ISSN:2782-8492

FEDPOLAD Journal of Engineering & Environmental Studies (FEDPOLADJEES); Vol. 4, ISSUE 1. OCTOBER, 2024 Edition

Website: https://seemjournals.fedpolyado.edu.ng/index.php/fedpoladjees

Proudly Sponsored by: tetfund TERTIARY EDUCATION TRUST FUND

TETFund/ESS/POLY/ADO-EKITI/ARJ/1

DEVELOPMENT OF INTERFACING CIRCUIT FOR TGS 26XX SERIES BASED ELECTRONIC NOSE SYSTEM

Olowojebutu O. Akinyemi[1] Raphael O. Oloke[2], Akinwumi F. Akinleye[3]

[1]Department of Computer Science, The Federal Polytechnic, Ado-Ekiti, Ekiti-State; [2,3] Department of Electrical and Electronic Engineering, Federal Polytechnic, Ado-Ekiti.

E-mails: [1]yemi.olowo@gmail.com; [2]Princeoloke@yahoo.com; [3]akinleyeakin@yahoo.com

Abstract

This study presents the design and development of a cost-effective electronic nose system utilizing Figaro gas sensors (TGS 2612, TGS 2600, and TGS 2602) for detecting volatile compounds. An interfacing circuit was successfully constructed using printed circuit board (PCB) technology, enabling connection to a computer-aided Pico data logger. The system's performance was evaluated using methane, ammonia, carbon monoxide from cigarette smoke, and ethanol. Results show sensor-specific sensitivity: TGS 2602 detected ammonia, TGS 2612 and TGS 2600 detected methane, TGS 2602 and TGS 2600 exhibited high sensitivity to ethanol, while TGS 2600 uniquely detected carbon monoxide. This research demonstrates the feasibility of developing an affordable electronic nose system, comparable to commercial versions, using TGS 26xx series gas sensors and a custom-built interfacing circuit. The results have shown that it is possible to develop a low cost interfacing circuit for TGS 26xx series based electronic nose system that will perform the same function that ready-made electronic nose system will perform in order to make electronic nose system readily affordable.

Keywords*: electronic nose system, gas sensors, TGS 26xx series, volatile compounds, odour detection*

INTRODUCTION

The detection and classification of gases have become increasingly important in various fields, including environmental monitoring, industrial safety, and healthcare. Electronic nose (e-nose) systems, inspired by the human olfactory system, have emerged as a promising solution for gas detection and identification. The TGS 26XX series of gas sensors, known for their high sensitivity and stability, are widely used in e-nose systems.

However, the TGS 26XX series sensors require a sophisticated interfacing circuit to accurately measure and process the sensor signals. The development of a reliable and efficient interfacing circuit is crucial for the optimal performance of the e-nose system.

This project aims to design and develop an interfacing circuit for the TGS 26XX series based electronic nose system. The proposed circuit will be designed to provide a stable and accurate signal conditioning, analog-to-digital conversion, and data processing. The developed interfacing circuit will be tested and validated using various gas samples to evaluate its performance and reliability.

Electronic nose (e-nose) systems have gained significant attention in recent years due to their potential applications in various fields such as environmental monitoring, industrial safety, and healthcare. The TGS 26XX series of gas sensors are widely used in e-nose systems due to their high sensitivity and stability. However, the development of a reliable and efficient interfacing circuit is crucial for the optimal performance of the e-nose system.

Gas Sensors and Electronic Nose Systems

Gas sensors are an essential component of e-nose systems, and various types of gas sensors have been developed, including metal oxide semiconductor (MOS) sensors, conducting polymer sensors, and surface acoustic wave (SAW) sensors. The TGS 26XX series of gas sensors are MOS-based sensors that are known for their high sensitivity and stability.
Interfacing Circuits for Gas Sensors

The interfacing circuit plays a crucial role in the performance of the e-nose system, as it is responsible for conditioning the sensor signals, converting the analog signals to digital signals, and processing the data. Various interfacing circuits have been developed for gas sensors, including voltage divider circuits, Wheatstone bridge circuits, and operational amplifier-based circuits.
Several studies have reported the development of interfacing circuits for TGS 26XX series gas sensors. For example, a study by Liu et al. (2020) reported the development of a voltage divider-based interfacing circuit for a TGS 2620 gas sensor. The circuit was designed to provide a stable output voltage and was tested using various gas samples.

The development of a reliable and efficient interfacing circuit is crucial for the optimal performance of the e-nose system. Various interfacing circuits have been developed for gas sensors, including voltage divider circuits, Wheatstone bridge circuits, and operational amplifier-based circuits. This project aims to design and develop an interfacing circuit for the TGS 26XX series based electronic nose system Liu, X., Zhang, Y., & Wang, X. (2020)..

For a sensor to be useful, it must be able to distinguish between gases. The circuit connections of these sensors with other electrical devices constitute an electronic nose system.
For a sensor to be useful, it must be able to distinguish between gases. The circuit connections of these sensors with other electrical devices constitute an electronic nose system.

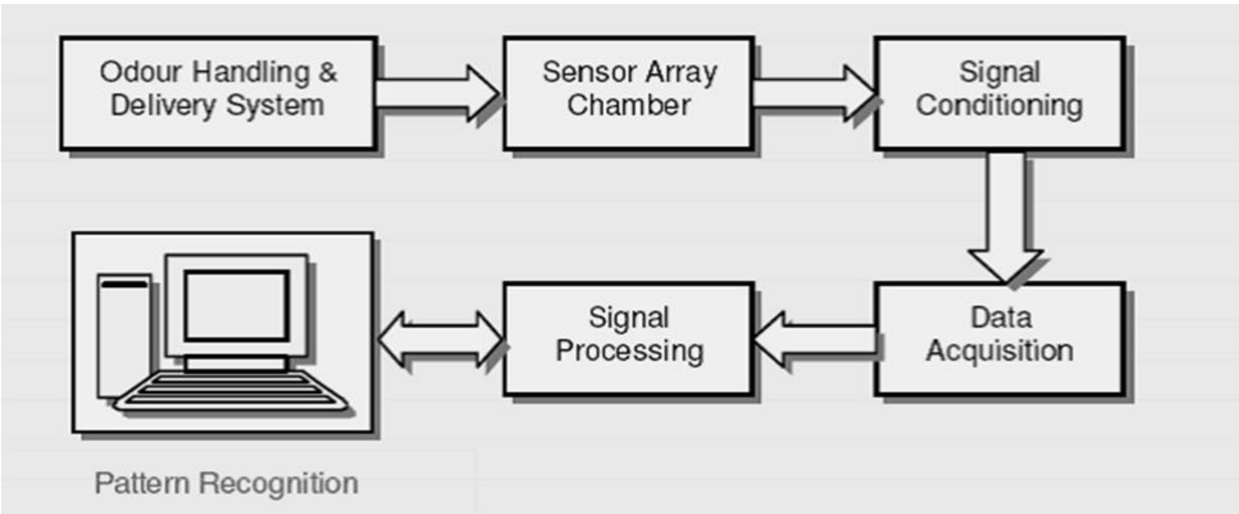


Figure 1: Functional Units of an Electronic Nose System

Figaro has developed MOS sensors for detection of solvent vapours. The Taguchi-type gas sensors (TGS) obtained from Figaro Co. Ltd. are: TGS 821, TGS 822, TGS 825, TGS 826, TGS 830,TGS 831,TGS 2104, TGS 2201, TGS 2442, TGS 2600,TGS 2602, TGS 2610, TGS 2620,TGS 3870,TGS 4160,TGS 4161,TGS 5042,TGS 6810. Exposure of a tin-oxide sensor to a vapour produces a large change in its electrical resistance.

ISSN:2782-8492
FEDPOLAD Journal of Engineering & Environmental Studies (FEDPOLADJEES); Vol. 4, ISSUE 1. OCTOBER, 2024 Edition
Website: https://seemjournals.fedpolyado.edu.ng/index.php/fedpoladjees
Proudly Sponsored by: tetfund TERTIARY EDUCATION TRUST FUND
TETFund/ESS/POLY/ADO-EKITI/ARJ/1

MATERIAL

Variable Resistors
Jumper wires
Soldering Iron
9 volt Battery
Methane
Cutter
Soldering Lead
Precision sets of screw drivers
Pliers
Lead sucker
Single Pole Single Throw (SPST) Switch

Methods

The Gas Sensors' specification

The sensing unit consists of various gas sensors with their different series and properties, the types of gas sensors that are available for this project work under 2000 series are:

- 2602 series
- 2600 series
- 2620 series
- 2612 series

The sensor requires two voltage inputs: heater voltage (VH) and circuit voltage (VC). The heater voltage (VH) is applied to the integrated heater in order to maintain the sensing element at a specific temperature which is optimal for sensing. Circuit voltage (VC) is applied to allow measurement of voltage (Vout) across a load resistor (RL) which is connected in series with the sensor.

DC voltage is required for the circuit voltage since the sensor has a polarity. A common power supply circuit can be used for both VC and VH to fulfill the sensor's electrical requirements. The value of the load resistor (RL) should be chosen to optimize the alarm threshold value, keeping power consumption (PS) of the semiconductor below a limit of 15mW. Power consumption (PS) will be highest when the value of Rs is equal to RL on exposure to gas.

The sensor is working on the principle of the potential divider and the formula is given below

V_{RL} = (RS/RL) x Vc
RS = Sensor Resistance
RL = Load resistance
VH = Heater Voltage
GND = Ground
Ps =VC2 x Rs/ (Rs + RL)2

So that when the concentration of the contaminants increases the sensor resistance reduces thereby increasing the Output voltage.

The sensitivity graph for TGS 2602 is shown in the Figure 3.3 below as given by Figaro products information datasheet.

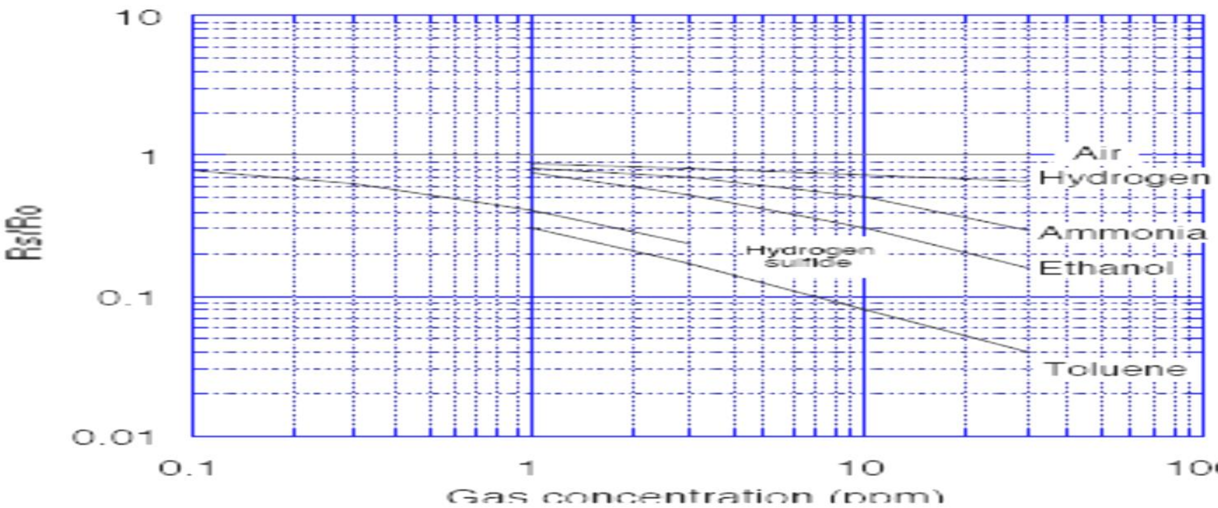


Figure 2: sensitivity graph of TGS 2602 gas sensor

FEDPOLAD Journal of Engineering & Environmental Studies (FEDPOLADJEES) is a Bi-Annual Publication Series of the Federal Polytechnic, Ado-Ekiti, Ekiti State. For more details, kindly visit https://seemjournals.fedpolyado.edu.ng/index.php/fedpoladjees. All critics, reviews, correspondence, or submission of articles for scholarly publication in the next edition of this Journal should be forwarded to seemjournal@fedpolyado.edu.ng. For more enquiries, please contact +234 806 701 4621 or +234 803 506 0823.

Specification for TGS 2600 Sensor

The TGS 2600 has high sensitivity to low concentrations of gaseous air contaminants such as hydrogen and carbon monoxide which exist in cigarette smoke. The sensor can detect hydrogen at a level of several ppm. Figaro also offers a microprocessor (FIC02667) which contains special software for handling the sensor's signal for appliance control applications. Due to miniaturization of the sensing chip, TGS 2600 requires a heater current of only 42mA and the device is housed in a standard TO-5 package. The gas sensor basic sensitivity graph for TGS 2600 are shown in Figure 2 below.

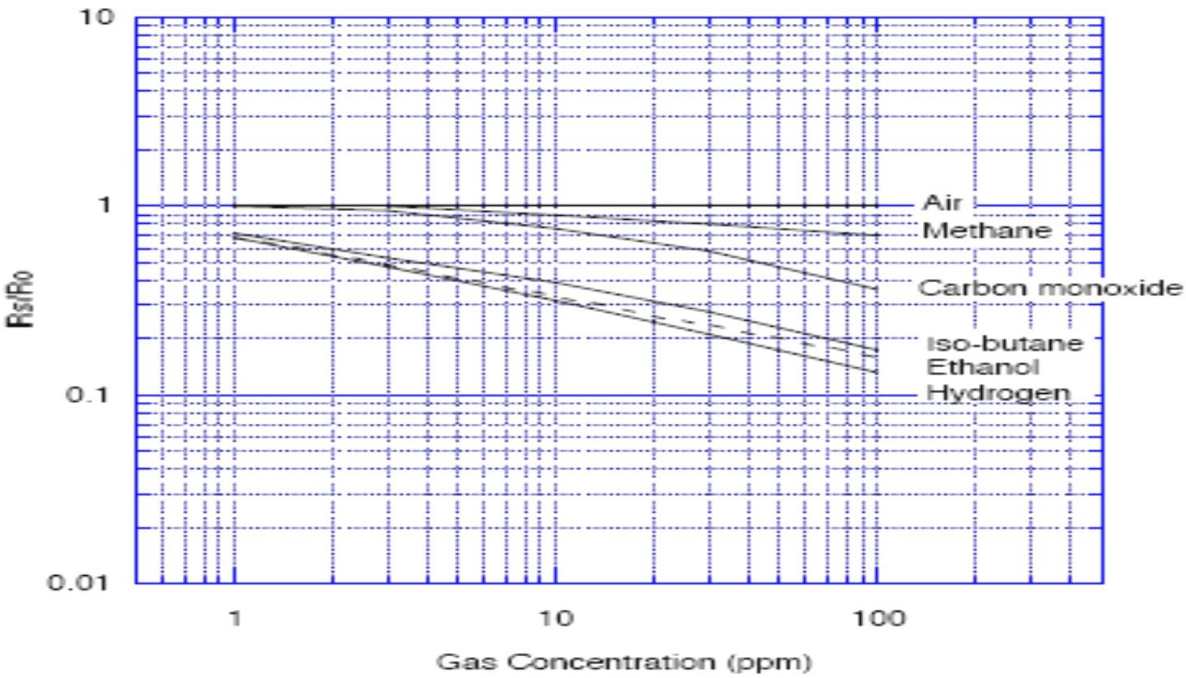


Figure 3: sensitivity graph of TGS 2600 gas sensor

Specification for TGS 2620 sensor

The TGS 2620 has high sensitivity to the vapors of organic solvents as well as other volatile vapors. It also has sensitivity to a variety of combustible gases such as carbon monoxide, making it a good general purpose sensor.

Due to miniaturization of the sensing chip, TGS 2620 requires a heater current of only 42mA and the device is housed in a standard TO-5 package. TGS2620 sensor requires two voltage inputs: heater voltage (Vh) and circuit voltage (Vc). The heater voltage is applied to the integrated heater in order to maintain the sensing element at a specific temperature which optimal for sensing. Circuit voltage is applied to allow measurement of voltage across a load resistor which is connected in series with the sensor. A common power supply unit is used for both circuit voltage and heater voltage to fulfill the sensor electrical requirements.

Specification for TGS 2612

The TGS 2612 has high sensitivity to methane, propane and butane, making it ideal for LNG and LPG monitoring. Due to its low sensitivity to alcohol vapors (a typical interference gas in the residential environment), the sensor is ideal for consumer market gas alarms.

Due to miniaturization of the sensing chip, TGS 2612 requires a heater current of only 56mA and the device is housed in a standard TO-5 package. The picture for

FEDPOLAD Journal of Engineering & Environmental Studies (FEDPOLADJEES) is a Bi-Annual Publication Series of the Federal Polytechnic, Ado-Ekiti, Ekiti State. For more details, kindly visit *https://seemjournals.fedpolyado.edu.ng/index.php/fedpoladjees*. All critics, reviews, correspondence, or submission of articles for scholarly publication in the next edition of this Journal should be forwarded to seemjournal@fedpolyado.edu.ng. For more enquiries, please contact +234 806 701 4621 or +234 803 506 0823.

ISSN:2782-8492
FEDPOLAD Journal of Engineering & Environmental Studies (FEDPOLADJEES); Vol. 4, ISSUE 1. OCTOBER, 2024 Edition
Website: https://seemjournals.fedpolyado.edu.ng/index.php/fedpoladjees
Proudly Sponsored by: tetfund TERTIARY EDUCATION TRUST FUND
TETFund/ESS/POLY/ADO-EKITI/ARJ/1

sensitivity graph for TGS 2612 are shown in the figure 4 below.

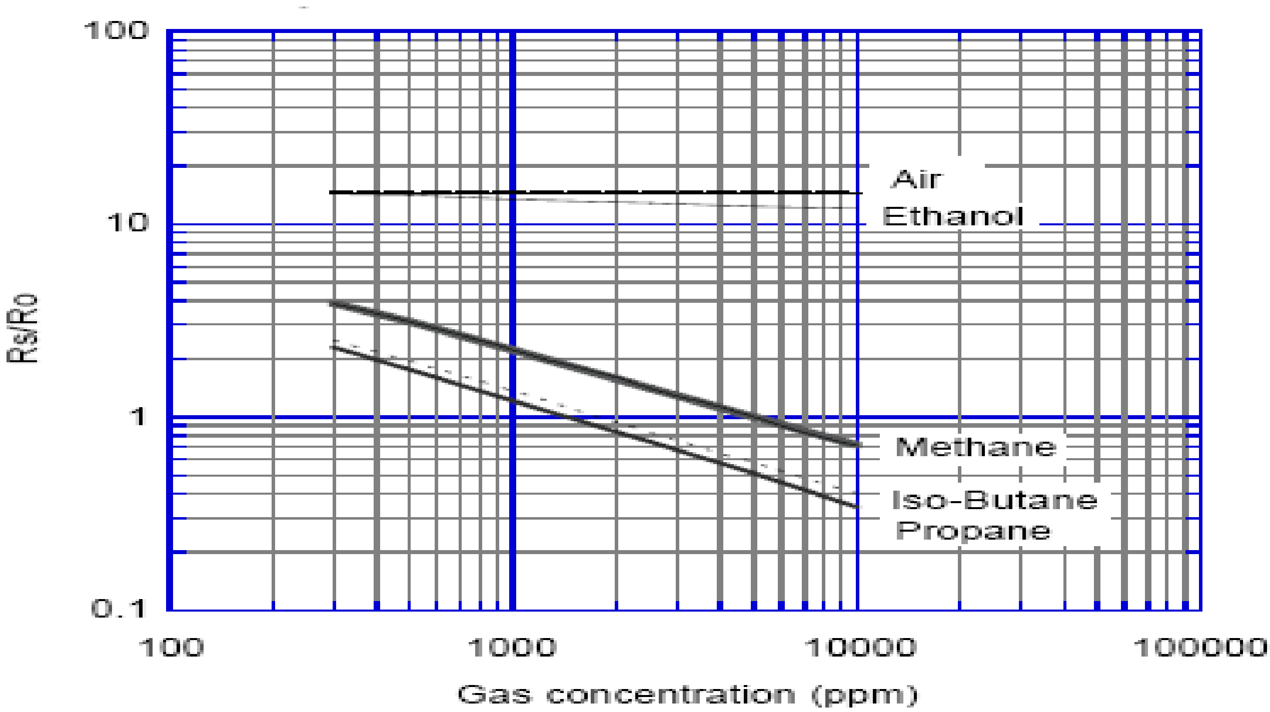


Figure 4: Sensitivity graph for TGS 2612 Gas Sensor.

The construction of Interfacing circuit

The construction process was done within a short period of time and within this period so many operations were carried out. The whole project work was completed in six weeks and the analysis of the construction in that four weeks are analyzed below.

Week 1 & 2: The simulation of the circuit diagram

Week 3& 4: The construction on the Ferro-Board

Week 5&6: The construction on PCB.

The construction of the circuit was done on the PCB clad, the process that was involved in the preparation of the PCB are as listed below:

- Circuit simulation
- PCB drawing
- Printing of Films
- Transferring to PCB
- Etching
- Drilling
- Assemblage

Circuit Simulation

The circuit simulation was carried out on different software such as Tina IDE, Circuit Maker and the circuit simulated correctly. The sensors were replaced with their respective resistors so as to simulate it because the sensors are not available in the software. When the simulation was successful the PCB layout drawing was started. The figure 4 below show the circuit diagram as drawn with Tina software

ISSN:2782-8492

FEDPOLAD Journal of Engineering & Environmental Studies (FEDPOLADJEES); Vol. 4, ISSUE 1. OCTOBER, 2024 Edition

Website: *https://seemjournals.fedpolyado.edu.ng/index.php/fedpoladjees*

Proudly Sponsored by: tetfund TERTIARY EDUCATION TRUST FUND

TETFund/ESS/POLY/ADO-EKITI/ARJ/1

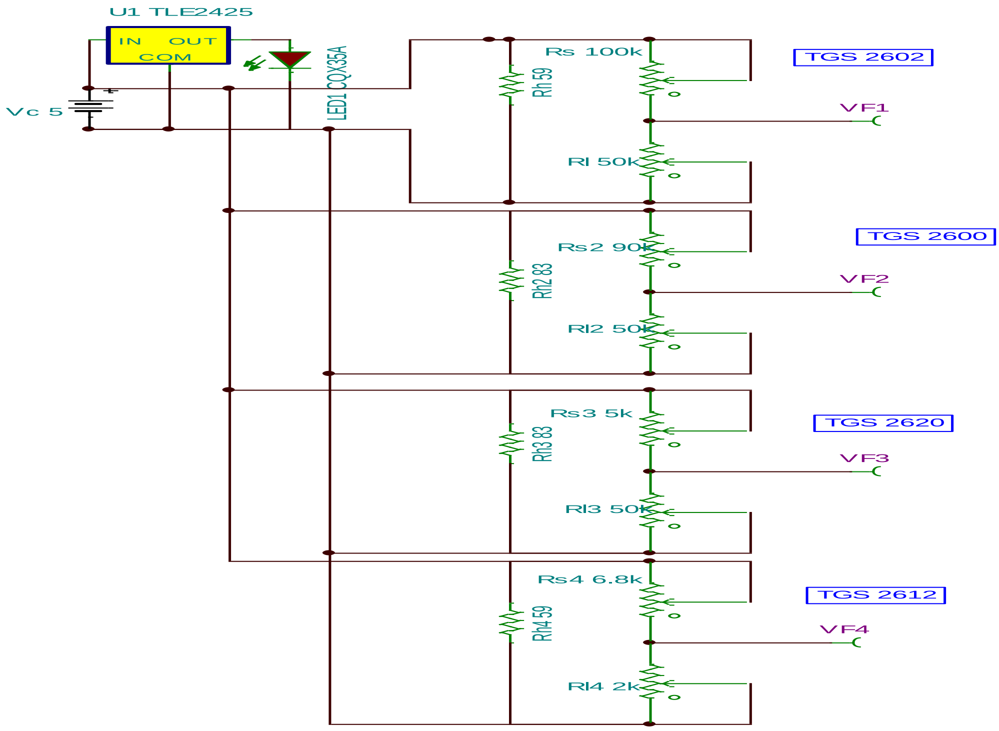


Figure 5: simulated interfacing circuit

PCB (Printed Circuit Board) Drawing

PCB drawing was carried out on a software known as the PCB express, this software allows user to draw their PCB layout and provides all needed components needed to design the PCB. So after the drawing of the PCB then the PCB layout was printed through a laser jet printer with tick toner level (DeskJet printer cannot be used). The printed PCB is being transferred to the Copper clad by heating the pressing iron for few minutes to heat up to a high temperature, the PCB layout film is placed on the clad and an insulator is placed on it and then the iron is used to press it. This process will last for a few minutes and the film will be removed.

Figure 6: The PCB layout

The drilling follows immediately after the etching process and the drilling was done with the aid of the hand drilling machine that works in dc supply. The drilling parts have been indicated on the PCB clad so the drilling processes do not really take much time and skills.

After the drilling the assemblage followed immediately, the components that are needed have been gathered and they are inserted as the circuit specify. The assemblage process do not also take time since every component to be placed have been indicated by the PCB layout.

Testing

After the soldering was finished the testing took place across the nodes of the circuit and the following readings were taking as shown in Table 1.2 below

Table 1.2: testing across the nodes

NODE	CURRENT	VOLTAGE
POWER	100mA	5.05V
HEATER	1mA	5V

FEDPOLAD Journal of Engineering & Environmental Studies (FEDPOLADJEES) is a Bi-Annual Publication Series of the Federal Polytechnic, Ado-Ekiti, Ekiti State. For more details, kindly visit *https://seemjournals.fedpolyado.edu.ng/index.php/fedpoladjees*. All critics, reviews, correspondence, or submission of articles for scholarly publication in the next edition of this Journal should be forwarded to seemjournal@fedpolyado.edu.ng. For more enquiries, please contact +234 806 701 4621 or +234 803 506 0823.

ISSN:2782-8492
FEDPOLAD Journal of Engineering & Environmental Studies (FEDPOLADJEES); Vol. 4, ISSUE 1. OCTOBER, 2024 Edition
Website: https://seemjournals.fedpolyado.edu.ng/index.php/fedpoladjees
Proudly Sponsored by: tetfund TERTIARY EDUCATION TRUST FUND
TETFund/ESS/POLY/ADO-EKITI/ARJ/1

Figure 7: picture of designed interfacing circuit

Precautions Taking While Constructing the interfacing circuit

1. we ensured that the temperature of the soldering iron remain constant at the normal 150^0C that is needed by the components and the board so as to prevent the layers on the PCB from pilling off.
2. We ensured that the right placement of the components on the board so as to prevent damage to the components.

Analog To Digital Conversion

The variation in the output voltage of the sensor is being measures and logged by the use of the PICO ADC11 data logger. The ADC-11 Terminal Board is an accessory for the 11-channel ADC-11 Data Logger. It enables you to build sensor circuits that take measurements for the data logger to process. The screw terminals allow sensor wires to be attached direct to the board without the need for solder. Figure 8and Figure 9 below show the picture of Pico ADC11 data logger and ADC-11 terminal board respectively.

Figure 8: The picture of ADC-11 data logger

ISSN:2782-8492

FEDPOLAD Journal of Engineering & Environmental Studies (FEDPOLADJEES); Vol. 4, ISSUE 1. OCTOBER, 2024 Edition

Website: *https://seemjournals.fedpolyado.edu.ng/index.php/fedpoladjees*

Proudly Sponsored by: tetfund TERTIARY EDUCATION TRUST FUND

TETFund/ESS/POLY/ADO-EKITI/ARJ/1

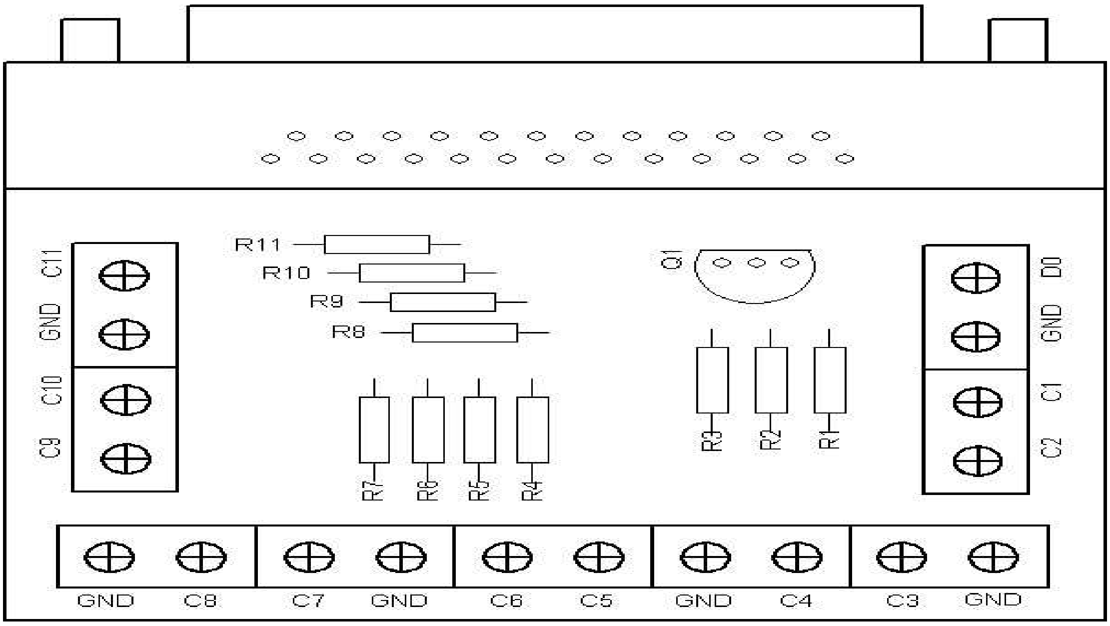


Figure 9: ADC-11 Terminal Board

The table 1.3 below shows the purpose of each of the terminals and empty component sites.

Table 1.3: terminals and components sites

Terminal or site	**Description**
C1 to C11	Connections to ADC channels 1 to 11.
D0	Digital output. If you write your own application you can use this as a low-current supply to power sensors.
GND	Connection to ground.
Q1	Site for LM35 temperature sensor. See Section 2.4.2.
R1 to R3	Sites for resistors between D0 and channels 1 to 3.
R4 to R7	Sites for series resistors in inputs to channels 5 to 8. Shown as R[illegible] in the text. If you fit a resistor in one of these sites, you must cut the corresponding thin track on the back of the circuit board.
R8 to R11	Sites for shunt resistors between channels 5 to 8 and GND. Shown as R[illegible] in the text.

Terminals and component sites

FEDPOLAD Journal of Engineering & Environmental Studies (FEDPOLADJEES) is a Bi-Annual Publication Series of the Federal Polytechnic, Ado-Ekiti, Ekiti State. For more details, kindly visit *https://seemjournals.fedpolyado.edu.ng/index.php/fedpoladjees*. All critics, reviews, correspondence, or submission of articles for scholarly publication in the next edition of this Journal should be forwarded to seemjournal@fedpolyado.edu.ng. For more enquiries, please contact +234 806 701 4621 or +234 803 506 0823.

ISSN:2782-8492
FEDPOLAD Journal of Engineering & Environmental Studies (FEDPOLADJEES); Vol. 4, ISSUE 1. OCTOBER, 2024 Edition
Website: https://seemjournals.fedpolyado.edu.ng/index.php/fedpoladjees
Proudly Sponsored by: tetfund TERTIARY EDUCATION TRUST FUND
TETFund/ESS/POLY/ADO-EKITI/ARJ/1

Connecting to the data logger

The output of each sensor is connected to terminal board of the pico data logger and the pico data logger is connected to the computer system through the used of USB (Universal Serial Bus) cord, as shown in the figure 10 below.

Figure 10: Picture of the designed interfacing circuit connected with PICO data logger and computer system.

Here's a comparison of the natural data of a human nose with the development of an interfacing circuit for a TGS 2600 series-based electronic nose system:

Natural Data of a Human Nose

1. Odor Detection: 1-10 ppm (parts per million)
2. Odor Recognition: 100-1000 odorants
3. Sensitivity: 10^-12 g/ml (minimum detectable concentration)
4. Selectivity: 90% (ability to distinguish between similar odors)
5. Response Time: 100-500 ms (time to detect and recognize an odor)
6. Recovery Time: 1-10 s (time to recover from an odor stimulus)

Development of Interfacing Circuit for TGS 2600 Series-Based Electronic Nose System

1. Odor Detection: 10-100 ppm (parts per million)
2. Odor Recognition: 10-100 odorants
3. Sensitivity: 10^-6 g/ml (minimum detectable concentration)
4. Selectivity: 80% (ability to distinguish between similar odors)
5. Response Time: 1-10 s (time to detect and recognize an odor)
6. Recovery Time: 10-60 s (time to recover from an odor stimulus)

Comparison

1. Odor Detection: The human nose can detect odors at much lower concentrations (1-10 ppm) compared to the electronic nose system (10-100 ppm).
2. Odor Recognition: The human nose can recognize a much wider range of odorants (100-1000) compared to the electronic nose system (10-100).
3. Sensitivity: The human nose is much more sensitive (10^-12 g/ml) compared to the electronic nose system (10^-6 g/ml).
4. Selectivit: The human nose has better selectivity (90%) compared to the electronic nose system (80%).
5. Response Time: The human nose responds much faster (100-500 ms) compared to the electronic nose system (1-10 s).

ISSN:2782-8492
FEDPOLAD Journal of Engineering & Environmental Studies (FEDPOLADJEES); Vol. 4, ISSUE 1. OCTOBER, 2024 Edition
Website: https://seemjournals.fedpolyado.edu.ng/index.php/fedpoladjees
Proudly Sponsored by: tetfund TERTIARY EDUCATION TRUST FUND
TETFund/ESS/POLY/ADO-EKITI/ARJ/1

6. Recovery Time: The human nose recovers much faster (1-10 s) compared to the electronic nose system (10-60 s).

The comparison highlights the impressive capabilities of the human nose, which has evolved over millions of years to detect and recognize a wide range of odors. The electronic nose system, while impressive in its own right, still has limitations compared to the human nose.

Testing of Designed Interfacing Circuit

The designed circuit was tested with the carbon monoxide from cigarette smoke, ammonia, methane, and ethanol.

Test with Ammonia

The output of each of the sensor in the designed circuit is connected to the ADC Terminal board channel in this arrangement, TGS 2612 was connected to channel 1,TGS 2600 was connected to channel 2 and TGS 2602 to channel 3 of the Pico data logger . The graph is as shown in the figures 11, 12, and 13 below with load resistors of 3kΩ, 25kΩ, and 50kΩ respectively.

Figure 11: Test with Ammonia when the load resistor is 3kΩ

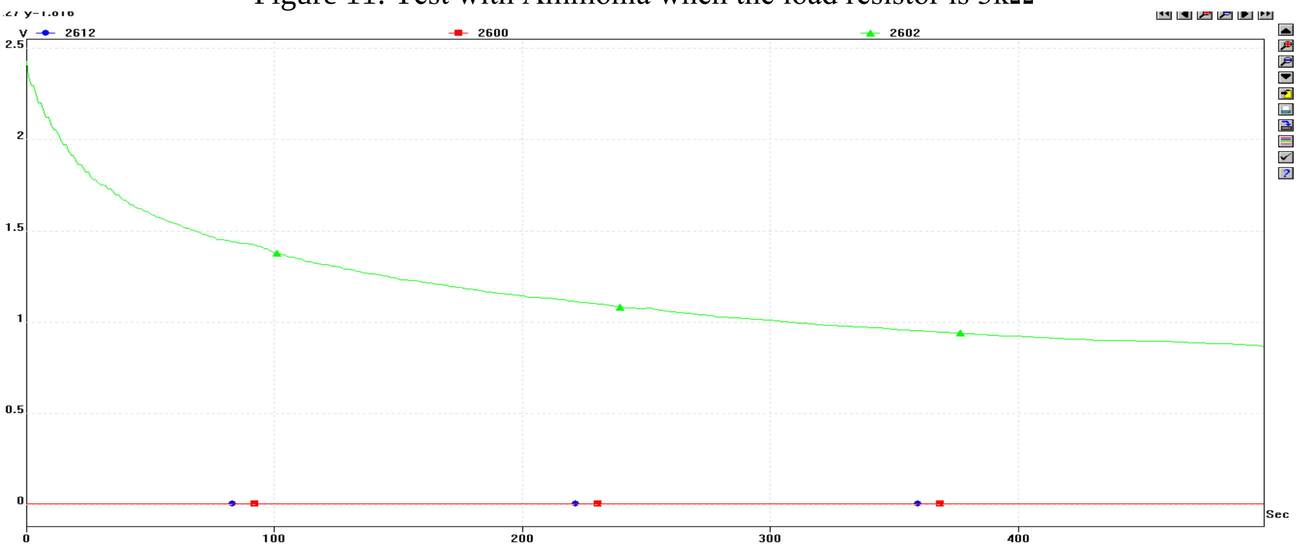
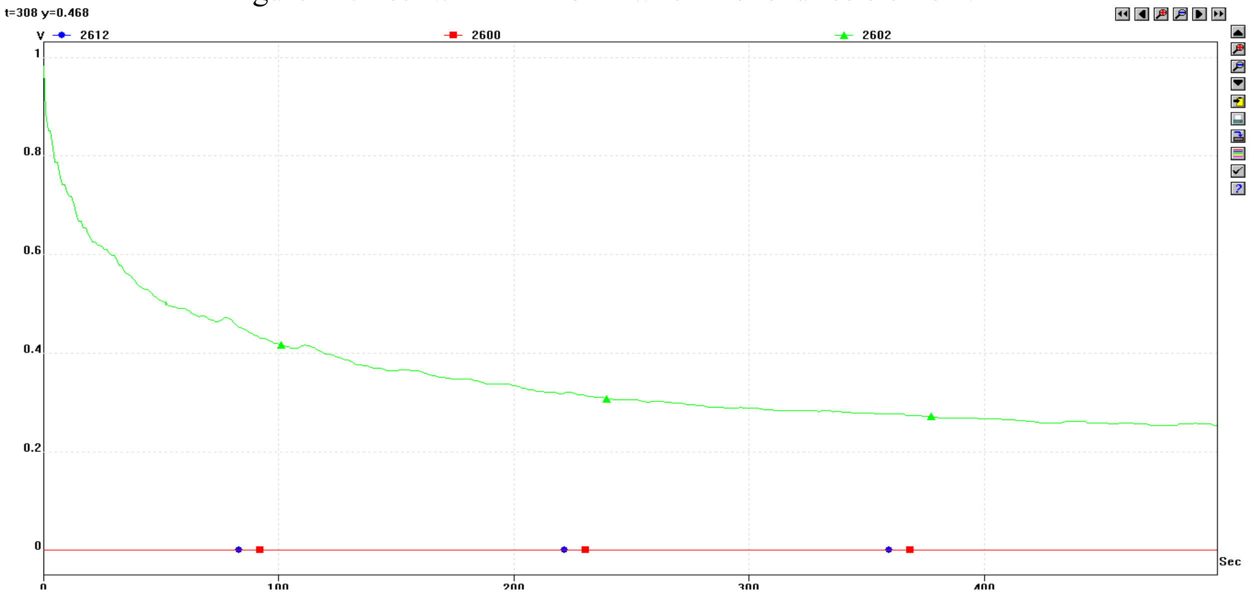


Figure 12: Test with Ammonia when the load resistor is 25kΩ



FEDPOLAD Journal of Engineering & Environmental Studies (FEDPOLADJEES) is a Bi-Annual Publication Series of the Federal Polytechnic, Ado-Ekiti, Ekiti State. For more details, kindly visit *https://seemjournals.fedpolyado.edu.ng/index.php/fedpoladjees*. All critics, reviews, correspondence, or submission of articles for scholarly publication in the next edition of this Journal should be forwarded to seemjournal@fedpolyado.edu.ng. For more enquiries, please contact +234 806 701 4621 or +234 803 506 0823.

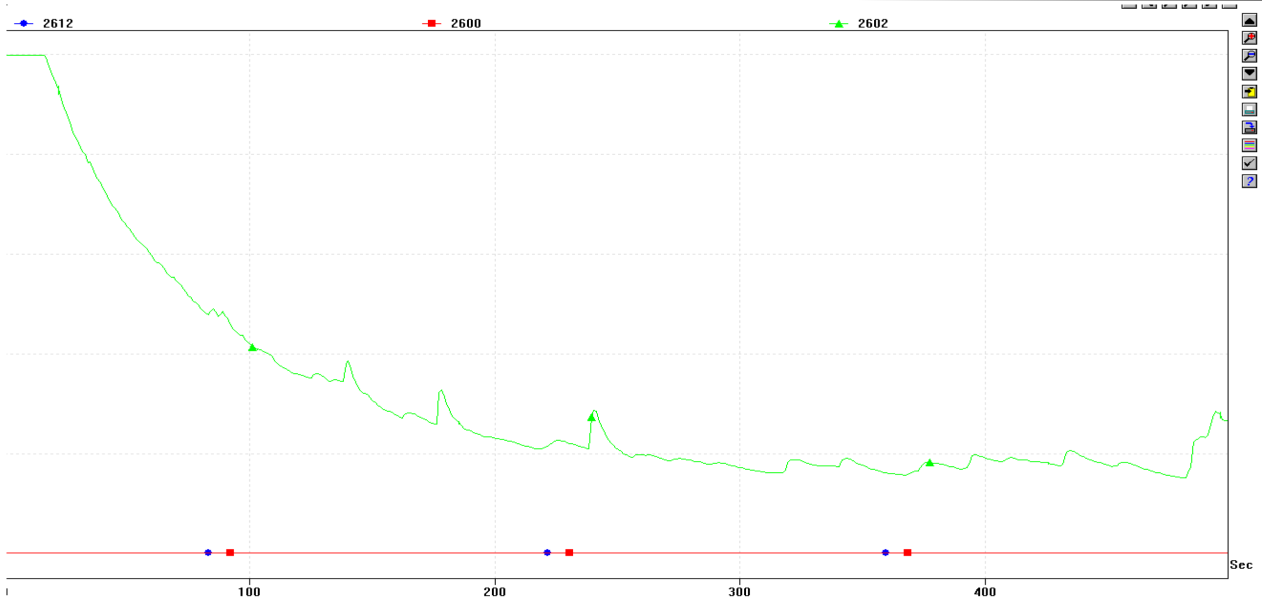


Figure 13: Test with Ammonia when the load resistor is 50kΩ

It can be seen from the figures 11, 12 and 13 that only TGS 2602 was sensitive to the ammonia gas while the rest of the sensor are at zero level, indicating that they are not sensitive to the ammonia gas. This prove that TGS2602 responding to ammonia gas the sensor, this is in consonance with the data sheet specification of TGS 2600 sensor and data sheet specification of TGS 2612 sensor are not sensitive to ammonia gas in agreement with the data sheet provided by the Figaro sensor.

3.4.2 Test with Ethanol

The test was conducted for 500 seconds and the outputs of the sensors were connected as follows:
TGS 2602 was connected to channel 1, TGS 2600 was connected to channel 2 and TGS 2612 was connected to channel 3 of the PICO data logger.

And the reading were taking for the different values of load resistors, figures 14, 15 and 16 below show the graph of the test for 3k, 25k and 50k for the value of load resistance respectively.

Figure 14: test with Ethanol when the load resistor is 3kΩ

FEDPOLAD Journal of Engineering & Environmental Studies (FEDPOLADJEES) is a Bi-Annual Publication Series of the Federal Polytechnic, Ado-Ekiti, Ekiti State. For more details, kindly visit *https://seemjournals.fedpolyado.edu.ng/index.php/fedpoladjees*. All critics, reviews, correspondence, or submission of articles for scholarly publication in the next edition of this Journal should be forwarded to seemjournal@fedpolyado.edu.ng. For more enquiries, please contact +234 806 701 4621 or +234 803 506 0823.

ISSN:2782-8492

FEDPOLAD Journal of Engineering & Environmental Studies (FEDPOLADJEES); Vol. 4, ISSUE 1. OCTOBER, 2024 Edition

Website: *https://seemjournals.fedpolyado.edu.ng/index.php/fedpoladjees*

Proudly Sponsored by: tetfund TERTIARY EDUCATION TRUST FUND

TETFund/ESS/POLY/ADO-EKITI/ARJ/1

Figure 15: test with Ethanol when the load resistor is 25kΩ

Figure 16: test with Ethanol when the load resistor is 50kΩ

It was shown in the figure 14, 15 and 16 that the three sensors were sensitive to Ethanol but with different degrees. TGS 2600 and TGS 2602 are highly sensitive to Ethanol this is can be seen in Figure 14 and Figure 15 that they are of higher voltages, while TGS 2612 is the least sensitive to Ethanol this is explain in figure 14 as the graph is almost at zero level.

Test with Carbon monoxide from cigarette smoke

The test was conducted for 500 seconds and the output of the sensors where connected thus; TGS 2612 was connected to channel 1,TGS 2602 was connected to channel 2 and TGS 2600 was connected to channel 3 of PICO data logger.

The circuit was tested for different load resistors and the result is shown in the figures 17, 18, and 19 below with load resistor of 3kΩ, 25kΩand 50kΩ respectively.

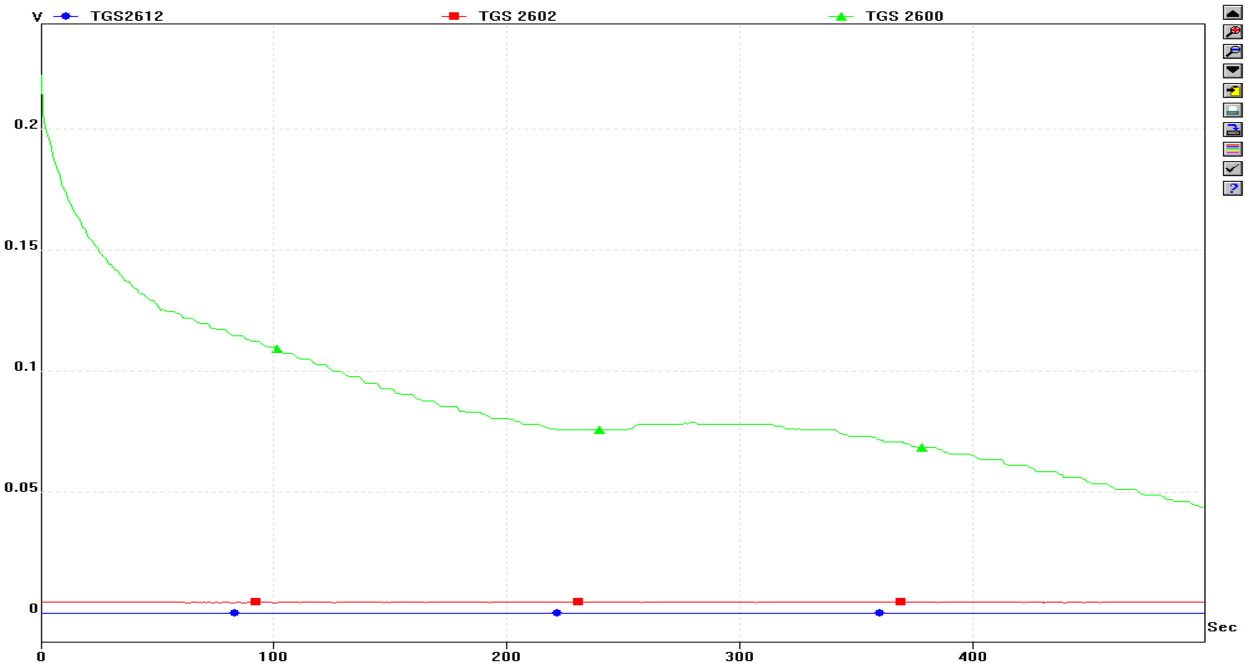


Figure 17: Test with carbon monoxide from cigarette smoke with 3kΩ load resistor.

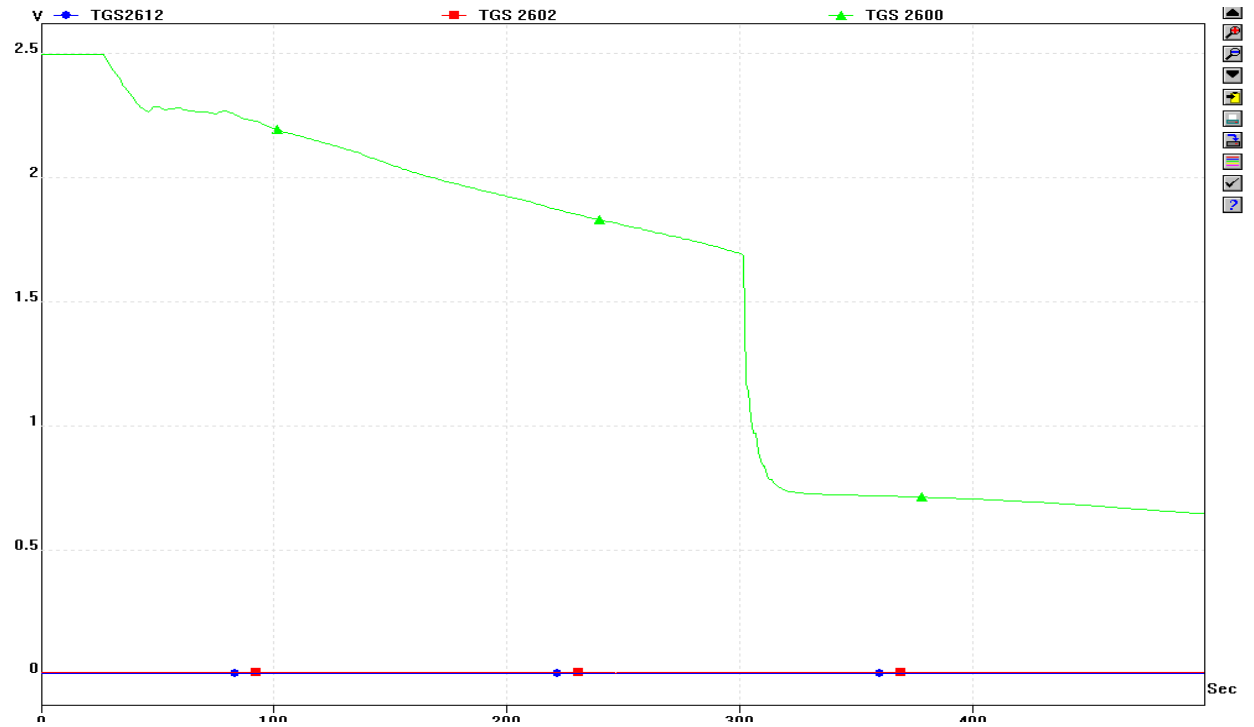


Figure 18: Test with carbon monoxide from cigarette smoke when load resistor is 25kΩ

ISSN:2782-8492
FEDPOLAD Journal of Engineering & Environmental Studies (FEDPOLADJEES); Vol. 4, ISSUE 1. OCTOBER, 2024 Edition
Website: *https://seemjournals.fedpolyado.edu.ng/index.php/fedpoladjees*
Proudly Sponsored by: tetfund TERTIARY EDUCATION TRUST FUND
TETFund/ESS/POLY/ADO-EKITI/ARJ/1

Figure 19: Test with carbon monoxide from cigarette smoke when load resistor is 50kΩ

It was shown from the graph of the figures 17, 18 and 19 that only TGS 2600 is sensitive to the carbon monoxide gas while TGS 2612 and TGS 2602 were at the zero level which shows that they are not sensitive to carbon monoxide .

Test with Methane Gas

The test was conducted for 500 seconds and the output of the sensors where connected thus; TGS 2612 was connected to channel 1,TGS 2602 was connected to channel 2 and TGS 2600 was connected to channel 3 of PICO data logger.

The circuit was tested for different load resistors and the results are shown in the figures 20, 21 and 22 below with load resistor of 2kΩ, 25kΩ and 50kΩ respectively.

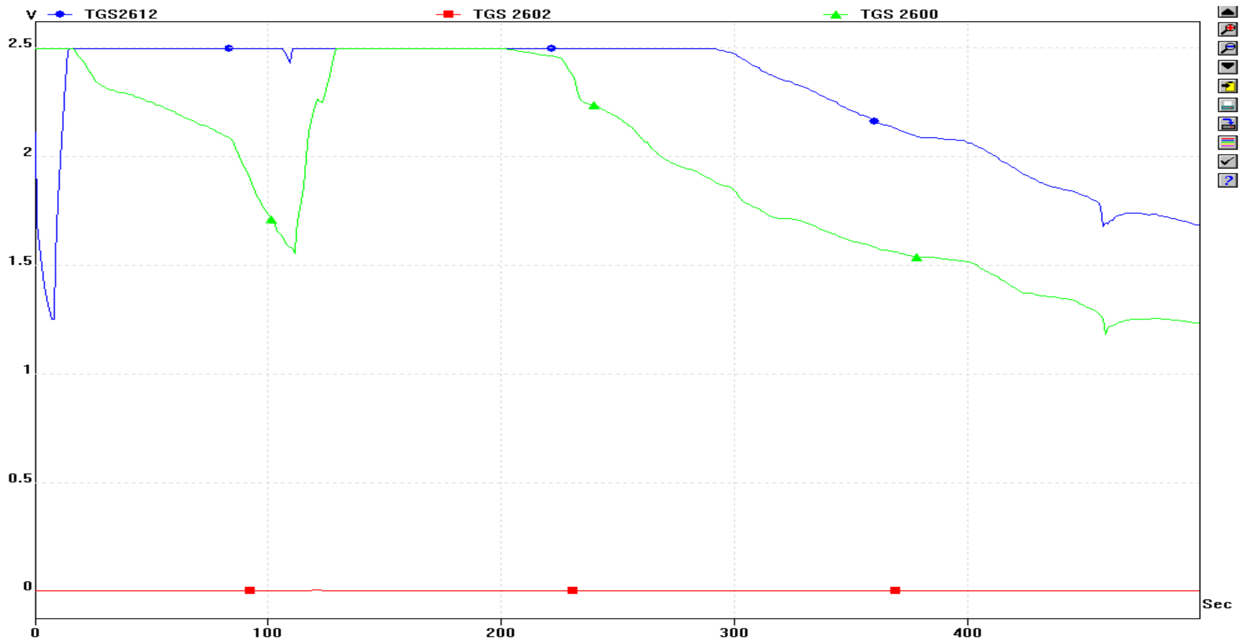


Figure 20: Test with methane when load resistance is 2kΩ

FEDPOLAD Journal of Engineering & Environmental Studies (FEDPOLADJEES) is a Bi-Annual Publication Series of the Federal Polytechnic, Ado-Ekiti, Ekiti State. For more details, kindly visit *https://seemjournals.fedpolyado.edu.ng/index.php/fedpoladjees*. All critics, reviews, correspondence, or submission of articles for scholarly publication in the next edition of this Journal should be forwarded to seemjournal@fedpolyado.edu.ng. For more enquiries, please contact +234 806 701 4621 or +234 803 506 0823.

ISSN:2782-8492
FEDPOLAD Journal of Engineering & Environmental Studies (FEDPOLADJEES); Vol. 4, ISSUE 1. OCTOBER, 2024 Edition
Website: *https://seemjournals.fedpolyado.edu.ng/index.php/fedpoladjees*
Proudly Sponsored by: tetfund TERTIARY EDUCATION TRUST FUND
TETFund/ESS/POLY/ADO-EKITI/ARJ/1

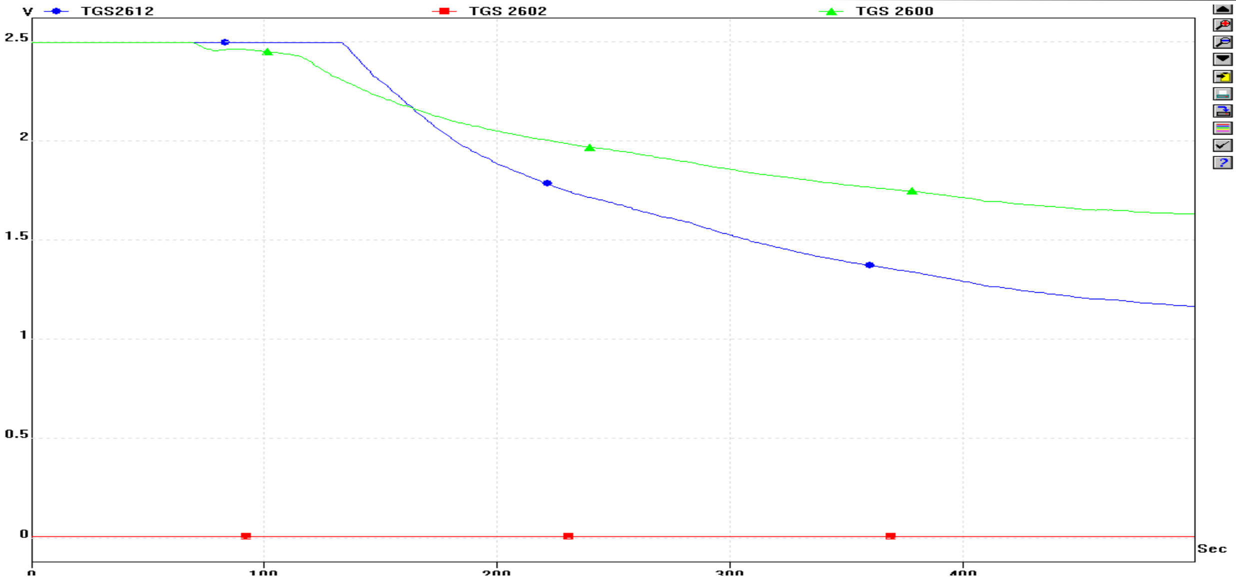


Figure 21: Test with methane when load resistor is 25kΩ

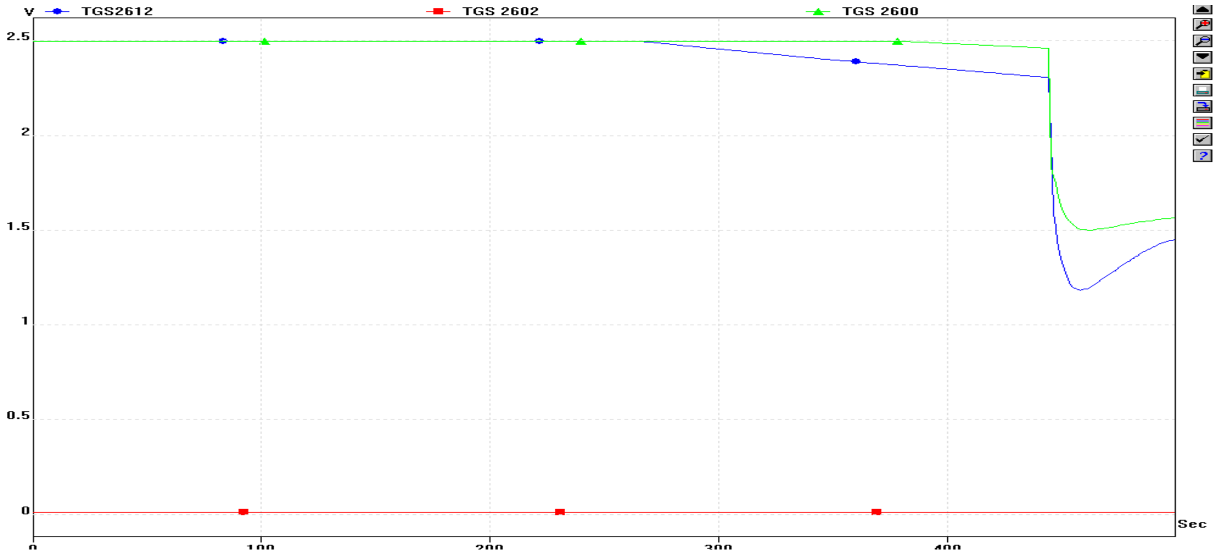


Figure 22: Test with methane when the load resistor is 50kΩ

It is shown from the graph in the figures 20, 21, and 22 that TGS 2612 and TGS 2600 are at higher voltage, this means that they are sensitive to methane while TGS 2602 is at the zero level indicating that it is not sensitive to methane.

CONCLUSION AND RECOMMEDATION

Conclusion

From the developed interfacing circuit for TGS 26xx series based electronic nose system using printed circuit Board technology (PCB) which was connected to Pico data logger and computer system. After the interfacing circuit was tested with methane, ammonia, carbon monoxide from cigarette smoke, and ethanol .The results of the test has shown that out of the selected gas sensors only TGS 2602 gas sensor is sensitive to ammonia gas, TGS 2612 and TGS 2600 are sensitive to methane, TGS 2602 and TGS 2600 are highly sensitive to ethanol while TGS 2612 have a low sensitivity to ethanol, and that TGS 2600 is the only sensor from the selected sensor that is sensitive

FEDPOLAD Journal of Engineering & Environmental Studies (FEDPOLADJEES) is a Bi-Annual Publication Series of the Federal Polytechnic, Ado-Ekiti, Ekiti State. For more details, kindly visit *https://seemjournals.fedpolyado.edu.ng/index.php/fedpoladjees*. All critics, reviews, correspondence, or submission of articles for scholarly publication in the next edition of this Journal should be forwarded to seemjournal@fedpolyado.edu.ng. For more enquiries, please contact +234 806 701 4621 or +234 803 506 0823.

to carbon monoxide from cigarette smoke. The result have shown that it is possible to develop a low cost interfacing circuit for TGS 26xx series based electronic nose system that will perform the same function that ready made electronic nose system will perform in order to make electronic nose system readily affordable .

Recommendation

This research work is recommended for use under atmospheric temperature of 20°C .
Since the circuit is sensitive to carbon monoxide which is dangerous to human health because it can combine with haemoglobin and reduce the power of blood to carry oxygen which can lead to suffocation, therefore, the circuit is recommended for environmental monitoring.
Also, this work is capable for analysis of alcohol as it is sensitive to different levels of alcohol concentration.

REFERENCES

1. Arulogun O.T. (2008): Development of a framework for condition monitoring and diagnosis of gasoline Engine, unpublished PhD. Thesis, Department of computer science and engineering, Ladoke Akintola University of Technology, Ogbomoso, Oyo state, Nigeria.
2. Baba S., Watanabe Y., Gejyo F., Arakawa M. (1984): High-performance liquid chromatographic determination of serum aliphatic amines in chronic renal failure, Clinica Chimica Acta 136:49-56.
3. Bartlett P. N., Elliot J. M., and Gardner J. W. (1997): Application of, and Developments in, Machine Olfaction, Annali Di Chimica, 87:33-44.
4. Bourgeois W., Burgess J. E., Stuetz R M. (2001): On-line monitoring of waste water quality: a review, J. Chem. Technol. Biotechnol. 76:337-348.
5. Bourronnet B *et al*. (1995): Application of a multi-gas-sensor device in the meat industry for boar-taint detection, Sensors and Actuators B, 26-27:250-254.
6. Bowen D., Cowburn D., Rennekamp M., Sullivan J. (1975): Benzyl alcohol: high levels found in plasma of uremic patients on hemodialysis, Clinica Chimica Acta 61:399-401.
7. Canaud B., Bosc J. Y., *et al*. (2000): Urea as a marker of adequacy in hemodialysis: Lessons from in vivo urea dynamics monitoring, Kidney Internation, 58:28-40
8. Capodicasa E., Trovarelli G., De Medio G., Pelli M., Lippi G., Verdura C., Timio M. (1999): Volatile Alkanes and Increased Concentrations of Isoprene in Exhaled Air during Hemodialysis, Nephron 82:331-337.
9. Chandiok S., Crawley B. A., Oppenheim B. A., *et al*. (1997): Screening for bacterial vaginosis: a novel application of artificial nose technology, Journal of Clinical Pathology, 50:790-795.
10. Chang S. M., Muramatsu H., Nakamura C. *etal*. (2000): The principle and applications of piezoelectric crystal sensors, Materials Sciences and Engineering C, 12:111-123.
11. James Giese (2000): "Electronic Noses", *Food Technology* 54(3): 96-100.
12. Nagle, H. T.,(1998): The How and Why of Electronic Noses. IEEE Spectrum, pp: 22-33
13. Mahmoud Z. Iskandarani, Nidal F. Shilbayeh.(2005): Design and Analysis of a Smart Multi Purpose Electronic Nose System**.** 2Faculty of Computer Science and Information Technology, Applied Science University P.O. Box 41, Post Code 11931,
Amman, Jordan.
14. K. Arshak, E. Moore, G.M. Lyons, J. Harris and S. Clifford (2004): A review of gas sensors employed in electronic nose applications. Volume 24 · Number 2 · 2004 · pp. 181–198.
15. Gardner, J.W.; Bartlett, P.N.(1999): *Electronic noses principles and applications*, Oxford University Press Inc., New York.
16. Reuss R. and Pratt, S.J.(2001): Accumulation of carbon monoxide and carbon dioxide in stored canola. Journal of Stored Products Research, 37, 23–34.
www.figarosensortechnology