



Sudan University of Science and Technology
College of Graduate Studies



Microcontroller logger Design for Water Distribution Network Via GSM

A thesis submitted in partial fulfillment of requirement of the degree of MS.C in
computer engineering

**تصميم مسجل للتحكم الدقيق بشبكة توزيع المياه عبر النظام
العالمي للاتصالات بالهواتف الجواله**

By:

HalaAbdalrheem Ahmed Abdalgader

Supervisor:

Dr.AbdalrsoulJabarAlzubaidi

Jan, 2016

الآية

ط ڈ

چ چ چ چ چ چ چ چ چ چ چ چ چ چ چ چ
ٹ ٹ ٹ ٹ ٹ ٹ ٹ ٹ ٹ ٹ ٹ ٹ ٹ ٹ ٹ ٹ
ک ک ک ک ک ک ک ک ک ک ک ک ک ک ک ک

العلق: ۱ - ۵

Dedication

I would like to dedicate my work to ...

My father, who made all my dreams and aspirations real

my mother, for her love and pray

my husband, for his support and my wonderful baby Ahmed.

Acknowledgement

I would like to Express my Gratitude and deep appreciation to Dr. abdalsouljabar for his advices and help and my thanks extended to all people helped me in this work.

Abstract

Water distribution systems consist of an interconnected series of pipes, storage facilities, and components that convey drinking water and meeting fire protection needs for cities, homes, schools, hospitals, businesses, industries and other facilities. Public water systems depend on distribution systems to provide an uninterrupted supply of pressurized safe drinking water to all consumers. It is the distribution system mains that carry water from the treatment plant to the consumer. This research introduces a design of a data logger based on using microcontrollers for recording the data related to the water distribution network. The logged data includes recording the pressure and rate of flow sensing in the water distribution network. The system design operates automatically. Any malfunction in the water distribution network will be reported in real time in order to take immediate action and therefore avoiding possible damages.

المستخلص

تتكون شبكة توزيع المياه من أنابيب متصلة, وسائل تخزين المياه للاستخدامات المتعددة لنقل وتخزين المياه للإطفاء ومكافحة الحرائق . وتوفير المياه في المدن للمنازل والمدارس والمستشفيات والشركات وكافة الصناعات والمنشآت .

يعتمد نظام توزيع المياه على شبكة توزيع لضخ المياه بشكل متواصل ومنع انقطاعها من كل المستهلكين . يقوم نظام توزيع المياه بنقل المياه من مصادر معالجة وتنقية المياه لكل المستخدمين.

يقدم هذا البحث تصميم لمتحكم يقوم بتسجيل وحفظ البيانات المتعلقة بشبكات توزيع المياه.

تتضمن البيانات المسجلة قراءات لضغط المياه ومعدل تدفق المياه مقاسه بواسطة حساسات موجودة في شبكة توزيع المياه. النظام مصمم للعمل اوتوماتيكياً وتسجيل القياسات للتبليغ حالياً عند حدوث أي عطل أو خلل في الشبكة ؛ لضبط عمل الشبكة وتجنب حدوث المشاكل المحتملة .

List of Contents

الآية.....	I
Dedication.....	II
Acknowledgement.....	III
Abstract.....	IV
Abstract in Arabic.....	V
List of Contents.....	VI
List of Figures.....	VIII
List of Table.....	IX
1.1 Background.....	1
1.2 Problem Statement.....	1
1.3 Proposed solution.....	1
1.4 Objective.....	2
1.5 Methodology.....	2
1.6 Research outline.....	3
2.1 Overview.....	4
2.2 Water distribution system	6
2.2.1 The pipes	7
2.2.2 The pump.....	9
2.2.3 The valves	9
2.2.4 The storage tank and reservoir	10
2.2.5 Fire-fighting capacity	12
2.3 Distribution system requirements	12
2.4 Distribution system types	13
2.4.1 Branching pattern with dead ends	14
2.4.2 Grid pattern	15
2.4.3 Grid pattern with loops	17
2.5 Data logger	17

2.5.1 Definition of data logger	17
2.5.2 Characteristics of data loggers	18
2.5.3 Advantages of data loggers	19
2.5.4 Applications of data loggers	19
2.6 Literature survey	20
3.1 System layout	23
3.2 The hardware component in the system design	24
3.3 Microcontroller "ATmega32"	25
3.3.1 Microcontrollers	25
3.3.2 Microcontroller operation	26
3.4 Pressure transducer	27
3.5 Flow rate sensor	28
3.5.1 Features	29
3.5.2 Applications	29
3.5.3 Electrical	29
3.6 Memory	29
3.6.1 Random access memory (RAM)	29
3.6.2 Electronically erasable and programmable read only memory (EEPROM)	30
3.7 Power supply	31
3.7.1 None-rechargeable batteries	31
3.7.2 Rechargeable batteries	32
3.8 Liquid-crystal display	32
3.9 GSM modem	33
4.1 Overview	36
4.2 The flow chart	38
5.1 The results measurement.....	39
5.2 The Discussion.....	41
6.1 Conclusion	42
6.2 Recommendation	43
Reference	45
Appendices.....	47

list of figure:

Figure2.1: water in our body.....	4
Figure 2.2: Sector's water distribution network (DMA)	7
Figure 2.3: branching pattern.....	14
Figure 2.4: grid pattern.....	15
Figure 2.5: logger process.....	18
Figure 3.1: Block diagram of the system	23
Figure 3.2: The Structure of GSM SIM900	35
Figure 4.1: Flow chart.....	38
Figure 5.1: system design.....	39

List of tables:

Table 5.1: pressure sensor measurement.....	40
Table 5.2: Rare of flow sensor measurement.....	40

CHAPTER ONE

INTRODUCTION

1.1 Background

The processes to collect, analyze and store the data for later use is called logging. It is a process to record events during a test or measurement with the use of a system or product.

A data logger (also datalogger or data recorder) is an electronic device that records data over time or in relation to location either with a built in instrument or sensor or via external instruments and sensors. Increasingly, but not entirely, they are based on a digital processor (or computer). Data loggers generally are small, battery powered, portable, and equipped with a microprocessor, internal memory for data storage, and sensors. Some data loggers interface with a personal computer and utilize software to activate the data logger and view and analyze the collected data, while others have a local interface device (keypad, LCD) and can be used as a stand-alone device.

1.2 Problem Statement

Leakage and diversion of water are the most common problems. They cause loss in the water and waste of it. Leakage water disrupts people from their daily lives because they need water in all of their affairs and it costs a lot to maintain and repair the damage so it requires time, effort and money. So a good and organized structure to facilitate must be built for management and maintenance.

1.3 Proposed solution

Microcontroller data logger will be designed to collect and store data over time, then analyze this recording data to observe the normal rate of a

wanted parameter to solve problems and also improve the Water distribution systems in the network.

1.4 Objective

The objectives of the research are:

- Design microcontroller to reduce the cost.
- Implementation of a pro-type system will be done.
- Performance evaluation for the system will be done.
- The proposed system should satisfy the following points:
 - Solve water problems in the network.
 - Improved the performance.

1.5 Methodology

- **The Microcontroller(ATmega32):**The heart of the system is the microcontroller. The 40pin dip is used to control the activities of all other sections. ATmega32 was selected due to its good features of being cheap. The high-performance, low-power Atmel 8-bit AVR RISC-based microcontroller combines 32KB of programmable flash memory, 2KB SRAM, 1KB EEPROM, an 8-channel 10-bit A/D converter, and a JTAG interface for on-chip debugging. The device supports throughput of 16 MIPS at 16 MHz and operates between 4.5-5.5 volts. Atmega32 has got 40 pins.
- **Sensors:**
 - Rate of flow sensor.
 - Pressure sensor.

- **LCD (20×4):** The data retrieved may be sent to the LCD for display, sent to the GSM modem for onward transmission to a phone address in another location.
- **Power supply:** The PSU for the system should be capable of providing the required supply voltage and current to all the various sub-units in the system.
- **Memory for data storage (EEPROM):** the EEPROM was used to log the pressure, flow rate and any need parameter at specific intervals.
- **GSM Modem:** which is responsible for sending short messages when require.
- **Key pad:** The operation can be changed when desired. To change the operation to reset or start logging an external human interface is required.
- **Buzzer:** To alert when leakage happened.

1.6 Research Outline:

Chapter 1:The introduction part and provides problem statement and the proposed solution with the objectives.

Chapter 2:Literature review covers previous work in the area of the research.

Chapter 3:Electronic circuit design for microcontroller logger.

Chapter 4:Software for the circuit.

Chapter 5:Simulation and results discussion.

Chapter 6:Conclusion and recommendations for future works.

CHAPTER TWO

LITERATURE REVIEW

2.1OVERVIEW

Historically, humans have settled near sources of water. It is a vital resource necessary for survival, contributing to human health, irrigation, and transportation.

Exploration and the transportation of ideas, people, and goods have also been facilitated by water. This natural resource has also served as a source of power and conflict, especially prior to the industrial revolution and the invention of steam power. Humans can live without food for longer than they can without water. Consider the significant role of water amidst natural disasters. Also, Water is the life source that keeps our bodies alive as it is essential to every function that our bodies need to perform. This leads to better health, better skin and much more longevity.

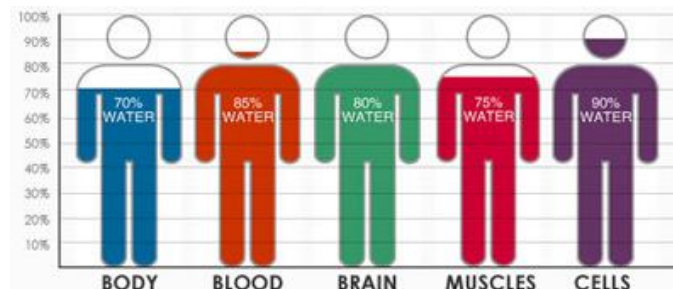


Figure2.1: water in our body.

Most customers think distribution systems are the network of pipes beneath roads and streets that transport water from treatment plants to individual households, businesses, and other customers. And while this is

true, distribution systems also include pumps, storage tanks, fire hydrants, service connections, meters, and other equipment.

There's more than one type of distribution systems. It may be classified as grid or branching systems, or a combination of the two. Generally, engineers prefer a grid system to a branching system because it can supply water to any point from at least two directions. It also permits any broken pipe sections to be isolated for repair without disrupting service to large areas of the community.

A branching system has numerous terminals or "dead ends" that prevent water from being circulated throughout the system. Further, water tends to stagnate in dead-end patterns, making them more susceptible to taste and odor problems. This kind of pattern requires frequent flushing, so hydrants should be placed at the extreme end of these lines. A combination system is the type most commonly used. It can incorporate loop feeders, which distribute the flow to an area from several directions. As pressure increases, so do leaks and breaks. Communities then spend money to transport a product that never makes it to its destination and is, therefore, wasted. Because more than half the cost of a municipal water supply system is for the distribution network, it is important that the system's design maintains a reasonably uniform pressure.

In hilly or mountainous terrain, the distribution system is usually divided into two or more service areas or zones. These areas are typically interconnected, and workers may close interconnections using valves during normal operation hours. This prevents the system from having to maintain extremely high pressure in low-lying areas to ensure reasonable pressures at higher

elevations. In addition, water pressure can remain relatively constant when pressure-regulating valves are installed.

Head difference is maintained in a distribution system either by gravity or by pressure (pumping). Often, public water supply systems use some combination of both. In gravity systems, tanks store water at strategic locations sufficiently elevated to create the working pressure water requires to move the water to demand points. Water always flows in the direction of gravity, which means downhill. Further, water will always try to equalize its level. However, water that is at the same level does not have a head difference. So, pressure must be applied to force water through the pipe. Hence, when elevated storage is impractical, pumps provide the required working pressure within the system. In these pressure systems, the pumps are normally located at the treatment plant and perhaps within the distribution system.

2.2 Water Distribution System

The main elements of the distribution system are:

- Pipe systems
- Pumping stations
- Valves
- Storage facilities
- Fire hydrants

- House service connections
- Other appurtenances

Block diagram for water network district meter area (DMA). The design consists:

- Valve.
- Flow meter.
- Pressure reducing valve (PRV).
- Data Logger.

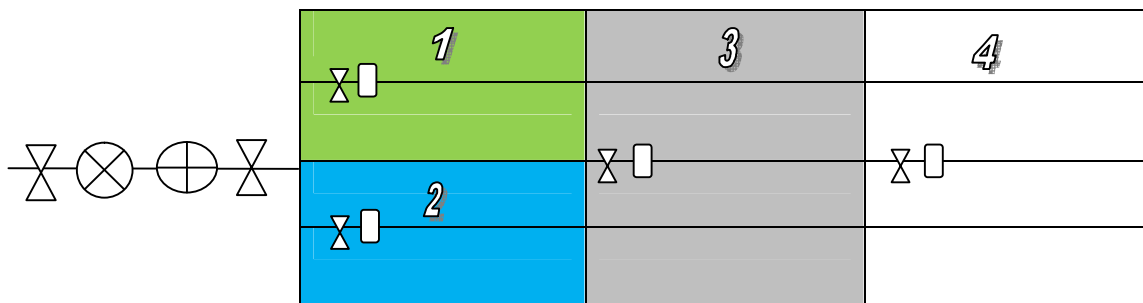


Figure 2.2: Sector's water distribution network (DMA)

2.2.1 The pipes

The pipeline network consists of arterial water mains also called "primary feeders" or "trunk lines." These lines carry water from the treatment plant to areas where it's needed in the community.

Water mains must be placed three to six feet below the ground surface to protect against traffic loads, prevent freezing, and protect against accidental damage from digging or construction activities. Because the water in a distribution system is under pressure, pipelines can follow the shape of the land, uphill as well as down.

Smaller-diameter pipelines called “secondary feeders” or “branch lines” tie into the mains. Usually not less than six inches in diameter, these pipe-lines are placed within the public right-of-way so workers can install service connections for all potential water users.

Pipelines must be installed with proper bedding and backfill. Soil compaction under the pipe (bedding) as well as above the pipe (backfill) is necessary to provide proper support. A water main should never be installed in the same trench with a sewer line. Where the two must cross, the water main should be placed above the sewer line to prevent possible cross connection issues.

Pipes must be able to resist internal and external forces as well as corrosion. Water pressure inside the pipes, the weight of the overlying soil, and vehicles passing over them place stress on pipelines. In addition, metal pipes may rust internally if the water supply is corrosive or externally because of corrosive soil conditions.

Pipelines also may have to withstand what are known as “water-hammer” forces. Water hammers occur when valves are closed too rapidly, causing pressure surges through the system. To avoid water hammers, try not to open or close hydrants or valves too quickly.

2.2.2 The pumps

Pumps are an integral part of the system many kinds of pumps are used in distribution systems. Pumps that lift surface water and move it to a nearby treatment plant are called low-lift pumps. These pumps move large volumes of water at relatively low discharge pressures. Pumps that discharge treated water into arterial mains are called high-lift pumps. These operate under higher pressures. Pumps that increase the pressure within the distribution system or raise water into an elevated storage tank are called booster pumps. Well pumps lift water from underground and discharge it directly into a distribution system.

Centrifugal pumps are the most common type used in distribution systems. With these pumps, a rapidly rotating impeller adds energy to the water and raises the pressure inside the pump casing. The flow rate through a centrifugal pump depends on the pressure against which it operates. The higher the pressure, the lower the flow or discharge. Another kind of pump is the positive-displacement type. This pump delivers a fixed quantity of water with each piston cycle or rotor. Water is literally pushed or displaced from the pump casing. A positive-displacement pump's flow capacity is unaffected by the pressure of the system in which it operates.

2.2.3 The Valves

To function properly, a water distribution system requires several types of fittings, including hydrants and shut-off valves. The hydrant's main purpose is to provide water for fire-fighting. However, they also are used for flushing

water mains, pressure testing, water sampling, and washing debris off public streets.

Many types of valves are used to control the quantity and direction of water flow. Gate valves are usually installed throughout the pipe network. They allow sections to be shut off and isolated while repairing broken mains, pumps, or hydrants. A type of valve commonly used for throttling and controlling the rate of flow is called a “butterfly valve.”

Safety valves or pressure relief valves are important in long pipelines for surge control. Air relief valves are desirable at high points in pressure lines where other relief is not available. Blow-off valves are used at low system elevations and dead-end lines to permit emptying or flushing when necessary. Vacuum relief valves are used to prevent complications caused by negative pressures.

2.2.4 The Storage Tanks and Reservoirs

Distribution storage tanks, familiar sights in many communities, serve three basic purposes: they must meet the water needs of residential and commercial customers, accommodate fire-fighting and emergency purposes, and equalize operating pressures. Distribution storage tanks are built at ground level or on hilltops higher than the service area. In areas with flat topography, the tanks may be elevated above ground on towers to provide adequate water pressures, or ground-level storage tanks with booster pumping may be used.

Reservoirs are classified as underground, ground level, elevated, or standpipe. An underground reservoir or basin either open or covered may be at or below grade level and formed either by excavation or embankment.

An elevated reservoir is a tank supported above ground by a structural framework. Steel and wood have been used in constructing stand-pipes and elevated tanks, which are normally enclosed. Most systems prefer to use covered reservoirs for treated water because water in open reservoirs is subject to falling dust, soot, and dust-borne microorganisms; to contamination by animals, including birds and human beings; and to algae growth. Utilities may need to control algae and microbial slime growths in open distribution reservoirs by adding copper sulfate or chlorine (or both) to the water.

Surface reservoirs are usually lined with concrete, Guniting, asphalt, or an asphalt membrane. While these reservoirs may be covered or uncovered, many systems cover them to prevent animals or humans from contaminating the water and to prevent algae from forming in the water.

Standpipes or elevated tanks are usually needed when a surface reservoir does not produce sufficient head. A standpipe is a tall, cylindrical tank that provides useful storage (the upper portion that is above the discharge pipe) and supporting storage, which acts to support the useful storage and provide the required head. The amount of storage needed should be about equal to the average daily demand and should take into consideration the volume of water needed to satisfy the community's peak hourly demands. During the late night and early morning hours when water demand is very low, high-lift pumps are used to fill storage tanks. During the day when the water demand is high, water flows out of the tank, helping satisfy hourly peak water needs. This allows for a uniform flow rate at the treatment plant and pumping station.

Emergency storage should sustain the community during periods when the inflow to the reservoir is shut off, such as when lines are shut down for service, repair, or when a pumping equipment failure occurs. Emergency storage should be sufficient to last several days.

2.2.5 Fire-Fighting Capacity

A distribution system's ability to deliver an adequate quantity of water to meet demands of the domestic, commercial, and industrial users and to provide the necessary flow for fire protection depends upon the carrying capacity of the system's network of pipes. In all but the largest systems, the flow necessary to fight a major fire is usually the major factor determining the amount of water to be stored, the size of the system's mains, and the pressure needed.

All of these elements must be incorporated into the a distribution system's design because when customers want fresh drinking water, all they want to do is turn on the tap. Without pipelines, pumps, valves, pressure, and storage, that wouldn't be possible.

2.3Distribution Systems Requirements

Distribution system is a network of pipelines that distribute water to the consumers. They are designed to adequately satisfy the water requirement for a combination of domestic, commercial, industrial and fire fighting purposes.

A good distribution system should satisfy the followings:

- Adequate water pressure at the consumer's taps for a specific rate of flow.
- Pressures should be great enough to adequately meet fire fighting needs.
- At the same time, pressures should not be excessive because development of the pressure head brings important cost consideration and as pressure increases leakages increases too.
- Purity of distributed water should be maintained. This requires distribution system to be completely water-tight.
- Maintenance of the distribution system should be easy and economical.
- Water should remain available during breakdown periods of pipeline. System of distribution should not such that if one pipe bursts, it puts a large area without water. If a particular pipe length is under repair and has been shut down, the water to the population living in the downstream side of this pipeline should be available from other pipeline.
- During repairs, it should not cause any obstruction to traffic. In other words, the pipelines should not be laid under highways, carriage ways but below foot paths .

2.4Distribution Systems Type

There are three types of distribution systems:

1. Branching pattern with dead end.
2. Grid pattern.
3. Grid Pattern with Loops.

2.4.1 Branching Pattern with Dead End:

Main line is the main source of water supply. There is no water distribution to consumers from trunk line. Sub-mains are connected to the main line and they are along the main roads.

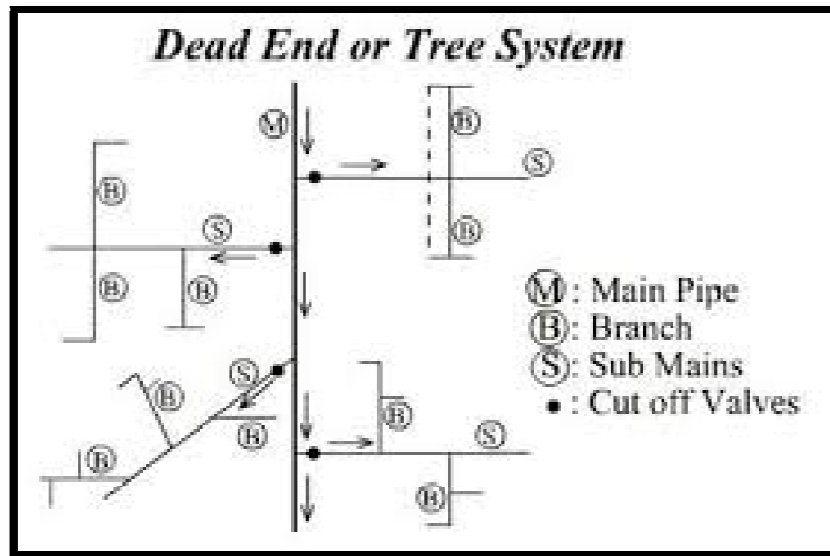


Figure 2.3: branching pattern.

Branches are connected to the sub-mains and they are along the streets. Lastly service connections are given to the consumers from branches.

Advantages:

- It is a very simple method of water distribution. Calculations are easy and simple to do.
- The required dimensions of the pipes are economical.
- This method requires comparatively less number of cut-off valves.

However, it is not usually favored in modern water works practice for the following disadvantages.

Disadvantages:

- The area receiving water from a pipe under repair is without water until the work is completed.
- In this system, there are large numbers of dead ends where water does not circulate but remains static. Sediments accumulate due to stagnation of the dead end and bacterial growth may occur at these points. To overcome this problem drain valves are provided at dead ends and stagnant water is drained out by periodically opening these valves but a large amount of water is wasted.
- It is difficult to maintain chlorine residual at the dead ends of the pipe.
- Water available for fire-fighting will be limited since it is being supplied by only one water main.
- The pressure at the end of the line may become undesirably low as additional areas are connected to the water supply system.

2.4.2 Grid Pattern

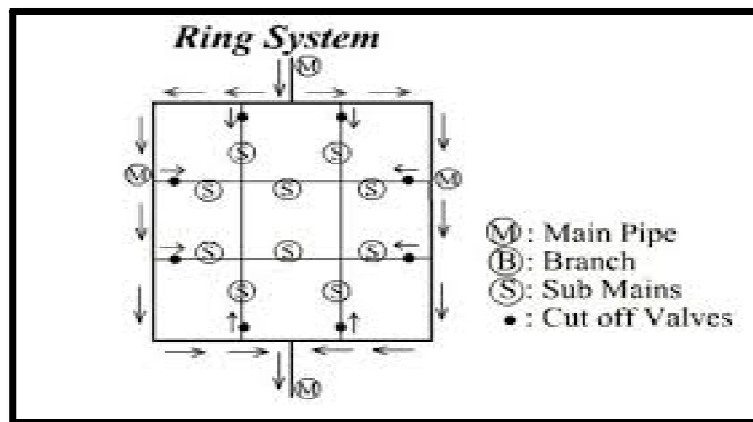


Figure 2.4: grid pattern.

In grid pattern (Ring System), all the pipes are interconnected with no dead-ends. In such a system, water can reach any point from more than one direction.

Advantages:

- Since water in the supply system is free to flow in more than one direction, stagnation does not occur as readily as in the branching pattern.
- In case of repair or break down in a pipe, the area connected to that pipe will continue to receive water, as water will flow to that area from the other side.
- Water reaches all points with minimum head loss.
- At the time of fires, by manipulating the cut-off valves, plenty of water supplies may be diverted and concentrated for fire-fighting.

Disadvantages:

- Cost of pipe laying is more because relatively more length of pipes is required.
- More number of valves are required.
- The calculation of pipe sizes is more complicated.

2.4.3 Grid Pattern with Loops:

Loops are provided in a grid pattern to improve water pressure in portions of a city (industrial, business and commercial areas).

Loops should be strategically located so that as the city develops the water pressure should be sustained.

The advantages and disadvantages of this pattern are the same as those of the grid pattern. In Sudan the method often used is Ring System .but now a day they use DistrictMeter Area system (DMA) it shown in figure 2.2. And they implement data logger device in each sector to read and store the wanted data like pressure and rate of flow.

2.5 Data logger

The data logger is an invaluable tool to collect and analyze experimental data, having the ability to clearly present real time analysis with sensors and probes able to respond to parameters that are beyond the normal range available from the most traditional equipment. The differences between various data loggers are based on the way that data is recorded and stored.

2.5.1 Definition of Data Logger

Data logger is an electronic device that automatically records, scans and retrieves the data with high speed and greater efficiency during a test or measurement, at any part of the plant with time. The type of information recorded is determined by the user i.e. whether temperature, relative humidity, light intensity, voltage, pressure or shock is to be recorded,

therefore it can automatically measures electrical output from any type of transducer and log the value. A data logger works with sensors to convert physical phenomena and stimuli into electronic signals such as voltage or current. These electronic signals are then converted into binary data. The binary data is then easily analyzed by software and stored on memory for post process ana

lysis. Logger function shown in below figure:

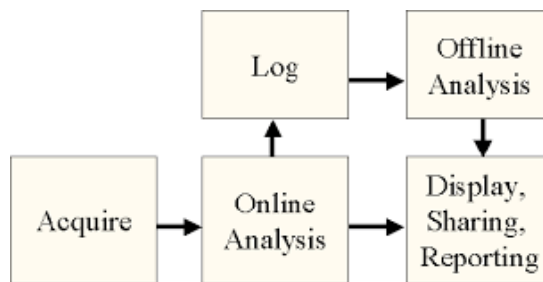


Figure 2.5: logger process.

2.5.2 Characteristics of Data Loggers

Data loggers possess the following characteristics:

- 1.Modularity: Data loggers can be expanded simply and efficiently whenever required, without any interruption to the working system.
2. Reliability and Ruggedness: They are designed to operate continuously without interruption even in the worst industrial environments.
3. Accuracy: The specified accuracy is maintained throughout the period of use.

4. Management Tool: They provide simple data acquisition, and present the results in handy form.

5. Easy to use: These communicate with operators in a logical manner, are simple in concept, and therefore easy to understand, operate and expand.

2.5.3 Advantages of Data Loggers:

1. Data Loggers don't interfere with the users in performing their tasks.

2. They can operate independently of a computer and they are available in various shapes and sizes.

3. The range of data loggers varies from simple channel inputs to multichannel devices.

2.5.4 Applications of Data Loggers:

They can be used in the following applications such as:

1. In unattended recording at weather stations to record parameters like temperature, wind speed / direction, solar radiation and relative humidity.

2. For hydrographic recording of water flow, water pH, water conductivity, water level and water depth.

3. In the recording of soil moisture levels.

4. To record gas pressure and to monitor tank levels.

5. In transportation monitoring, troubleshooting, educational science, quality studies, field studies and general research.

6. Remote collection of recorded data and alarming or unusual parameters are possible with the help of data loggers where these are connected to modems and cellular phones.

2.6 Literature survey

Dr. Saul Greenburg [1] has described the concept of logging and how logging is done in detail. Logging is a process to record events with the use of data loggers during a test or field use of a system or a product. Logging is one of the usability methods that can and should be used to gather more supplementary information as an integral part of the iterative design of the usability engineering cycle. Logging has the major advantage compared with other usability methods of not interfering with the users in their performing their tasks. Users can basically ignore the log and use the system in exactly the way they would anyway.

S.J.Perez, M.A.Calva, R.Castañeda(1997)[2] described a microcontroller-based data logging system to record temperature and relative humidity for acoustic measurement applications. The system is simple to use, requires no additional hardware and allows the selection of amount of data and the time intervals between them. The collected data can easily be exported to a PC computer via a serial port.

H S kalsi (1999) [3] has detailed the concept of data loggers and its basic operation is described. A data logger is a comprehensive and highly advanced data acquisition system. It is made versatile and flexible, to render it suitable for widely varying applications, specific requirements being met

simply by setting up a suitable program. It can measure electrical output from any type of parameters and log the value automatically.

Craig Steiner [4], (8051 tutorial, Copyright 1997- 2005 by vault information) discussed about the 8051 family of microcontrollers. In addition to the types of memory, special function registers, basic registers, basic registers, addressing modes discussed in this tutorial additional features including introduction to 8052 and timers are also described.

Craig Steiner [5] (1997- 2005) gave a tutorial on LCD programming. This tutorial has presented the underlying concepts of programming an LCD display. A detailed description of Control and data signals of LCD is provided. The 44780 LCD offers many other functions which are accessed using other commands. Subroutines for initializing, for giving command and data to the LCD is discussed. Thus, it provides information from initializing to displaying the data.

Muhammad Ali Mazidi and Janice GillispeMazidi (2004) [6] discussed the overview of 8051 microcontroller. Microcontrollers and microprocessors are widely used in embedded system products. An embedded product uses a microcontroller to do one task and one task only. In addition to the description of criteria for choosing a microcontroller, the interfacing with the real world devices such as LCDs, ADCs, sensors and keyboard is described in detail. Finally; they discussed the issue of interfacing external memories, both RAM and ROM.

ismaila S. and Momoh M. (2011) [7]. A system had successfully design that should prove very useful in the health care field of in Nigeria. It is designed to help manage the temperature of a patient that is possibly critically

ill in the hospital or to monitor the temperature of other hospital operations such as preservation of drugs, foods and there likes.

The design work is found to meet specification as it is capable of logging temperature on a continuous base and send text message whenever a pre-set temperature is exceeded

CHAPTER THREE

ELECTRONIC CIRCUIT DESIGN

3.1 System layout

The aim of the hardware and software design is to automate the monitoring operation of water flow in the water distribution networks and water pressure then establishing sms message in case of malfunctions in the network if there any up normal data. The electronic devices required to construct the system include a personnel computer, microcontroller, and pressure sensor, rate of flow sensor, keypad, LCD, GSM modem plus interconnection links and lab link cables. The figure below show how the system works.

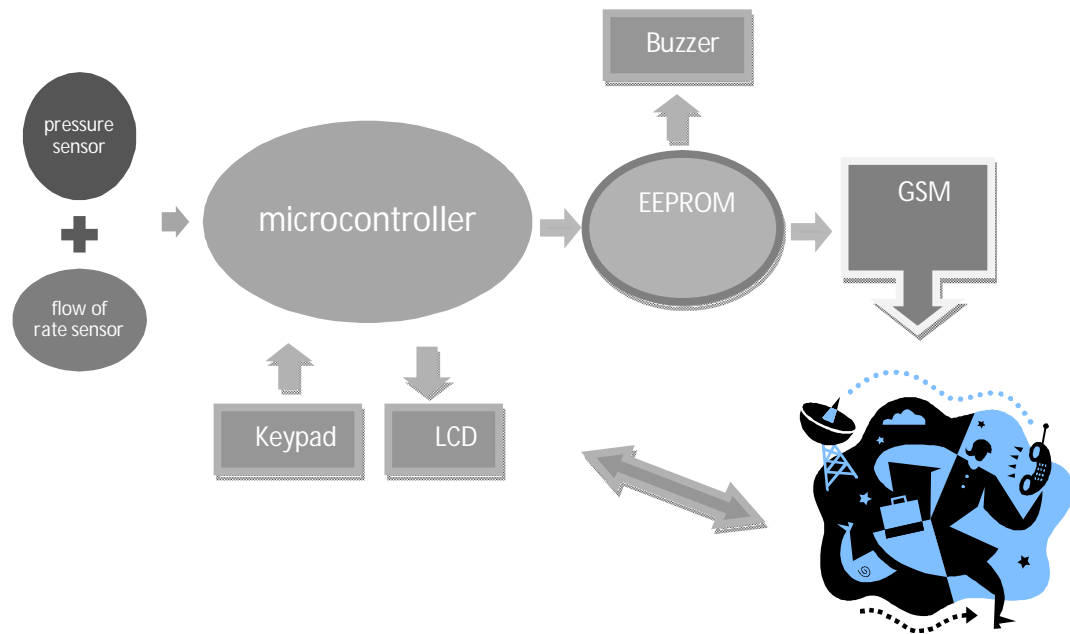


Figure 3.1:Block diagram of the system

3.2 The hardware components in the system design

The basic elements for the system are:

- Personnel computer (PC): A PC furnished with parallel ports is used for programming the microcontroller.
- Lab links: Lab links are sort of cables that connect the computer port to external electronic devices. They are used for programming the microcontroller.
- Rate of flow sensor: It measures the rate of flow of water in the water distribution network.
- Pressure sensor: It measures the pipes water pressure in the water distribution network.
- Twelve keys matrix keypad: The keypad is connected to the ATmega32 microcontroller. It represents data entry to the microcontroller. The operation can be changed when desired. To reset the operation or start logging an external human interface is required.
- Liquid-crystal display: LCD is used to display the data entry and the real time data during the system operation.
- Power supply: The PSU for the system should be capable of providing the required supply voltage and current to all the various sub-units in the system.
- Memory for data storage (EEPROM): The EEPROM is used to log the pressure, rate of flow and any needed parameter at specific intervals.

- **GSM Modem:** It is responsible for sending short messages when required to obtain any up normal data to the network observer.
- **Buzzer:** is an audio signaling device which may be mechanical, electromechanical, or piezoelectric. Typical uses of buzzers and beepers include alarm devices, timers and confirmation of user input such as a mouse click.

3.3 Microcontroller "ATmega32"

3.3.1 Microcontrollers

Like all good things, this powerful component is basically very simple. It is made by mixing tested and high- quality "ingredients" (components) as per following receipt:

1. The simplest computer processor is used as the "brain" of the future system.
2. Depending on the taste of the manufacturer, a bit of memory, a few A/D converters, timers, input/output lines etc. are added
3. All that is placed in some of the standard packages.
4. Simple software able to control it all and which everyone can easily learn about has been developed.

On the basis of these rules, numerous types of microcontrollers were designed and they quickly became man's invisible companion. Their incredible simplicity and flexibility conquered us a long time ago.

The following points have had a crucial influence on development and success of the microcontrollers:

- Powerful and carefully chosen electronics embedded in the microcontrollers can independently or via input/output devices (switches, push buttons, sensors, LCD displays, relays etc.), control various processes and devices such as industrial automation, electric current, temperature, engine performance etc.
- Very low prices enable them to be embedded in such devices in which, until recent time it was not worthwhile to embed anything. Thanks to that, the world is overwhelmed today with cheap automatic devices and various “smart” appliances.
- Prior knowledge is hardly needed for programming. It is sufficient to have a PC (software in use is not demanding at all and is easy to learn) and a simple device (called the programmer) used for “loading” ready-to-use programs into the microcontroller.

3.3.2 The microcontroller operation

Even though there is a large number of different types of microcontrollers and even more programs created for their use only, all of them have many things in common. Thus, if you learn to handle one of them you will be able to handle them all. A typical scenario on the basis of which it all functions is as follows:

1. Power supply is turned off and everything is still, the program is loaded into the microcontroller.

2. Power supply is turned on and everything starts to happen at high speed. The control logic unit keeps everything under control. It disables all other circuits to operate. While the preparations are in progress, the first milliseconds go by.
3. Power supply voltage reaches its maximum and oscillator frequency becomes stable. SFRs are being filled with bits reflecting the state of all circuits within the microcontroller. All pins are configured as inputs.
4. Program Counter is set to zero. Instruction from that address is sent to instruction decoder which recognizes it, after which it is executed with immediate effect.
5. The value of the Program Counter is incremented by 1 and the whole process is repeated several million times per second. The features and pin count of microcontroller refer to appendix (B).

3.4 Pressure Transducer

A pressure sensor measures pressure, typically of gases or liquids. Pressure is an expression of the force required to stop a fluid from expanding, and is usually stated in terms of force per unit area. A pressure sensor usually acts as a transducer; it generates a signal as a function of the pressure imposed. For the purposes of this article, such a signal is electrical.

Pressure sensors can vary drastically in technology, design, performance, application suitability and cost. Features of Pressure Sensor 4017 in appendix (c).

All pressure transducers no matter what they are made of, how expensive they are, or how accurate are susceptible to sensor drift over time. Pressure sensor drift is a gradual degradation of the sensor and other components that can make readings offset from the original calibrated state. This offset value can then be used to correct future level logger readings. If using a depth water measurement for comparison, the deployment depth of the levellogger, minus the manual depth to water measurement, should equal the compensated levelloggerreading. If not, the difference between the two readings is the offset value, or calculated sensor drift.

Water should be delivered to the consumer at minimum pressure of 35 psi measured at the property line or meter. A typical working pressure in most system is 60 psi the absolute minimum pressure at all points in the distribution system is 20 psi, while 100 psi is the maximum pressure desirable. Excess pressure will potentially damage water heaters, fixtures and appliance.

3.5Flow Rate Sensor

The flow rate sensor measures the velocity of water in a river, stream, or canal. It can be used to study the discharge, flow patterns, and sediment transport of a stream or river.

Water flow sensor consists of a plastic valve body, a water rotor, and a hall-effect sensor. When water flows through the rotor, rotor rolls. Its speed changes with different rate of flow. The hall-effect sensor outputs the corresponding pulse Signal.

3.5.1 Features:

- Accurate and reliable.
- Low cost.
- Easy installation.

3.5.2 Application:

- Residential and commercial water treatment system.
- Water dispenser.
- Water cooler.

3.5.3 Electrical:

- Supply voltage : 2.4 – 26 V DC
- Supply current: typical 2.8 Amps, maximum 8.0 Amps.
- Output mode: open collector
- Output rise time: typical 1.0μsecond. maximum 10μsecond.
- Output falling time: typical 0.3μsecond. maximum 1.5μsecond.
- Flow Rate: 0.8 – 8.0 liter/min. (0.21 – 2.11 gallon/min.)
- Temperature : 0 to 40°C
- Pressure: Max. 6.0 bar (85 psi)

3.6Memory

Two types of memory are used in data loggers:

3.6.1Random access memory (RAM):

Unlike a PC's RAM which is used as a 'workshop area', a data logger can use RAM to store data (readings from the input channel). RAM chips are

inexpensive but must be battery backed up in order to retain the data. RAM chips are downloaded via the serial port of a PC. It can't save data when power is off.

3.6.2 Electronically erasable & programmable read only memory (EEPROM):

Developed for data loggers in the late 1980's EEPROM memory does not need to be backed up by a battery. Many data loggers use EEPROM chips for both storing the operating system of the microprocessor, as well as for data storage. An EEPROM chip can be programmed, read (stored data) and erased via the serial port of a PC.

EEPROM stands for Electrically Erasable Programmable Read-Only Memory and is a type of non-volatile memory used in computers and other electronic devices to store small amounts of data that must be saved when power is removed. Unlike bytes in most other kinds of non-volatile memory, individual bytes in a traditional EEPROM can be independently read, erased, and re-written. When larger amounts of static data are to be stored (such as in USB flash drives) a specific type of EEPROM such as flash memory is more economical than traditional EEPROM devices. An EPROM usually must be removed from the device for erasing and programming, whereas EEPROMs can be programmed and erased in-circuit, by applying special programming signals. Originally, EEPROMs were limited to single byte operations which made them slower, but modern EEPROMs allow multi-byte page operations. It also has a limited life - that is, the number of times it could be reprogrammed was limited to tens or hundreds of thousands of times. That

limitation has been extended to a million write operations in modern EEPROMs. In an EEPROM that is frequently reprogrammed while the computer is in use, the life of the EEPROM can be an important design consideration. It is for this reason that EEPROMs were used for configuration information, rather than random access memory.

3.7 Power supply

A feature that clearly distinguishes data loggers from PC's is the low power requirements of data loggers. Data loggers are designed to operate in remote locations for long periods of time void of main AC power. Most data loggers require a 12 VDC power source.

Battery capacities are measured in Milli-Amp hours (mAh) which determines the length of time that the battery can provide power for a given load. Increased capacity requires greater battery size and weight.

The various types of batteries available for data logging applications:

3.7.1 Non-rechargeable batteries

“Lithium Batteries” The best non-rechargeable power source available today and are available in the same sizes as alkaline batteries. They have a very high capacity size, work very well at cold temperatures and do not discharge over time. However they are expensive compared to alkaline batteries (about 5 times the cost!) and are not available in large capacity sizes.

“Alkaline Batteries” One of the best sources of power for a data logger. Alkaline batteries have a high capacity size, do not discharge over

time, work well at cold temperatures and most importantly are widely available at a reasonable cost.

3.7.2 Rechargeable batteries

“Sealed Lead Acid Batteries” Commonly used for ATV's, snowmobiles and motorized wheel chairs. These batteries are very similar in design to automobile batteries however the acid liquid is impregnated in a foam matrix and are sealed and therefore not refillable. The advantage to these batteries over automobile batteries is they can be orientated in any position, including upside down. The Deep-Cycle version of these batteries, as their name implies, can safely be discharged to low levels and recharged unlike automobile batteries. Also, Deep-Cycle batteries are available in very large capacities, work well at cold temperatures and have good re-charging characteristic (no battery memory). These batteries are widely available in a huge array of sizes at a reasonable cost and are commonly used for data logger applications requiring minimal maintenance (visits). Solar panels are often connected to these batteries to keep them charged up.

3.8 liquid-Crystal Display

A liquid-crystal display (LCD) is a flat panel display, electronic visual display, or video display that uses the light modulating properties of liquid crystals. Liquid crystals do not emit light directly.

LCDs are available to display arbitrary images (as in a general-purpose computer display) or fixed images which can be displayed or hidden, such as preset words, digits, and 7-segment displays as in a digital clock. They use the

same basic technology, except that arbitrary images are made up of a large number of small pixels, while other displays have larger elements.

LCDs are used in a wide range of applications including computer monitors, televisions, instrument panels, aircraft cockpit displays, and signage. They are common in consumer devices such as DVD players, gaming devices, clocks, watches, calculators, and telephones, and have replaced cathode ray tube (CRT) displays in most applications. They are available in a wider range of screen sizes than CRT and plasma displays, and since they do not use phosphors, they do not suffer image burn-in. LCDs are, however, susceptible to image persistence.

Each pixel of an LCD typically consists of a layer of molecules aligned between two transparent electrodes, and two polarizing filters (parallel and perpendicular), the axes of transmission of which are (in most of the cases) perpendicular to each other. Without the liquid crystal between the polarizing filters, light passing through the first filter would be blocked by the second (crossed) polarizer.

3.9GSM Modem (SIM 900)

A GSM modem is a specialized type of modem which accepts a SIM card, and operates over a subscription to a mobile operator, just like a mobile phone. From the mobile operator perspective, a GSM modem looks just like a mobile phone.

When a GSM modem is connected to a computer, this allows the computer to use the GSM modem to communicate over the mobile network. While these

GSM modems are most frequently used to provide mobile internet connectivity, many of them can also be used for sending and receiving SMS and MMS messages.

A GSM modem can be a dedicated modem device with a serial, USB or Bluetooth connection, or it can be a mobile phone that provides GSM modem capabilities. GSM modem circuit and configuration as recommended in the appendix (d).

The SIM900 is a complete Quad-band GSM/GPRS solution in a SMT module which can be embedded in the customer applications. Featuring an industry-standard interface, the SIM900 delivers GSM/GPRS 850/900/1800/1900MHz performance for voice, SMS, Data, and Fax in a small form factor and with low power consumption. With a tiny configuration of 24mm x 24mm x 3 mm, SIM900 can fit almost all the space requirements in applications, especially for slim and compact demand of design.

- SIM900 is designed with a very powerful single-chip processor integrating AMR926EJ-S core
- Quad - band GSM/GPRS module with a size of 24mmx24mmx3mm
- SMT type suit for customer application
- An embedded Powerful TCP/IP protocol stack
- Based upon mature and field-proven platform, backed up by our support service, from definition to design and production

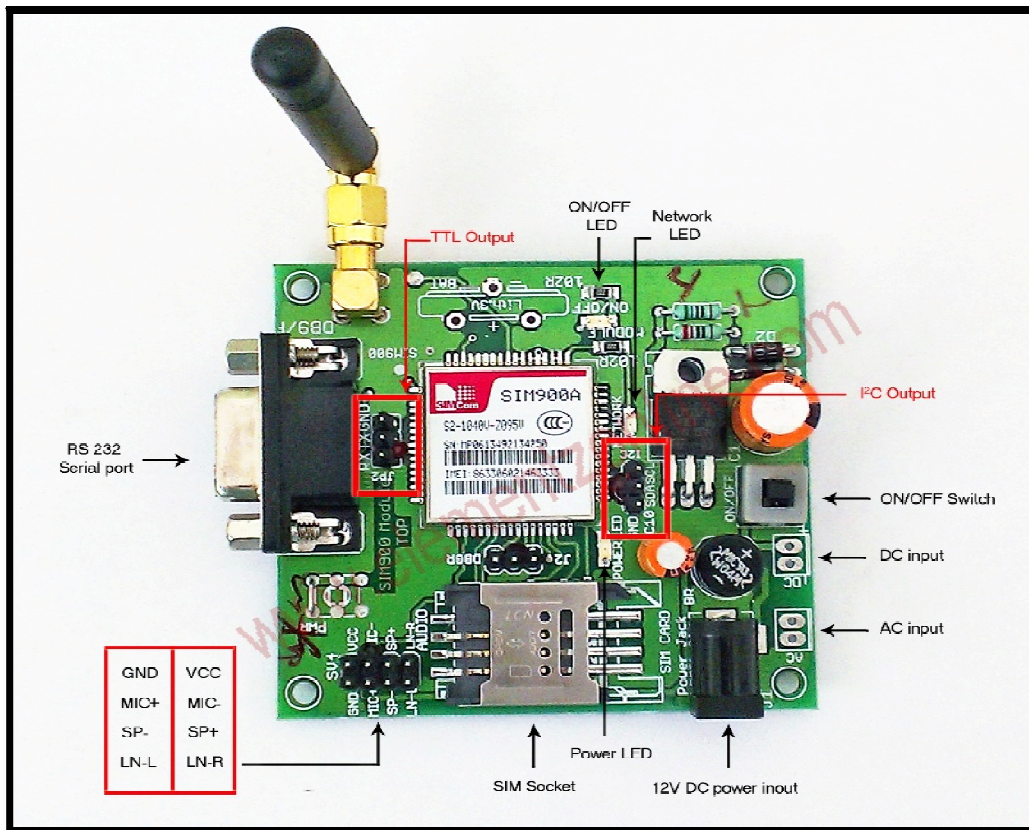


Figure3.2: The Structure of GSM SIM900

CHAPTER FOUR

SOFTWARE FOR THE CIRCUIT

4.1 Overview

Microcontrollers, such as the AVR, are controlled by software. The AVR programs are written on a PC using the BASCOM-AVR. This software is a type of computer program called a compiler

BASCOM is an Integrated Development Environment (IDE) that supports the 8051 family of microcontrollers and some derivatives as well as Atmel's AVR microcontrollers. Two products are available for the various microcontrollers - BASCOM-8051 and BASCOM-AVR. In a microcontroller project one needs to know the hardware base, i.e. the microcontroller with internal and connected peripherals, and the software used, i.e. IDE handling, programming and debugging.

BASCOM-LT, a BASIC compiler for Windows.3.1 It was the first Windows application that offered a complete and affordable solution, editor, compiler, simulator and programmer .BASCOM-LT was an 8051 BASIC compiler. The reason it became popular was that it included a lot of functionality that was easy to use from BASIC .Using an LCD display was simple, just a configuration line to define the used pins and voila, a working application in minutes. When you needed a different LCD display, you could simply change the CONFIG line .

When a different processor was needed, you only had to change the name of the definition file. No need for a lot of .h files .Another reason for its success was that we hide much of the complexity for the user. No ASM to deal with, simple statements. Ofcourse free updates and support.

Small companies that used the BASIC Stamp also recognized another advantage: There was no need for expensive modules and the code ran much quicker. When Windows 95 became an industry standard, users also wanted a 32bit version. A big part of BASCOM-LT was rewritten with the additional support for arrays and floating point (single).

With the many different 8051 variants, it was impossible to support all the chips. Having device definition “DAT” files, made it easy for the user to configure the 8051 variants. When Atmel launched the AVR chip, the 8051 compiler was rewritten, once again, to support the powerful AVR chips. The result was BASCOM-AVR. The AVR chip has a lot of internal memory. It uses simple linear memory addressing. The best part is that you can make the chip program itself. No wonder this chip family became so popular.

The coding for the system is done by using Bascom language. Refer to appendix (A) for the coding of the program.

4.2 The Flow Chart:

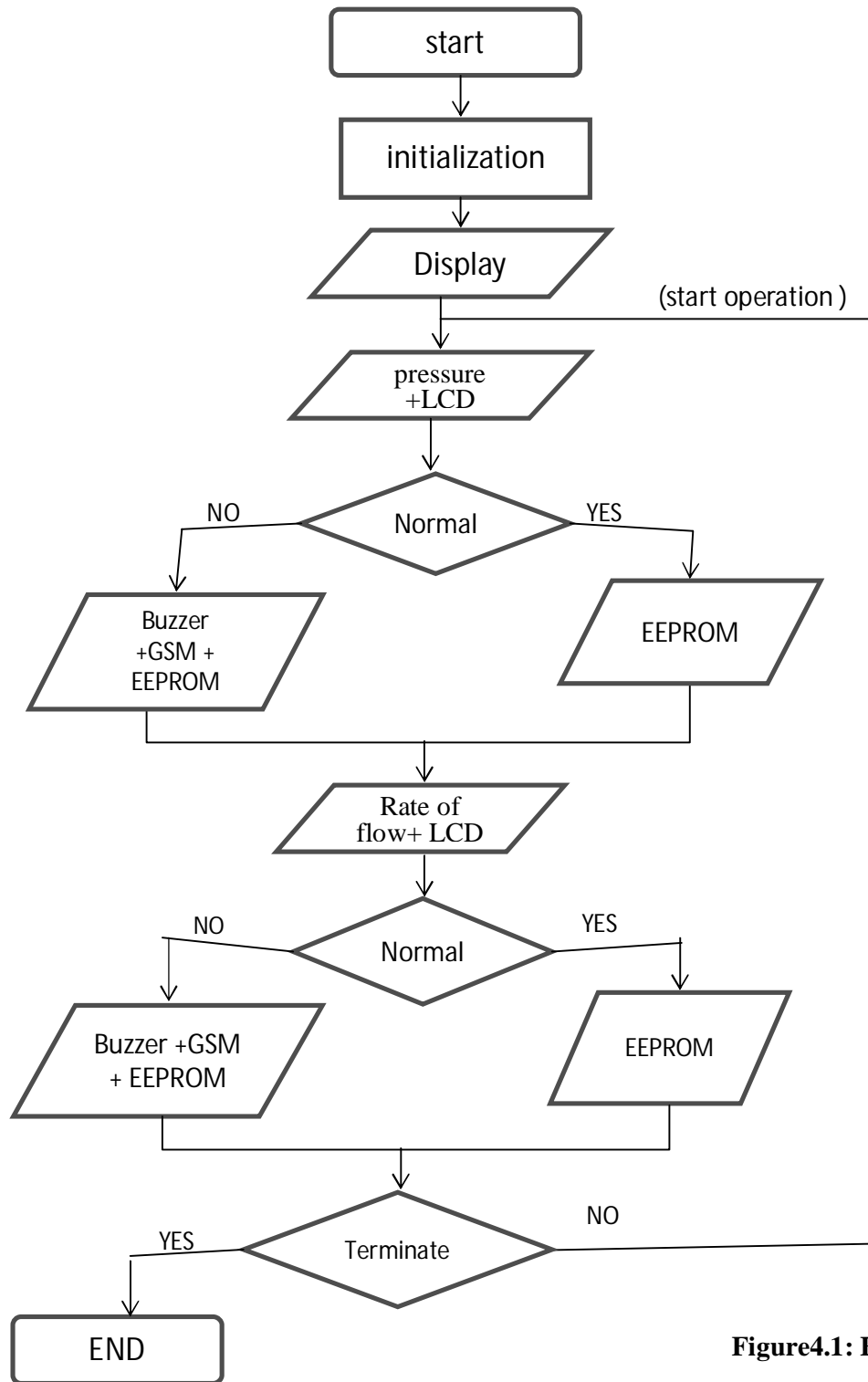


Figure4.1: Flow chart.

CHAPTER FIVE

RESULTS AND DISCUSSION

5.1The Results

This chapter covers the results obtained from the design in all readings of pressure sensor and rate of flow sensor.

Before the system start the designer enters the lowest and highest values of pressure and the rate of water flow.

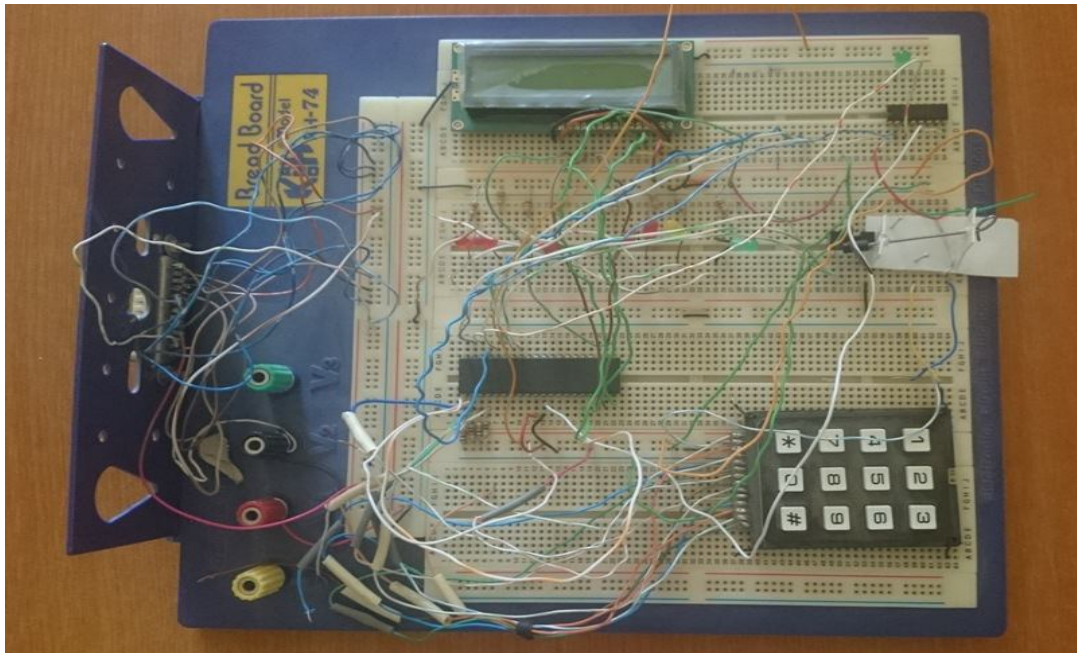


Figure 5.1: system design.

The results in this chapter divided in two parts:

1. Resultsof pressure Sensor.
2. Resultsof rate of flow senor.

Table 5.1: pressure sensormeasurement.

DATE	TIME	PRESSURE SENSOR /PSI
18-6-2015	7:00	50
18-6-2015	7:10	52
18-6-2015	7:20	57
18-6-2015	7:30	60
18-6-2015	7:40	71
18-6-2015	7:50	87
18-6-2015	8:00	102

Table 5.2: Rare of flow sensor measurement.

DATE	TIME	RATE OR FLOW (L/H)	LITER/PULS
18-6-2015	7:00	0.8 – 1.0	0.0039
18-6-2015	7:10	1.0 – 2.5	0.0040
18-6-2015	7:20	2.5 – 5.0	0.0041
18-6-2015	7:30	5.0 - 8.0	0.0052

5.2 The Discussion

This table describes the results of the pressure sensor and rate of flow sensor when the system starts the following scenario will be resulted.

- Microcontroller receives value from pressure and rate of flow sensors.
- The LCD display the sensor value.
- Microcontroller compares the value with highest value stored.

In this case two results:

1. Not equal to the highest values stored at the microcontroller , logging the value in EEPROM memory.
2. Equal the highest value of pressure , logging this value in EEPROM then send SMS to the system's observer and the buzzer will be run.

When the system starts ,the pressure sensor measure pressure every ten minutes and compare the result with maximum value (100 psi)stored in Microcontroller if the measured value not equal to the highest values, it will be saved in EEPROM memory. But if measured value higher or equal to 100 psi the system will store it in EEPROM and send SMS to the user. As it shown in table 5.1

Table 5.2 show the results of rate of flow water. The minimum rate 0.8 litter/hour and the maximum rate is 8 litter/hour. If the measured value is higher or equal to the maximum value ,then the system will store it in EEPROM and send SMS to the user to obtain the problem.

CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6.1 Conclusion

The data logger is an invaluable tool to collect and analyses experimental data, having the ability to clearly present real time results, with sensors and probes able to respond to parameters that are beyond the normal range available from most traditional equipment. Data loggers used for measuring the pressure might have certain limitations in terms of speed, memory and cost. The management of existing water supply networks can be substantially improved by permanent water district metering (WDM) which is one of the most efficient techniques for water loss detection and pressure management. However, WDM may compromise water system performance, since some pipes are usually closed to delimit districts in order not to have too many metering stations, to decrease costs and simplify water balance. This may reduce the reliability of the whole system and not guarantee the delivery of water at the different network nodes. In practical applications, the design of district meter areas (DMAs) is generally based on empirical approaches or on limited field experiences.

This project suggested a design based on using a microcontroller for processing. The microcontroller performs processing and control of the peripheral devices in the system. The processing is sequential and repetitive for data acquisition from the sensors, data logging in the EEPROM, displaying on the LCD and issuing sms message in case of malfunctions in the water distribution network or alarming of certain parameters.

The microcontroller based on design has been successfully worked. The design work is found to meet specification as it is capable of logging pressure and rate of flow on a continuous base and send text message to the user.

6.2 Recommendation

Distribution system is a network of pipelines that distribute water to the consumers. They are designed to adequately satisfy the water requirement.

The data logger described here can have many educational, commercial and industrial applications. The design can be improved further by incorporating the following modifications to the hardware and software:

- The hardware and software can be modified by introducing triggering so that a channel data is only read after it is triggered by an external or an internal event.
- More digital or analogue channels can easily be added to the data logger.

This new innovation technology has become the trend for most industries and companies around the world to gather information due to its reliability and outstanding outcome. The advantage of this technology is that it did not use any physical components or wires to transfer the data obtained from sensor at transmitter side to the receiver side. As a result, an effective system is developed where it is not only removes all the

conventional hardware and replace with a transceiver modem for data transfer but also a cost effective system as well. Moreover, the data transmission range can be extended into longer range depending on the transceiver modem capability. With this feature, information from the transducer could be transmitted faster and acts as an early alert in case of accident or disaster such as fire.

REFERENCES

- [1] HalaAbdalrheem Ahmed Abdalgader ,AbdelrasoulJabarAlzubaidi “Microcontroller Based Logger Design For Water Distributed Network” ,2015
- [2] Datasheet/20*4-LCDmodule [www.alldatasheet.com3/1/2015]
- [3] Datasheet archive. /ATmega16 [www.atmel.com – 1/1/2015]
- [4]Aanderaa is a trademark of Xylem Inc. or one of its subsidiaries.
© 2012 Xylem, Inc. D357 January 2015
- [5]VinayDivakar, “Design and Implementation of Microcontroller Based Temperature Data Logging System” ,December – 2013
- [6] G. Saidu, and M. Momoh and A. S. Mindaudu” Temperature monitoring and logging system suitable for use in hospitals, incorporating GSM text messaging”, January 2013
- [7]Ismaila S. and Momoh M. “ Microcontroller based termometer. Energy Society Of Nigeria Annual Conference “. Sokoto Energy Research Center,(2011).
- [8] Golden Plaza, Chitoor Road, Cochin – 682018, Kerala State, India
- “SIM 900–RS232-GSM/GPRS Modem” 10 -DEC -2011
- [9] B. Collis - Mount Roskill Grammar School”An Introduction to Microcontrollers and Software Design” 2003-2009
- [10]Dogan Ibrahim,” Microcontroller and sd-card based multichannel data logger”,2008
- [11]NemanjaTrifunovic, “Introduction to Urban Water Distribution
”, 2006

[12]. S. J. Perez, M. A. Calva, R. Castaneda, “A microcontroller based data logging” , 2006 “

[13]. Muhammad Ali Mazidi and Janice GillispieMazidi, “The 8051 microcontroller and embedded systems”, Pearson education ltd., India, 2004.

[14]Kay Chambers, John Creasey and Leith Forbes, “Design and operation of distribution networks” 2004

[15]. <http://www.loggingtutorial/dr.saulgreenburg/htm>.

[16] Claus Kuhnel “BASCOM Programming of Microcontrollers with Ease: An Introduction by Program Examples” , Copyright ' 2001

[17]. H S kalsi, “Electronic instrumentation”, Tata McGraw-Hill Ltd., New Delhi,1999.

[18]2004 World Health Organization. Safe Piped Water: Managing Microbial Water Quality in Piped Distribution Systems. Edited by Richard Ainsworth. ISBN: 1 84339 039 6. Published by IWA Publishing, London, UK.

[19]<http://www.ecs.umass.edu/cee/reckhow/courses/371/371hw03/371hw03s.pdf>

APPENDICES

Appendix (A)

Program

'-----

'name : ENG. HalaAbdelraheem

'Specialisation - Communication engineering

'copyright : (c) 1995-2005, MCS Electronics

'purpose : water distrib. network

'micro : ATmega32

'suited for demo : yes

'commercialaddon needed : no

'-----

\$regfile = "m32def.dat" ' we use the M32

\$crystal = 1000000

\$baud = 9600

'LCD CONFIGURATION

'-----

ConfigLcd = 16 * 2

ConfigLcdpin = Pin , Db4 = Portd.4 , Db5 = Portd.5 , Db6 = Portd.6 ,
Db7 = Portd.7 , E = Portd.3 , Rs = Portd.2

Cls

Cursor Off

Dim Count As Integer

'Disply a message

Count = 0

Cls

Locate 1 , 1

Lcd "WELCOME" ; Count

Waitms 5000

'init. PORT B

Config Pinb.0 = Input

Config Pinb.1 = Input

Config Pinb.2 = Input

Config Pinb.3 = Input

'init. PORT A

Config Porta.0 = Output

Config Porta.1 = Output

Config Porta.2 = Output

Waitms 5000

' Poll the sensors

' Check pressure sensor (sensor=1 means abnormal,sensor=0 means normal)

Do

 If Pinb.0 = 1 Then

 Waitms 1000

' Send SMS message through the GSM alarm system II (Relay ON- II short with GND)

Pina.0 = 1

Cls

Locate 1 , 1

Lcd "STORE PR.IN EEPROM"

Locate 2 , 1

Lcd "ALARM SMS-ABNORMAL PRESSURE"

Elseif Pinb.0 = 0 Then

Pina.0 = 0

Cls

Locate 1 , 1

Lcd "NOTHING"

Waitms 5000

End If

' Check rate of flow sensor (sensor=1 means abnormal,sensor=0 means normal)

```

    If Pinb.1 = 1 Then

Waitms 1000

' Send SMS message through the GSM alarm system II (Relay ON- I2
short with GND)

        Pina.1 = 1

    Cls

    Locate 1 , 1

    Lcd "STORE RF.IN EEPROM"

    Locate 2 , 1

    Lcd "ALARM SMS-ABNORMAL RF."


Elseif Pinb.1 = 0 Then

        Pina.1 = 0

    Cls

    Locate 1 , 1

    Lcd "NOTHING"

    Waitms 5000

End If

```

' Case of both sensors (PR.&RF. sensors=11 means abnormal,sensors=00 means normal)

If Pinb.0 = 1 And Pinb.1 = 1 Then

Waitms 1000

' Send SMS message through the GSM alarm system II (Relay ON- I3 short with GND)

Pina.2 = 1

Cls

Locate 1 , 1

Lcd "STORE PR. & RF.IN EEPROM"

Locate 2 , 1

Lcd "ALARM SMS-ABNORMAL PR.&RF."

Elseif Pinb.0 = 0 And Pinb.1 = 0 Then

Pina.2 = 0

Cls

Locate 1 , 1

Lcd "NOTHING"

Waitms 5000

End If

Loop

End

Appendix (B)

The Microcontroller Features

- High-performance, Low-power AVR® 8-bit Microcontroller
 - Advanced RISC Architecture
 - 131 Powerful Instructions – Most Single-clock Cycle Execution
 - 32 x 8 General Purpose Working Registers
 - Fully Static Operation
 - Up to 16 MIPS Throughput at 16 MHz
 - On-chip 2-cycle Multiplier
 - Nonvolatile Program and Data Memories
 - 32K Bytes of In-System Self-Programmable Flash
- Endurance: 10,000 Write/Erase Cycles
- Optional Boot Code Section with Independent Lock Bits
- In-System Programming by On-chip Boot Program
- True Read-While-Write Operation
- 1024 Bytes EEPROM
- Endurance: 100,000 Write/Erase Cycles
- 2K Byte Internal SRAM
 - Programming Lock for Software Security
- JTAG (IEEE std. 1149.1 Compliant) Interface
 - Boundary-scan Capabilities According to the JTAG Standard
 - Extensive On-chip Debug Support

– Programming of Flash, EEPROM, Fuses, and Lock Bits through the JTAG Interface

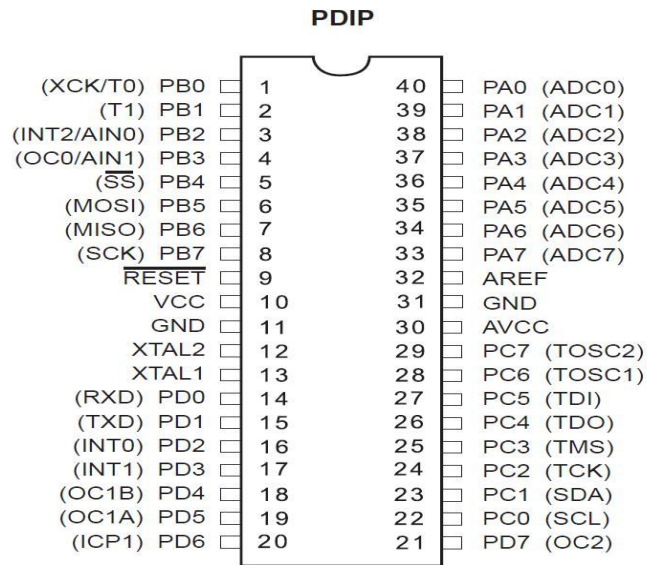


Figure1: Pin out Atmega32.

PIN count

Atmega32 has got 40 pins. Two for Power (pin no.10: +5v, pin no. 11: ground), two for oscillator (pin 12, 13), one for reset (pin 9), three for providing necessary power and reference voltage to its internal ADC, and 32 (4×8) I/O pins.

About I/O pins: ATmega32 is capable of handling analogue inputs. Port A can be used as either DIGITAL I/O Lines or each individual pin can be used as a single input channel to the internal ADC of ATmega32, plus a

pair of pins AREF, AVCC & GND (refer to ATmega32 datasheet) together can make an ADC channel.

No pins can perform and serve for two purposes (for an example: Port A pins cannot work as a Digital I/O pin while the Internal ADC is activated) at the same time. It's the programmers' responsibility to resolve the conflict in the circuitry and the program. Programmers are advised to have a look to the priority tables and the internal configuration from the datasheet.

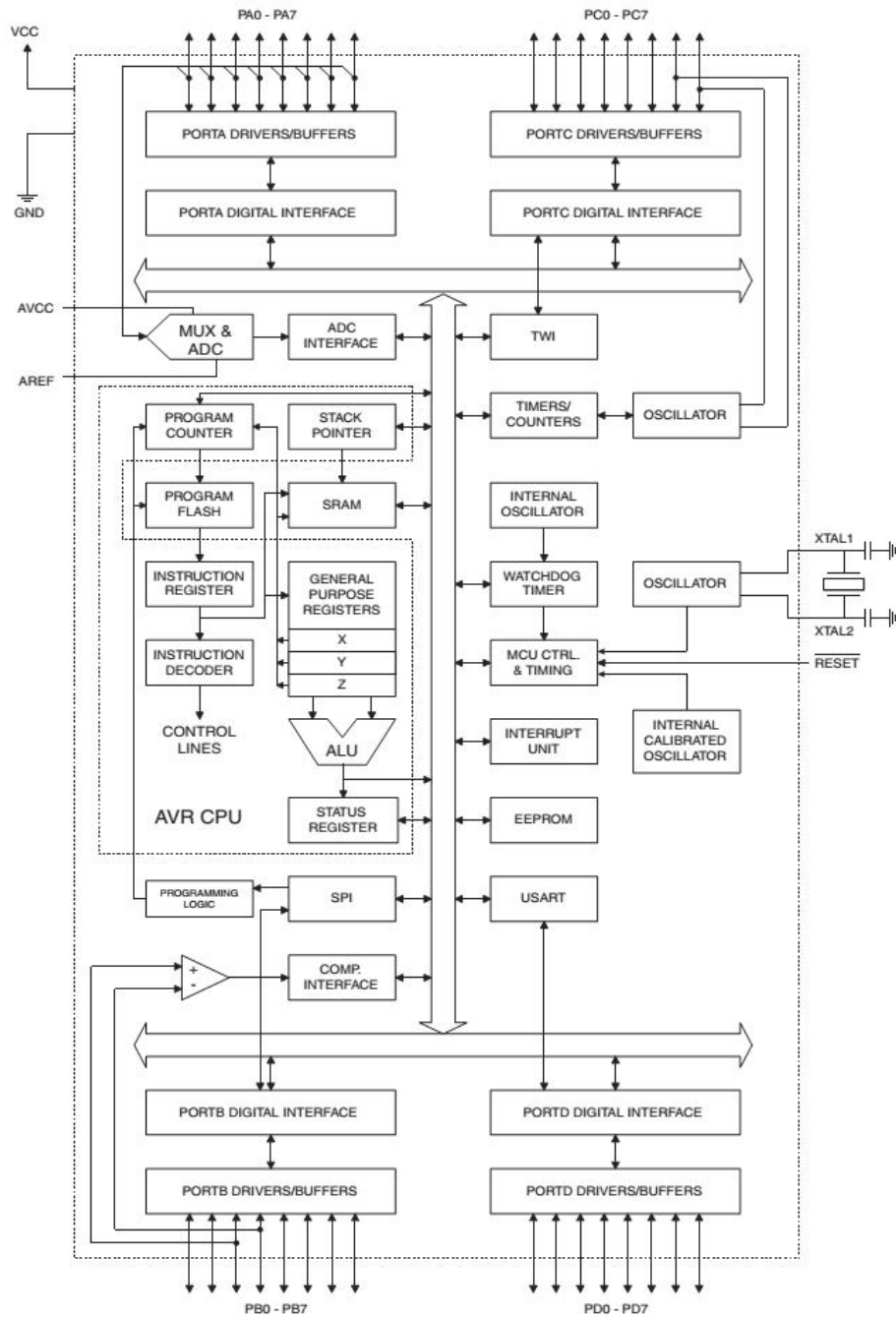
Digital I/O pins: ATmega32 has 32 pins (4portsx8pins) configurable as Digital I/O pins.

Timers: 3 Inbuilt timer/counters, two 8 bit (timer0, timer2) and one 16 bit (timer1).

ADC: It has one successive approximation type ADC in which total 8 single channels are selectable. They can also be used as 7 (for TQFP packages) or 2 (for DIP packages) differential channels. Reference is selectable, either an external reference can be used or the internal 2.56V reference can be brought into action. There external reference can be connected to the AREF pin.

Communication Options: ATmega32 has three data transfer modules embedded in it. They are Two Wire Interface USART Serial Peripheral Interface

Figure 2. Block Diagram



Appendix (C)

Pressure sensor 4017

Is a compact yet intelligent sensor designed to be used on our RCM 9, RCM 11, RDCP or AanderaaDataloggers as well as in other measuring systems. The sensor is based on a silicon piezoresistive bridge sampled and temperature compensated by an advanced digital signal processor. The sensor is housed in a rugged titanium cylinder.

Since all calibration and temperature compensation data are stored inside, the pressure can be presented directly in engineering units without any external calculation.

Pressure Sensor 4017 is a compact fully integrated sensor for measuring the pressure level and the water temperature. The sensor is designed to be mounted directly on the Top-end Plate of RCM 9/11, RDCP or via cable to AanderaaDatalogger using SR10. The sensor can also be used as standalone sensor using RS-232. The sensor is easily integrated in other measurement systems with third party Dataloggers

. Features Pressure Sensor 4017:

- Smart sensor technology - plug and play
- Calibration coefficients are stored in the sensor
- Low maintenance needs

- Low current drain
- Depth rating of 6000 meters
- Direct readout of engineering data
- Output parameters: Pressure, Temperature
- Selectable interval from 1 second to 255 minutes
- Rugged and robust with low maintenance needs
- Output formats: SR10, RS-232
- Up to 60MPa range
- Configured using Pressure setup program 4047 (or via Hyper Terminal)

Two SR10 channels are available; one for pressure and one for temperature. The user may configure the range on both outputs; best accuracy is achieved with a short measurement range.

The sensor can be mounted directly to the Top- end Plate of Aanderaa acoustic current meters and profilers and connected to the main control board (electronic board) with a short cable, Sensor Cable 3854.

The 10-pin receptacle in the sensor foot mates with Aanderaa CSP (Cylindrical Sealing Plug), giving access to RS-232 output. For connection to a PC the 1 meter Sensor Cable 4865L can be used. It is furnished with a watertight 10-pin CSP plug at the sensor end. An additional USB plug is used for providing power to the sensor.

The 4865 is also available in other cable lengths up to 20 meters

Pressure: 4017A Range: 0 – 1000kPa (0 – 145 psia)

4017B Range: 0 – 4000kPa (0 – 580 psia)

4017C Range: 0 – 10000kPa (0 – 1450 psia)

4017D Range: 0 – 20000kPa (0 – 2900 psia)

4017E Range: 0 – 40000kPa (0 – 5800 a

4017F Range: 0 – 60000kPa (0 – 8700 psia)

Resolution: $\pm 0.0001\%$ FSO(2)

Accuracy: $\pm 0.04\%$ FSO

Temperature: Range: 0 – 36°C (32 – 96.8°F)(1)

Resolution: 0.01°C (0.018°F)(3)

Accuracy: $\pm 0.1^\circ\text{C}$ (0.18°F)

Response Time (63%): <10 sec

Output format: AADI SR10 and ASCII RS-232(6)

Sampling interval: 2 sec – 255 min (SR10 controlled by datalogger)


Supply voltage: 6 to 14Vdc (SR10 -6 to -14Vdc

Appendix (D)

GSM Home Alarm Base with Text (II)

-----PlusMANUAL

FUNCTION:

- ◆ GSM 850/900/1800/1900 BANDS ALARM BASE FOR THE WORLD
 - ◆ FULL DUPLEX COMMUNICATION WITH THE BASE
 - ◆ MONITOR LIVING SURROUNDINGS
 - ◆ VOICE AND MESSAGE ALERT
 - ◆ SET ALARM ON OR OFF BY CONTROLLOR
 - ◆ CALL IN SET ALARM ON、OFF、MONITOR、OUTPUT
 - ◆ SEND SMS TO SET ALARM ON、OFF、MONITOR、OUTPUT
 - ◆ 5 GROUP PHONE + ROOM NUMBER
 - ◆ 1 GROUP ALARM CENTER MONITOR PHONE
 - ◆ 2 GROUP PHONE TO REPORT ALARM AND DISALARM STATUS
 - ◆ PROGRAMABLE 7 GROUP ALARM TEXT MESSAGES
 - ◆ 3 ZONE FOR WIRE DIRECTOR
 - ◆ 16 ZONE FOR WIRELESS DIRECTOR
 - ◆ EASILY SET ON OR OFF EVERY WIRE OR WIRELESS DIRECTOR
 - ◆ 1 RELAY OUTPUT TO POWER ON CAMERA WHEN ALARM
 - ◆ 2 OUTPUT FOR COOKER、AIR CONDITION
 - ◆ SMS INFORM EXTERNAL POWER FAILURE OR RECOVERY
- 
- A black, rectangular GSM Intelligent Alarm System base unit. It features a silver antenna on the top left and a SIM card slot on the top right. The front panel has several indicator lights and buttons, including 'ARM', 'DISARM', 'MONITOR', 'MESSAGE', 'STATUS', and 'POWER'. The text 'GSM Intelligent Alarm System (II)' is printed on the top right of the front panel.



◆ INDOOR AND OUTDOOR ALARM CONTROLLOR

Configuration of the base 1.1.1.1.1.1

There are 10 connector outside the back of base:

(GND; SIREN; RELAY1; RELAY2; SPEAKER; O2; O1; I3; I2; I1):

I1; I2; I3, this 3 point for line input, every one point can be connected with ground or open to make alarm out.

O1; O2; these 2 point for output, you can call in or send the SMS to set it . If this point output goes high, the lamp of OUT 1 or OUT 2 will light in the panel.

SPEAKER; this point for voice output, it connect to the speaker .the other point of speaker connect to ground. you can control it by call in or send the SMS. If this function avails, the lamp of OUT 3 will light in the panel.

RELAY1; RELAY2, this two point will close 3 minute when alarm happened .you can use this two point to start the power supply of the camera when alarm happened, but you can disable this function by set 16#1#, you can also make this relay close or open anytime by send the SMS or dial (94#1# or 94#0#).

SIREN, this point can output siren tone alarm, this connect to the siren .the other point of siren connect to ground.

GND, power ground



How can I start the base ?

1. Delete all telephone Numbers and messages in the SIM card memory or buy a new card. Insert SIM card into the base.

2. Connect antenna with the base.
3. Insert the power supply, which need 9V—12V DC, must be over 1000mA current. The signal status LED turns to red and last for 20 seconds, this status waiting program wireless detector into the base, After 20 seconds, the signal status LED is flashing in orange ,it show to check SIM card and search GSM network, when it finish check the base,if the signal status LED change slow flashing in green, this show phone number have saved in the base,and the base is in alarm status .if the signal status LED is go still green ,this show phone number have not saved in the base, and the base is in disalarm status .you must dial in or send the SMS to program the phone number.
you use controller to set the base in alarming or disalarm

How can I setup the alarm phone number and SMS?

1. you can send the message to the base to setup the 5 group alarm phone number and 7 kinds of SMS .The format:password#operation code # content #
 123456#51# 13905950001#.save first group alarm phone number into the base.

 123456#52# 13905950002#.save second group alarm phone number into the base.

 123456#53# 13905950003#.save third group alarm phone number into the base.

 123456#54# 13905950004#.save fourth group alarm phone number into the base.

 123456#55# 13905950005#.save fifth group alarm phone number into the base.
2. Set PSTN monitoring center:

You also can save: phone number # room No. #, it will dial the room number when alarming.(for the users whose alarm system is working with monitoring center)

123456# 71# 88886666 # 0001 # , show monitoring center:88886666; room No.0001

3. We have fix 7 kinds of SMS in the base ,but you can change it.
The first five messages are for 1-5 zone wireless detectors , The sixth messages are for 6-16 zone wireless detectors ,The seven message are for wired port I1, I2, I3.

The first wireless detectors alarming, the message is: wireless detectors activated (zone 1)

The second wireless detectors alarming, the message is: wireless detectors activated (zone 2)

The third wireless detectors alarming, the message is: wireless detectors activated (zone 3)

The fourth wireless detectors alarming, the message is: wireless detectors activated (zone 4)

The fifth wireless detectors alarming, the message is: wireless detectors activated (zone 5)

The sixth to sixteen wireless detectors alarming, the message is: wireless detectors activated (zone i);I=6-16

The seventh wire detectors alarming, the message is: wire detectors activated (zone i);I=1-3, for port 1 to 3 alarm

3. you can send the message to the base to rewrite 7 kinds of SMS, Every message cannot be more than 24 English characters.

123456#81# Front door open #.save first group message into the base as first wireless detectors alarming.

123456#82# Middle door open#.save second group message into the base as second wireless detectors alarming.

123456#83# Back door open#.save third group message into the base as third wireless detectors alarming.

123456#84# Front window open g#. save fourth group message into the base as fourth wireless detectors alarming.

123456#85# Back window open#. save fifth group message into the base as sixth wireless detectors alarming.

123456#86# Middle window open#. save sixth to sixteen group message into the base as sixth wireless detectors alarming.

123456#87# Upflood open#. save seventh group message into the base as port 1 to 3 wire detectors alarming.

How can I test the base alarm out?

When you start the base,if the base is in disarm status, the signal LED still green, you can use controller to change the base into alarm status,or you may sent SMS (123456#1#1#) to the base to change the base into alarm status, the signal LED shange green flash .

1. Under the arming state, with green LED on, any port of input (I1, I2, I3) touches ground or let it open, or wireless detectors has been activated, or you push emergency key of the controller ,the alarm system will send alarm information by SMS, and dialing out stored telephone numbers.
2. It will send SMS before dial alarm phone numbers. If the SMS has been closed or limited, It can only dial out the preset telephone numbers. You can make them disarm with remote controllor
3. When there is alarm, you can answer the phone(not need inter password)for listen-in, remote control , press 3# 1# to make the base to play the siren and press 3# 0# to stop it , press 4# 1# to

Start to listen-in and press 4# 0# to stop it , press 93# 1# to Start to talk with base and press 93# 0# to stop it .

4. When there is alarm, you can answer the phone(not need inter password),if you do not need the base dial next phone number programed in the base,you just press 1# 1# or 1#2# to re-turn the base in in alarm status.
5. When there is alarm, you can use the controller to change the base into disarm status when you are in nearby .
6. In normal use with inside recharger battery, you will receive the message 'external power failure' or 'external power recovery' when external power supply lost or recovery.

How Can I control the base ?

1. Sending the smessage to the host phone number (SIM Card number)

Send the message to the base :enter password 123456# ,add the following command to set the base;

2. calling the host phone number (SIM Card number)

Call in the base and enter password 123456# ,then input the following command to set the base:

Com	Function	Com	Function
1#1#	Outdood alarm* (all detectors work)	1#2#	Indoor alarm (part detectors work)
1#0#	Disalarm *(all detectors not work)		
3#1#	Sounder immediately	3#0#	Stop Sounder
4#1#	Start to listen-in (use phone key)*	4#0#	Stop to listen-in (use phone key)
11#1#	Need siren sound when alarming *	11#0#	No siren sound when alarming
12#1#	Sending SMS when alarming *	12#0#	No Send SMS when alarming
15#1#	Dial phone number when alarming *	15#0#	Just alarm and no dialing
16#1#	Disable Relay close 3 Min when alarm	16#0#*	Set Relay close 3 Min when alarm*
17#1#	SetPSTN monitoring center avail	17#0#	SetPSTN monitoring center disavail*
18#1#	Dial out whan base change to alarm status	18#0#	Not dial out whan base change to alarm

			status*
19#1#	dialing whan base change to disalarm status	19#0#	Not dial out whan base change to disalarm status*
30##	show the alarm and disalarm status of every zone		
31#--#	Change password. Enter a new password (1—6 bit).		
38#--#	Set on alarm of zone (wireless zone: 1—16; wire zone: 21—23)		
39#--#	Set disalarm of zone (wireless zone: 1—16; wire zone: 21—23)		
50##	show preset phone number in the base		
51#--#	First group phone number(0—15bit)	52#--#	Second group phone number(0—15bit)
53#--#	Third group phone number(0—15bit)	54#--#	fourth group phone number(0—15bit)
55#--#	Fifth group phone number(0—15bit)		
70##	show center phone number. in the base		
71#--#--#	Set PSTN monitoring center phone number. 71# center number # room No. #		
78#--#	Set Dial out phone number whan you make base change to alarm status(this phone do not answer)		
79#--#	Set Dial out phone number whan you make base change to disalarm status(this phone do not answer)		
80##	show preset SMS in the base		
81#--#	First group Message(0—24bit)	82#--#	Second group Message(0—24bit)
83#--#	Third group Message(0—24bit)	84#--#	Fourth group Message(0—24bit)
85#--#	Fifth group Message(0—24bit)	86#--#	Sixth group Message(0—24bit)
87#--#	Seventh group Message(0—24bit)		
90##	show Output status in the base		
91#1#	Set Output 1 change to high	91#0#	Set Output 1 change to low
92#1#	Set Output 2 change to high	92#0#	Set Output 2 change to low
93#1#	Set talk to the base avail (Output 3)	93#0#	Set talk to the base disavail (Output 3)
94#1#	make two point of Relay close	94#0#	make two point of Relay open
95#1#	Set alarm when line input 1 open	95#0#	Set alarm when line input 1 connect to Gnd*
96#1#	Set alarm when line input 2 open	96#0#	Set alarm when line input 2 connect to Gnd*
97#1#	Set alarm when line input 3 open	97#0#	Set alarm when line input 3 connect to Gnd*

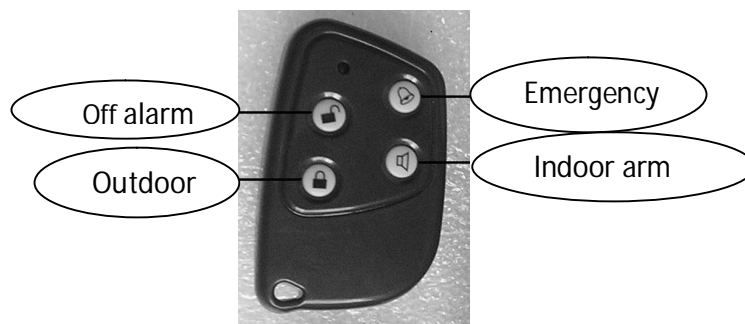
Note:

1. above table, ‘ * ’ stand for approves
2. In the above phone operation, one beep shows you inter each number is successful, a long beep show you inter the sentence is successful, two short beeps shows you inter the sentence is failed, you should try again.
3. In the above SMS operation, you will receive a answer message for confirmation after you send the message command to the base,thus you will know the working state of the base.(arm, disarm or alarm),if the answer is the present state of the base,you may send wrong seessage to the base.
4. You also can only send the password to check out the present state of the base. The replied message as follows:

Disarm,SMS-ON,Phone-ON,Siren-ON,monitor center -OFF, arm phone- OFF, Disarm phone-OFF

How Can I use controllers?

The remote controller has four buttons: outdoor alarm key, set alarm work when no one in the home, all the detectors in the home are ready on alarm, the lamp on panel will low flash green. indoor alarm key, set alarm work when some people in the home, some of the detectors are need not work, the lamp on panel will fast flash green;as the first floor no people inside, all of the detectors the first floor are ready on alarm, the second floor live people inside, all of the detectors in the second floor are off alarm when you use indoor alarm key.off alarm key, set alarm off, all the detectors are disalarm,the lamp on panel will still green.emergency call key, set emergency call, the lamp on panel will flash red; the system will make alarm,and the base will send the SMS and dial out.



How can I add more detectors?

You can add new sensors or detectors, such as wireless door sensors, PIR Sensors, gas and smoke detectors into the base.

1) The detectors are all ready on alarm when you set Outdoor alarm or Indoor alarm:

when the GSM base start power on ,At this time, The lamp on panel will bright on red in 20 second,You should trigger the sensor or detector, and the red LED will flash and shows successful .

After you finish doing it,you can waitting 20 seconds, it ends and automatically enter into working state, the lamp on panel change to yellow,then to the green.

2) The detectors are ready on alarm when you set Outdoor alarm ,and not-alarm when you set Indoor alarm(means those detectors will not work when you set Indoor alarm)

when the GSM base start power on ,At this time, The lamp on panel will bright on red in 20 second,first you push the reset button for a second, then you can trigger the sensor or detector, and the red LED will flash and shows successful .

After you finish doing it,you can waitting 20 seconds, it ends and automatically enter into working state, the lamp on panel change to yellow,then to the green

Note, if there are 4 zone in the base , the new detector will be 5 zone in the base.

How Can I cancel the lost detectors?

It often happens that some of coded detectors are lost. It is not safe for your home, but do not worry, you can cancel the coded information of this detector so that It can not control your alarm system. But how to do it? It is very simple, just reset the alarm system by keeping reset button and power the system and then beep or LED flashes, it shows reset is successful. All registered detector have been deleted. You can register them again with the above solution. But the SMS message was not changed.

SOME NOTE:

1) About (SIGNAL) lamp

(SIGNAL) lamp show red in 20 second when the base is power on. In this time,you can fit wireless detector into base,if you do this,the red flash.then, (SIGNAL) lamp flash yellow show it start to get in touch GSM network .If (SIGNAL) lamp still flash yellow,show SIM card is set un-correctly or GSM network is not good.If (SIGNAL) lamp still on yellow,show not name or phone number in SIM card .if every thing is ok, (SIGNAL) lamp show slow flash green (in outdoor alarm situation)or show fast flash green (in indoor alarm situation) , (SIGNAL) lamp show still green (not in alarm situation).if alarm happened, (SIGNAL) lamp show flash red and start dial out and sent SMS.

2) About (OUTPUT) lamp

If the base O1 output high(+5V),the OUT 1 lamp bright; If the base O2 output high(+5V),the OUT 2 lamp bright;

3) About (TALK) lamp (OUTPUT 3)

If the base speaker work,this talk voice output, the output 3 bright;

4) About (RELAY) lamp

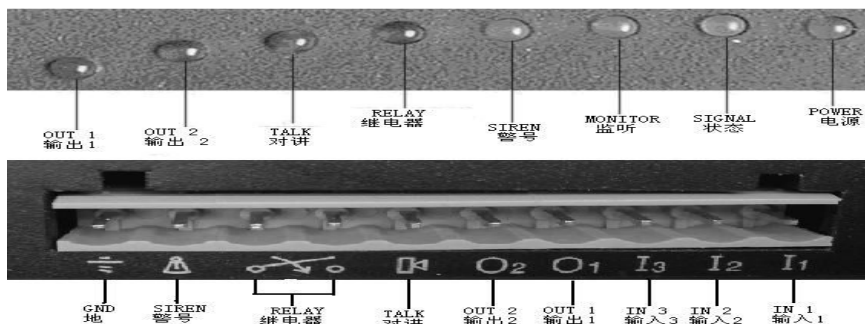
If the relay in the base close ,the relay lamp bright

5) About (SIREN) lamp

if the base siren out,the siren lamp bright.

6) About (MONINT) lamp

The monitor lamp bright If the base is work in monitor.



SOME TECHNIQUE PARAMETER

- 1) Static current:20mA
- 2) Power:9V-12V DC
- 3) Working temperature:-20°C +85°C
- 4) GSM850/900/1800/1900MHz band
- 5) Receiving code: ASK
- 6) Frequence:315/433/868/915MHZ
- 7) wireless distance: 100 M
- 8) wireless detectors:16
- 9) wire detectors:3

