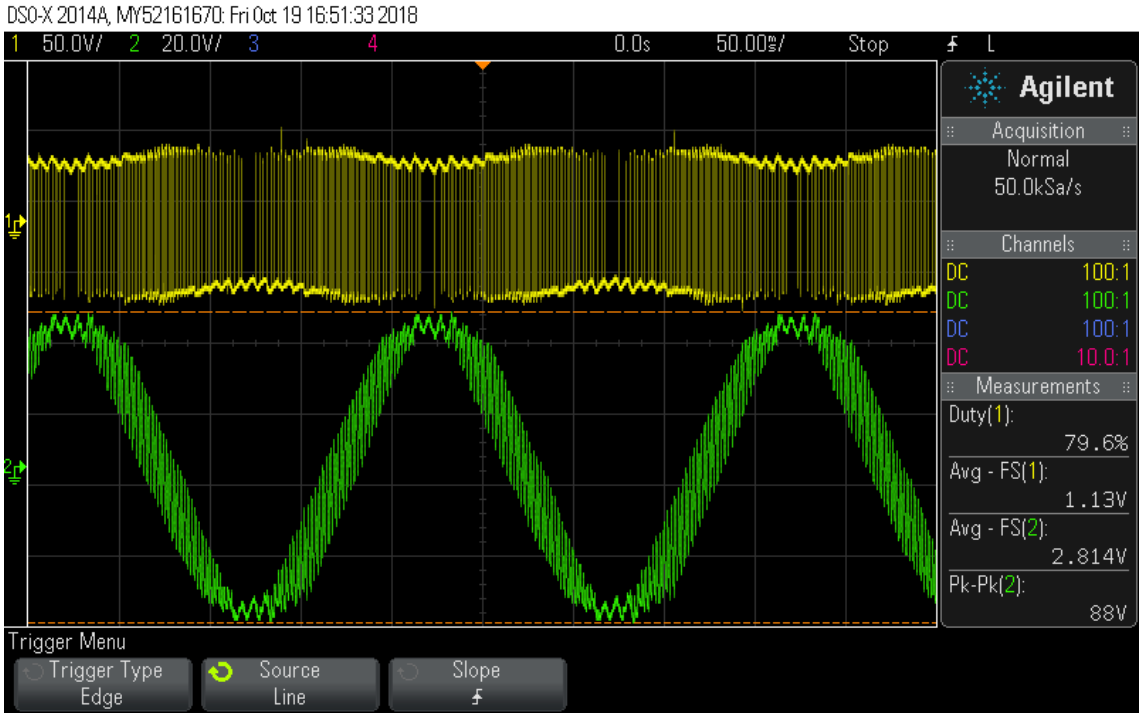
50Hz inverter frequency, at 2100Hz switching frequency



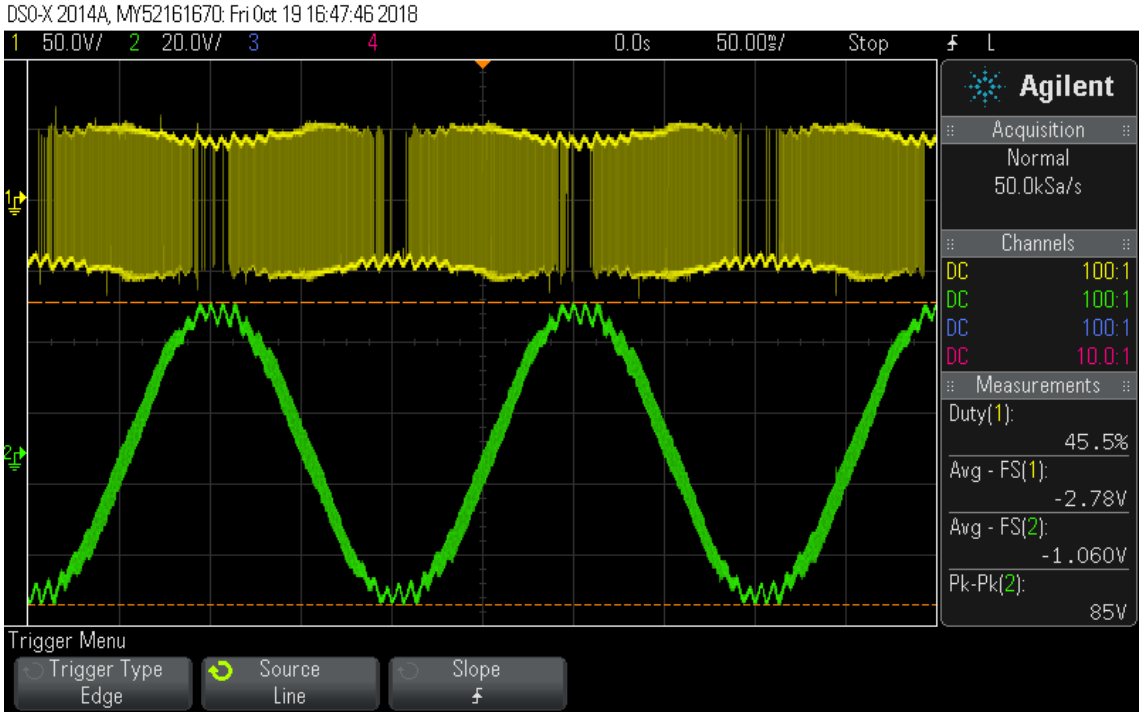
50Hz inverter frequency, at 3000Hz switching frequency



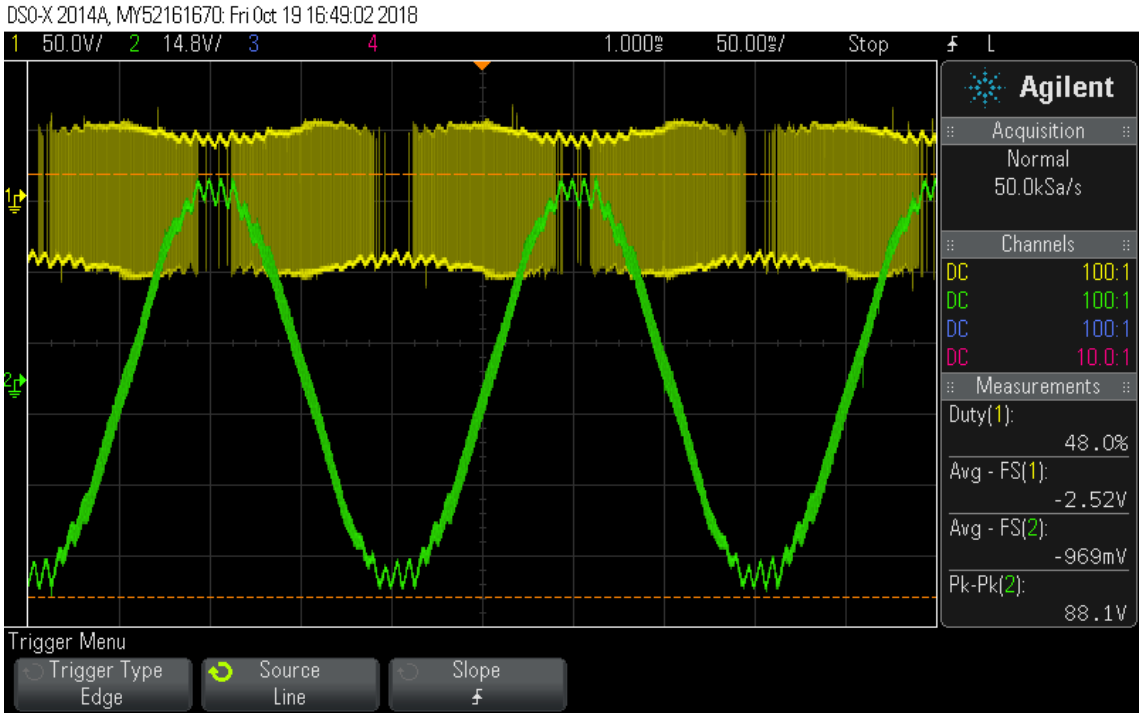
5Hz inverter frequency, at 500Hz switching frequency



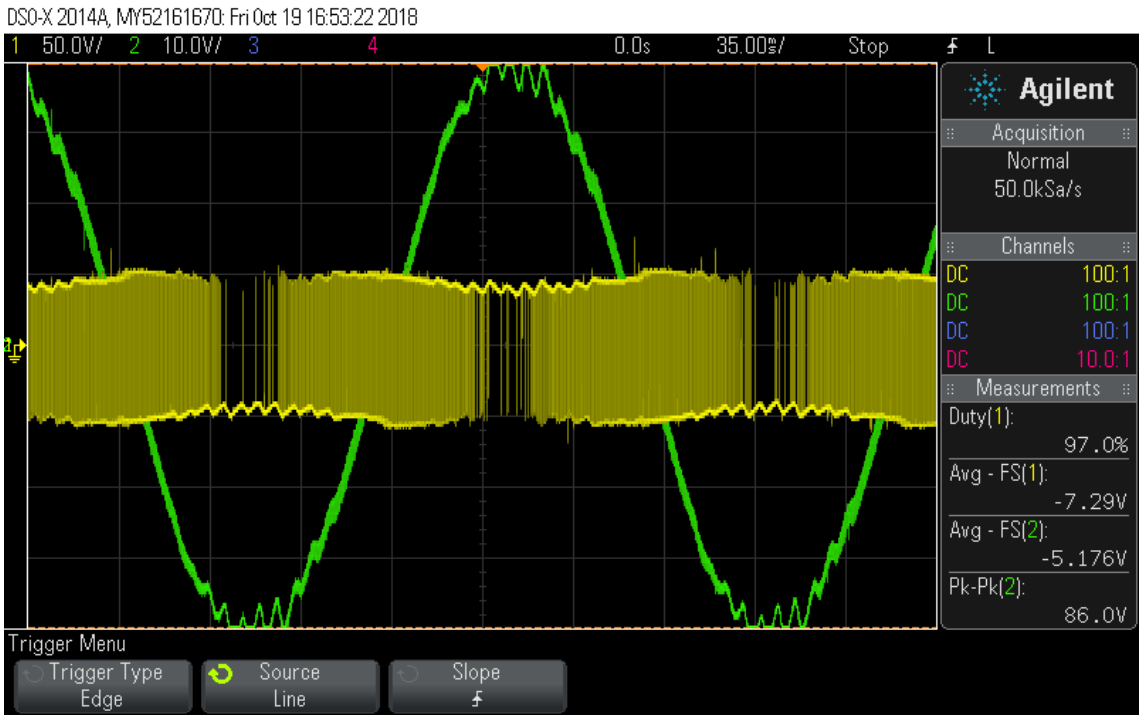
5Hz inverter frequency, at 1500Hz switching frequency



5Hz inverter frequency, at 2000Hz switching frequency



5Hz inverter frequency, at 3000Hz switching frequency



3.3 when the inverter output frequency is at the same value, the higher switching frequency produces better output voltage values (smooth).

When switching frequency is at the same value, a higher inverter output frequency produces better output voltage values (smooth).

So one can consider to set reasonably high inverter output frequency and switching frequency at the same time.