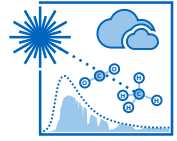




Technische Universität München  
TUM Department of Electrical and Computer Engineering  
**Professorship of Environmental Sensing and Modeling**  
Prof. Dr.-Ing. Jia Chen



*Bachelor's Thesis*

# Designing a Circuit for Alphasense NO2-B43F Sensor

Emre Özbas

September 16, 2018

Supervisor:

Prof. Dr.- Ing. Jia Chen

# Abstract

text text text text

---

I confirm that this Master's Thesis is my own work and I have documented all sources and material used.

Munich, September 16, 2018

---

Place, Date

---

Signature

---

# Table of Contents

	page
<b>1 Introduction</b> . . . . .	1
<b>2 Preparation</b> . . . . .	2
2.1 Initial Researches . . . . .	2
2.2 Getting a Better Understanding . . . . .	2
2.3 Ordering Parts . . . . .	3
<b>3 Challenges</b> . . . . .	4
3.1 Mechanical and optical challenges . . . . .	4
3.1.1 Critical parameters . . . . .	4
<b>4 Outlook</b> . . . . .	5
 <b>APPENDIX</b>	
<b>A Some Appendix</b> . . . . .	7
<b>B Source Code</b> . . . . .	8
<b>Bibliography</b> . . . . .	9

---

# Chapter 1

## Introduction

As the world population increases by millions every year, the environmental damage we cause increases dramatically. In densely populated areas -and especially in larger cities- air pollution is a major problem, which does not only have financial consequences but also affects the quality of our lives in many ways. Since air pollution today constitutes a significant problem, there are more than many researches and studies regarding this issue: " . . . the total damage costs of air pollution [is estimated] to be US\$ 3.0 trillion in 2010, or 5.6% of Gross World Product (GWP). These losses are equivalent to US\$ 430 for every person on the planet." [1] is from just one of the numerous studies made on financial damage caused by air pollution.

To be able to assess this problem correctly and take suitable measures to minimize the harm of air pollution, one should first be capable of finding out the cause accurately. Only after an accurate diagnosis can there be a suitable solution and thus a significant outcome. When it comes to air pollution, the best way to detect the cause is to make density measurements of air pollutants with electrochemical sensors sensitive to specific gases in various locations. However there are some requirements that must be fulfilled: "To adequately characterize air quality (AQ), measurements must be fast (real-time), scalable, and reliable (with known accuracy, precision, and stability over time)." [2] The more accurate and fast the sensors get, the more expensive the gas measurement station will be. Since it is important to make measurements in multiple locations to create a pool of air pollutant density data and thus getting a better understanding of the environmental damage, a collective of stations are needed, which increases the total cost dramatically.

The goal of this bachelor thesis is to design and build a low-cost circuit suited for Alphasense NO2-B43F sensor, which is sensitive to NO<sub>2</sub> concentration in the air.

---

## Chapter 2

### Preparation

#### 2.1 Initial Researches

Some research on the working principle of Alphasense NO<sub>2</sub> electrochemical sensor had to be made prior to the initialization of the mechanical and electronical sections of this project. A paper on previous experiments conducted in Boston, United States of America was very helpful to get a first idea about how I could start building my project designed for NO<sub>2</sub> density measurements. Previously mentioned researchs did not give much direct information about the circuit itself and were realistically not essential for me to realize my project, as my goal was to build a functioning circuit, to get meaningful data from it and to document the entire process of my project well. However, the researchs and the papers I read gave me even more motivation about how topical air pollution is and thus how important it is to try to build a low-cost air pollutant density measuring station and to collect useful environmental data.

#### 2.2 Getting a Better Understanding

I had to read the application notes on the Alphasense Webpage to get a better understanding of the inner structure as well as the pinout of the sensor and for this purpose I began to study the [XXXXXXXXXX](#) (kaynak) (inner structure). As I started to understand which electrode of the sensor was responsible for which purpose, I began to get an idea of how I could build my own circuit, which would be able to supply enough current to the sensor and output voltage, linearly proportional to the concentration of the air pollutant, in other words, the ppb level of NO<sub>2</sub> in the air.

Afterwards I started to read [XXXXXXXXXXXXXX](#)(designing a circuit), which gave me a starting point for the circuit. In diagram [XXXXXX](#) from [XXXX](#) you can see a circuit design for a three-electrode sensor. I was actually working with the sensor NO2-B43F, which is a four-electrode sensor, but this circuit schematic was nonetheless a good point to start building and testing the circuit.

## **2.3 Ordering Parts**

---

## **Chapter 3**

### **Challenges**

#### **3.1 Mechanical and optical challenges**

text text text text

##### **3.1.1 Critical parameters**

text text text text



---

## **Chapter 4**

### **Outlook**

text text text text

---

## **APPENDIX**

---

## **Appendix A**

### **Some Appendix**

text text text text

---

## **Appendix B**

### **Source Code**

text text text text

---

## Bibliography

- [1] Guy Hutton. Air pollution. *Global Damage Costs of Air Pollution from 1900 to 2050*, 2011.
- [2] Eben S. Cross. Use of electrochemical sensors for measurement of air pollution: correcting interference response and validating measurements. Technical report, Massachusetts Institute of Technology, Cambridge, MA 02139, USA, 2017.