Automation of CO2 Analyser System

[1]Jay H. Bhut, [2]Sujit D. Chavada
Electronics & Communication Department
Marwadi Education Foundation Group of Institutions, Rajkot, India
[1]bjay428@gmail.com , [2]sujit09chavada@gmail.com

***Abstract* - The main aim of this paper is to provide or implementing a system for operating the carbon dioxide analyser instrument in an automated mode with all necessary controls and corrections in a temperature controlled environment with reference of the database. This can be achieved by different objectives such as Selecting different calibration mixtures in a time sequenced manner, Controlling the temperature of the instrument, Real-time acquisition of data from the analyser, Monitoring and recording of housekeeping parameters, Providing a user-friendly access to the control and monitoring functions and Providing an environment to operate, store and self-check in an un-attended mode.**

***Keywords*— Gas analyser, Automation, Solenoid valve, UART, MOSFET as a switch**

I. INTRODUCTION

There are few gases in an earth's atmosphere that known as greenhouse gases because they trap the outgoing earth's infrared radiation/heat and keeps the earth warm. If the concentration of these greenhouse gases increases, more heat is trapped and which leads to global warming [1]. One of these gases is carbon-dioxide that plays an important role in global warming as its' concentration is 400 ppm (parts per million) at surface level. There is a device called LI-7000 CO_2/H_2O analyser which measures CO_2 and H_2O (water vapour) concentration by passing the ambient air through a sample cell with reference to a zero air (CO_2 free air) or known concentration gas through the reference cell of the instrument [2].

During observation using this instrument, many parameters should be controlled and observed to have high accuracy measurements. In addition to the data, the housekeeping information should be recorded to correct the data as well as to monitor the health of the system in the long run. Gas parameters are essential to correct the data for span drift, zero drift and for the slow deterioration of the analyser system [2].

The work presented here provides a complete automated system to record, store, display the data and the housekeeping information, automate zero and span calibration, provide users with full control of the instrument from a user friendly screen and maintain the database for a longer period. This paper uses the RS232 serial communication to communicate with the instrument, controller to control and monitor different processes.
This can be achieved by following objectives:

- Selecting different calibration mixtures and sample by operating a different valve at a time sequenced manner through valve drivers and controllers,
- Controlling the temperature of the instrument accurately through temperature controller with interfaces,
- Acquiring different environmental parameters like temperature through sensors and interfaces,
- Real-time acquisition of data from the analyser through communication port,
- Monitoring and recording of housekeeping parameters to make required corrections in the observed values,
- Providing a user friendly access to the control and monitoring functions and
- Providing an environment to operate, store and self-check in an unattended mode.

Figure-1 shows a block diagram which provides an outline for achieving the above function with necessary hardware and software. From the block diagram one can say that the calibration mixture controls through an analog circuit with reference of the user data and temperature of the device maintains at a constant level through temperature controller and all the time gas parameter stores in a database through communication port.

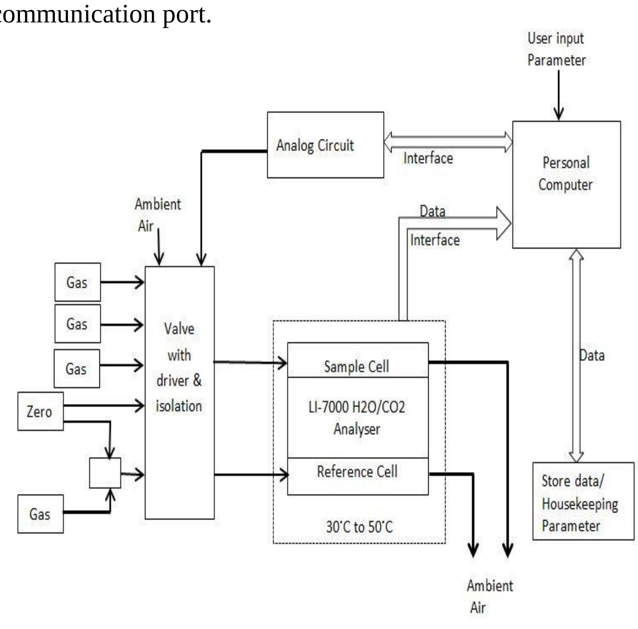

Fig. 1 Block diagram of work presented

II. CONTROL BOARD AND INTERFACES

The Analog circuit design is based on AT89C51 controller [4-6] and other interfaces have been done as per requirement to complete this work such as DS1307 real time clock IC [7] with I2C communication and ST232CN IC [8] for serial communication between UART and controller to convert the level of voltage. Power Supply of 24V uses in the circuit design in order to provide the power to solenoid valves and IRF540 MOSFET [9] uses to switch the solenoid valve ON and OFF. The figure-2 shows the circuit diagram to switch a single solenoid valve which connected with a controller's pin. Two resistors are used to improve the switching speed between ON and OFF duration of the valve. LED connected in circuit to shows the valve is in ON condition.

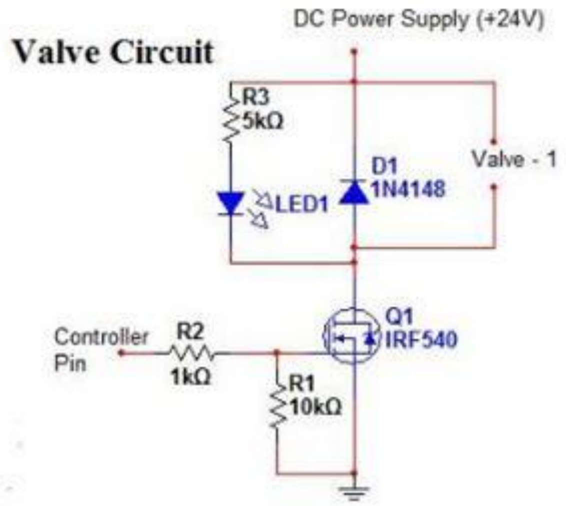

Fig. 2 Circuit diagram of single valve circuit

There are six solenoid valves are connected with port-2 of the controller and DS1307 real time clock IC used to ON and OFF the valves in a particular time sequence manner with the reference of user input data. DS1307 connected with two different pins of controller's port-1. It is an 8 pin IC with 32 kHz crystal oscillator frequency that works on I2C principle and uses SCL and SDA pin to communicate between more than one device. DS1307 has a time keeping resistors from 00H to 07H for storing time and date and update continuously. DS1307 also uses 3V lithium battery as in spare of power supply [8].

ST232CN is also known as level converter IC as it uses to convert the voltage level between RS232 port and controller. ST232CN mainly uses to convert 5V to +-12V or vice versa. Here, the purpose of using ST232CN compared with others is it has two receivers. So, we can use two receiver ports for a communication at a time [9].

The System block diagram is as shown in below figure 3 with reset circuit, crystal oscillator frequency of 11.0592 MHz for a controller and temperature controller circuit with temperature sensor. Here, analog to digital converter uses to convert the analog data from a sensor into digital for the controller understanding.

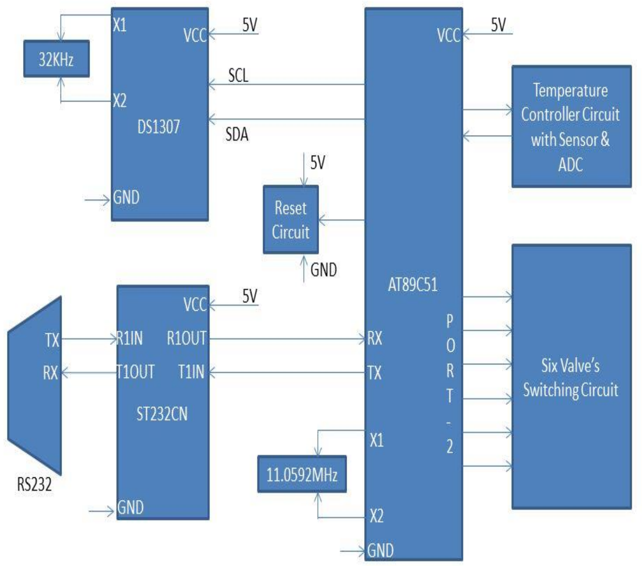

Fig. 3 System block diagram

SOFTWARE

The software used in this work can be divided into three different parts: the software for valve automation is in Embedded C, the software for PC in an object oriented language and the software for database with the use of the query.

The programming for valve automation was accomplished in the 'Embedded C' language using the Keil IDE. The function of the controller program is to automate the solenoid valve circuit in a particular time sequence manner with reference of the database and to maintain a constant temperature of an instrument.

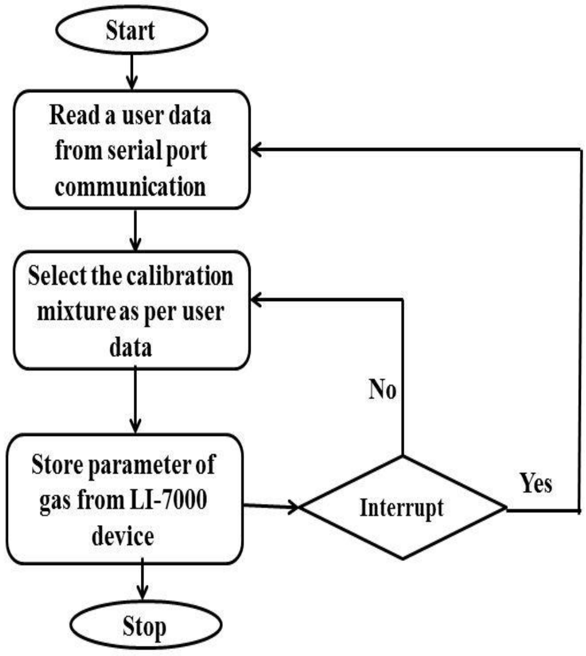

Fig. 4 System flow chart

The PC programming, html page creation and database query were done for getting user parameter for calibration mixture control and database to store gas parameter for further reference.

The sequence of this work describes in the flow chart as shows in figure-4. From the flow chart, a user enters the parameter and by taking that parameter as a reference controller maintains the calibration mixture and store the data continuously up to interrupt occurs.

III. SCOPE OF THE WORK

There are many different applications and scopes of the work are as listed below.

- Operating different valves in a time sequenced manner automatically through the controller as per user requirement.
- Maintaining constant temperature of an instrument accurately through the controller.
- Real-time acquisition of data from the analyser through communication port.
- Monitoring and recording of the gas parameters to make an observation after words on values.
- Providing user-friendly access to the control and monitoring functions.

IV. CONCLUSION

The work, presented here can be drawn from the investigations and implementation that have been done so far and it is intended to be of some use in Small Scale industries, laboratories, small research organization, etc. There are a few reasons why we expect this as:

- Instrument Automation is often Requirement by industry especially in smaller research institutions where the cost is matter.
- Providing a user friendly access to the control and monitoring functions to operate different task in an un-attended mode.

The system required accuracy is the major obstruction to project completion.

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