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Assignment: Experiment 3 report
Lab session: Friday
Instructor: Dr. Liu
Due Date 10/2/2016(Sunday)

“This report is prepared by **Haoru Xie(EE352)**, who is the first author and prepared the original draft of the report, and **Saisao Kham(EE312)**, who is the second author and revised the report.”

Cover and Score Sheet

Experiment 3 - DC Regulated, Variable Voltage Power Supply

Author: Haoru Xie Partner: SAISAO KHAM

Score

Item	Credit	Score
Data	3	
Full-Wave Rectifier		
Waveform		
π-Filter		
Voltage Versus Load Current Plot		
Ripple Versus Load Current Plot		
LM317 Regulator		
Circuit Diagram		
Voltage Dependence on R_3/R_2		
Voltage Versus Load Current Plot		
Ripple Versus Load Current Plot		
Minimum Voltage Across the Regulator IC		
Why Switching Power Supply can be Compact and More Efficient?		
Conclusion	1	
Total	**4**	

TA Signature: [signature] Date: 09/23/16

Scoring Sheet

Cover and Score Sheet

Experiment 3 - DC Power Supply

Author: Haonan Xie Partner: SAI SAO KHAM

Score

Item	Credit	Score
Data	4	
Full-Wave Rectifier		
Waveform		
π-Filter		
Waveform		
Voltage Versus Load Current Plot		
Ripple Versus Load Current Plot		
Conclusion	1	
Total	**5**	

TA Signature: [signature] Date: 09/23/16

Abstract

Linear power supply functions,analysis how to build and characterize a simple dc power supply. As every power supply must obtain the energy it supplies to its load, as well as any energy it consumes while performing that task, from an energy source. Depending on its design, a power supply may obtain energy from various types of energy sources, including electrical energy transmission systems, energy storage devices such as a batteries and fuel cells, electromechanical systems such as generators and alternators, solar power converters, or another power supply.

We know that the good DC power supply should have a small ac ripple, and the constant output of voltage independent of load current and the high efficiency. In the experiment 3, we used the Oscilloscope, Function Generator, Power Supply, Digital Multimeter, Breadboard, Resistors, Capacitors, 4 1N4001 Diodes and an LM317 IC to learn the DC regulated and the variable voltage power supply.the right pin of the LM317 voltage regulator is adj pin. The left pin is Vin, and the middle is Vout. we used this equipment to build the circuits as in the lab menu.

Introduction

In this experiment, we are introduced how a dc power supply could be implemented and the different components involved in order to make it possible. We also explore more in depth the underlying mechanics of how a diode works and why diodes are so important in everyday electronics. We also familiarize ourselves with a commonly used semiconductor, the LM317. This chip has 3 pins which correspond to different functional ity.

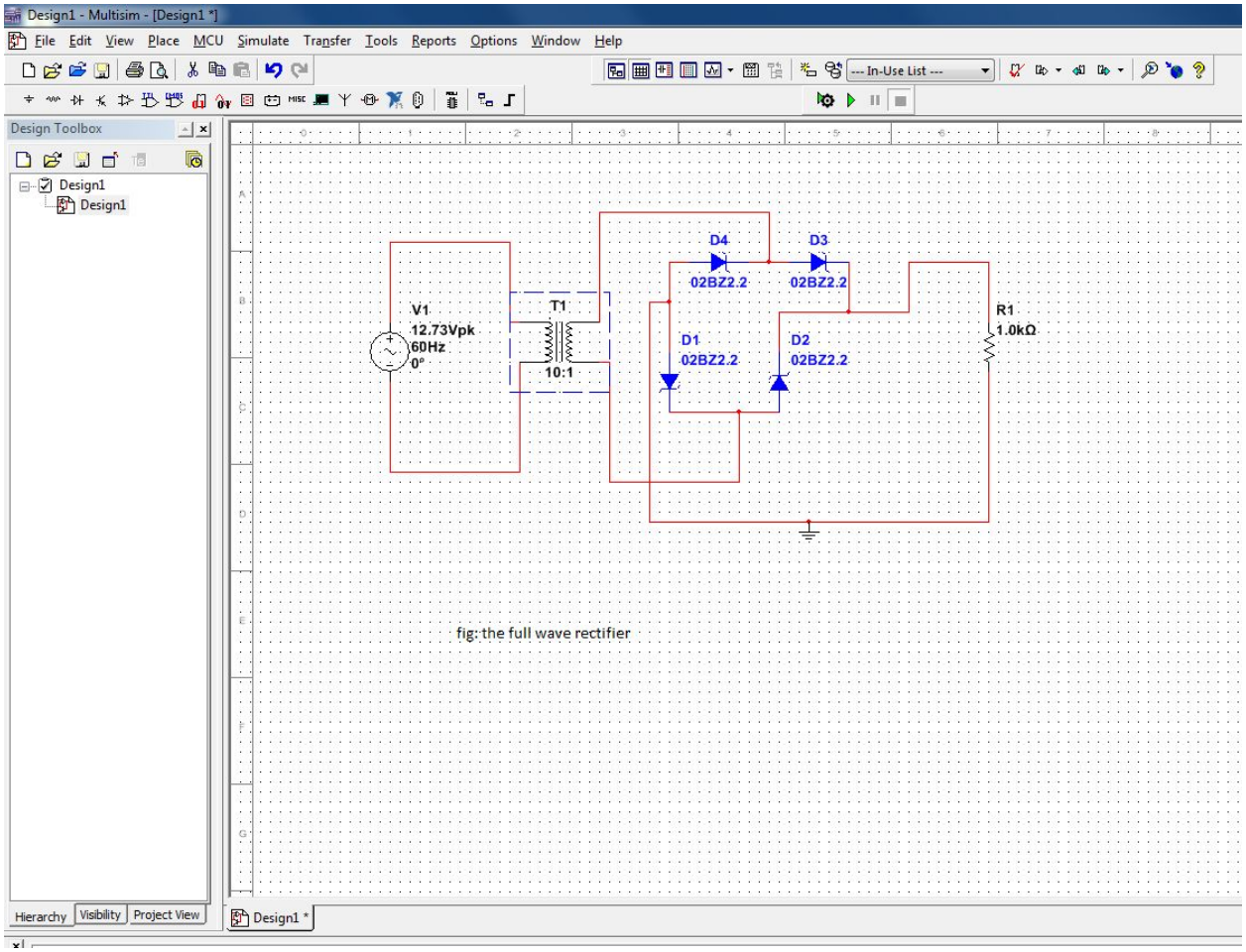
A DC power supply is one that supplies a voltage of fixed polarity (either positive or negative) to its load. Depending on its design, a DC power supply may be powered from a DC source or from an AC source such as the power mains. The output of an unregulated power supply can change significantly when its input voltage or load current changes. Adjustable power supplies allow the output voltage or current to be programmed by mechanical controls (example, knobs on the power supply front panel), or by means of a control input, or both. An adjustable regulated power supply is one that is both adjustable and regulated. An isolated power supply has a power output that is electrically independent of its power input; this is in contrast to other power supplies that share a common connection between power input and output.

Procedures

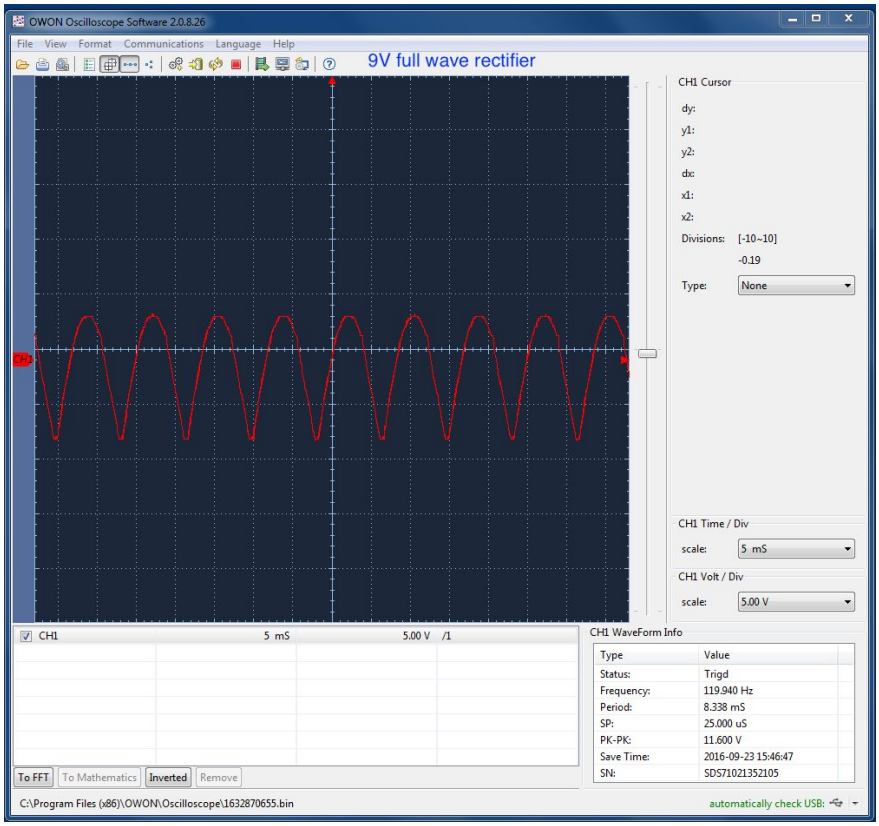
(1)full -wave rectifier Circuit Diagrams and its waveform from oscilloscope.

At the first step, we build the circuit of the full wave rectifier as below are circuit diagram and full waveform rectifier from oscilloscope.

As diode is the most fundamental semiconductor device with two terminals providing one-way conduction. Rectifying diodes can handle high current and convert ac power to dc. We are first going to build a full- wave bridge rectifier with four 1N4001 diodes as shown in Fig. 1 (the full wave rectifier). R1 value is 1K Ohm and it is a load resistor. We made sure that four diodes are arranged properly and the signal is ground. However, the output of the transformer is not connected to ground.After we adjust the variac to get a 9-V ac signal (RMS). Thereafter, we record the waveform of the full-wave rectifier. We measure and confirm the ac voltage with a multimeter in the ac voltage mode

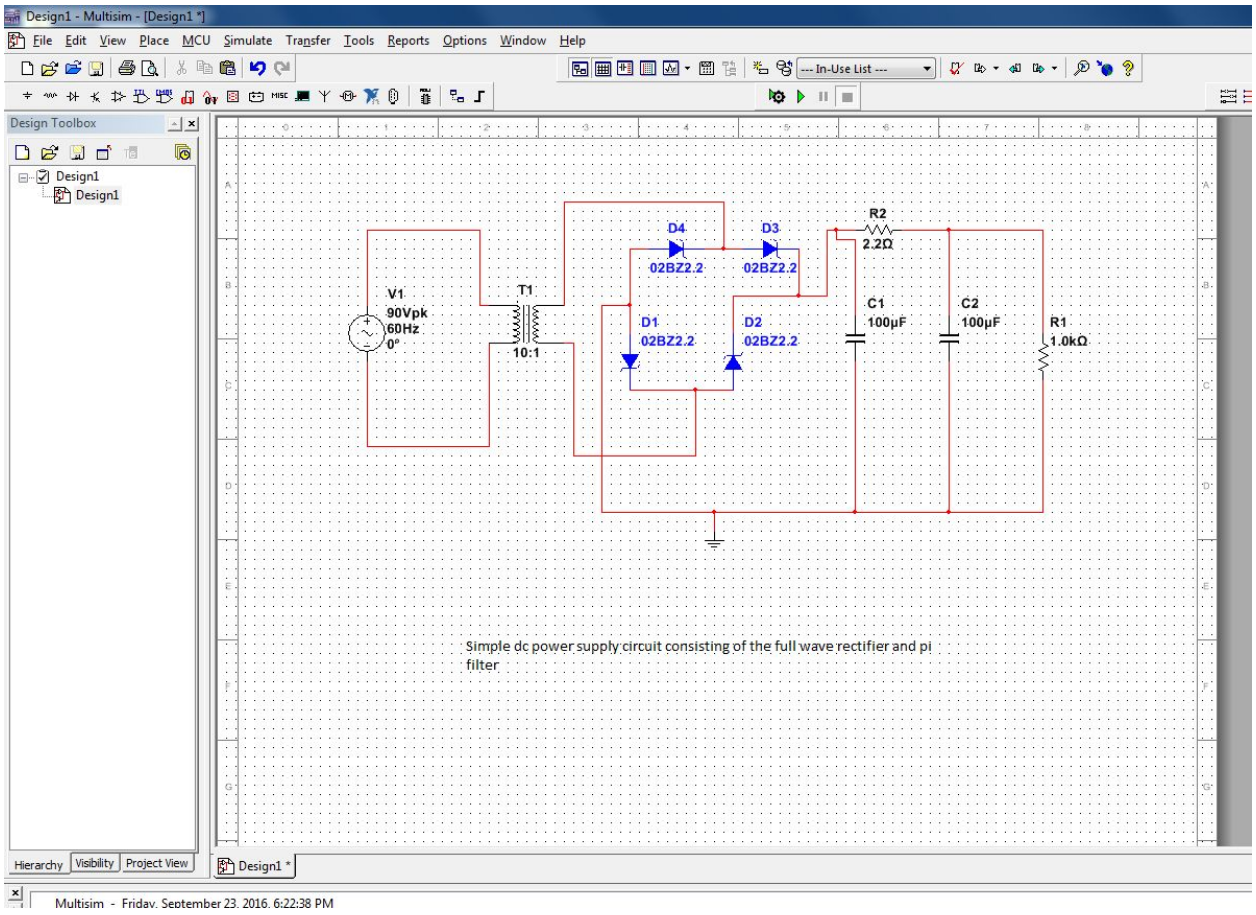


The purpose of the diodes is to somewhat regulate current flow in one direction. The rectifying diodes can handle high current and convert ac power to dc. We using R1=1k ohm to build the circuit.We had to take when implementing the circuit is not connecting a resistance value with a power rating of less than a watt because of possible burning and exploding hazards. We adjust the variac to 9v ac signal from the isolation transformer. Finally, we record the waveform of the full wave rectifier as below.



2) Simple dc power supply circuit consisting of the full wave rectifier and pi filter

For the second procedure, we use the low-pass filters to build the pi-filter consisting of C1, R1 and C2. . The pi filter is to control the amount of ac ripple in the circuit. We used the R1=2ohm as the R1 should less than 10 ohm. This circuit is located below:



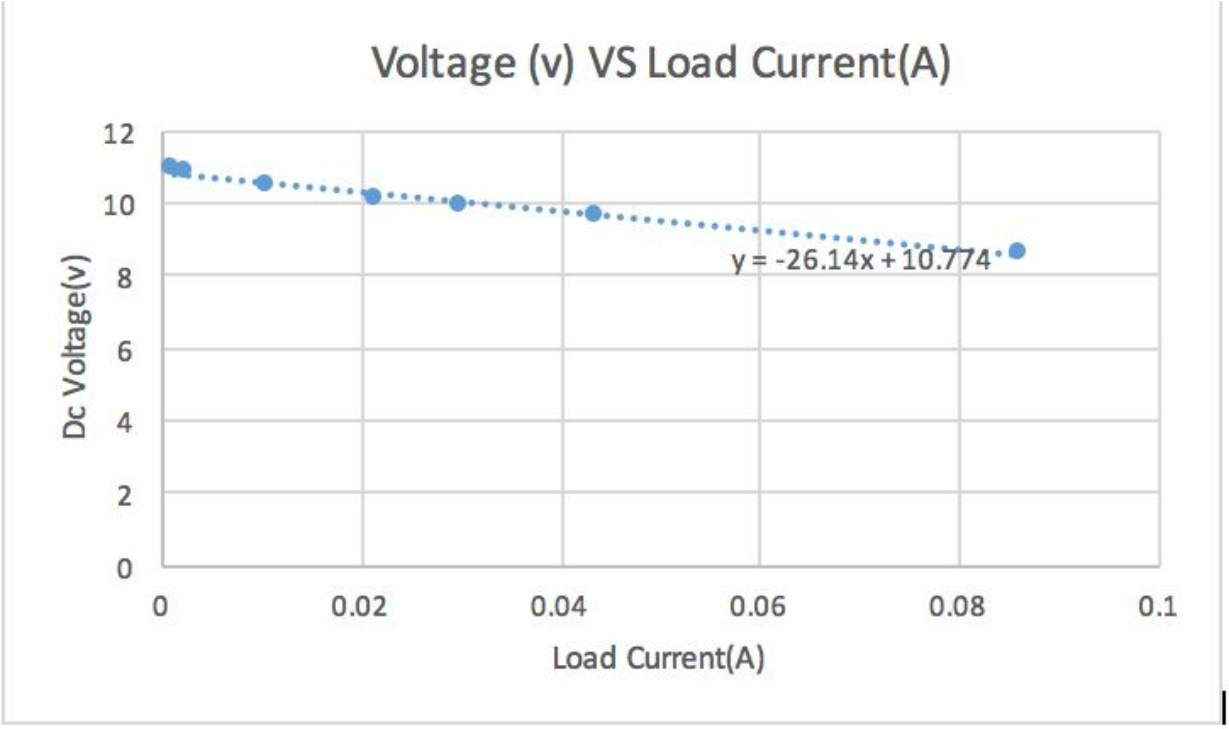
As figures below, we record the load resistance, dc voltage, calculated load current, and ac ripple. Vary the load resistance from 10kohm, 4.7kohm, 1kohm, 470ohm, 330ohm, 220ohm, to 100ohm. And we record all of the waveform and its individual.

The table about the data

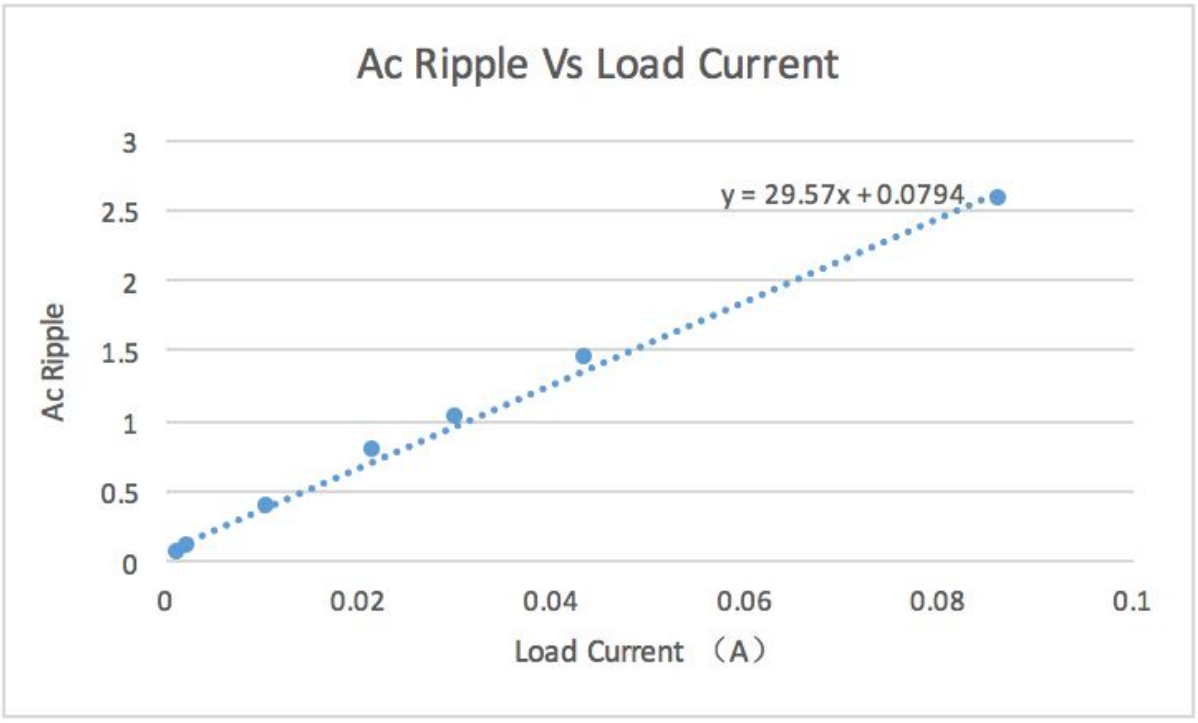
Load resistance (ohm)	dc voltage (V)	calculated load current (A)	ac ripple(V)
10000	10.916	0.0010916	0.048
4700	10.801	0.002298085	0.094
1000	10.434	0.010434	0.388
470	10.065	0.021414894	0.768

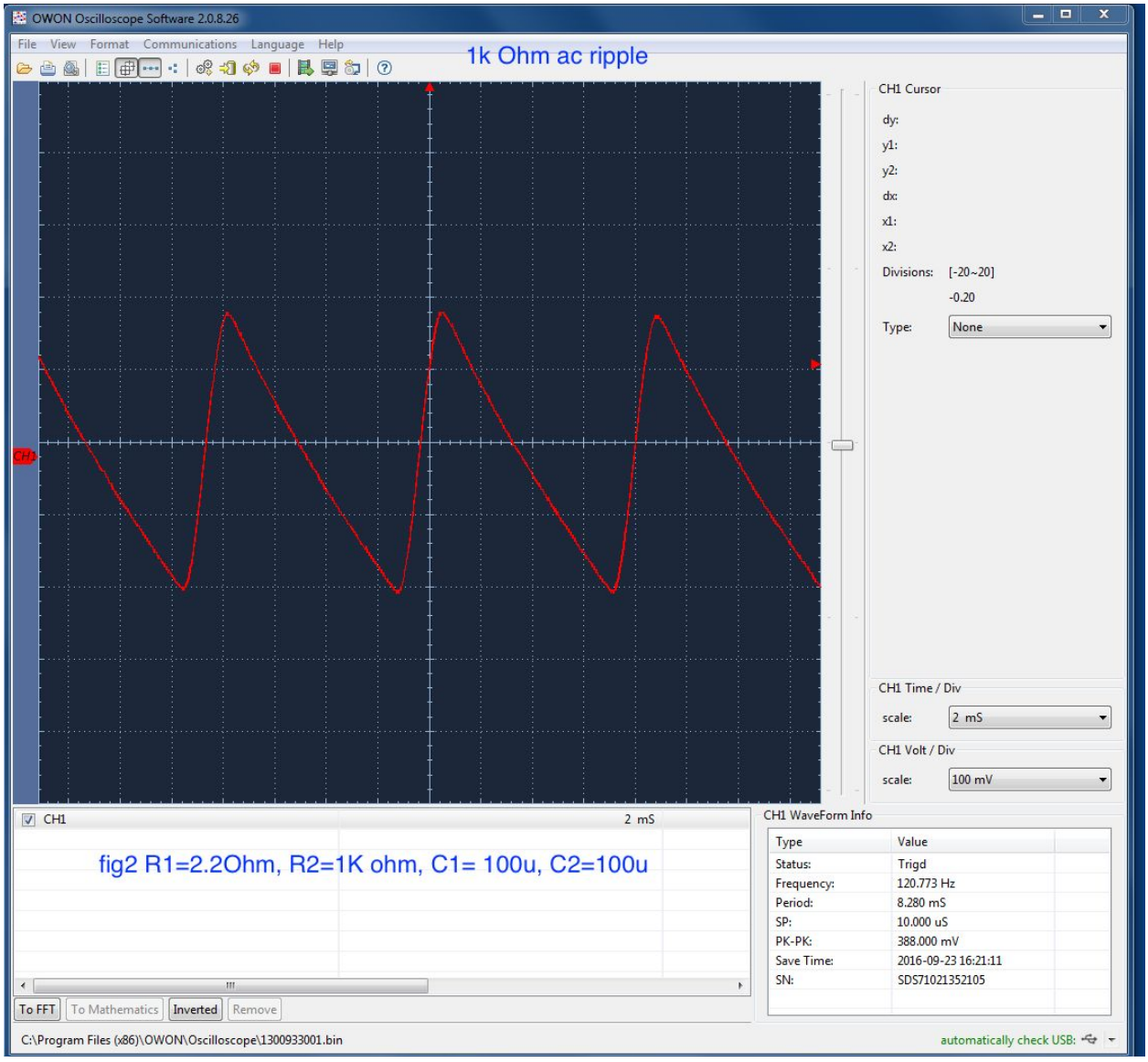
330	9.91	0.030030303	1.024
220	9.575	0.043522727	1.44
100	8.62	0.0862	2.56

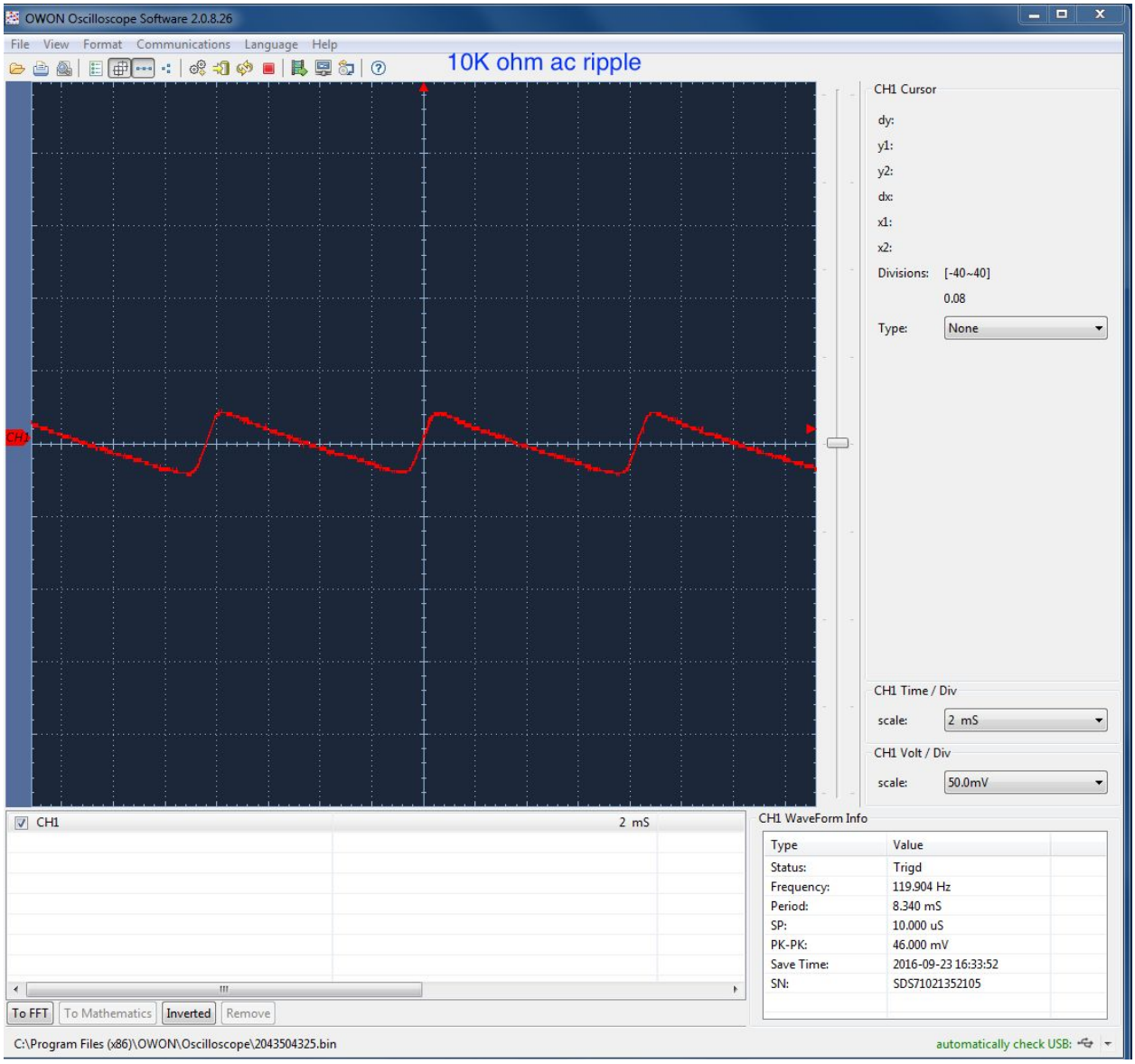
Plot the dc voltage VS the load current:



Plot the ac ripple versus the load current:


Ac Ripple Vs Load Current
y = 29.57x + 0.0794
Ac Ripple
Load Current （A）
3
2.5
2
1.5
1
0.5
0
0
0.02
0.04
0.06
0.08
0.1


OWON Oscilloscope Software 2.0.8.26
File View Format Communications Language Help
1k Ohm ac ripple
CH1 Cursor
dy:
y1:
y2:
dx:
x1:
x2:
Divisions: [-20~20]
-0.20
Type: None
CH1 Time / Div
scale: 2 mS
CH1 Volt / Div
scale: 100 mV
CH1
2 mS
fig2 R1=2.2Ohm, R2=1K ohm, C1= 100u, C2=100u
CH1 WaveForm Info
Type Value
Status: Trigd
Frequency: 120.773 Hz
Period: 8.280 mS
SP: 10.000 uS
PK-PK: 388.000 mV
Save Time: 2016-09-23 16:21:11
SN: SDS71021352105
To FFT
To Mathematics
Inverted
Remove
C:\Program Files (x86)\OWON\Oscilloscope\1300933001.bin
automatically check USB: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File View Format Communications Language Help
10K ohm ac ripple
CH1 Cursor
dy:
y1:
y2:
dx:
x1:
x2:
Divisions: [-40~40]
0.08
Type: None
CH1 Time / Div
scale: 2 mS
CH1 Volt / Div
scale: 50.0mV
CH1
2 mS
To FFT
To Mathematics
Inverted
Remove
CH1 WaveForm Info
Type Value
Status: Trigd
Frequency: 119.904 Hz
Period: 8.340 mS
SP: 10.000 uS
PK-PK: 46.000 mV
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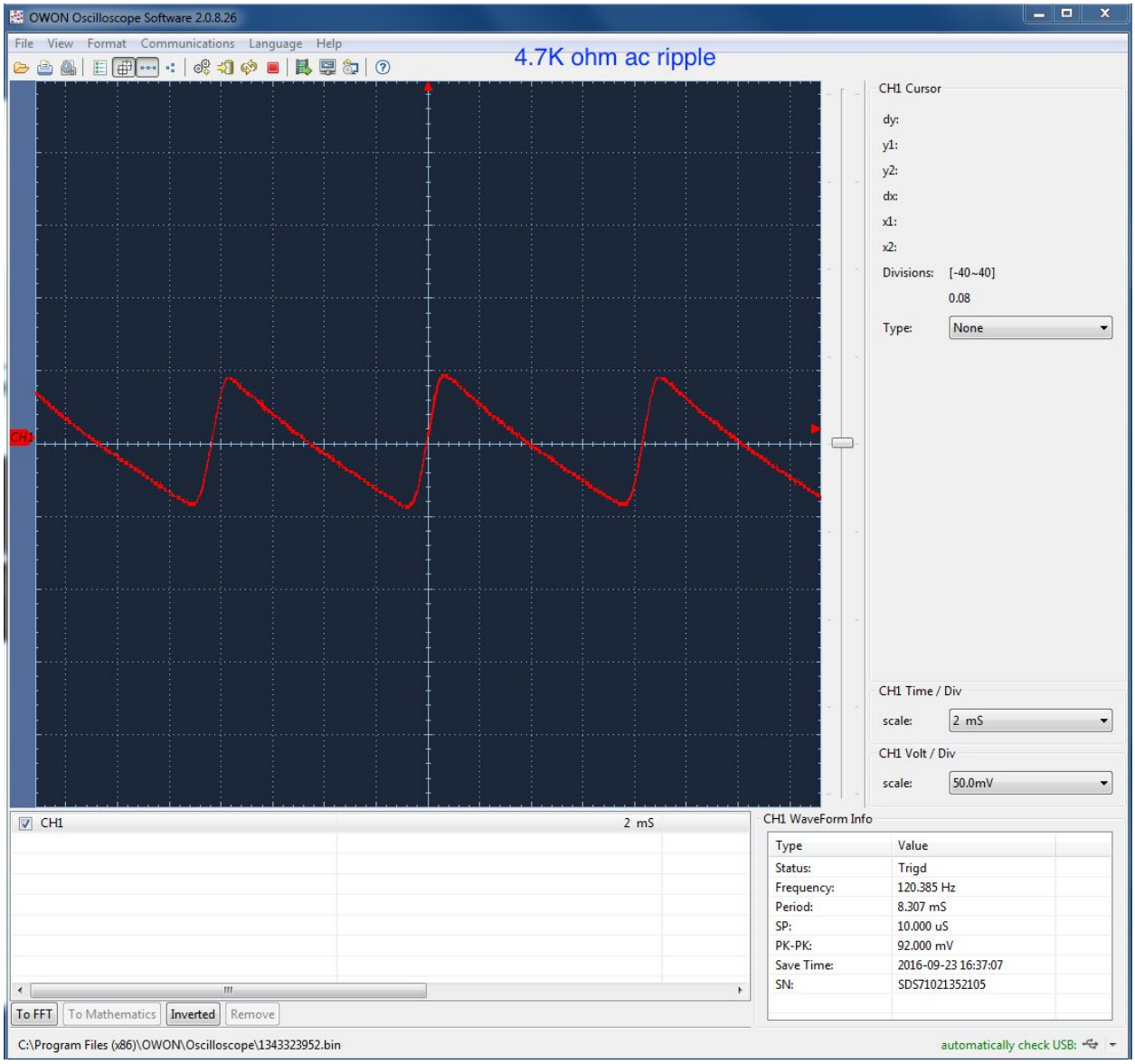
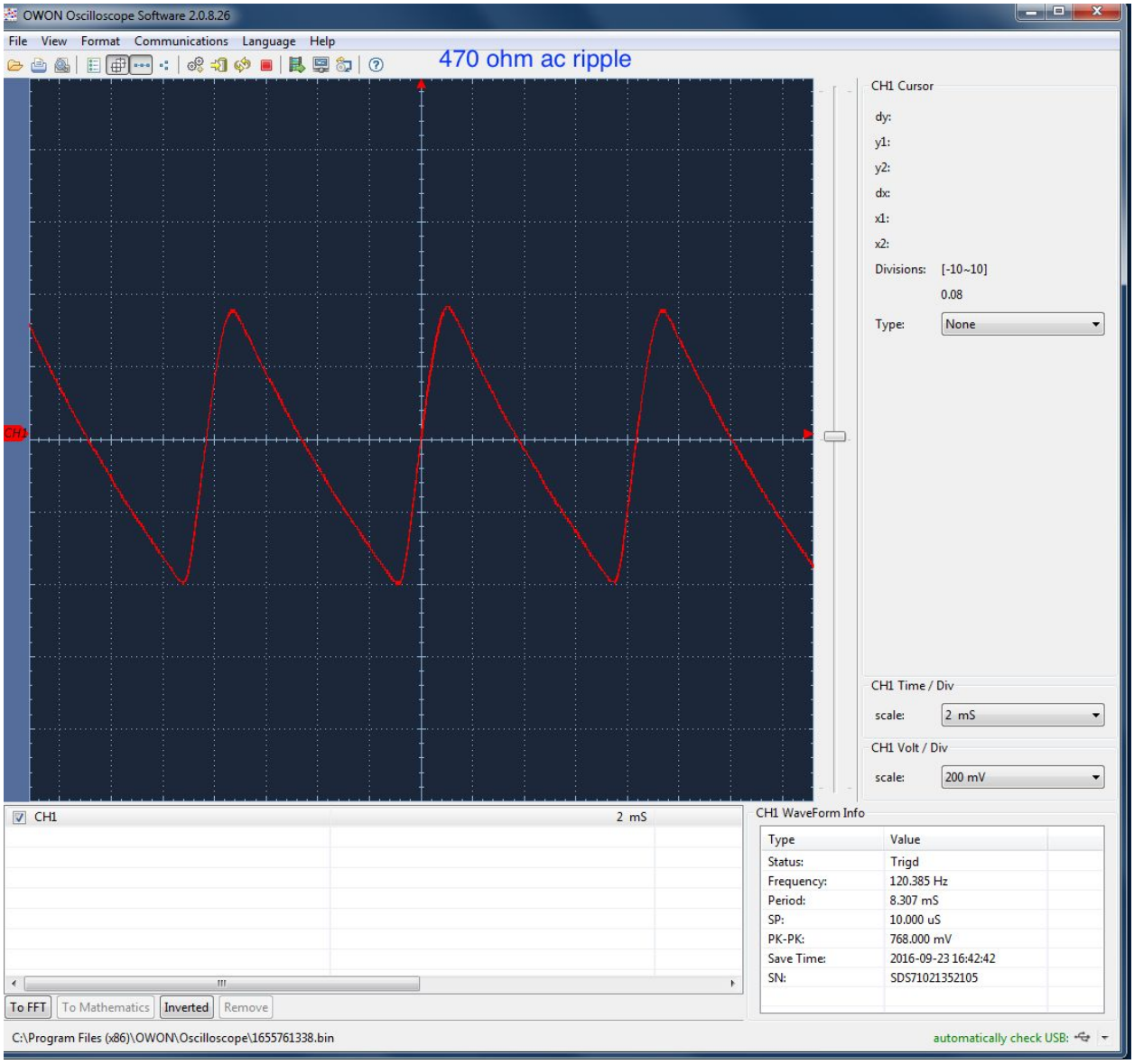

OWON Oscilloscope Software 2.0.8.26
File View Format Communications Language Help
4.7K ohm ac ripple
CH1 Cursor
dy:
y1:
y2:
dx:
x1:
x2:
Divisions: [-40~40]
0.08
Type: None
CH1 Time / Div
scale: 2 mS
CH1 Volt / Div
scale: 50.0mV
CH1
2 mS
CH1 WaveForm Info
Type Value
Status: Trigd
Frequency: 120.385 Hz
Period: 8.307 mS
SP: 10.000 uS
PK-PK: 92.000 mV
Save Time: 2016-09-23 16:37:07
SN: SDS71021352105
To FFT
To Mathematics
Inverted
Remove
C:\Program Files (x86)\OWON\Oscilloscope\1343323952.bin
automatically check USB:


OWON Oscilloscope Software 2.0.8.26
File View Format Communications Language Help
470 ohm ac ripple
CH1 Cursor
dy:
y1:
y2:
dx:
x1:
x2:
Divisions: [-10~10]
0.08
Type: None
CH1
CH1 Time / Div
scale: 2 mS
CH1 Volt / Div
scale: 200 mV
CH1 2 mS
CH1 WaveForm Info
Type Value
Status: Trigd
Frequency: 120.385 Hz
Period: 8.307 mS
SP: 10.000 uS
PK-PK: 768.000 mV
Save Time: 2016-09-23 16:42:42
SN: SDS71021352105
To FFT
To Mathematics
Inverted
Remove
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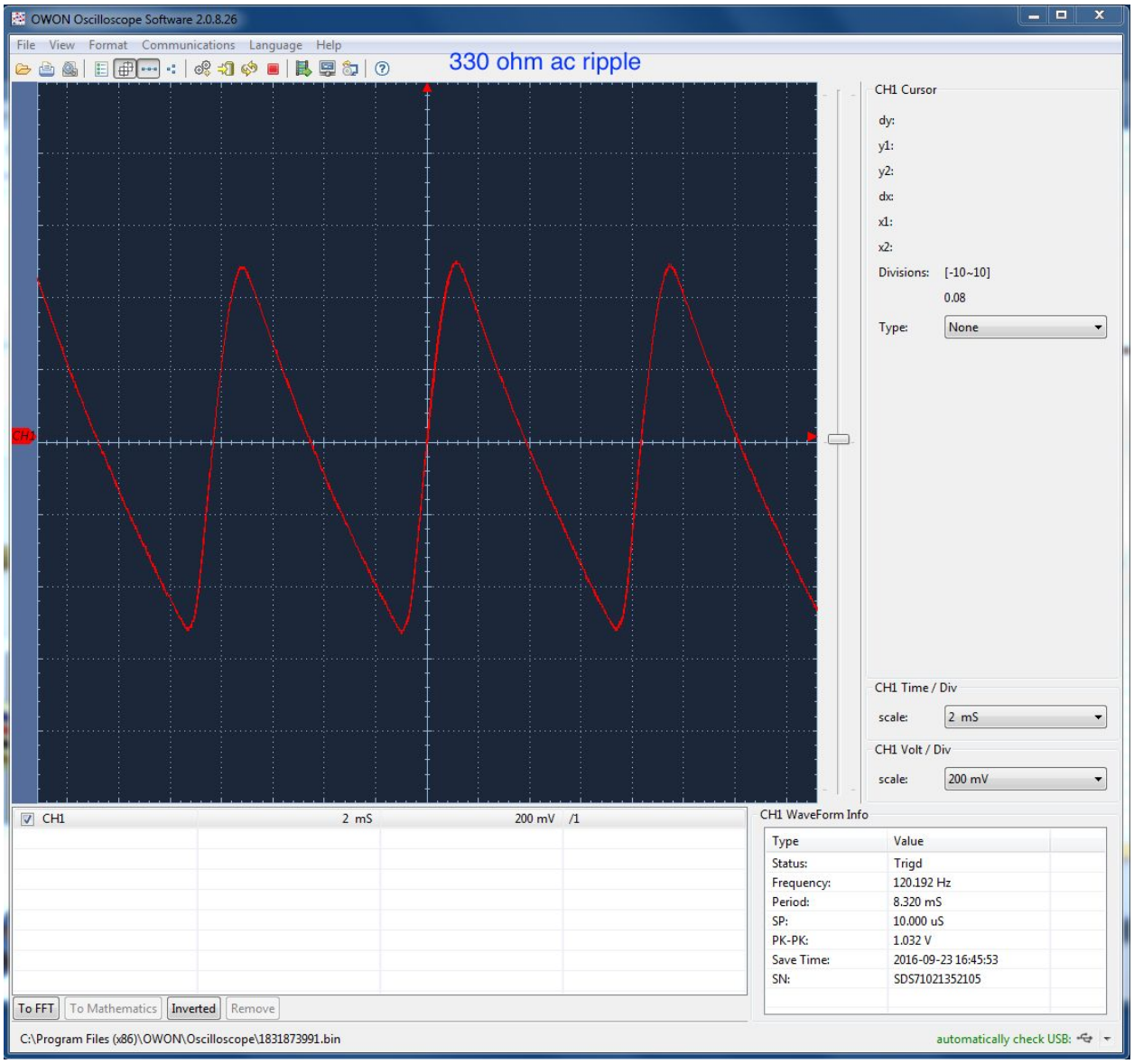
automatically check USB: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File View Format Communications Language Help
330 ohm ac ripple
CH1 Cursor
dy:
y1:
y2:
dx:
x1:
x2:
Divisions: [-10~10]
0.08
Type: None
CH1 Time / Div
scale: 2 mS
CH1 Volt / Div
scale: 200 mV
CH1 2 mS 200 mV /1
To FFT
To Mathematics
Inverted
Remove
CH1 WaveForm Info
Type Value
Status: Trigd
Frequency: 120.192 Hz
Period: 8.320 mS
SP: 10.000 uS
PK-PK: 1.032 V
Save Time: 2016-09-23 16:45:53
SN: SDS71021352105
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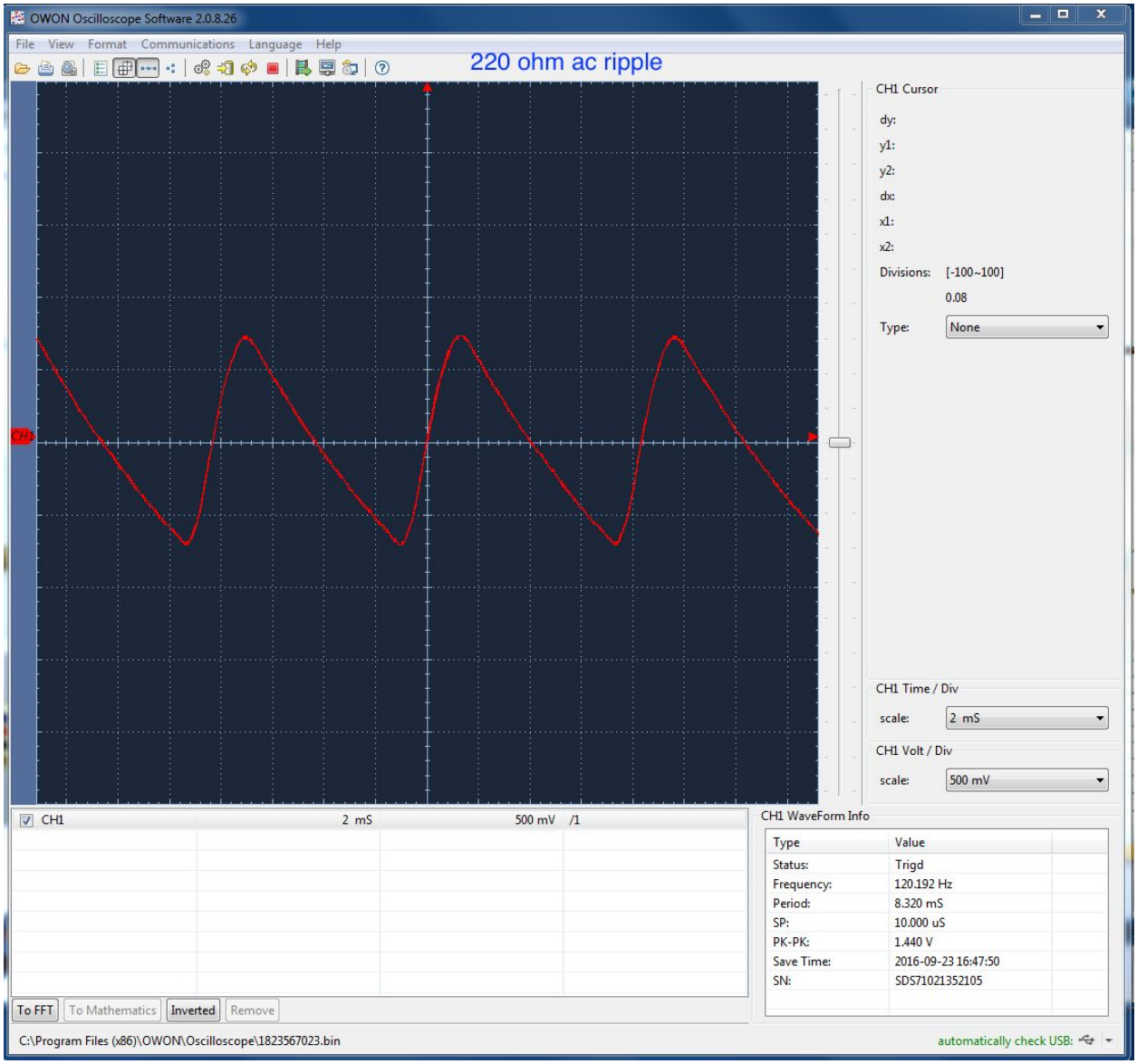
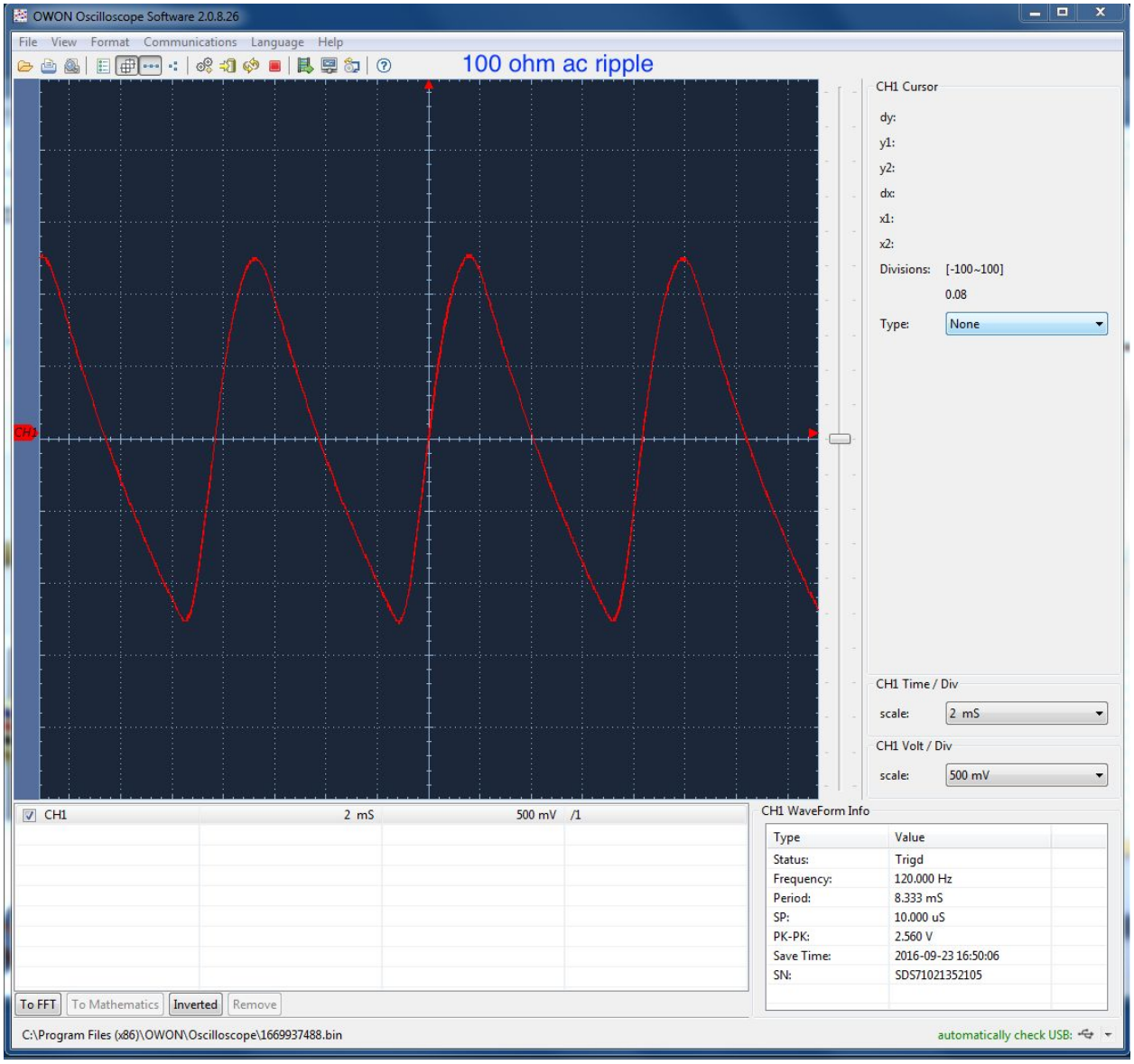

OWON Oscilloscope Software 2.0.8.26
File View Format Communications Language Help
220 ohm ac ripple
CH1 Cursor
dy:
y1:
y2:
dx:
x1:
x2:
Divisions: [-100~100]
0.08
Type: None
CH1 Time / Div
scale: 2 mS
CH1 Volt / Div
scale: 500 mV
CH1 2 mS 500 mV /1
CH1 WaveForm Info
Type Value
Status: Trigd
Frequency: 120.192 Hz
Period: 8.320 mS
SP: 10.000 uS
PK-PK: 1.440 V
Save Time: 2016-09-23 16:47:50
SN: SDS71021352105
To FFT
To Mathematics
Inverted
Remove
C:\Program Files (x86)\OWON\Oscilloscope\1823567023.bin
automatically check USB:


OWON Oscilloscope Software 2.0.8.26
File View Format Communications Language Help
100 ohm ac ripple
CH1 Cursor
dy:
y1:
y2:
dx:
x1:
x2:
Divisions: [-100~100]
0.08
Type: None
CH1 Time / Div
scale: 2 mS
CH1 Volt / Div
scale: 500 mV
CH1 2 mS 500 mV /1
CH1 WaveForm Info
Type Value
Status: Trigd
Frequency: 120.000 Hz
Period: 8.333 mS
SP: 10.000 uS
PK-PK: 2.560 V
Save Time: 2016-09-23 16:50:06
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To FFT
To Mathematics
Inverted
Remove
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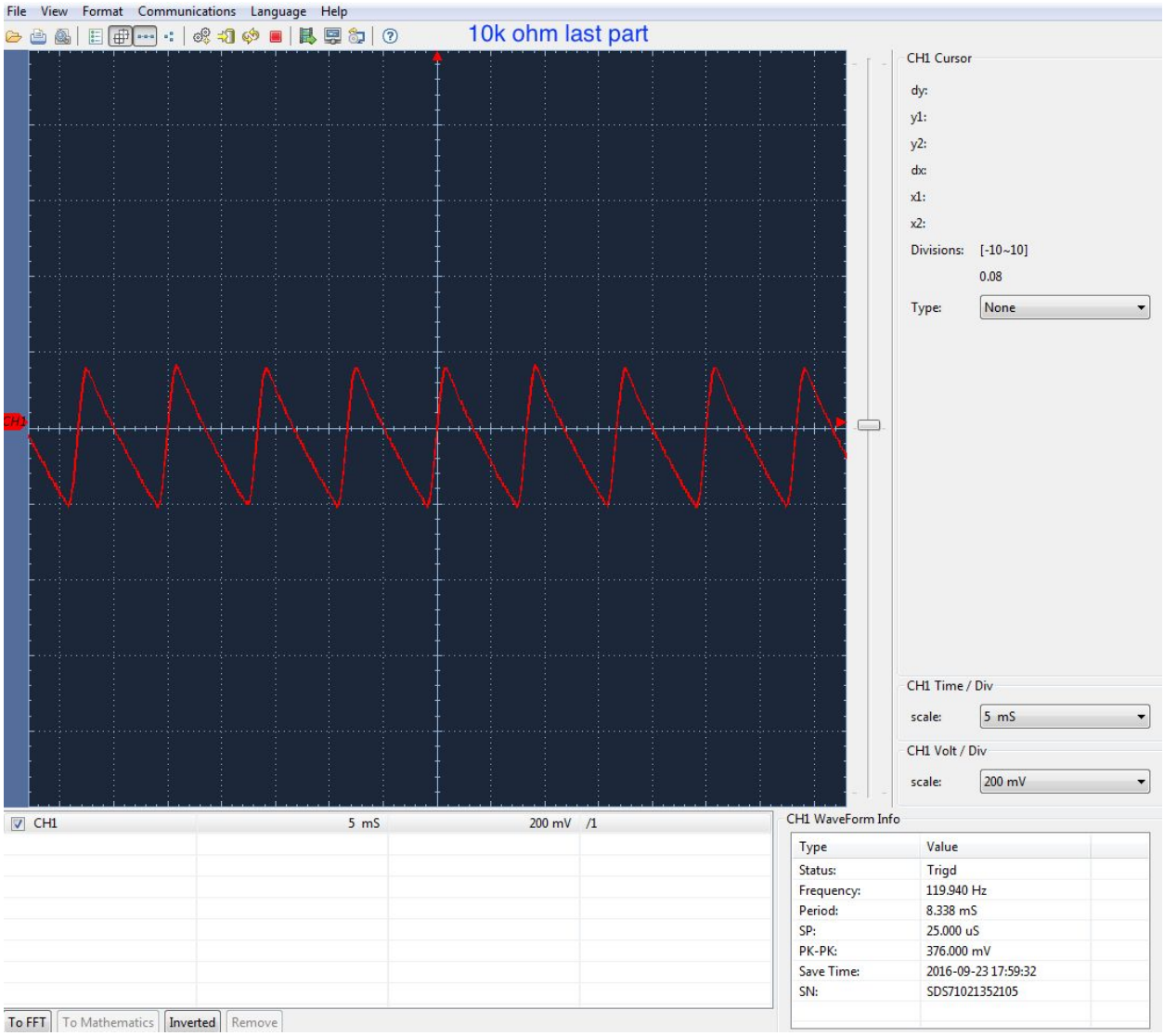
automatically check USB:



For the EE352

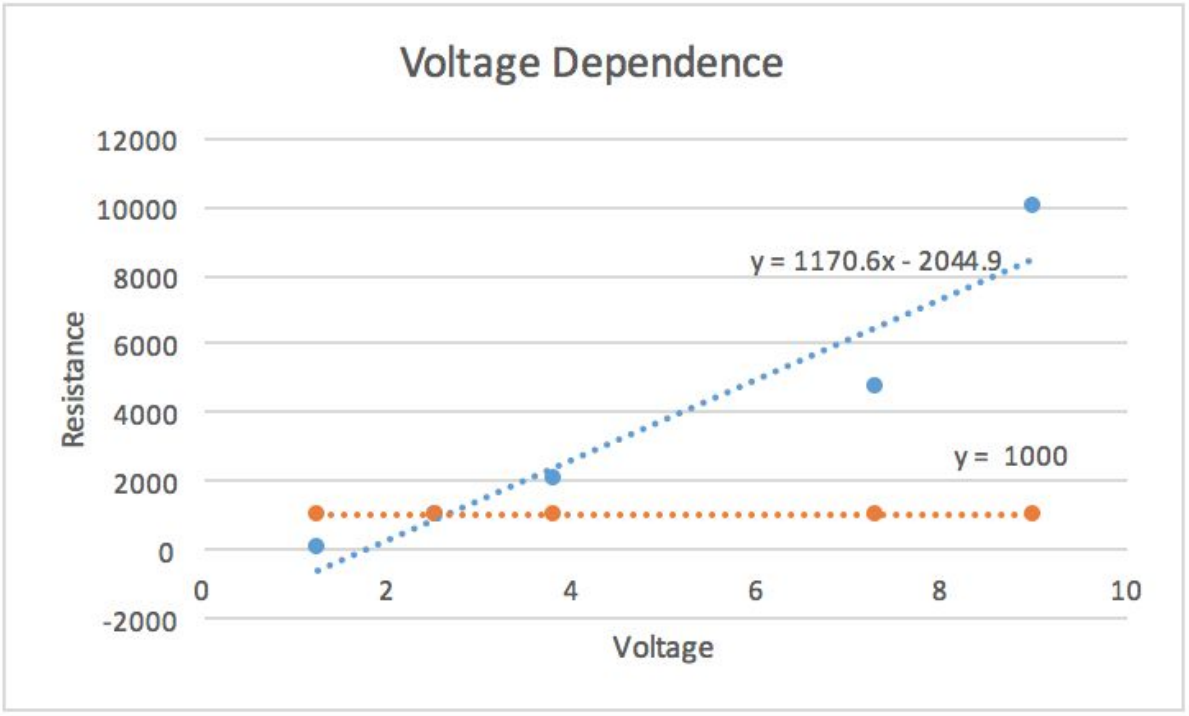
Lm317 Regulator
Using R2=1Kohm
Varying R3
The circuit for this part is in the below

R3	V-load	R3/R2	ripple (v)
0	1.24	0	0

1000	2.528	1	0
2000	3.803	2	0
4700	7.294	4.7	0
10000	8.99	10	0.368

We noticed that When R3 is increased, the output voltage is increased.

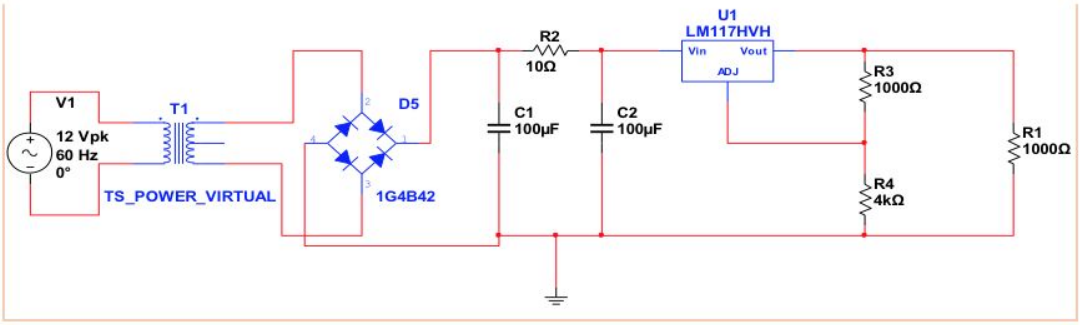
Plot the dependence of dc output voltage versus



The minimum Voltage across the regulator IC was found to be 1.24V.

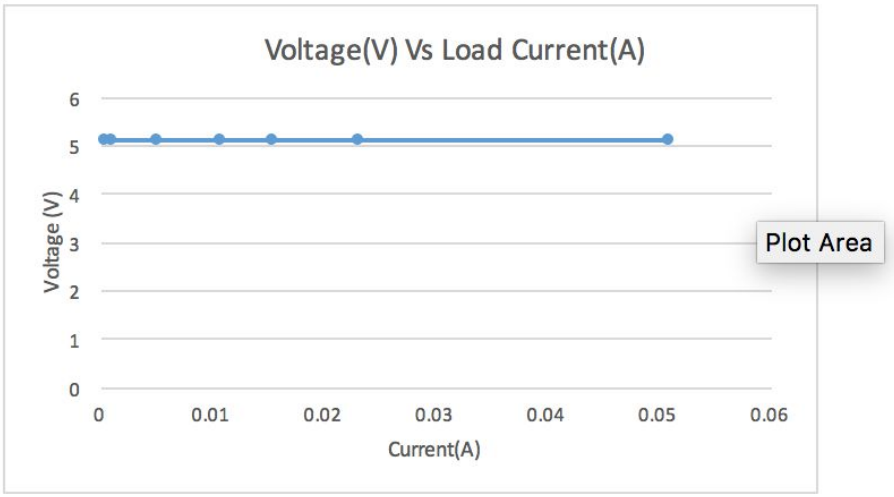
The input 10.53V
Output 8.99v
8.99/10.53=85%
The efficiency is defined as power dissipated by the load by the input power to the power supply.
We cannot measure the ac power in the lab because there is no ac power matter.

We build the circuit below:

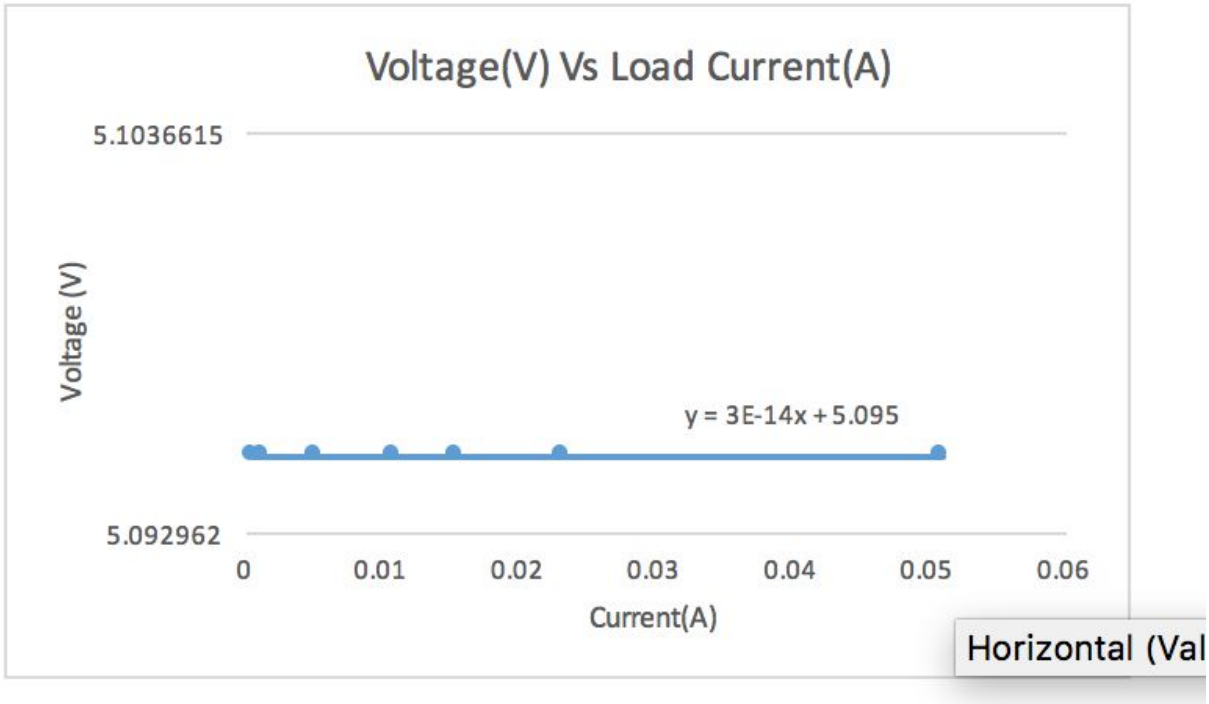


Load resistance (ohm)	dc voltage (V)	calculated load current (A)	ac ripple(V)	input
				5.095
10000	5.095	0.0005095	0.016	5.095
4700	5.095	0.001084043	0.016	5.095
1000	5.095	0.005095	0.016	5.095
470	5.095	0.010840426	0.016	5.095
330	5.095	0.015439394	0.016	5.095
220	5.095	0.023159091	0.016	5.095
100	5.095	0.05095	0.016	5.095

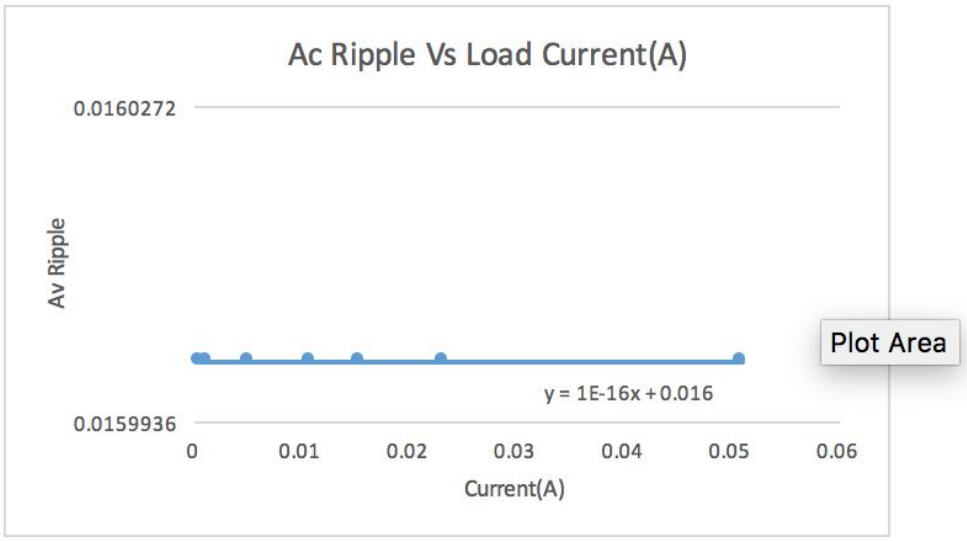
Plot the dc voltage Vs load current



With function



Plot ripple as a function of current:



Why switching power supply can be compact and more efficient?

The first reason why the switching power supply is more efficient is that the switching transistor just dissipates low power. The switching power just dissipate less heat and reduce energy consumption. It is small since there is no cooling-fins and frequency transformer for most of switching power supply.

Conclusion

We started with a generic power supply which consisted of just the rectifier, the transformer and the load resistance. At the first part, we did the full wave rectifier with 4 diodie. Using the diodes to make sure the current flow in one direction. It allows the ac signal to become dc. That is very important application for engineer to build the technology products.For the second part,we analysis dc power supply circuit consisting of the full-wave rectifier and the π filter.Hence,linear power supply circuits have significant internal power dissipation. Therefore, their efficiency is not high. They are fine for low power applications.The components we use for this part are resistor(R1=2 Ohm, R2=1k Ohmr, capacitors(C1= 100 uF, C2=100uF), and 4 diodes with variable transformer and dc power supply. The ripple can be very small, so we choose the ac line trigger and use ac coupling. We realize that if we placed resistors in parallel, it will increase the overall power handling capability. Afterall,we see the differences of dc voltage and ac ripple in the excel above.

As a last part, we than implemented the pi filter which filtered out most of the unwanted signal. We learned how to use the LM317 regulator integrated circuit. We

build the circuit with the integrated circuit with LM317 to finalized the power supply in the most efficient. We learned the switching power supply and know the reason of switching power supply can be compact and more efficient. However, in this lab, we cannot to measure the ac power going into the transformer that is why we cannot to calculate the efficiency.

References

https://en.wikipedia.org/wiki/Power_supply

Dr. Liu's experiment 3 description.

A. S. Sedra and K. C. Smith, "Microelectronic Circuits," 7th ed. Oxford University Press,

2015. Chap.1 through Chap.7. (ISBN: 9780199339136)

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