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GAS ANALYZER BASED ON THE ARDUINO MICROPROCESSOR BOARD

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Анотація

У цій роботі встановлено, що на основі платформи «Arduino» можна побудувати повноцінний недорогий газоаналізатор, який може використовуватися в житлових, офісних приміщеннях і інших будинках суспільного призначення. Цей недорогий прилад має досить просту конструкцію, технологічний у виготовленні і забезпечує виявлення вибухонебезпечних газів у навколишньому повітрі при їхній концентрації від 100 ppm.

Ключові слова: газоаналізатор, сенсор, Arduino.

Abstract

In this paper it was found that on the basis of the "Arduino" platform, it is possible to build a full-fledged inexpensive gas analyzer that can be used in residential, office and other public buildings. This inexpensive device has a fairly simple design, is technologically advanced and provides detection of explosive gases in the surrounding air at a concentration of 100 ppm.

Keywords: gas analyzer, sensor, Arduino.

Introduction

One of the causes of explosions is explosive gases that can accumulate for various reasons [1]. The most explosive and fire-hazardous mixtures with air are formed when gaseous and liquefied substances of the hydrocarbon series – methane, propane, butane, ethylene, propylene, etc. are leaked [1]. At some sites, such as landfills, solid waste dumps [2-9], coal mines, special production facilities, these products may appear randomly and spontaneously, so to ensure fire safety in such places, it is necessary to monitor the concentration of explosive gases in the air near objects where they can form and/or accumulate.

Research results

Measuring devices that allow you to determine the qualitative and quantitative composition of gas mixtures are called gas analyzers. Today, they are available for sale in a wide range, but their price is too high, which does not allow you to fully install gas analyzers in all places where they are needed. For air analysis for explosive gas mixtures on an industrial scale, magnetoeffective gas analyzers are often used, but they require high-precision stabilization of the flow rate of the analyzed mixture and the comparative gas, as well as constant temperature and power supply parameters [10]. However, in most cases, the device does not need to perform a detailed analysis of the gas mixture, just notifying the presence of a dangerous concentration of any of the explosive substances and compounds in the air. Based on this, the design of the gas analyzer can be significantly simplified, which will reduce its cost. As a result, you can get a simple alarm for dangerous gas levels.

A wide-purpose device for analyzing the surrounding air and warning of danger, in case of detection of explosive gases, can be implemented on the basis of a Board with a microcontroller "Arduino" (Mega, Uno, Nano) [11, 12], which is a hardware computing platform, and a sensor of the most common explosive gases "MQ-9", which is inexpensive (the price is about $2) and easily accessible. The block diagram of the basic design of such a gas analyzer is shown in Fig. 1.

The control system contains all the elements necessary for setting up and controlling the device, such as buttons, switches, switches, potentiometers (you can also install encoders), etc.

The display and notification system, depending on the needs of the consumer, can contain various devices. The basic elements are: a red led (for a light indication of an increased concentration of dangerous gases), a buzzer or other sound source (for a sound alert about the content of dangerous gas concentrations in the air), a display of any type (for accurate display of gas concentrations and implementation of user settings of the device).

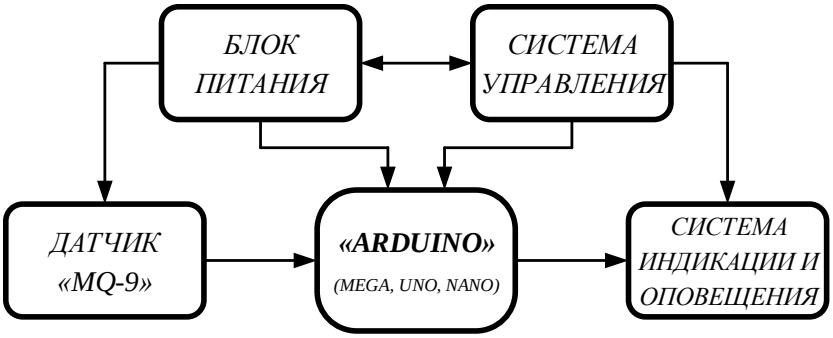

Fig. 1 – Block diagram of the gas analyzer with the sensor "MQ-9"

The sensitive element of this gas analyzer is an electronic sensor of chemical type manufactured by Hanwei Electronics Group Corporation "MQ-9". This sensor is sensitive to carbon monoxide and explosive gases such as natural gas, butane, propane, methane, hydrogen, and alcohol vapors.

The MQ-9 sensor is a semiconductor electronic device based on metal oxide film technology. In contrast to optical sensors [13, 14], the principle of operation of the "MQ-9" sensor is based on changing the resistance of a thin-film layer of tin dioxide SnO_2 in contact with the molecules of the analyzed gases in the air. Using this property, you can apply a known voltage to the sensor and then read its changed values. The sensor's sensing element consists of a ceramic tube coated with aluminum oxide Al_2O_3 and a sensitive layer of tin dioxide applied to it. Inside the tube, a heating element is installed that increases the temperature of the sensitive layer to a value at which it begins to react to the presence of gases (250±10 °C) [15]. The sensitivity of the sensor to various gases is achieved by varying the composition of impurities in its sensitive layer. The disadvantage of this sensor is the dependence of indicators on the temperature and humidity level of the environment, as well as low sensitivity compared to piezoelectric sensors, which have a fairly high cost, and with semiconductor sensors, which in turn have a very limited service life. However, the sensitivity of "MQ-9" to combustible hydrocarbon gases in the range from 100 to 10000 ppm, and for carbon monoxide from 10 to 1000 ppm is quite sufficient for household tasks.

"MQ-9" has analog and digital outputs. The voltage on the analog output will change in proportion to the concentration of gases in the environment. The higher the output voltage value, the higher the amount of explosive gas contained in the air. The sensor module has a built-in potentiometer that allows you to adjust the sensitivity depending on how accurately you need to register the level of explosive gas concentration in the surrounding air and what the gas concentration is considered to be the maximum permissible.

The sensor "MQ-9" has the following technical characteristics [15]: heater voltage 5 V ± 0.1 V (DC / AC); operating voltage 3...15 V (DC); response time less than 10 s; power 340 mW; relative sensitivity ≤ 0.6; heater resistance 33 Ohms; operating temperature range -20...+50 °C.

We assembled the layout of the described gas analyzer, the necessary components were selected according to Fig. 1, the corresponding program was loaded into the memory of the microcontroller and the power supply unit was connected to the power source. The display system consists of a red led and a BC-1602 LCD display. Additionally, you can install an audio alarm system on the Board.

Tests have shown that for the sensor to work correctly, the heating element must be alternately supplied with a voltage of 1.5 V (for 90 s) and from 5 V (60 s). You can also provide a sinusoidal voltage change with the appropriate amplitude and area under the graph. In the low-voltage supply range, maximum sensitivity to carbon monoxide is achieved, and in the high-voltage range, hydrocarbon gases are fixed and condensate evaporation occurs. If it is necessary to fix only carbon monoxide, it is sufficient to supply the sensor with a constant voltage of 1.5 V.

The sensor starts producing correct data after 20 seconds of operation, since this time is necessary to warm up the sensor tube. It is worth noting that this delay is typical for most gas sensors [16].

Conclusions

Thus, on the basis of the "Arduino" platform, you can build a full-fledged inexpensive gas analyzer that can be used in residential, office and other public buildings. This inexpensive device has a fairly simple design, is technologically advanced and provides detection of explosive gases in the surrounding air at a concentration of 100 ppm.

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