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DESIGN AND IMPLEMENTATION OF MONITORING SYSTEM FOR FROZEN FOOD DURING TRANSPORTATION USING 1-WIRE PROTOCOL: A REVIEW

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Abstract— Monitoring of pharmaceutical and frozen food is one of the issues in recent times because there is high probability of food spoilage during transport. The problem in other techniques like RFID based or Wi-sensors based is that these systems are not suitable in environment that is dusty, dirty and polluted. Along with this the likelihood of antenna parameter interference is high since food contains large part of water that amounts to interfere in antenna gain parameters and propagation abilities are affected that is surely eliminated in this system. The movement of shipment from source to destination along with abrupt or slow temperature and humidity changes during transport can be recorded by thermochron DS1921G and humidity sensor SHT11 that implements 1-wire protocol respectively. This project demonstrates the use of 1-wire technology for the monitoring of shipment. The micro- controller of ARM7 family LPC 2148FBD64 will be used at the heart of the system. Tracking and monitoring will be done using GPS and GSM technologies. The main purpose of this paper is to design and implement a system for monitoring temperature and humidity and location at particular time during transit. The system of monitoring the temperature and humidity will be stored inside the cool box in order to continuously monitor the consignment.

Keywords— Thermochron, 1-wire, ARM7, GPS, GSM, Transport

I. INTRODUCTION

Cooling systems are widely used for the preservation of food items, pharmaceutical products and blood derivatives. To avoid perishing, products must always be kept in a suitable temperature range. Along with temperature, humidity will be monitored. An effective control of temperature and humidity changes for cooling box by means of a continuous monitoring system makes it possible to record the temperature at which each and every product was actually submitted thereby ensuring the quality of the product(frozen or pharmaceutical) has been maintained. A 1 –wire based system, appropriately designed and controlled system implies the temperature and humidity variations and improving the cooling condition and the product quality. The use of frozen foods and the boom in industry of pharmaceutical products for life saving drugs has increased manifolds. Cold chain companies have been monitoring conditions of storage facilities for frozen foods in the past years using several techniques such as wi-sensors [1] and RFID [2]. The main goal is to design an integrated traceable and quality assurance information system for a generic food processing unit [3]. The quality of these foods changes rapidly if there is any minor change in temperature during storage and transport. Therefore, any system that can monitor parameters can easily get information about the food or medicines and circulation of counterfeited products can be reduced.

Fig 1 : DS1921g Dimensions

1.1Thermochron sensor

Thermochron (Fig. 1) is one of the members of the I-button family of electronic tags. It is a digital thermometer that measures temperature in 0.5°C increments. The operating range is -30°C to +70°C with an accuracy of ±1°C. The thermochron has a real-time clock. The timer has an accuracy of ±2 Minutes per Month. This device automatically wakes up and measures temperature at user-programmable intervals from 1 Minute to 255 Minute. It has 2KB of Data-Log Memory and 512 Bytes of general purpose battery-backed SRAM. It also records a long-term temperature histogram with 2.0°C resolution. Programmable temperature high and low alarm trip points. Records up to 24 timestamps. There are six different types of I - buttons. Identification only (often used for access control to various resources like building, equipment etc.), memory (non-volatile and programmable

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data storage), real time clock, secure (password protected memory), sensor (temperature) and data loggers. The proposed plan has the use of DS1921g temperature sensor.

1.2 1-wire protocol overview

The objective of 1-wire protocol is to digitally communicate over twisted-pair cable with 1-wire slave devices over a 1-wire network. The 1-wire network consists of an open-drain master/slave multidrop network. The 3-components of a 1-wire system are a bus master with controlling software here ARM7 LPC2148FBD, wiring and associated connectors and 1-wire slave. The 1-wire concept links the master initiating communication and the slave synchronizing with the master signals. There are four different modes through which a master initiates communication with the slave. Accessing an I-button through 1-wire port involves four steps[4] to start communication that is called reset or presence pulse, ROM function command, memory function command and finally transferring data.

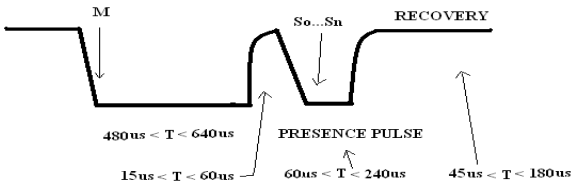

Fig 2 : Wire Signalling Commands

The 1-wire bus is usually idleing high.The micro controller initiates communication with the slave devices on the 1-wire bus,the master pulls the 1-wire bus low as shown in the Fig.2 'M' for 480us and maximum 640us. Next, the master leaves the 1-wire bus causing it to again go into the idleing high state. The bus remains in this state for a period of 15us to 60 us to check if any slave is present and wants to transfer information. Then in case a slave is present on the line it shows its presence by pulling the line low for about 60us to 240 us.

During this time the other slaves are dropped off the line. This is called the 'presence pulse'. After this recovery mode is achieved by the 1-wire bus going back into idle high state. After the device shows its presence the ROM command sequence is executed as shown in Fig 3. There are several commands like 'Read' ROM,search ROM,skip ROM**,** match ROM and so on. The ROM identification is detected which is an unalterable factory programmed sequence that every slave device possess'.

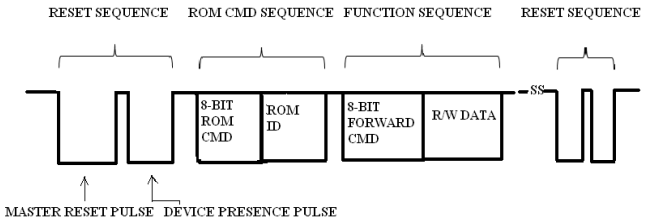

Fig 3 : Wire Signalling Commands

The globally unique address of 64 bits is composed of eight bytes divided into three main sections as shown in Fig 4. Beginning with the LSB, the first byte stores the 8-bit family codes. The next six bytes store a customizable 48-bit individual address for serialization. The last byte, the most significant byte (MSB), contains a cyclic redundancy check (CRC) with a value based on the data contained in the first seven bytes for proper data integrity.

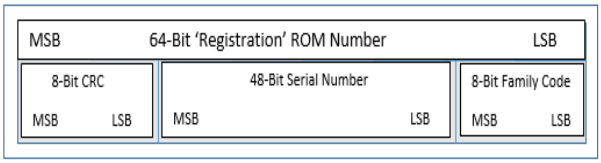

Fig 4 : 64-bit unique ROM 'registration' number

Finally the R/W sequences are executed as shown in Fig.5 Usually the 1-wire bus is idleing high. When the master wants to communicate with the slave device it pulls this line low. It should be noted that the master will only initiate the communication and the slaves willl remain in the vegetative state until not woken up by the micro- controller. The master initiates the write1 sequence in which first the 1-wire line is pulled low for a duration less than 15us and then releases the line.

The slave device that will be the thermochron will sample this line after 15 us and will note that the line is high this is in turn is recognised as WRITE1 sequence.

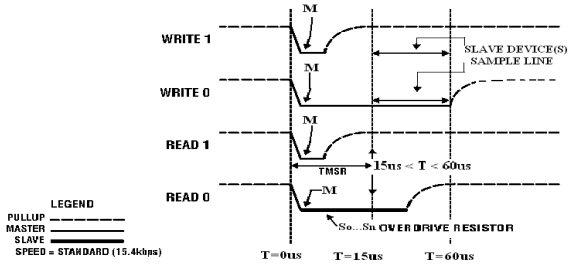

Fig 5 : Timing Diagram

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Next, the WRITE0 sequence is similar to WRITE1 only that the 1- wire bus goes low after 15us. The master initiates communication and pulls the line low for 15 us T_{msr} and releases it. This command is recognized by the master as READ1. For the READ0 command the master pulls the bus low for more than 15 us $T_{msr.}$

II. LITERATURE REVIEW

According **to Kai-Xin Tee, Moi-Tin Chew and Serge Demidenko** [4] paper implements the use of I-buttons in warehouses where conventional storage has been replaced by the revolutionary I-button. Stock controlling and container tracking done using 1-wire protocol. Complete 1-wire communication inside warehouse using microLAN network has been done. Here only the location of goods in a ware house is determined using I-buttons. The same idea can be used in cool boxes; thermochrons are placed to monitor temperature and time.

According to **Eugen Diaconescu and Cristian Spirleanu** [5] a hardware and software application using the 1-wire technology has been introduced. Understanding of all the process tension levels of the 1-wire protocol, 1-wire transmission speed and finally the software implementation using Visual Studio Net platform has been done. Practical application finds use in intelligent structures, alarm and anti-burglary systems and sensor networks. Here only simulation has been done. And explanation as to how 1-wire implemented. The basics of this paper could be applied in the proposed project.

According to **Chen- Ming Li,Chin-Chung Nien,Jia-liang liao and Yu-chee tseng**[6] the proposed module here has been placed outside the cool box. It consists of wireless microcontroller JENNIC and thermocouple sensing convertor. An aperture has been made and thermocouple has been guided into cool box. Large part of food is made up of water hence the antenna gain parameters and propagation abilities are affected. This will be eliminated in the proposed project because thermochron is not affected by these parameters.

III. METHODOLOGY

Current scenario does have the use of temperature and humidity data loggers along with other technologies as mentioned but the use of 1-wire protocol along with temperature and humidity monitoring along with tracking location of consignment at given time during transport is the need of any cold chain company. Use of SHT11 used for humidity sensing as power consumption can be reduced [8] Circuit designing will start by designing the schematic on paper. Then using tool design will be replicated. Etching of the same on the printed circuit board. Testing of connectivity. Finally components will be mounted on this PCB. Next stage will be programming using ARM instruction leading to efficient monitoring of humidity and temperature. Debugging will be done next. The block diagram of the system is shown in Fig. 6.

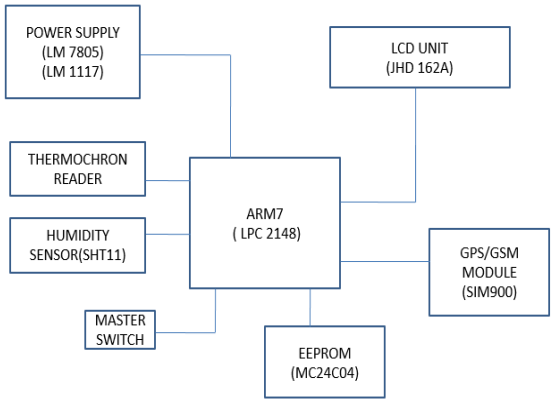

Fig 6. Block Diagram of System

IV. CONCLUSION

The proposed 1-wire [5] based system used for cool box temperature and humidity monitoring in cold chain logistics will be developed. This system can be tracked anytime from anywhere. Taking the advantage of low power capabilities of system can be used for monitoring humidity and temperature the 1-wire based system and the large battery life. Many methods are available for the purpose of temperature and humidity monitoring for example wi- sensor networks, humiture sensors, wireless sensor modules [6] and RFID/USN based systems. Temperature changes during transit and the spoilage of food can easily be tracked whether it happened during loading, transport or unloading. In the proposed system, the thermochron will be monitoring the temperature and SHT11 will be monitoring the humidity.

GPS and GSM module will be monitoring the position and sending messages to the destination side respectively. All information will be sent at the destination by the GSM module. The problem of blaming each other for spoilage of food can be eliminated and where actually the spoilage of food happened can be tracked. Cost reduction of complete system can be achieved in comparison to the already implemented designs. Bulkiness of older designs will be replaced by the sleek design. Power dissipation in the proposed system will be reduced significantly.

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