

Golie Masoumian

Department of Electrical and Computer Engineering

University of Alberta

Introduction

- Power disturbance: interruption in the power system
- Causes electrical equipment to malfunction or breakdown
- Important for the power quality (ability of electrical equipment to consume the energy being supplied to it)

Simulation

Power Disturbance: harmonic frequency, distorted waveform

$$V1 = 10 \cdot \sin(2 \cdot \pi \cdot 60 \cdot t)$$

$$V2 = 3 \cdot \sin(2 \cdot \pi \cdot 60 \cdot 3 \cdot t)$$

$$V3 = 10 \cdot \sin(2 \cdot \pi \cdot 60 \cdot t) + 3 \cdot \sin(3 \cdot \pi \cdot 60 \cdot 3 \cdot t)$$

$$V4 = 10 \cdot \sin(2 \cdot \pi \cdot 60 \cdot t) + 3 \cdot \sin(3 \cdot \pi \cdot 60 \cdot 3 \cdot (t + \pi/3))$$

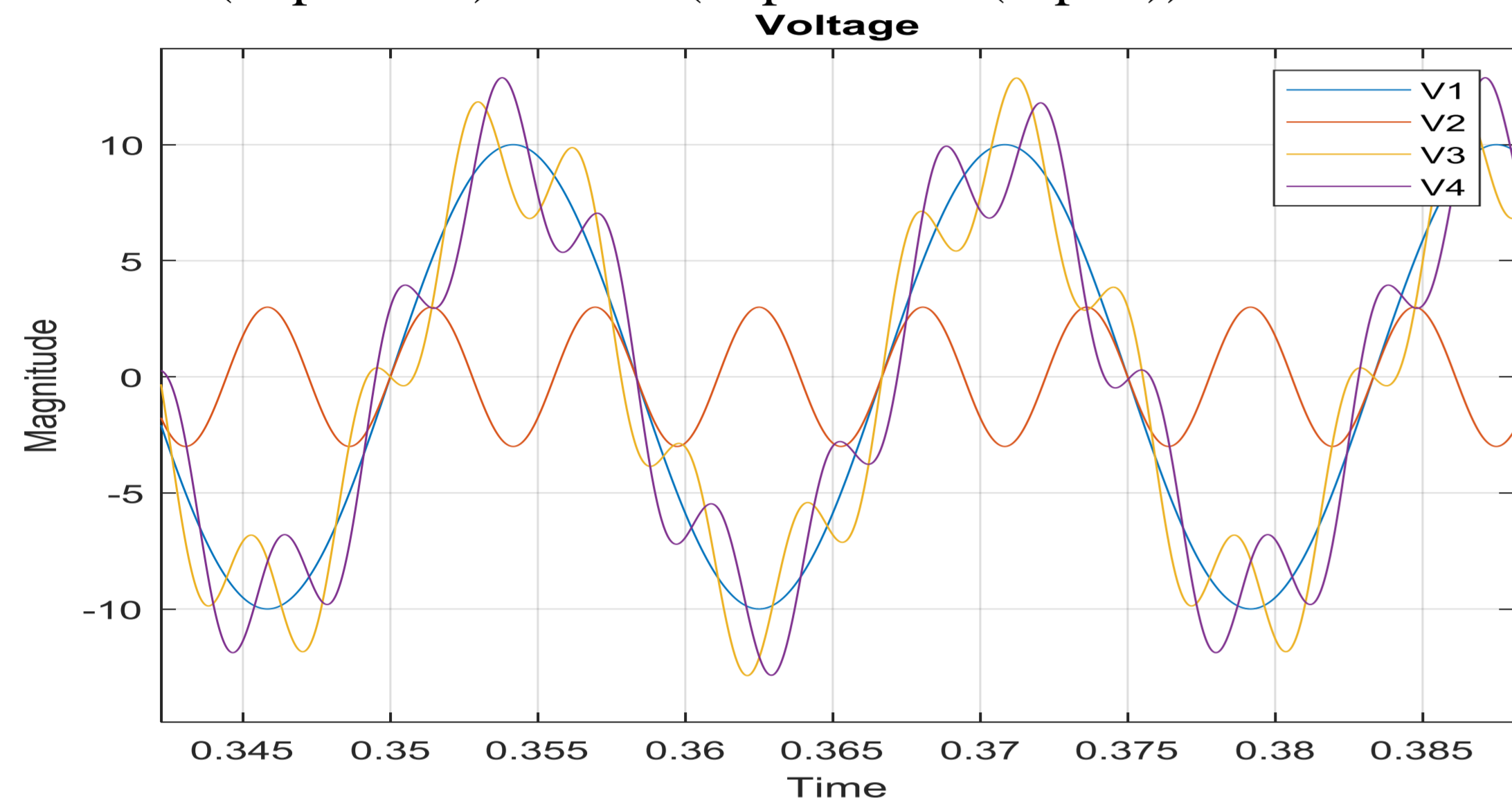


Figure 1: Voltage functions graphed using Matlab.

- Waveforms are sine waves
- More cycles for higher frequencies
- Distorted waveform is found in harmonic frequencies

Power Disturbance caused by motor start

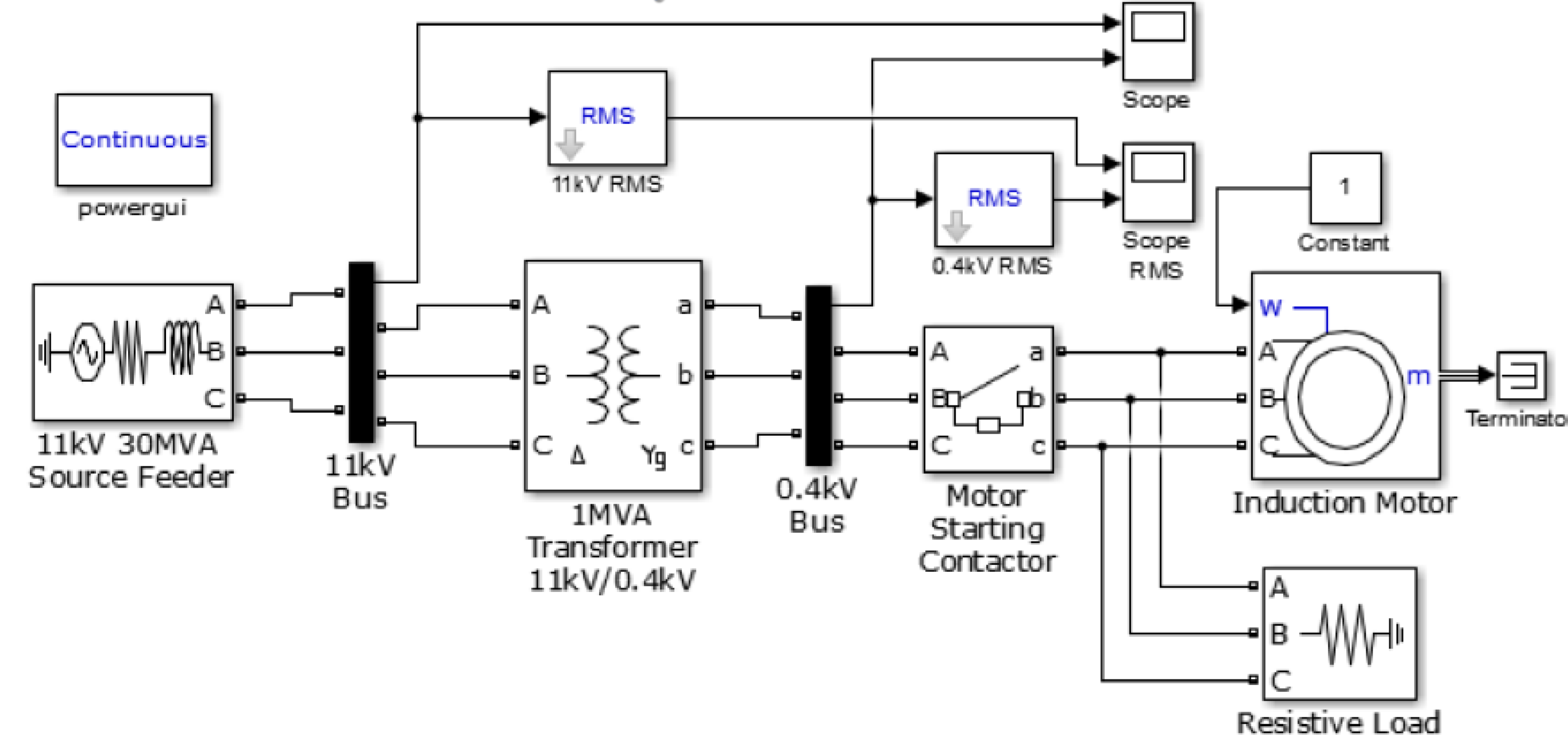


Figure 2: Power Quality Issues in Distributed Generation by IntechOpen. Motor Simulink model.

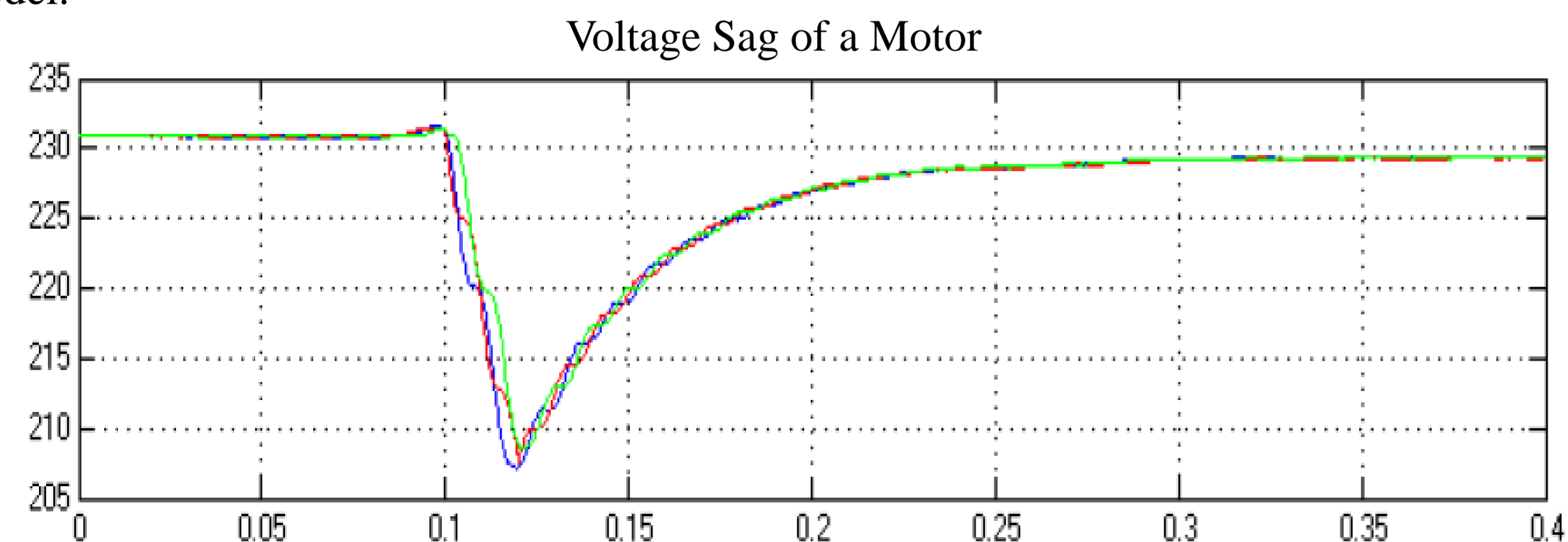


Figure 3: Power Quality Issues in Distributed Generation by IntechOpen.

- Starting up a motor causes voltage sag at power system bus

Experiment

Comparison of simulation and experiment results

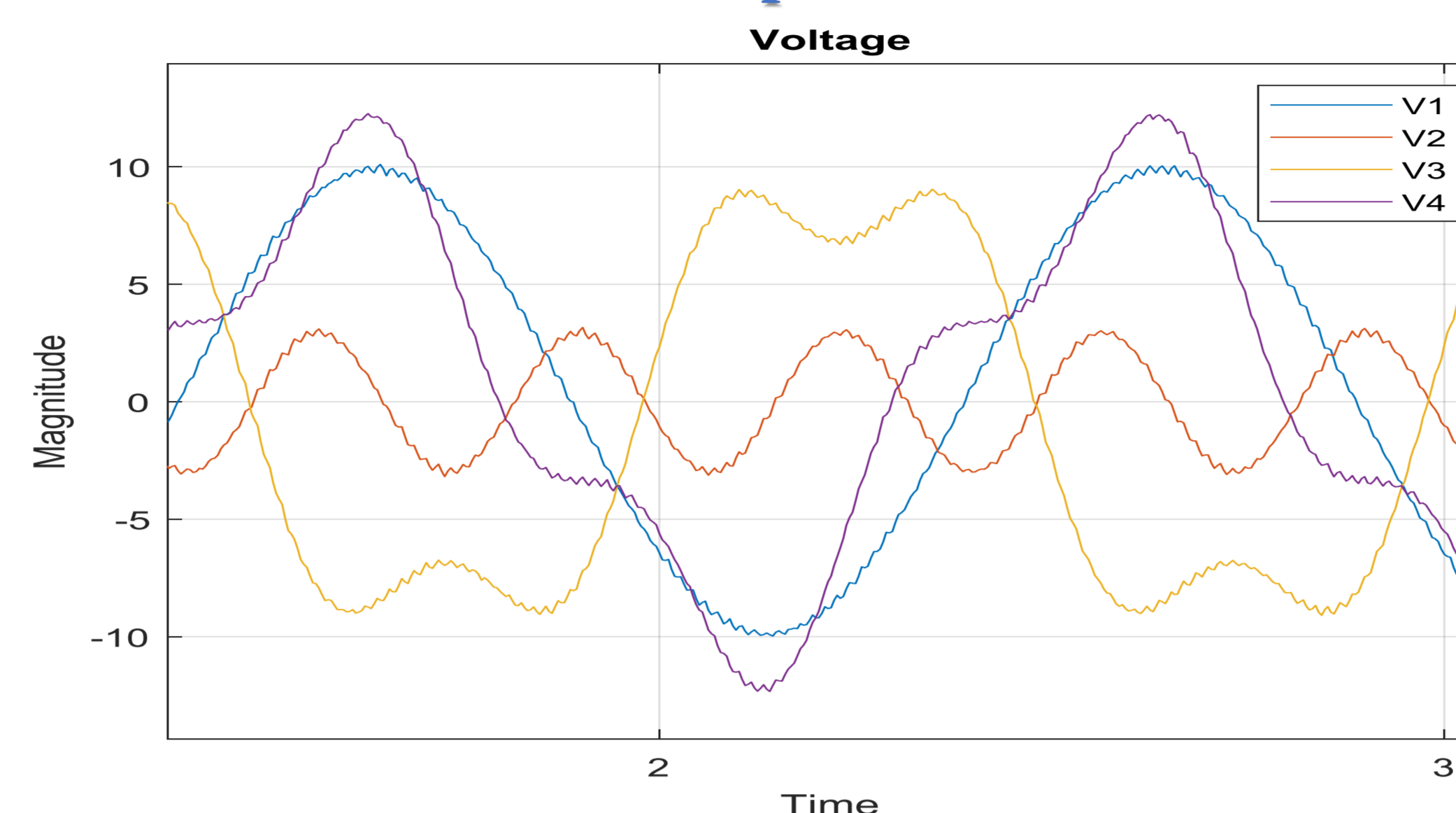


Figure 4: Voltage functions recorded on Labview.

- Waveforms are exactly the same

Measurement of Power Disturbance generated by appliance (laptop, incandescent lamp, compact fluorescent lamp)

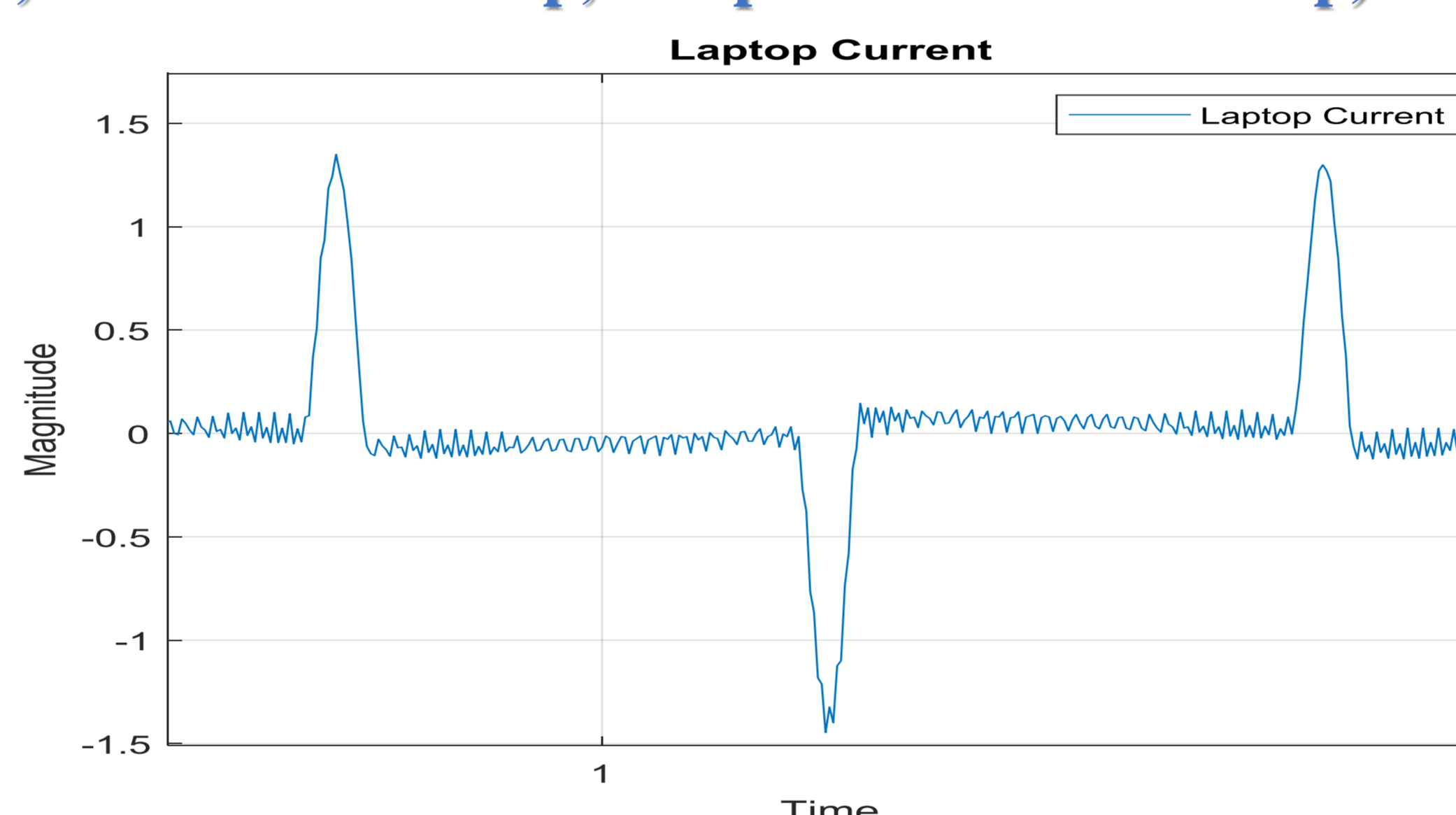


Figure 5: Laptop current measured on Labview.

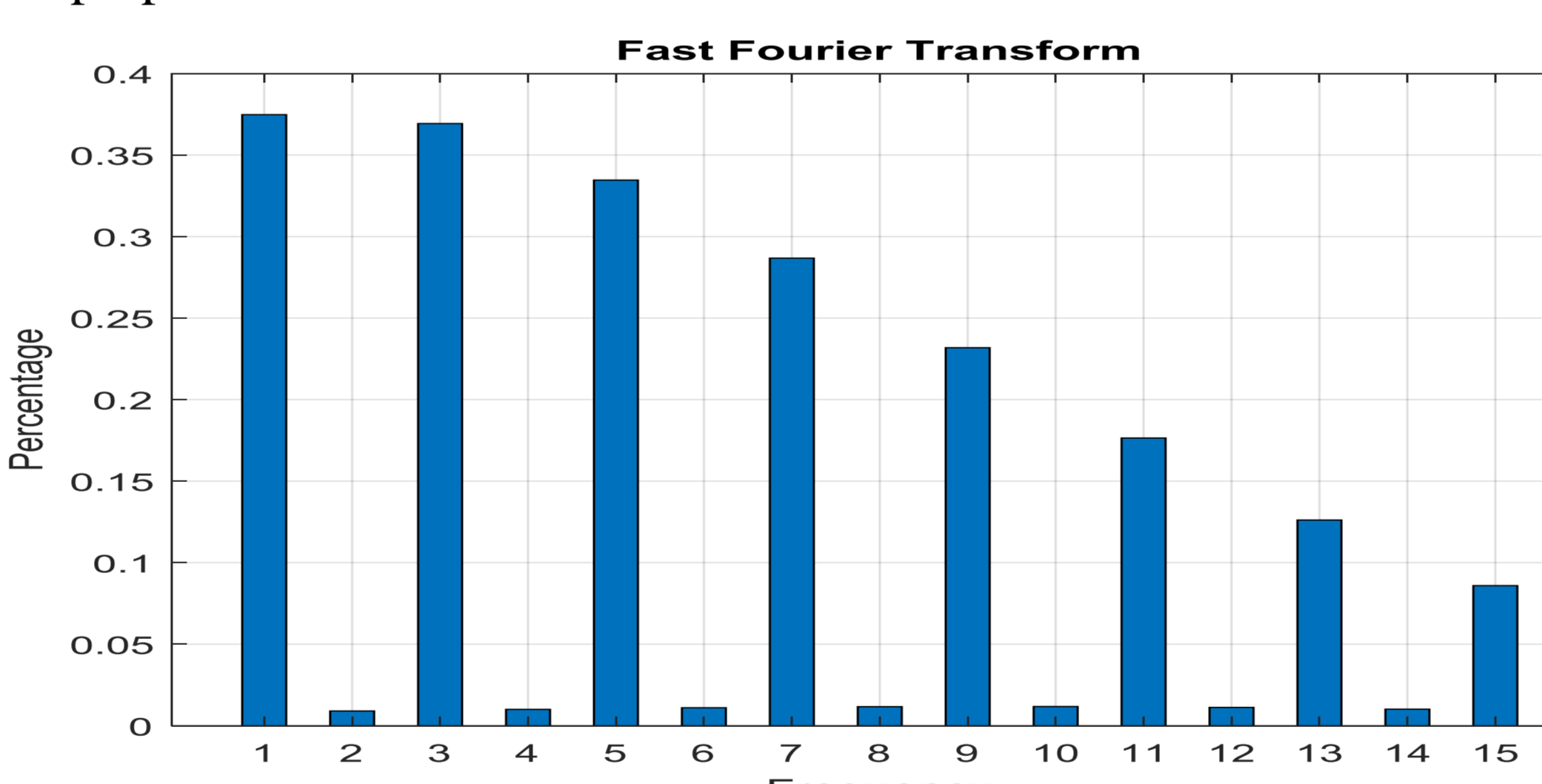


Figure 6: Fast Fourier Transform graph of laptop current.

- The waveforms are distorted
- FFT analysis reveals the waveform comprises odd harmonics

Measurement of Power Disturbance generated by motor start



Figure 7: Three-phase motor.

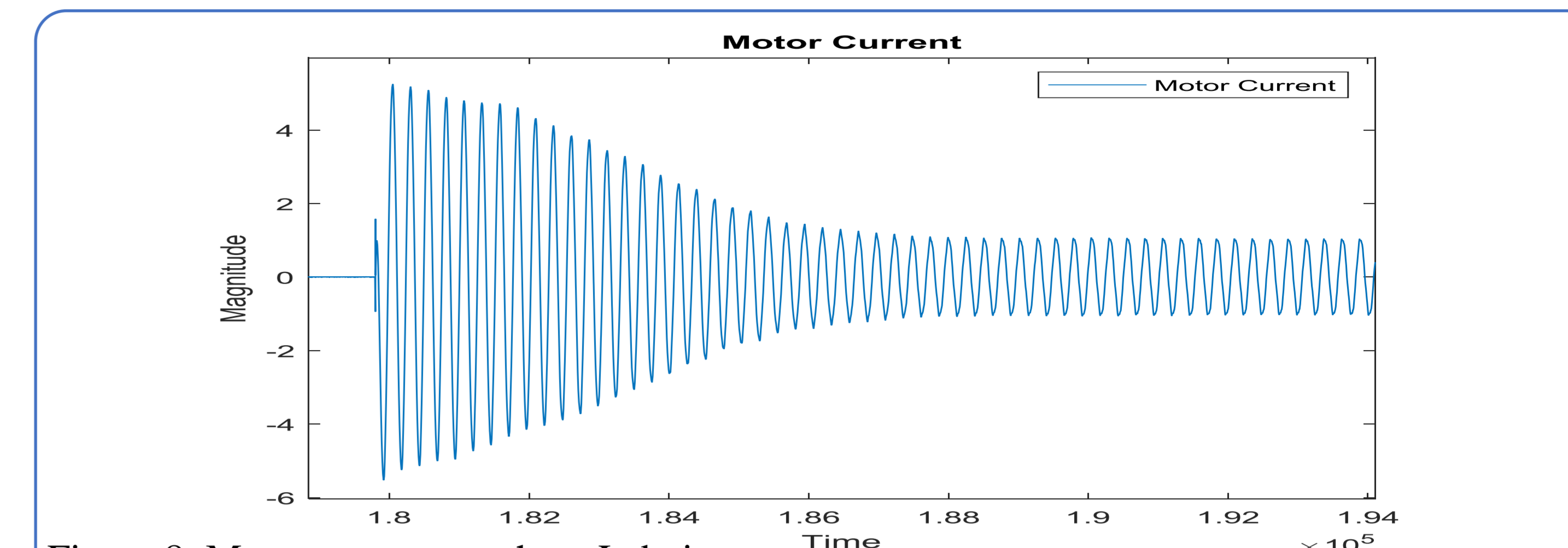


Figure 8: Motor current graph on Labview.

- The high current at the beginning causes voltage sag

Measurement of Power Disturbance generated by rectifier bridge

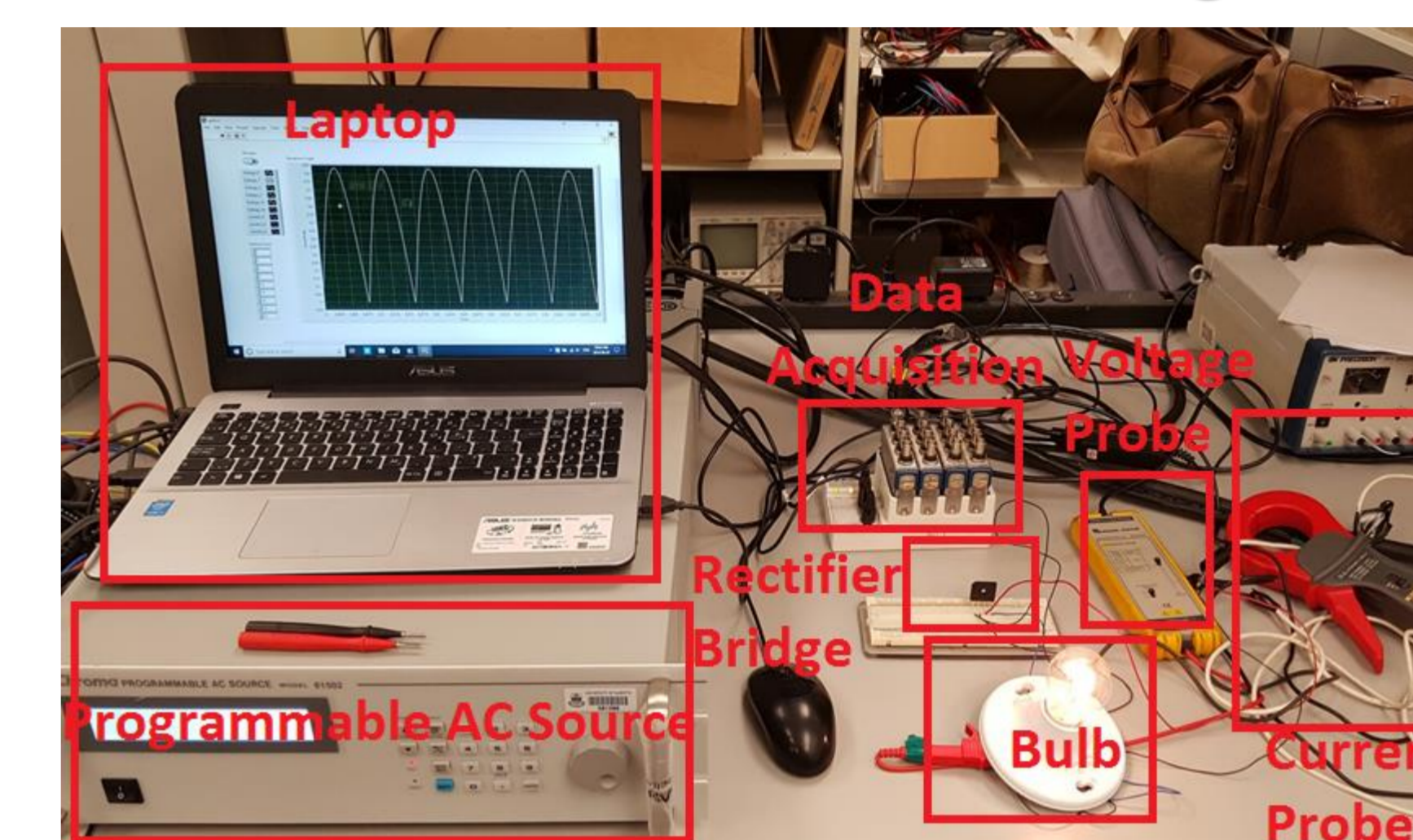


Figure 9: Experiment setup.

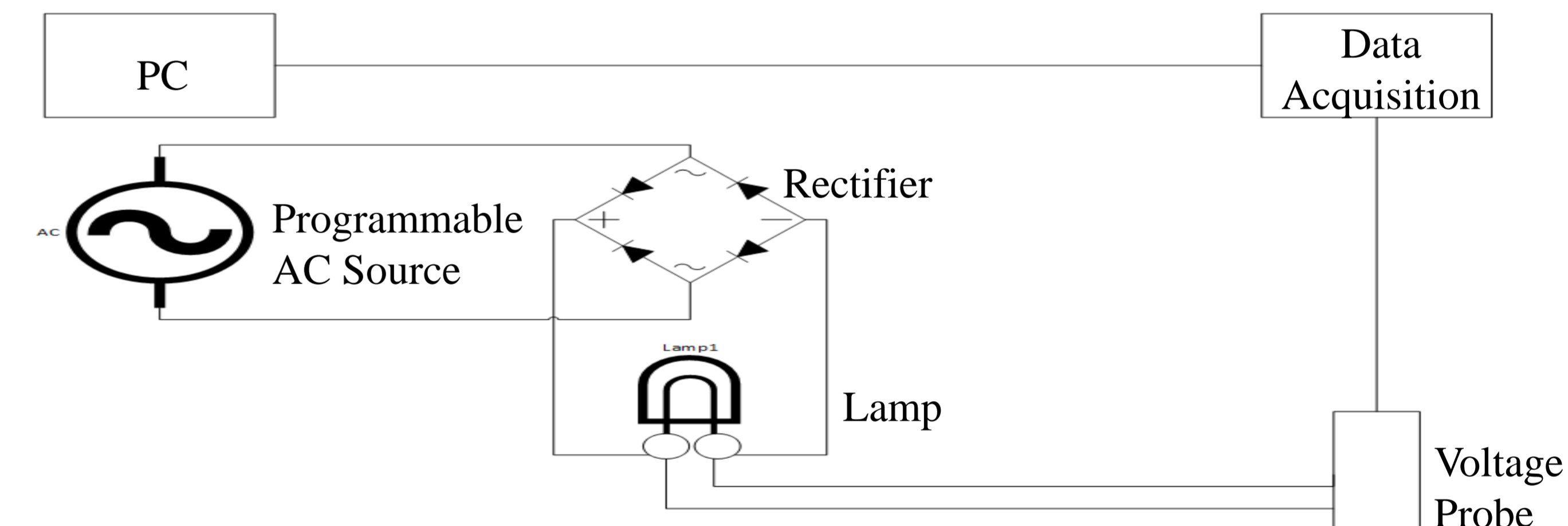


Figure 10: Circuit diagram of experiment setup.

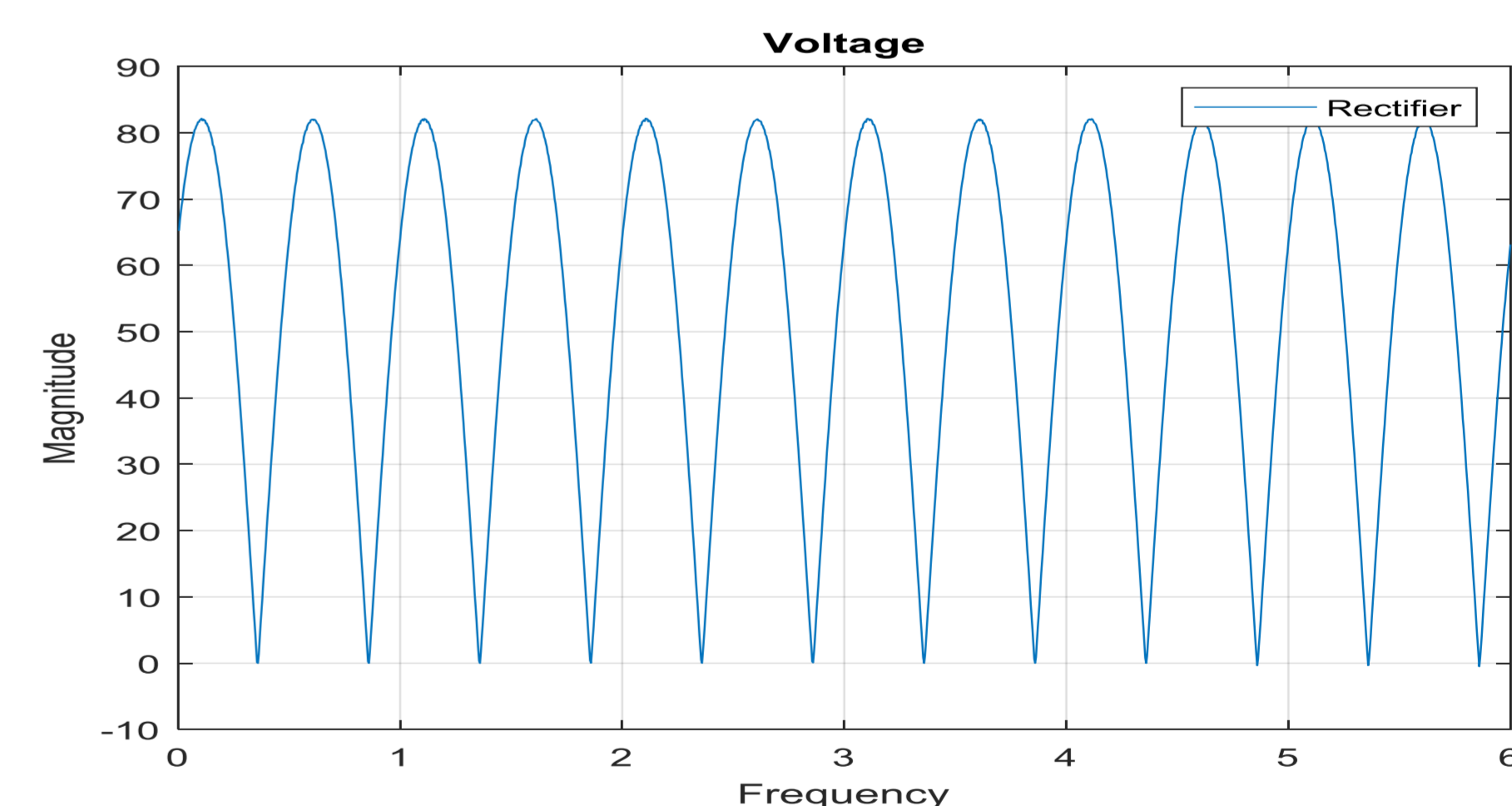


Figure 11: Voltage across the bulb after the AC/DC conversion by the rectifier bridge.

- Waveforms are positive because of direct voltage
- Waveform is not a straight line due to the operation principle of rectifier bridge

Conclusion

- FFT helps to analyze the distorted waveforms
- The research on power disturbance is helpful for improving power quality

Acknowledgement

- Special thanks to my team: Dr. Wilsun Xu (PI), Dr. Jing Yong (supervisor), Difei Tang (Postdoc) and my sponsors Dr. Wilsun Xu, Canada Summer Jobs and Syncrude