Wireless Data Acquisition System Using LabVIEW

Project Report

Submitted in partial fulfillment of the requirements
for the degree of

MASTER OF TECHNOLOGY

IN

INSTRUMENTATION AND CONTROL ENGINEERING

(Control and Automation)

By

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Ahmedabad-382 481
May 2015

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Under the Guidance of

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Declaration

This is to certify that

(i) The thesis comprises my original work towards the degree of Master of Technology in Instrumentation and Control Engineering at Nirma University and has not been submitted elsewhere for a degree.

(ii) Due acknowledgement has been made in the text to all other material used.

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Undertaking for Originality of the Work

I, Vishwa M.Vardiwale,Roll.No.**13MICC26**,give undertaking that the Major Project entitled **"Wireless Data Acquisition System Using LabVIEW"** submitted by me, towards the partial fulfillment of the requirements for the degree of Master of Technology in Instrumentation and Control Engineering (Control and Automation) of Nirma University, Ahmedabad is the original work carried out by me and I give assurance that no attempt of plagiarism has been made. I understand that in the event of any similarity found subsequently with any published work or any dissertation work elsewhere; it will result in severe disciplinary action.

———————————————

Signature of Student

Date:

Place: NU,Ahmedabad

Endorsed By

———————————————

(Signature of Guide)

Certificate

This is to certify that the Major Project entitled **"Wireless Data Acquisition System using LabVIEW"** submitted by **Vardiwale Vishwa Manubhai (13MICC26)** towards the partial fulfillment of the requirements for the degree of Master of Technology in Instrumentation and Control Engineering (Control & Automation) of Nirma University, Ahmedabad is the record of work carried out by her under my supervision and guidance.In my opinion the submitted work has reached a level required for being accepted for examination. The results embodied in this major project to the best of my knowledge have not been submitted to any other university or institution for award of any degree or diploma.

Date: Place:Ahmedabad

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Abstract

It is likely to acquire data wirelessly and eliminating the system from cabling complexity.The replacement of cabling connection between a data acquisition system and the data processing unit with wireless connection makes the system very much flexible and mobile. The whole Wireless System incorporates the transmitter,receiver and GUI(PC) system. Transmitter module contains the sensors and senses the data and send it to the receiver module by wireless means. Different wireless technologies can be incorporated according to the range, data rate and efficiency. At the receiver module, data is received and then send to the PC for data analyzing.

Here it is assumed that the data are available from transmitter module to the receiver. So the sensors are directly connected through wires to the receiver module. And from PC the data are monitored wirelessly on phone and web page. The aimed computational platform is PIC microcontroller at the receiver module.To monitor the parameters like temperature, barometric pressure and altitude, pressure sensor and CO2 sensor to monitor CO2 concentration in air is directly connected to the receiver module.

Microcontroller sends these four parameters' data to the data processing unit (PC) through UART serial communication and the received data is analyzed, stored,controlled and displayed by the graphical programming platform implemented using LabVIEW through VISA serial communication which will carry real time processing and display. LabVIEW provides the Data Dashboard application through which the same four parameters will be monitored in the android based device remotely in the same connected wireless network. Also the same system is monitored remotely from different PC or smart phone in web browser using Web publishing tool in the same local network.

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Chapter 1

Introduction

With the growth of the communication industry, the demand for high quality communications with economically affordable cost is increasing. Wireless network is the most economic solution for the communication in developing countries. It is desirable to acquire data wirelessly and thus by eliminating the system from cabling complexity.So monitoring and controlling the system from the distance is becoming possible. So the replacement of connection between a data acquisition system and the data processing unit with wireless connection makes system flexible and mobile.The wireless network is fast, cheap and feasible in conditions when there is not possible to establish wired network[1].

This section gives the glimpse of the requirement of the wireless technology and basic need to measure the atmospheric (Barometric) pressure,Altitude, Temperature and the concentration of CO2(Carbon Dioxide) in the atmosphere.

1.1 Motivation

Barometric pressure is important parameter in weather observation. In weather forecasting applications for prediction of weather, measurement of barometric pressure is calculated.Engine performance is based on air intake pressure. As barometric pressure and altitude are inversely related,aircraft's altitude is calculated from barometric pressure. Some polar watches uses the barometer for altitude measurement.

The accuracy of the GPS system is affected by air pressure so the system accuracy is enhanced by barometric pressure information. GPS in smart phone is used to estimate the location. Barometric pressure measurement gives the altitude measurement from 3 dimensions of space that used are latitude, longitude and altitude. So for faster GPS lockons in smart phones like samsung galaxy nexus and iPhone6 uses the barometer.Many industrial processes are worked on accurate barometric pressure measurements.

CO2(Carbon dioxide) is needed to measure in many applications as in indoor air quality monitoring, greenhouse and indoor gardening, incubator analyzer, as a sedative.

1.2 Literature Survey

This section intends to highlight major as well as very relevant studies and research projects undertaken at various levels and papers presented at IEEE International conferences and journals. This rigorous exercise enables to develop an insight into various dimensions of the project.

In [2],the falls event detector system is developed along with triaxial accelerometer and barometric pressure measurement to improve existing accelerometry based fall event detection technique. A falls event detection algorithms from the signals of triaxial accelerometer and atmospheric (barometric) pressure sensors are developed and sent to the workstation through bluetooth module.

The data acquisition device includes triaxial accelerometer MMA7260 from Freescale, microcontroller MSP430F149 from Texas Instrument with 12bit analog -to-digital converter (ADC), SCP1000 atmospheric pressure sensor from VTI Technologies, and bluetooth module WML-C30AH from Mitsumi are used. The triaxial accelerometer measures the acceleration along with the three orthogonal axes with sampling rate of 40Hz and full scale deflection fixed at ± 6 G with ADC resolution of 0.00293 G/division. The barometric pressure sensor having resolution of 1.5 Pa and sampling rate of 1.8 Hz. The microprocessor receives the signals from the sensors and transmits the data to the workstation by bluetooth module. The device is powered by rechargeable Li-Pol 6V battery which works up to 24 h with bluetooth connection.The wireless device dimensions are 70 X 54 X 14 mm and weight of 57.5 g.

Three experiment protocols are defined such as indoor simulated movements and falls, simulated outdoor falls and indoor and outdoor simulation of normal activities of daily life. All test protocols are applied to three algorithms. Algorithm 1 assumes that a fall is always due to an extreme impact. And discriminate between standing position (angle in $0\,^{\circ}$-20° range) and non standing body orientation angle $>20^{\circ}$. Algorithm 2 classifies a fall as a possible fall if signal magnitude exceeds threshold 1.8 G and the tilt angle is angle $>20^{\circ}$. Algorithm 3 calculates altitude from barometric pressure and assumes that when falls occurs , the altitude of the device changes that is placed at subject's waist. The data is analyzed in MATLAB to calculate the performance of three falls detection algorithms. Algorithm 3 with barometric pressure based altitude gives best results. Thus the use of barometric pressure sensor with accelerometry based falls detection system detects early the falls events among the elders in the home or community environments. This results in improved outcome for falls sufferers, reduce the postevent psychological trauma and decreases the healthcare expenditure.

In [3], the interface IC ZSSC3027 which uses resistive bridge type pressure sensor , is used for Barometric pressure based altitude sensing. The IC itself can be communicated with microcontroller through SPI interface (with up to 20MHz) and I2C interface with normal, fast and high speed mode. This IC is composed of two sections namely high-voltage (HV) section that contains digital interface, power on reset , bias and regulators and Low voltage (LV) section containing controller that includes arithmetic logic unit(ALU), memory, analog signal processing front-end(AFE). ADC provides the resolution up to 16 bits. Internal temperature sensor is used for temperature measurement. The integrated calculation unit performs 2nd order pressure and temperature compensation. Pressure based altitude is measured. The experiment shows that the low noise of 0.01hParms gives the exact separation of building's individual floor levels. The investigated pressure range is 260hPa to 1100hPa and temperature range is -40 to +85 and the absolute pressure accuracy is ±0.5hPa. The figure of merit (FOM) for ADC ,that combines both the ENOB(effective number of bits) and required energy per conversion , is 0.66nJ/Step.

The below figure shows the comparison of commercially available barometric pressure sensors.

SENSOR	this work [7]	BMP180 [10]	T5400 [11]	LPS331AP [12]	MS5637 [13]	MPL3115A [14]
Pressure Range [hPa]	**50-1100**	300-1100	300-1100	260-1260	300-1200	500-1100
Temperature Range	**(-40…+85)°C**	(0…+65)°C	(0…+70)°C	**(-40…+85)°C**	(0…+85)°C	**(-40…+85)°C**
Supply Voltage	(1.7-3.6)V	(1.8-3.6)V	(1.7-3.6)V	(1.71-3.6)V	**(1.5-3.6)V**	(1.95-3.6)V
Digital Sensor Signal Correction	**yes**	no	no	**yes**	no	**yes**
Absolute Accuracy [1]	**±0.5hPa**	±4hPa	+4hPa/-2hPa	±2hPa	±4hPa	±4hPa
Pressure Noise, p_{rms} [hPa_{rms}]	**1e-2**	5e-2	3.2e-2	16e-2	10e-2	1.5e-2
Idle Current [nA]	70	100	1000	500	**10**	2000
Energy Consumption, E_{conv} [μJ]	22.1	**9**	23.9	13.8	60	517
External Components	**none**	100nF, 1μF	90nF	100nF, 10μF	470nF	100nF, 10μF
ENOB [bit_{Pa}]	**15.04**	12.72	13.36	11.04	11.72	14.46
FOM - Energy Efficiency [nJ/step]	**0.66**	1.33	2.27	6.52	17.77	22.95

Figure 1.1: comparison of commercially available barometric pressure sensors

This paper[4] discusses the reliability of the altitude measurement calculated from the barometric pressure sensor in indoor environment. According to the 'standard atmosphere' produced by ICAO(International Civil Aviation organization), height changes by about 8.7m for every 1hPa change in air pressure. As the barometric pressure depends on time and location, the outdoor altitude readings vary by tens of meters by sudden change in pressure though actual altitude is not changed. When the barometric pressure is stable then the altimeter is more reliable and accurate. So user should periodically recalibrate the instrument.

Several tests are done in which AIR-HB-1A altimeter/barometer , model s710i polar watch, Samsung Galaxy Nexus S and Samsung Galaxy S4 smart phones are used. Firstly with AIR barometer/altimeter tested in quick lift , latency of several seconds was observed. When changing a floor level with stairs, altimeter takes a while and its readings stabilized. With floor change in lift, samsung galaxy nexus gives about 0.2hPa pressure change that having built in pressure sensor. Two barometers/altimeters and one polar watch are tested at survey control point. Pressure readings between barometers have the clear offset of 0.6 hPa and the height having 5.3m offset. When two smart phones are tested over a day, air pressure haves the constant offset. A similar test is conducted in office building where air pressure, humidity and temperature are measured and logged at every 10 minutes. The weather observations from the 5 km away airport is taken and compared which show the clear offset. Similarly by testing two AIR barometers/altimeters and one polar watch for air pressure and height in air conditioned UNSW library tower during 26 minutes, readings are taken at different levels and recorded. Constant offset is seen between different instruments. Later it is compared with the theodolite/EDM total station having initial offset and drift. After allowing the drift and offset, the altimeter only shows the maximum error of 2.8m and less than 2m. Thus it concludes the fact that the altitude can be estimated accurately but some of the requirements like reference station and recalibration over period is necessary.

The prototype personal navigation system is developed in [5] by Honeywell Laboratories. along with DARPA which has funded for individual personal navigation system (iPNS). GPS equipment that is used by soldiers has degraded performance in the urban areas,indoor and underground areas, and thick foliated areas. So for accurate GPS location, personal navigation system is developed by Honeywell IR&D which uses BG1930 MEMS inertial measurement unit (IMU), a Rockwell Collins NavStorm GPS receiver, a Honeywell designed processor,Honeywell magnetometer HMR3300 and a Honeywell precision altimeter(HPA). This system is interfaced by Mini PING which provides power management,interface signal translation from RS-232 to RS-422 and breakout capability to allow various signal to be monitor. Also hand held remote unit is made to easily on-off system, to provide discrete I/O capability which is used for placing system in calibration, enable/disable the GPS, mark an event. LEDs are placed on remote unit to reflect the system status. Software for iPNS is developed by Honeywell Lab's ECTOSTM II c software developed in C++. Honeywell's human motion algorithm is developed in four classes like walking forward, walking backward, running and stopped. Different models are developed to check the algorithm and checked by analysing treadmill data which shows the subject have maximum speed of 9.5 mph, starting speed of 2.5mph and ended speed of 2.0 mph. The treadmill speed is changed in 0.5 mph increments. The subject is considered as from walking to running when treadmill speed changed from 4.5 to 5.0 mph.

As iPINS is developed by DARPA, its demonstration was done at Wright Patterson Air Force Base in june 20-24, 2005 in three scenarios like urban canyon, forested area and indoors. Terrain correlation is applied to iPINS for navigation aid which depends upon map accuracy and resolution, terrain stability and altitude sensor error characteristics. For iPINS, the barometric altitude sensor model is used. The altitude measurement is given to the terrain correlator as a input. So the iPINS has the actual data of the barometric altitude and model used for the sensor's error characteristics. Terrain correlation algorithms and PTAN terrain navigation system are developed by honeywell. Algorithms are based on the Minimum Absolute Difference (MAD) correlator. Thus for GPS based personal navigation system , algorithms are developed. The system's accuracy and frequency is based on the terrain based position updates. The barometric altitude sensor used in the iPINS system provides the accurate correlation in low slope variation scenario.

A remote sensing and wireless data acquisition system is developed to measure the fluctuating wind pressure during hurricanes in coastal homes at Florida. The objective is to determine easy of deployment, sensors performance in a group,transmission range and battery life. The wireless system consists of three components as (i) one data collector unit, (ii) the base unit and (iii) the remote units. The remote units have PIC16F876 microcontroller of 4 MHz and RAM to save up to 94 samples, FM transceiver LINX SC-PA-916 having transmitting rate up to 33.6 kbps with distance of 50 m for half duplex communication between remote unit and base unit, sampling circuit for analog - to- digital conversion with sampling rate of 0.125-100 Hz, and PowerSonic PS-1220 12-V, 2.2 Amp-Hr lead-acid battery for remote unit operation with 48 h continuous operation in fully charged condition. Each remote unit consists of 23 pressure sensors from Honeywell 142-PCA ranging from 0-1034 mbar and one cup anemometer from Davis Instruments Manufacturing Company,Inc. The base unit consists of one PIC16F876 micro-controller operating at 4 MHz,half duplex FM transceiver LINX SC-PA-916 running at 916 MHz. It communicates to data manager through hardwired serial transmission at 115.2 kbps and hardware flow control using DB-9 connector. Base unit is directly powered from data manager unit so battery is not required.Toshiba satellite Pro 4600 laptop with Pentium III 650 MHz processor is Data manager having serial transmission at 115.2 kbps. Upto 24 sensors on a house can be installed in hour to provide reliable data upto 10 m distance continuously for 48 h with 30 samples/s per sensor. The range of the wireless communication can be increased to 60 m with more powerful transceiver[6].

The main objective is to develop a digital system for energy usage evaluation, condition monitoring, diagnosis and supervisory control by applying wireless sensor networks(WSNs) with Dynamic Power Management(DPM). The system consists of Intelligent Sensors Modules(ISMs), Remote Data Acquisition Units (RDAUs), Gateway, Remote servers(RSs), and Supervisory Control(SC). (i) ISM has - Power subsystem of batteries with 3.6 V and 300mA, low - dropout (LDO) regulator to provide 3.3V. Sensor sub system uses LM35 as a temperature sensor, PIC18F4520 microcontroller chosen with lowest energy consumption versus processing power by comparing it with AVR, PIC16 and 8051. it also has support like SPI, I2C, RS485, RS232 with auto wake up, capture modules, PWM and AD converter with 10 bits and 13 channels. Communication subsystem consists of nRF2401A as transceiver having best overall performance with frequency 2.4 MHz and 1 Mbps of data rate is well suited for environments with physical barriers. (ii) RDAU has power sub system that having 5,15 and -15 V fed either from 220 VAC or 125 VDC, transducer LV20-P as voltage acquisition and LA25-NP as current acquisition. Also digital signal processor (DSP) TMS320F2812 by Texas Instruments is used for I/O interfaces and communication unit which operates at 150 MHz has 64 Kb program and data memory, 18 Kb RAM and 1 MB external memory. Its software is written using C++ in code composer platinum platform developed by Texas Instruments. (iii) Gateway is the interconnection between the data acquisition subsystem and wired network which is connected to RS through RS232 interface and SC with USB. RS232 base serial architecture consists of external power, TPS76933 LDO for 3.3V, nRF2401A, PIC16F628A microcontroller and MAX232 for level convertor for RS232 transmission. Now USB based architecture has no need for external power supply and has TUSB3410 as USB to serial converter. (iv) RS(Remote server) receives packets from RDAUs and transmits to SC by MOD-BUS/TCP-IP or by wireless communication. It is based on the AMD ElanSC520 processor of 133 MHz, 64-MB SDRAM, compact Flash type I/II socket, two ethernet RJ45 jacks, one DB9 Serial port, two PC-Card, and 12 V dc power. Voyage Linux from debian Linux is selected which only requires disk place of 128MB. (v)Supervisory Control(SC) can process and present results to operators through SCADA or a Human Machine interface (HMI).It runs on standard PC architecture with Linux OS and interface is developed in C++ language. Results shows that power consumed by sensor node is not only after the node in different state but also during the switching of sensor nodes. So by applying DPM-SSM with scheduled switching mode is applied to sensor node to extend network lifetime by allowing the node to transmit one third more packets by very short sleep time of 1 ms after every transmission without any DPM protocol. Test result shows that without any obstacle sensor node transmits data up to 80m without any packet losses, at 90 m antennas directed at each other 10 percent packet losses and up to 100 m unacceptable number of packet losses[7].

The main objective is to develop a system in LabVIEW to handle big and powerful data and showing function to carry out a real time processing, analysis and display of data between two computers. For data, DAQcard and interface board is used and LabVIEW is used for data acquisition. Data transmission and remote analyzation are done through TCP/IP and Datasocket. TCP/IP protocol is based on Client/Server model . The server side to send data to client,Write TCP Data function is used and waits for clients. The client program has the IP address and port number of specified servers. Corresponding to the server program, it uses two Reading TCP Data function to receive the data in which first read the length of data and second read the actual data sent from server. Datasocket is most powerful and one of the best scalable method of communication. It has two modules named Datasocket Server and client Datasocket API. Datasocket API defines a Datasocket Transfer Protocol(DSTP) to transmit data across the network which is based on URL and can be used anywhere in network connection with protocol independent, language and operating system. Datasocket API allows to read data from DSTP server, HTTP server, FTP server, and local file. By designing a communication interface based on LabVIEW, Data acquisition and serial communication is combined with real time transmission[8].

The main objective is to design a low cost battery operated micro controller based data acquisition system for continuously monitoring a solar radiation on a horizontal surface. The whole system includes the collection,recording and transmission of the data to the computer for storage and off-site analysis of the system. Developed system is compact (70 x 50 x 30) mm and low cost. ST62E20 8-bit micro-controller at 8 MHz is selected with inbuilt 8bit A/D converter with 8 analog channels with conversion time of 70 micro sec and has low power consumption and low cost. The SolData Silicon cell pyranometer which is the solar radiation sensor and it is the most expensive about 300 dolars and produces a voltage between 0 and 100 mV so LM358 from SGS-Thomson Microelectronics is used for signal amplification. Its offset voltage is 2mV and Offset current is 2 nA which is very low. Two quad switches from SGS Thomson Microelectronics HCF4066BE are used with A/D converter to select sample signals from Silicon cell sensor and the 2.5V reference voltage from LM336. Among 8 analog lines, 4 lines are used for reference voltage necessary for calibration, one is used for solar radiation sensor and other remaining 3 lines can be used for environmental parameters such as ambient temperature and Humidity. A smart serial EEPROM from Microchip 24C65 with HCMOS 8-pin, and 64 -kbit is interfaced to the micro-controller with SDA and SCK with attractive feature of data retention over 40 years without a power source. The LED is blinked when measurements are taken and transferring to the computer using RS232. MAX232 driver IC is used with serial interfacing between data acquisition system and computer to convert the TTL (0-5V) voltages to the -12 V and +12 V needed for RS232 communication.DAS is kept in low-power mode and timer interrupt awakes the system after every 10-min intervals to sample data whose A/D reading is 20 and stores in EEPROM. if it is low than 10 i.e. equivalent to irradiance of 65 W/m2 then system assume the night time and does not record the data but only lapsed time is measured. 18 bytes are used per hour during the daytime and one byte for lapse time during the night. At the end of each data collection period the acquired data is transferred to the computer through RS232 for analysis. Quality control and data analyzed is done in laboratory. The system is compared with standard Eppley Precision spectral pyranometer (PSP) and shows the accuracy of system which is +- 13 W/m2 which is fairly good[9].

The primary objective is to design and implement a wireless weather data acquisition system. This system can monitor and collect weather data automatically from a remote weather station and upload the data to the server. Measurement of the weather data is essential for weather station and at renewable energy systems like Photovoltaic (PV) system. This Wireless data Acquisition System (WDAS) contains the (i) Remote station, (ii) Base Station , (iii) Remote server and (iv) central Database. System describes the low cost, autonomous WDAS in which remote station wake up once a minute to collect and transfer sensor data is sent to the base station wirelessly where the data is further transferred to Remote Server (RS) for storage and processing either using a wired or wireless interface. The data is moved from RS to the server which stores data in LabVIEW and can be analyze. The remote station uses the different sensors to collect the weather information that is wind speed, wind direction, rainfall, ambient temperature, atmospheric pressure(Barometer), relative humidity and irradiance of the sun. For Humidity, HS1101 capacitive sensor with the TLC555 astable multivibrator from Texas Insrtuments is used that produces the humidity dependent frequency from 5 Khz to 300 Khz. LM335 is used as Temperature sensor whose output is equal to the absolute temperature in degrees kelvin divided by 100. For Barometric Pressure, pressure sensor MPX5100A from Motorola operating range from 0 to 16 PSI is used. Although the barometric pressure ranges from 13.75-15.72 PSI. The wind speed is measured using A100R type anemometer and wind direction using W200P type wind vane. PIC16F877 micro-controller with 8 Kb internal flash program memory, 8-channel 10-bit A/D converter with resolution of 4mV per count is chosen. This remote station based on solar power and drives the 50mA current source formed by 2N3906 transistor, LM334 . Linear regulator LT1121CZ provides 3.3V for RF trsnceiver. The RF design utilizes TX5002 and RX5002 monolithic RF chips. The same board is used for both transmitter and Receiver. The Base station uses PIC16F877 micro-controller and MSSP UART for asynchronous communication with the host pc (RS).MAX232 is used for buffering and level translation and standard DB25 connector is used. Power is provided from 9VDC wall mount power supply and uses 78L05 regulator for 5V and LT1121 for 3.3V. Simple green LED as a power indicator is used. A simple program in LabVIEW is developed to collect the data from the base station and perform the calibration corrections on it and data conversions and displayed on screen in PC . By characterization of PV modules by given I-V curve, the solar radiation data and ambient temperature is obtained. With a long period of collected database, the correlation between the different meteorological data is obtained[10].

1.3 Problem statement

The basic objective of this project named "Wireless Data Acquisition System Using LabVIEW" is to develop a hardware to detect the accurate measurement of the barometric pressure, temperature, altitude and CO2 concentration in the air and to analyze the data in pc using LabVIEW. The same parametrs should be analyzed wirelessly in the android based device and on web page from any remote place.

For sensing the data from sensors the PIC microcontroller is used at the receiver module. The microcontroller should interfaced to the pressure sensor through the I2C protocol and to the CO2 sensor using UART serial protocol. Data is monitored in LabVIEW and stored in the excel sheet for analyzing later. Also monitored in the android based device from LabVIEW through single wireless wi-fi network.LabVIEW also provides web page for monitoring and the controlling of the front panel from remote place in the same network using web publishing tool. For controlling of front panel, block diagram should be saved in the remote PC.

To analyze the data in android device from anywhere, application should be developed on server base.

1.4 System Architecture

The block diagram for the system is shown as in figure 1.2.

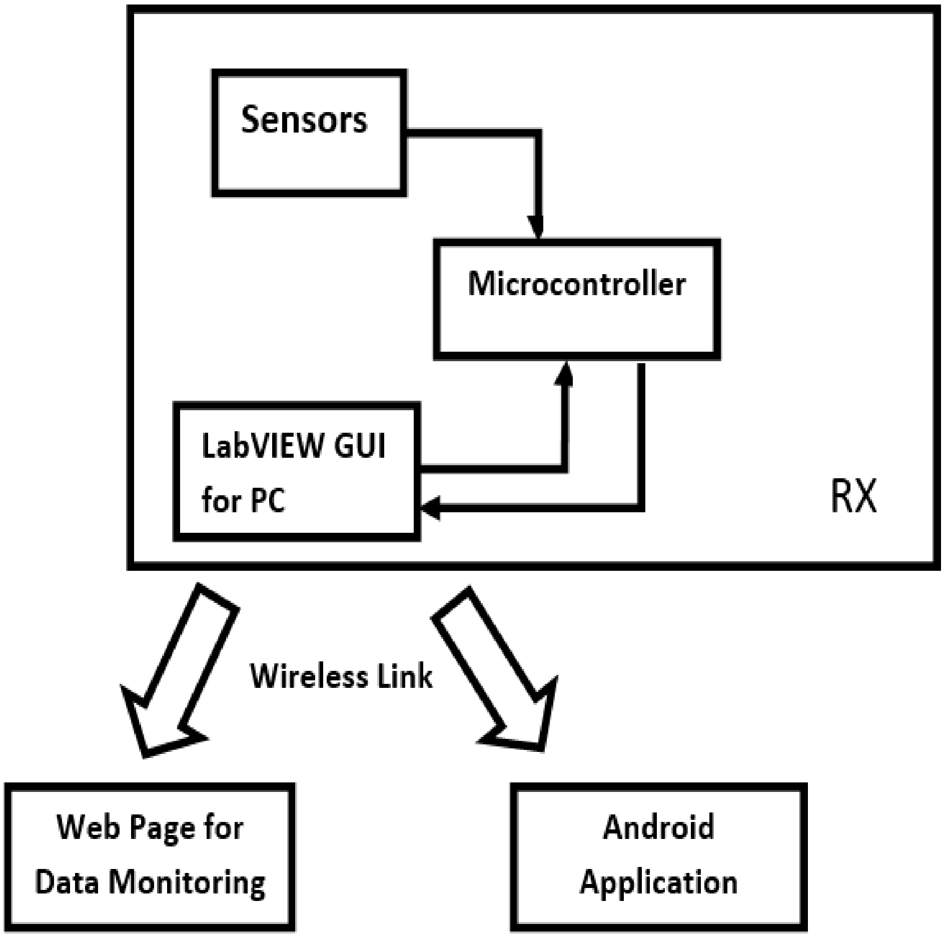

Figure 1.2: System Block Diagram

1.5 Organization of the Project

The organization of the report is given as

- Chapter 2 describes the technical specification of hardware components used.

- Chapter 3 describes about the basic of the I2C communication. I2C Write data to slave and read data flow from slave is described. The barometric pressure sensor and microcontroller interface circuit, algorithm for temperature and pressure measurement from sensor is described.

- Chapter 4 describes how the CO2 sensor interface to the microcontroller and about the UART protocol.

- Chapter 5 describes the UART serial communication flow for microcontroller at receiver module. LabVIEW interface block diagram and front pannel is shown to visualize the data. Also the shared variable deployment and web publishing tool application for remote monitoring is described. About the database and connectivity to it from LabVIEW is described. PHP API and android application interfacing for data acquisition at anywhere are given.

- Chapter 6 is for conclusion.

Chapter 2

Hardware Design and Implementation

This chapter includes the hardware design of test circuit board used at receiver module having PIC micro-controller, Power supply unit, and LDO LM1117 for low dropout voltage of 3.3V. Pressure sensor and CO2 sensor is connected to the microcontroller of the receiver module. From receiver to PC data is transferred using USB to serial bridge converter PL-2303HX from robokits. All the technical specifications of all the components are included and the schematic design and the component list of the test circuit board is also included. For the wireless transmission of the data to the android device and web page, wi-fi network is used.

2.1 Introduction

The schematic of the circuit board for PIC controller is shown as in figure 2.1 and the component list along with the descriptor, footprint and number of quantity is as given as in figure 2.2

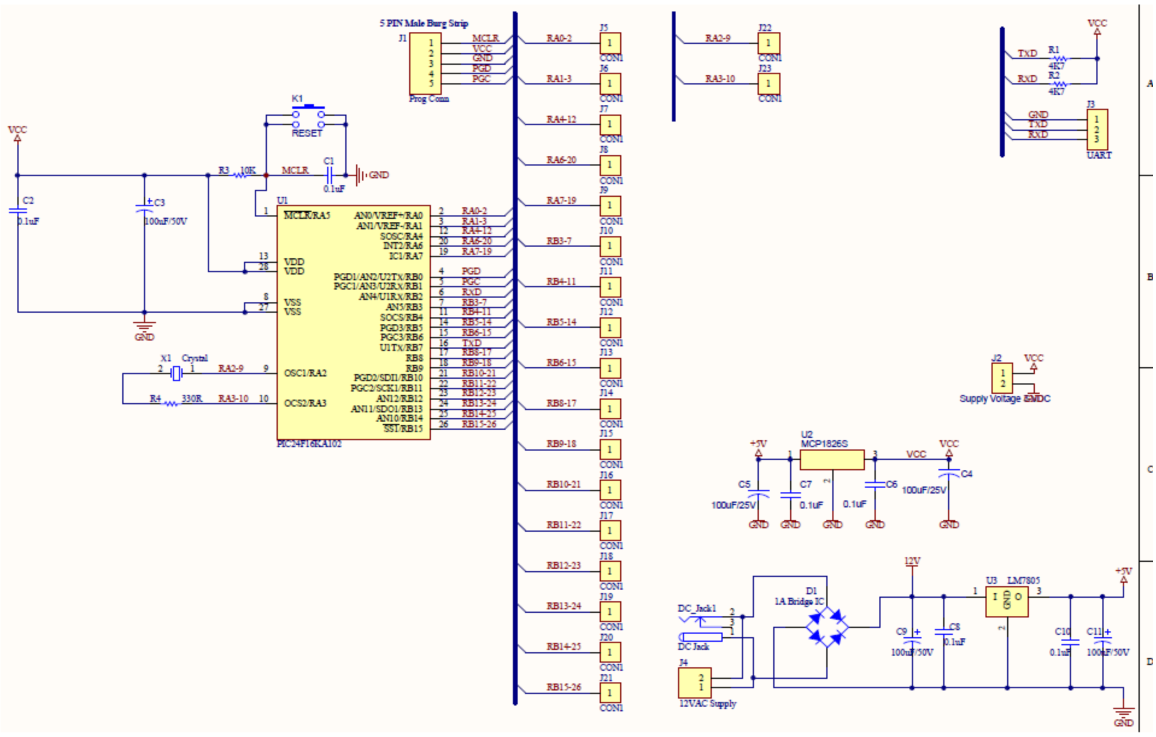

Figure 2.1: Schematic of the hardware

Comment	Description	Designator	Footprint	LibRef	Quantity
0.1uF	Capacitor	C1, C2, C6, C7, C8, C10	CAP_CER_0.2	Cap	6
100uF/50V	Polarized Capacitor (Radial)	C3, C9, C11	CAP_ELE_0.2/0.3	Cap Pol1	3
100uF/25V	Capacitor	C4, C5	CAP_ELE_0.1/0.2	CAPACITOR	2
1A Bridge IC	Full Wave Diode Bridge	D1	E-BIP-P4/D10	Bridge1	1
DC Jack	Low Voltage Power Supply Connector	DC_Jack1	DC_JACK_2	PWR2.5	1
Prog Conn	Header, 5-Pin	J1	SIP_CONN_5	Header 5	1
Supply Voltage 3 VDC	Connector	J2	PBT2	CON2	1
UART		J3	SIP_CONN_3	CON3	1
12VAC Supply	Header, 2-Pin	J4	PBT2	Header 2	1
CON1		J5, J6, J7, J8, J9, J10, J11, J12, J13, J14, J15, J16, J17, J18, J19, J20, J21, J22, J23	WIRE3_S	CON1	19
RESET		K1	TACTTILE_6_6	SW-PB	1
4K7	Resistor	R1, R2	RES0.4	Res1	2
10K	Resistor	R3	RES0.4	Res1	1
330R	Resistor	R4	RES0.4	Res1	1
PIC24F16KA102		U1	DIP28_300	PIC24F16KA102	1
MCP1826S		U2	SIP_CONN_3	IC7805	1
LM7805	Header, 3-Pin	U3	SIP_CONN_3	MHDR1X3	1
Crystal	Crystal Oscillator	X1	XTAL	XTAL	1

Figure 2.2: bill of material

2.2 Components Description

The detailed description and technical specification of each components are included.

2.2.1 PL-2303HX USB to Serial bridge controller

Description

The PL-2303HX connects to RS232 full duplex asynchronous device to any USB host. It is fully compliant with USB specification v2.0. The pin diagram is shown as below [11] The hardware used for serial communication is from robokits as shown below

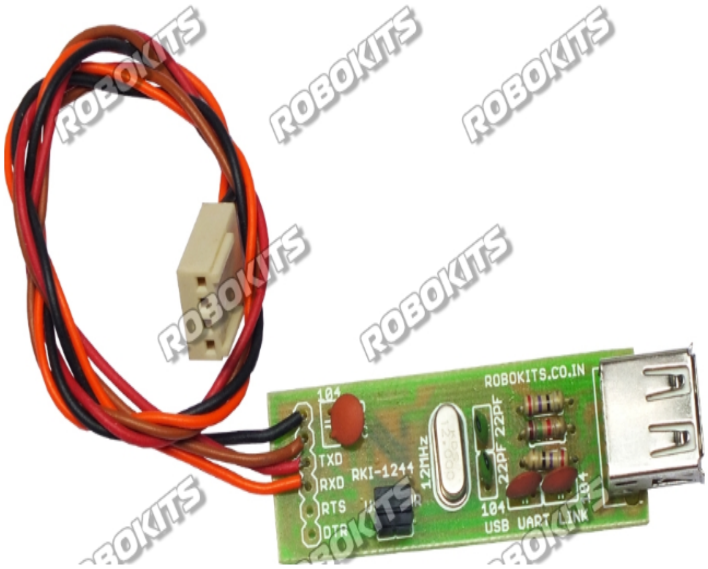

Figure 2.3: USB to UART converter

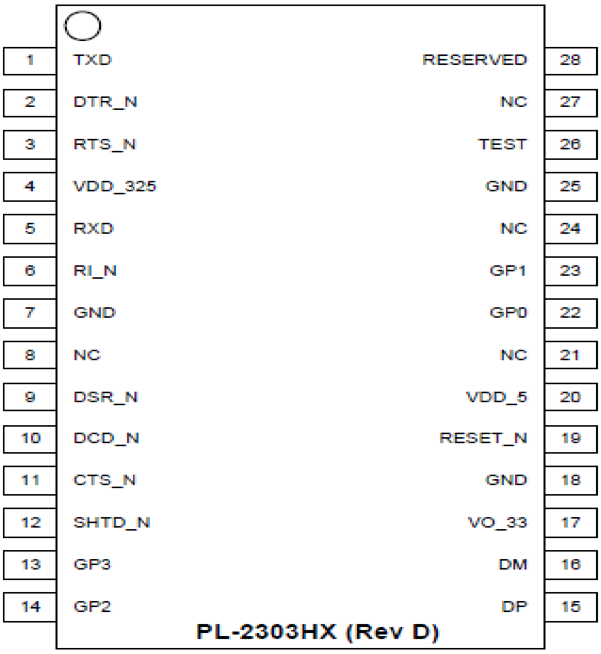

Figure 2.4: PL-2303HX pin diagram

Features

- on chip 1.1 USB transceiver with 5 V to 3.3 v voltage regulator
- on chip 96MHz clock generator
- supports RS232 serial interface
- full duplex transmitter(TXD) and receiver(RXD)
- six modem control pins
- 5,6,7 or 8 data bits transmission
- Odd, Even, Mark, Space, or None parity mode
- one, one and half and two stop bits
- programmable baud rate between 75 bps to 12M bps[11]

2.2.2 LM1117 LDO regulator

The LM1117 is a low dropout voltage regulator IC. Its circuit diagram with a power supply is shown in below figure. Here used is a fixed output version of 3.3V. Adjustable output voltages versions are also available with output voltage of 1.2V, 1.8V, 2.5V, 2.85V , 3.0V and 5.0 V.

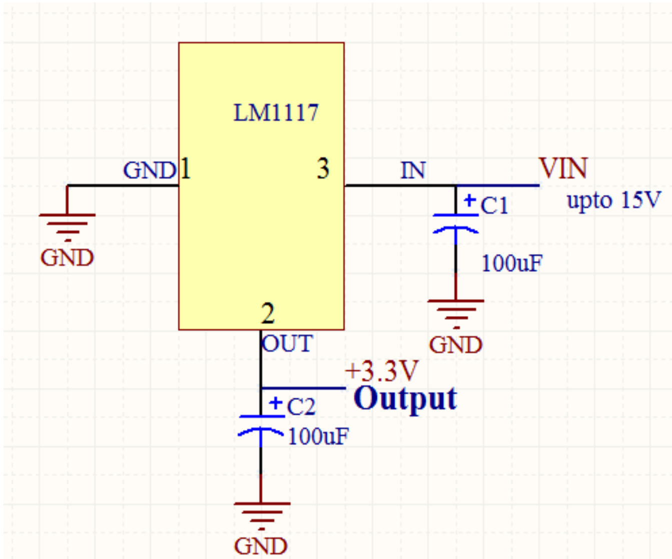

Figure 2.5: Circuit diagram of LDO

Features

- operating input voltage up to 15V
- adjustable output voltage range 1.2 V to 5.0V
- Standard fixed output voltages are 1.2V, 1.8V, 2.5V, 2.85V, 3.0V, 3.3V, 5.0V
- 800mA output current capability

Chapter 3

Barometric Pressure sensor Interface to Microcontroller Through I2C

3.1 Introduction

This chapter includes the Barometric pressure sensor interface to the PIC microcontroller of the receiver module using the I2C interface protocol. I2C basic functions and its functional flowcharts are described to initiate transmission for PIC microcontroller as a master and pressure sensor as a slave. Also interface circuit diagram, barometric pressure sensor algorithm for reading temperature and pressure value along with calibration data is described.

3.2 I2C Description

The Inter-integrated circuit (I2C) is a serial interface invented by philips. it is useful to communicate with other microcontroller or peripheral devices. peripheral devices may be EEPROMs, diaplay drivers, A/D converters, digital sensors etc... Its a two wire communication of data line SDA and clock SCL. all the devices on I2C bus are connected to these lines SDA and SCl through Pull up registers to the supply voltage. pull up register value may be choosen from 2.2kΩ to 10kΩ. but 4.7KΩ is normally taken.Only one set of pull up registers is needed for the whole I2C bus as shown below figure 3.1. pull up supply can be +5V or +3.3V accordig to the devices used[12],[13].

The devices in I2C bus may act either as master or slave. only the master can drive the SCL line and slaves are respond to the master. The slave cannot initiate the transmission but only master. slave only responds when asked for data either to be read or to be written.

The PIC microcontroller has the following I2C bus specifications

- Independent master and slave logic so can work as master and slave as we define
- 7 bit and 10 bit device addresses.
- Automatic SCl stretching operation.
- works on 100 kHz,400 kHz and 1 MHz.

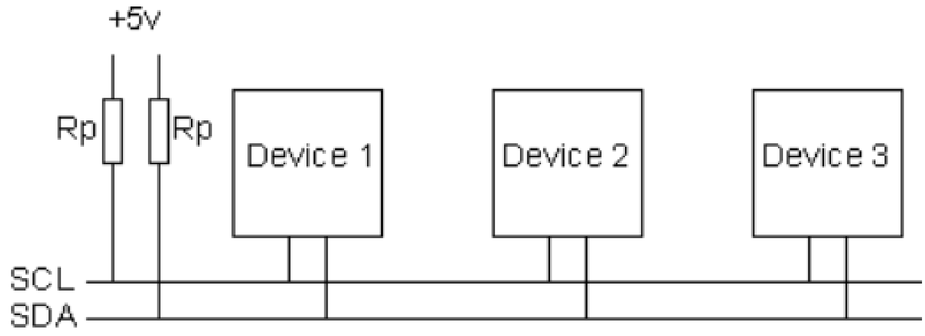

Figure 3.1: pull up register connection on SDA and SCL

3.3 I2C Functions

Two main I2C functions for transmission are I2C write data to slave and I2C read data from slave.

3.3.1 I2C Write Data to Slave Device

For the transmission by master,start sequence is initiated by master. SDA line is pull low when SCL is High. The data is transferred in the sequence of 8 bits. with first 7 bits defines the address, 1 bit R/-W command and 9th bit is the ACK from the slave. The start sequence can be shown by below figure 3.2

For Data write to slave, first start sequence is sent, then 7 bit slave address is sent followed by R/-W command, ACK low bit is checked sent by slave. Then again Register address with write is send, ACK is checked. and finally 8 bit Data are sent. ACK from slave is checked. respective data bytes are sent. After the completion of write by master, stop sequence is created.In Stop sequence, SDA must become stable when SCL is High and should not change. The Stop sequence is given in figure 3.3 The data write to slave sequence can be given as in below figure 3.4[13].

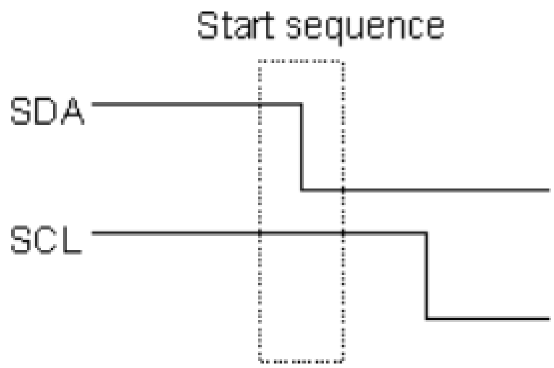

Figure 3.2: Start sequence on SDA and SCl

The flowchart for the write function is given as below figure 3.5

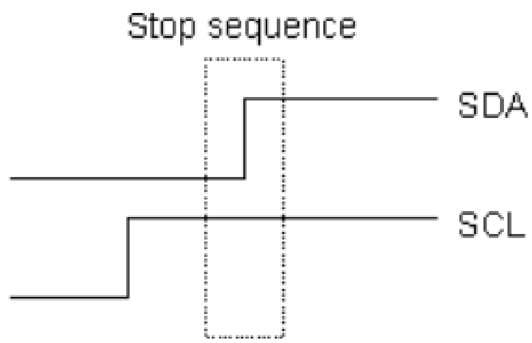

Figure 3.3: Stop sequence on SDA and SCl

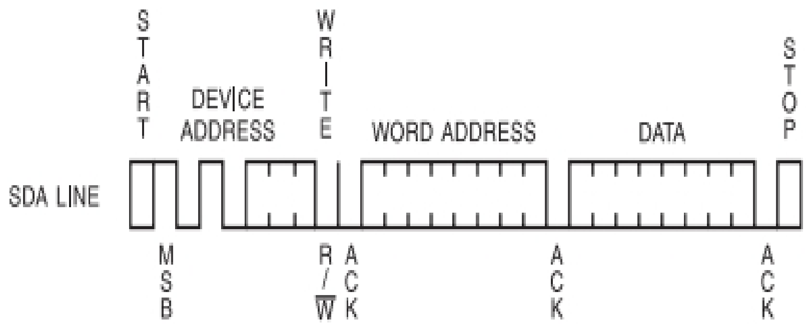

Figure 3.4: Write Data Sequence

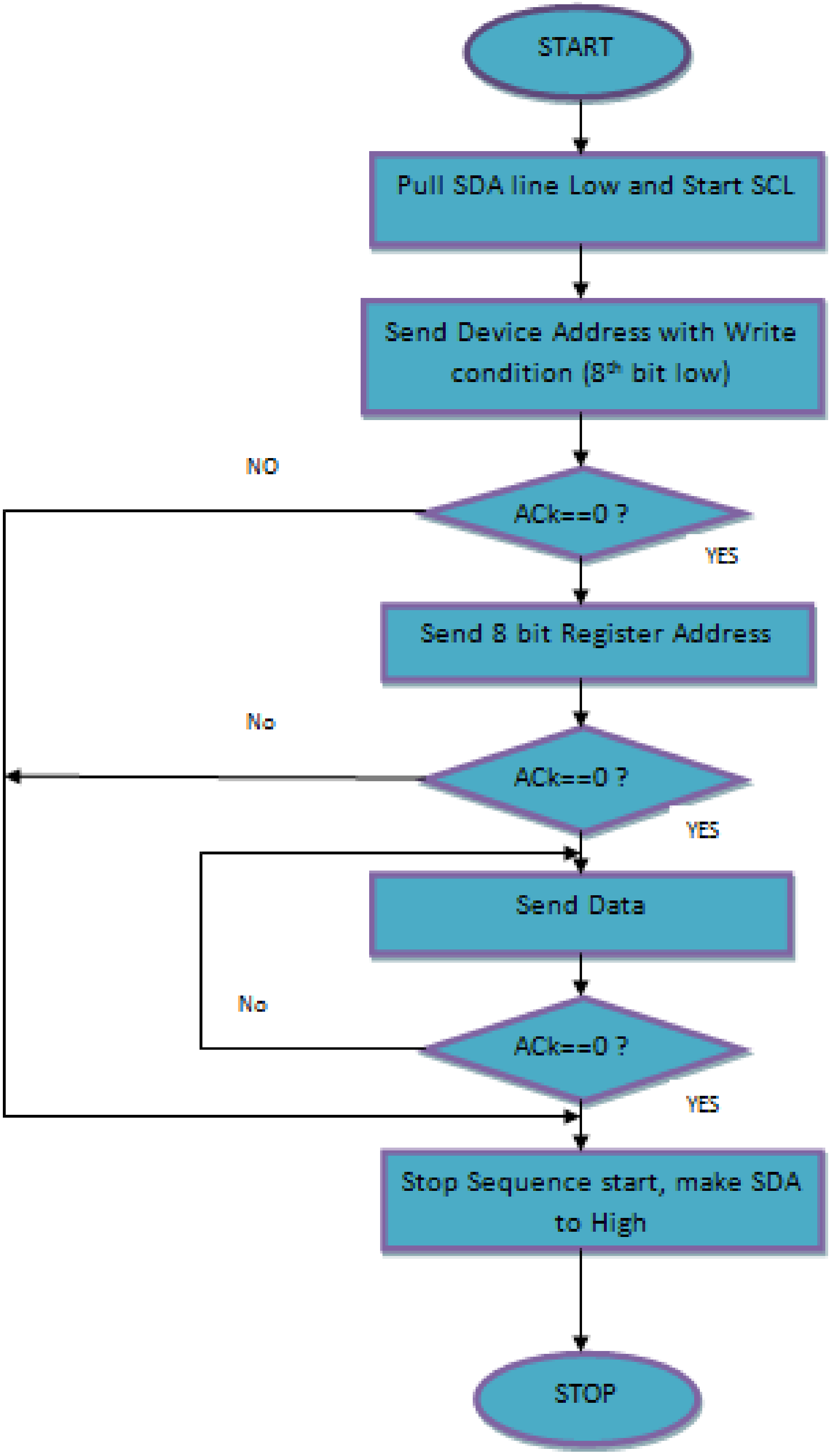

Figure 3.5: Write Data Sequence Flowchart

3.3.2 I2C Read Data from Slave Device

The Read function also start as the data write. The master initiates the communication by starting start sequence as shown before in figure 3.2. The SDA line is low while SCL is high. Then as before in Data write function, the 7 bit device address followed by data write sequence is sent. When master gets the ACK from slave which is low, the register address of location that master wants to read is sent which is of 8 bit. wait until ACK is received. Then restart condition is initiated followed by the slave address with data read command at 8th bit as high. ACk is received and then clock is released by the master and slave stretches the clock and master receives the data from the consecutive locations. After master has completed the data receive, NACK is sent followed by the Stop sequence as shown in figure 3.3. The data read sequence is given in figure 3.6. The flowchart for the random read can be given as in figure 3.7[12],[13].

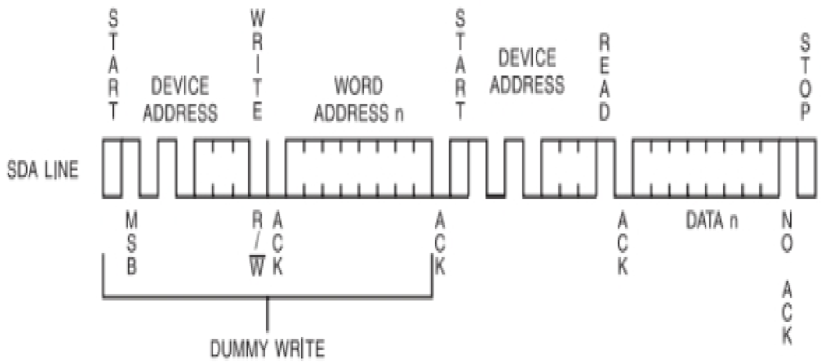

Figure 3.6: Data Read Sequence

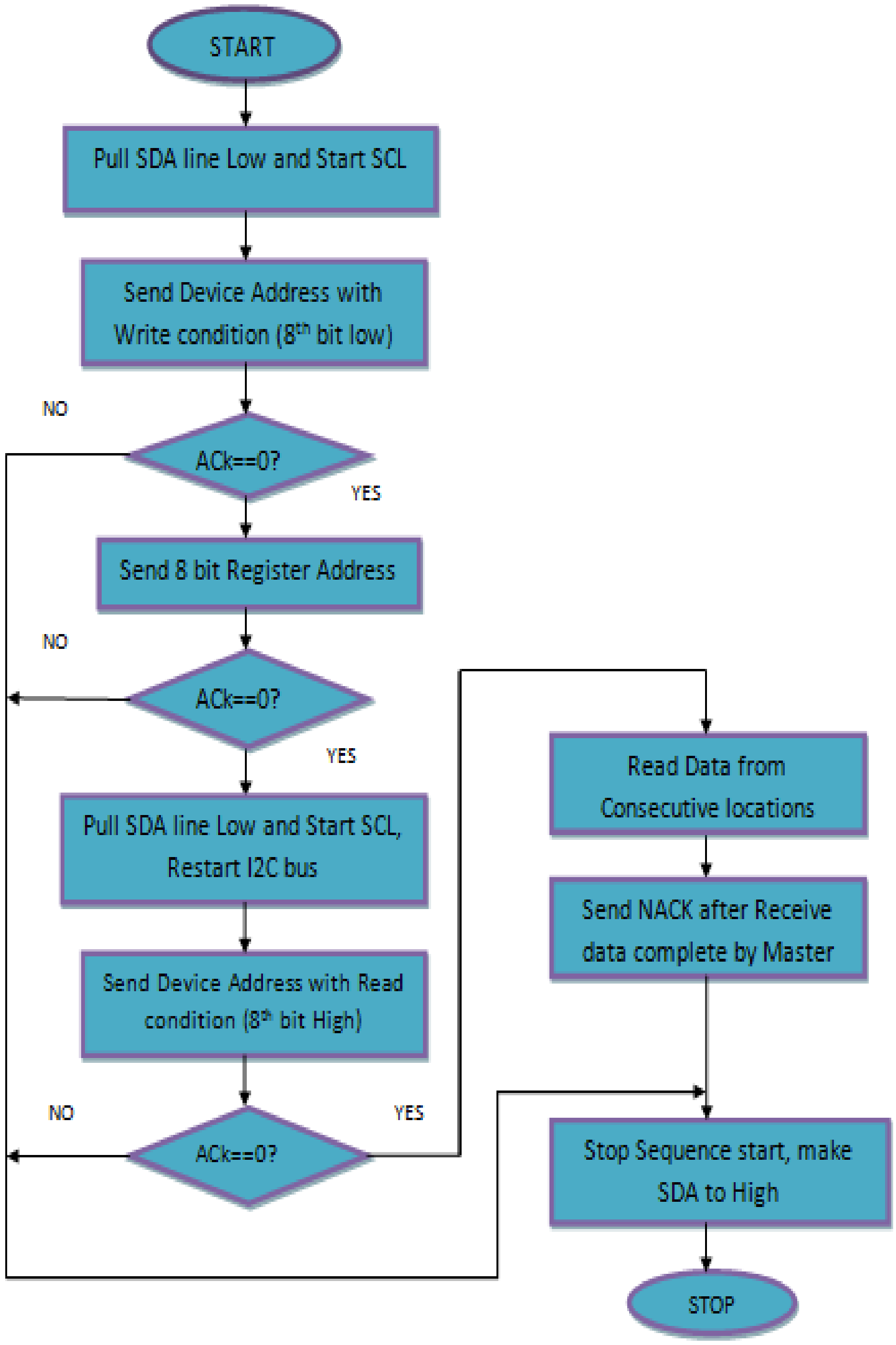

Figure 3.7: Read Data Sequence Flowchart

3.4 Barometric Pressure Sensor Interface to the Microcontroller of Receiver Module

3.4.1 Interface Circuit

The interface diagram of pressure sensor with microcontroller can be given as in figure 3.8

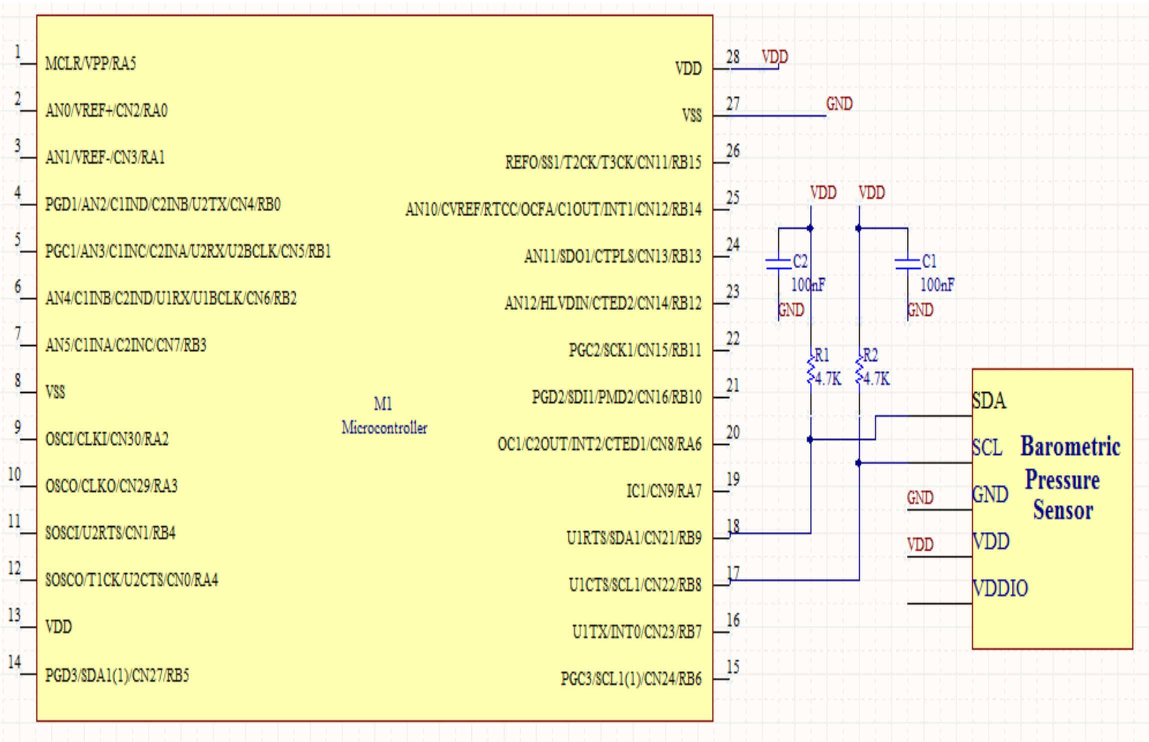

Figure 3.8: Barometric pressure sensor interface Circuit with Microcontroller

Connect four terminals of barometric pressure sensor with microcontroller as

- **SDA**: It is the I2C data Input/Output pin connected to the SDA1 of the microcontroller with Pull up register having value of 4.7kΩ. Data is transferred with this line.

- **SCL**: I2C synchronous clock Input/ Output which is connected to the SCL1 of the microcontroller. This pin is used for providing clock. Pull up register having value of 4.7kΩ are also connected to it.

- **GND**: connect with common GND.

- **VDD**: This pin is connected to the input supply voltage ranging from 1.8V to 3.6V.

- **VDDIO**: This pin is kept low because it is internally connected to the VDD pin.

This sensor is interfaced with microcontroller using I2C. And gives the temperature, barometric pressure measurements. Altitude is calculated from the barometric pressure measurement.

For measuring all these parameters, first calibration coefficient are calculated. For this, 11 words each of 16 bit is read from the EEPROM before the first calculation of the temperature and pressure. Each sensor has individual coefficients. Temperature value is calculated first and then pressure is calculated because pressure is dependent on temperature.

3.4.2 Units Of Pressure and Relation between them

The units of pressure are as follow: The International system of Units (SI) for pressure is pascal but generally used for atmosphere is millibar(mb) and hPa.
The relation between them can be given as:
1hPa = 1mb = 100Pa
The other units are N/m2, atm, torr and conversion between them is
1 atm = 101325Pa = 760 torr
The standard atmospheric pressure is 1013.25 mb or hPa.

3.4.3 Oversampling setting (OSS)

There are 4 pressure accuracy modes are defined. According to it conversion time of pressure changes. If OSS is 3 , it means ultra high resolution then conversion time for pressure will be maximum. And with ultra low power (OSS = 0) then conversion time will be less that is given in below table. OSS is content used in the equation of pressure.

Mode	Parameter oversampling_setting	Internal number of samples	Conversion time pressure max. [ms]	Avg. current @ 1 sample/s typ. [µA]	RMS noise typ. [hPa]	RMS noise typ. [m]
ultra low power	0	1	4.5	3	0.06	0.5
standard	1	2	7.5	5	0.05	0.4
high resolution	2	4	13.5	7	0.04	0.3
ultra high resolution	3	8	25.5	12	0.03	0.25

Figure 3.9: Oversampling setting

3.4.4 Algorithm for Temperature and Pressure Data Measurements

Calculation Steps

1. Read the EEPROM data before first calculation of temperature and pressure. Its coefficients are used in equations for calculation. Read it once in Main function out of the while(1) loop. Its coefficients are as given below in fig. 3.10.

2. For Temperature measurement

- In while loop, first write 0x2E in control register 0xF4 and wait for 4.5mSec.
- After 4.5 mSec, read registers 0xF6(MSB) and 0xF7(LSB).
- Make the uncompensated temperature value UT as whole 16 bit
  UT = MSB«8 + LSB
- From this UT, calculate the actual temperature by applying the following equations as

$$X1 = (UT - AC6) * AC5/2^{15} \tag{3.1}$$

$$X2 = MC * (2^{11})/(X1 + MD) \tag{3.2}$$

$$B5 = X1 + X2 \tag{3.3}$$

AC1 (0xAA, 0xAB)	(16 bit)	short
AC2 (0xAC, 0xAD)	(16 bit)	short
AC3 (0xAE, 0xAF)	(16 bit)	short
AC4 (0xB0, 0xB1)	(16 bit)	unsigned short
AC5 (0xB2, 0xB3)	(16 bit)	unsigned short
AC6 (0xB4, 0xB5)	(16 bit)	unsigned short
B1 (0xB6, 0xB7)	(16 bit)	short
B2 (0xB8, 0xB9)	(16 bit)	short
MB (0xBa, 0xBB)	(16 bit)	short
MC (0xBC, 0xBD)	(16 bit)	short
MD (0xBE, 0xBF)	(16 bit)	short

Figure 3.10: EEPROM coefficients

Temperature $T = (B5 + 8)/(2^4)$ this is the temperature in 0.1°C. so multiply this with 0.1 which is the true temperature in °C. For example , if $T = 150$ then multiply it with 0.1 so actual temperature will be 15 °C.

3. For Pressure measurement

- Write 0x34+(OSS«6) into 0xF4 control register, here take OSS as 0,1,2 or 3. So if $OSS = 0$ then only write 0x34 in 0xF4 register and wait according to the OSS value that is shown in fig. 3.11

OSS	Wait in mSec for pressure
0	4.5
1	7.5
2	13.5
3	25.5

Figure 3.11: Wait in msec

- Then after waiting accordingly, read the registers 0xF6(MSB), 0xF7(LSB) and 0xF8(XLSB)
- Make the uncompensated pressure value UP as whole 24 bit as

$$UP = (MSB << 16 + LSB << 8 + XLSB) >> (8 - OSS) \quad (3.4)$$

Here, first read MSB byte, then LSB and XLSB byte. And rotate left 16 times MSB add it with LSB having rotated left 8 times and add with XLSB to form a 24 bit UP.

- From this UP, calculate the actual pressure by applying the equations. This P is the actual barometric pressure in Pascal(Pa). devide this value with 100 which gives pressure in mb.

4. Absolute Altitude Measurement

The altitude in meters is calculated from international barometric formula with measured barometric pressure P and pressure at sea level $p0 = 1013.25$hPa, as

$$Altitude = 44330 * [1 - (P/p0)^{(1/5.255)}] \tag{3.5}$$

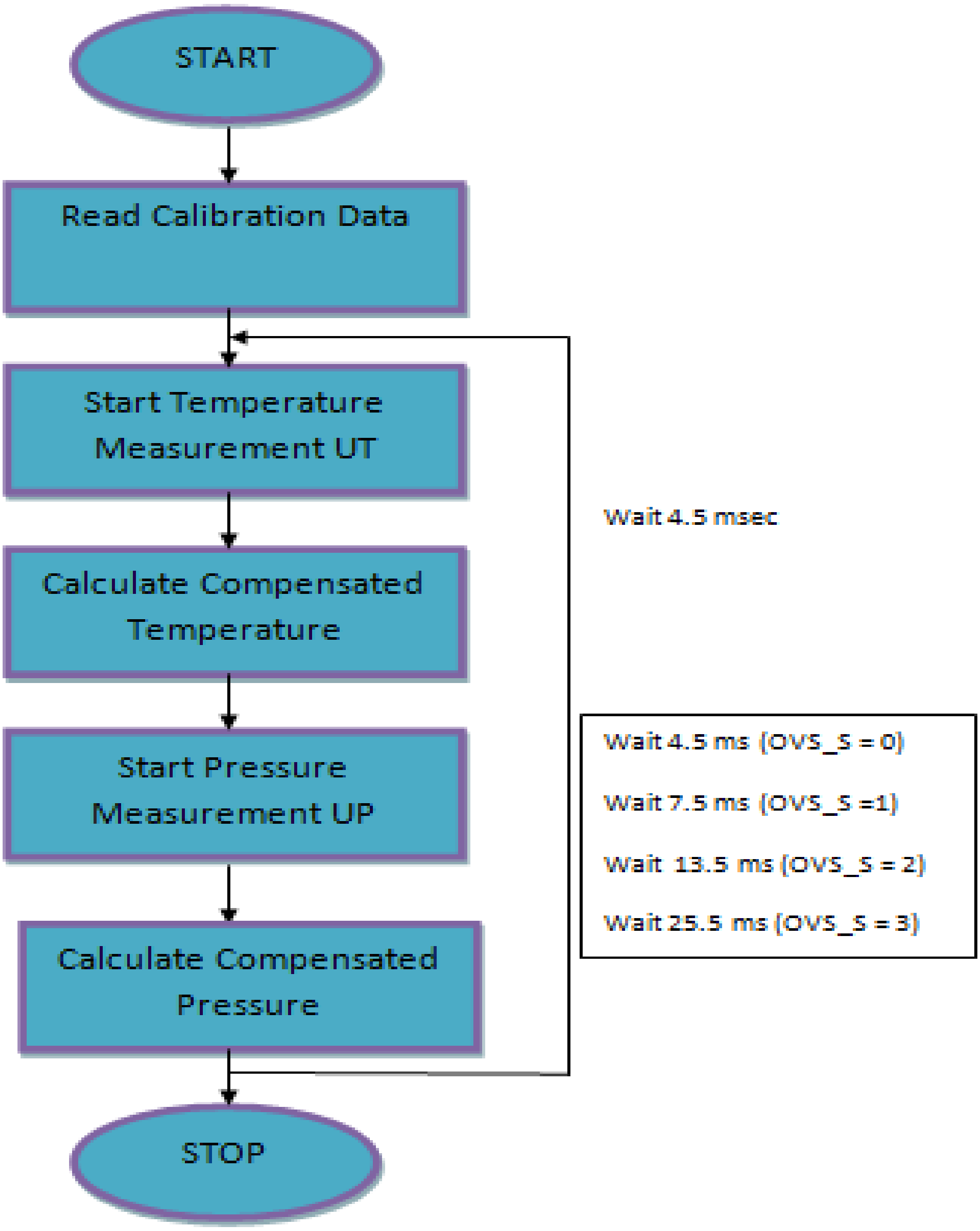

Figure 3.12: Flowchart for Temperature and Pressure Measurements

3.5 Applications as Barometer

- **Automated Weather Station (AWS):** Barometric pressure is the most important parameter in weather forecasting. By large barometric pressure change, the large atmospheric change is predicted. It is assumed that by rapid pressure drop, the chances of rain are predicted. Rises of the barometric pressure lead to the improved weather conditions[15].

- **At Weather Buoys and Ships:** Measures the weather parameters such as barometric pressure, air temperature, wind speed and direction and reports these data via satellite radio links to meteorological centers for forecasting and climate study[16].

- **Industrial Applications:** Used in pressure sensitive industrial applications such as laser interferometers, lithography systems, exhaust gas analysis and in environmental monitoring in calibration laboratories.

- **Agriculture Metrology:** For professional and research centers related to agriculture, different environmental parameters including barometric pressure are needed to measure for evapotranspiration, plant growth and development and disease handling.

3.6 Applications as Altimeter

- **Aviation Appliances:** Barometric pressure and altitude are inversely related. Aircraft's altitude is calculated from barometric pressure[15].

- **Polar watches:** uses the barometer for altitude measurement.

- **GPS System:** Accuracy of GPS(Geometrical Positioning System) system is dependent on barometric pressure data. For location in 3-axis, Altitude, longitude and latitude are necessary. Used for faster GPS lock on[16].

Chapter 4

Co2 Sensor Interface with microcontroller through UART

4.1 Introduction

To interface the CO2 sensor,connect four terminals with microcontroller as shown in schematic diagram fig 4.1.

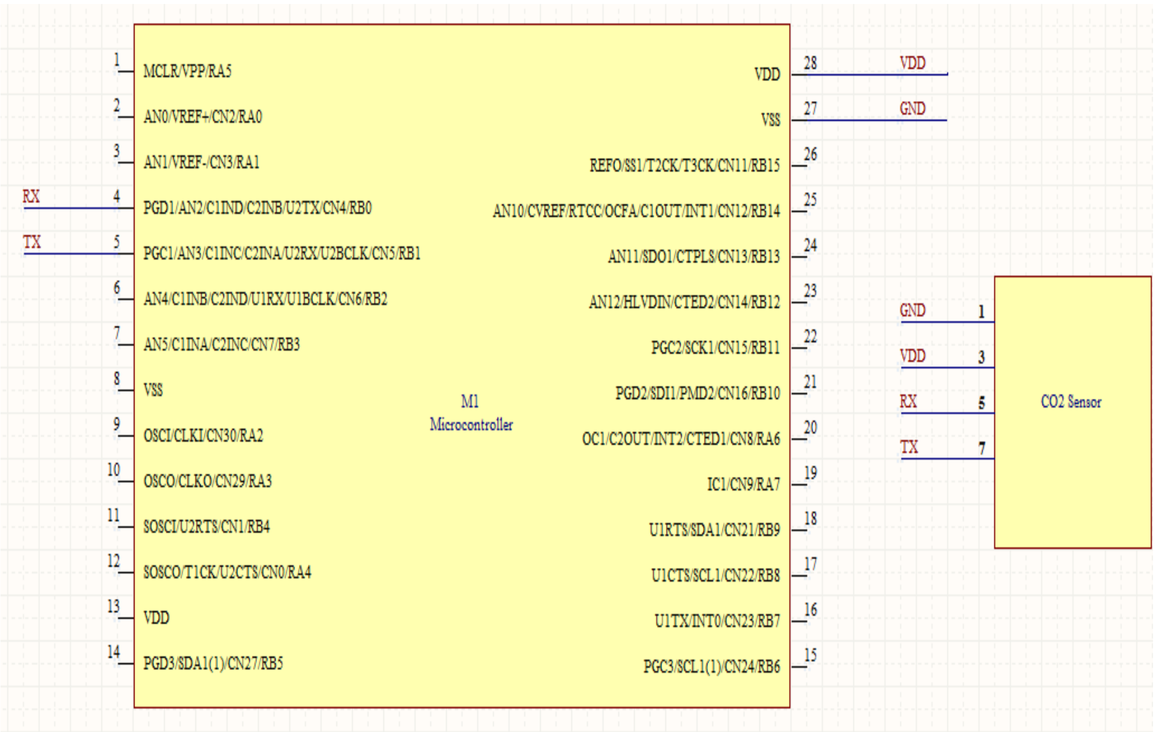

Figure 4.1: Schematic for CO2 sensor connection

- Pin No.1 GND connect with common GND.
- Pin No.3 connect with 3.3V supply.

- Pin No.5 RX connect with TX pin of either UART1 or UART2 of microcontroller.
- Pin No.7 TX connect with RX pin of either UART1 or UART2 of microcontroller.

All other pins are kept float.

4.2 Interface Algorithm

The algorithm for CO2 sensor connection with microcontroller can be given as in fig 4.2.

This sensor is interfaced with microcontroller using UART(Universal Asynchronous Receiver Transmitter) serial connection with 9600 baud rate, 8 bits, no parity, 1 stop bit and no hardware flow control.

It uses the NDIR(Non-dispersive Infrared) absorption for sensing the CO2 in atmosphere. By default sensor comes in streaming mode from factory. so the microcontroller has to read the data from CO2 sensor using UART receive functions. The algorithm for reading the data serially is given as in fig.4.2. For CO2 sensor connection, UART2 of microcontroller is used.

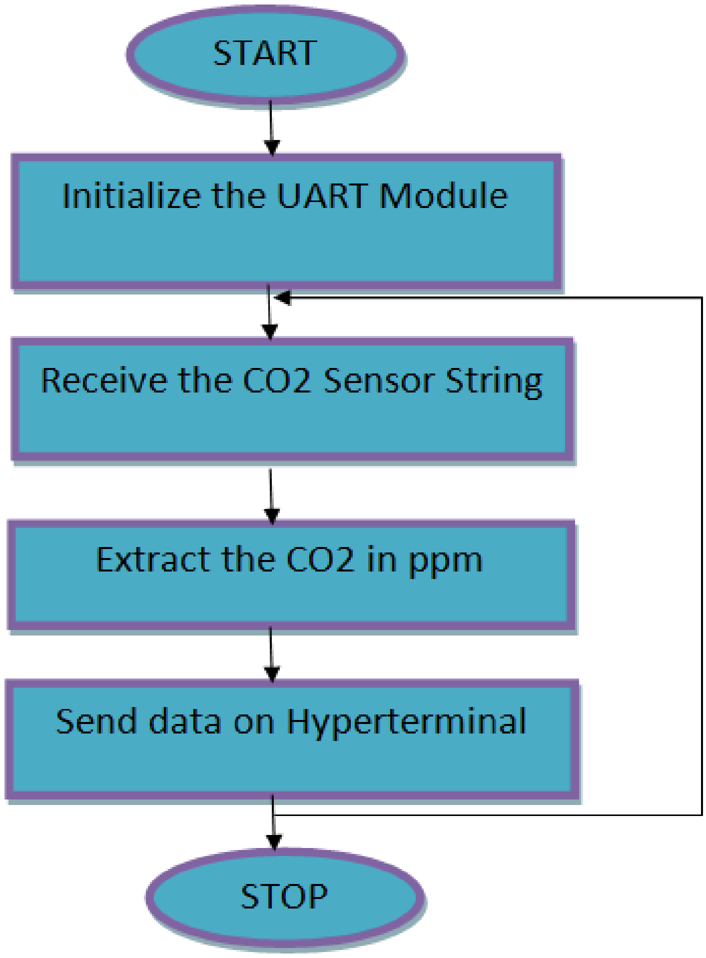

Figure 4.2: Algorithm for CO2 in ppm

4.3 Applications as CO2 Meter

CO2 measurement is needed for

- **Indoor Air Quality:** Due to excessively CO2 in indoor environment causes tiredness, lack of concentration and illness.The concentration higher than 1000 ppm in indoor environment is harmful for health[17].

- **Greenhouse and Indoor Gardening:** Plants are equally required proper Carbon dioxide for growth along with the light, nutrients and water. The process of photosynthesis is reliable on the amount of carbon dioxide[17].

- **Incubator Analyzer:** in the laboratories, the incubators are needed to run at the constant temperature, humidity and CO2 level to maintain the correct condition for the growth of the cell cultures.

- **As a sedative:** CO2 is used as sedative at many places like operating rooms, X-ray department, dental clinic and veterinary clinic where staff is at long risk of exposure.

also used at the public places for safety perpouses.

- **At Boarder and custom patrol:** For stowaway detection at the boarder and at custom, CO_2 sensors are used to monitor the accurate CO_2 level in ppm in vehicles and containers.

Chapter 5

LabVIEW Application For Wireless Data Acquisition At Reciever Module

5.1 Introduction

The LabVIEW(Laboratory Virtual instrument Engineering Workbench) is a graphical visualization platform and development environment developed by National Instuments. Here it is connected to the microcontroller of the receiver module for analyzing and storing the sensors' data as temperature, barometric pressure, altitude and CO2 concentration in air. The microcontroller is connected to the LabVIEW interface software using the VISA serial communication.

5.2 UART Implementation For Serial Communication With Micro controller

The data received wirelessly are transmitted on hyperterminal through UART serial communication. it is a full duplex asynchronous communication system that can communicate with peripheral devices such as personal computers, RS-232 etc... The flowchart for UART(Universal Asynchronous Receiver Transmiter) is shown below as in figure 5.1 The Baud rate of the serial communication is taken as 9600 by configuring U1BRG=103. In main loop, Uart1 is initialised with 9600 baud rate, 8 data bits, 1 stop bit and with no parity. The data coming from sensors are transmitted on UART by converting it from Float to Ascii for serial communication.PL-2303HX is used as the USB to serial converter[11].

Primary features of the PIC controller of UART Module are given as:

- Full duplex 8 bit or 9 bit data transmission through UxTX and UxRX pins. here UART1 module is used.
- Even, odd and no parity are available for 8 bit data
- one or two stop bits
- Fully integrated Baud rate generator ranging from 1Mbps to 15 bps.

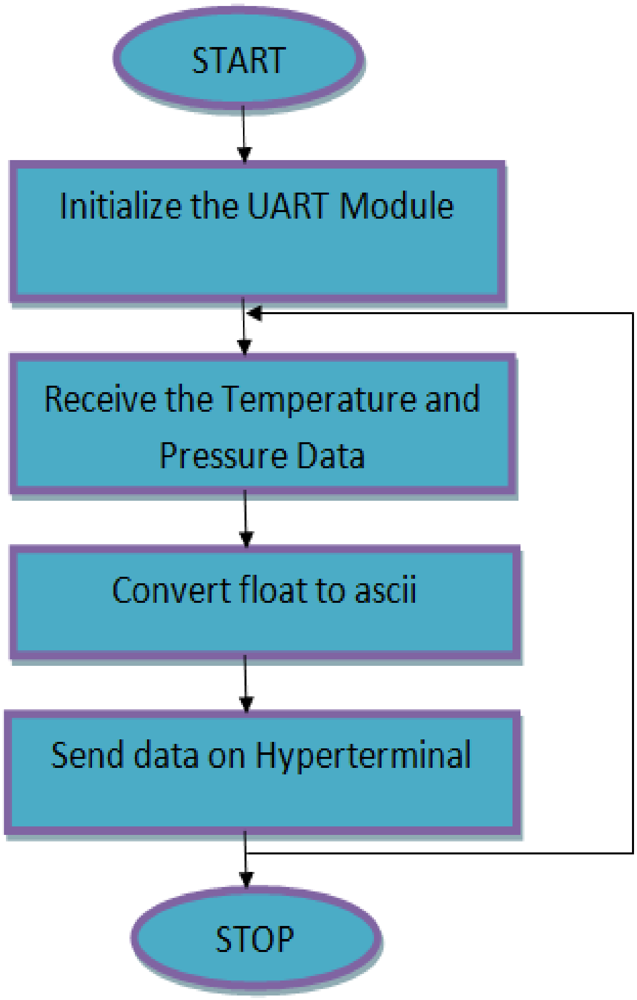

Figure 5.1: Flowchart For UART

5.3 LabVIEW Interface to microcontroller using VISA Serial Communication

5.3.1 LabVIEW Block Diagram

To visualize and display the data, LabVIEW program code with 9600 baudrate, 8 data bits, 1 stop bit, no parity and with hardware flow control is developed. The block diagram is shown as below in figure 5.2.

- **VISA Serial**: In the block diagram, The VISA Serial block is used at the beginning of the while loop which initializes the serial port with the following specifications: VISA resource name is used define the COM port where the serial device is configured. Here PL-2303HX is used as the USB to serial controller.

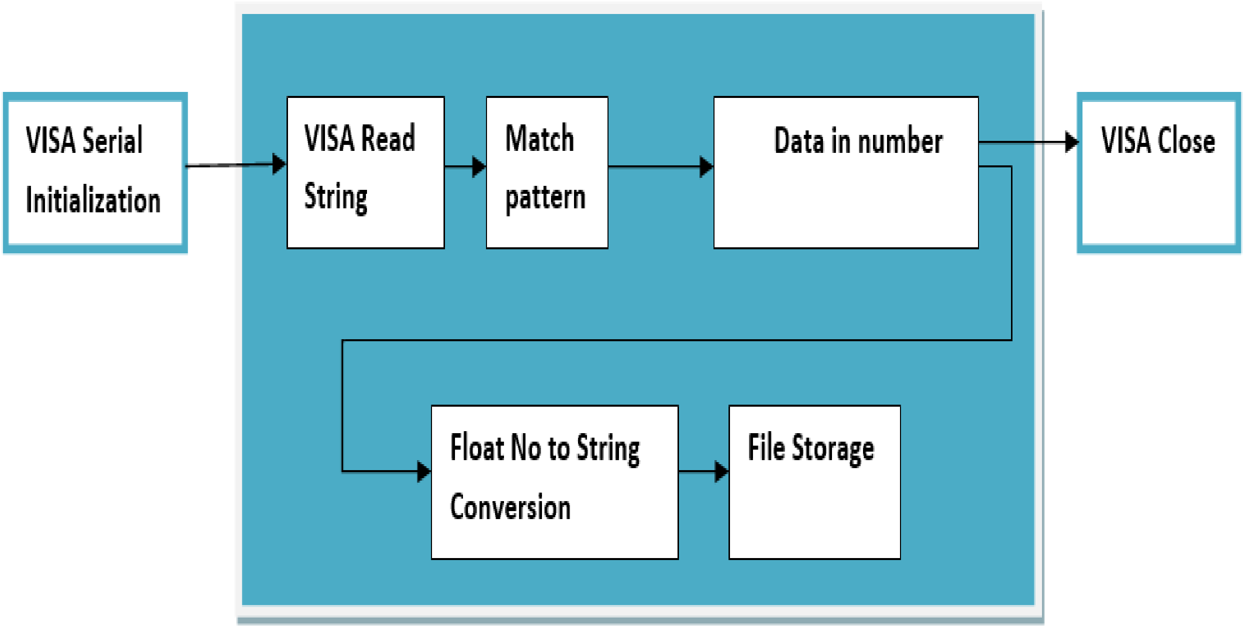

Figure 5.2: LabVIEW Block Diagram

- **while loop**:It is used to repeat the code within its sub diagram until some specific condition occurs.
- **VISA read**: VISA read is kept inside the while loop which reads the specified number of bytes from the connected device at each 100ms. Read buffer indicates the data that VISA read reads from the microcontroller.
- **Match Pattern:** It match the substring coming from the string and provides the three different outputs as match before substring, match substring and after substring.
- **Scan from String:** scans the input string and provides the different outputs according to the format string.
- **Number to Fractional String**: It convert the floating point number to floating point string.
- **Concatenate string**: which concatenate the floating point strings.
- **Replace Array Subset**: The concatenated data and the data string are replace in one index. so according to the even loop data will indexed to the temperature and odd will in second string pressure.
- **Write to Spreadsheet**: This 2D array data is applied to the write to spreadsheet which appends data to the specified file for analyzing.

- **VISA Close**: At the outside of the while loop VISA close is used to close the device session.

5.3.2 LabVIEW Front Pannel

For visualization and display, the front panel is shown as below in figure 5.3. For visualization of data, pannel is operated from here. VISA Resourse name will define the COM Port used for communication with device. Baud rate and other settings like parity, data bits , stop bits are configured from here. File path will give the option to choose the file in which data has to be store. The file format for storing the data is .CSV.

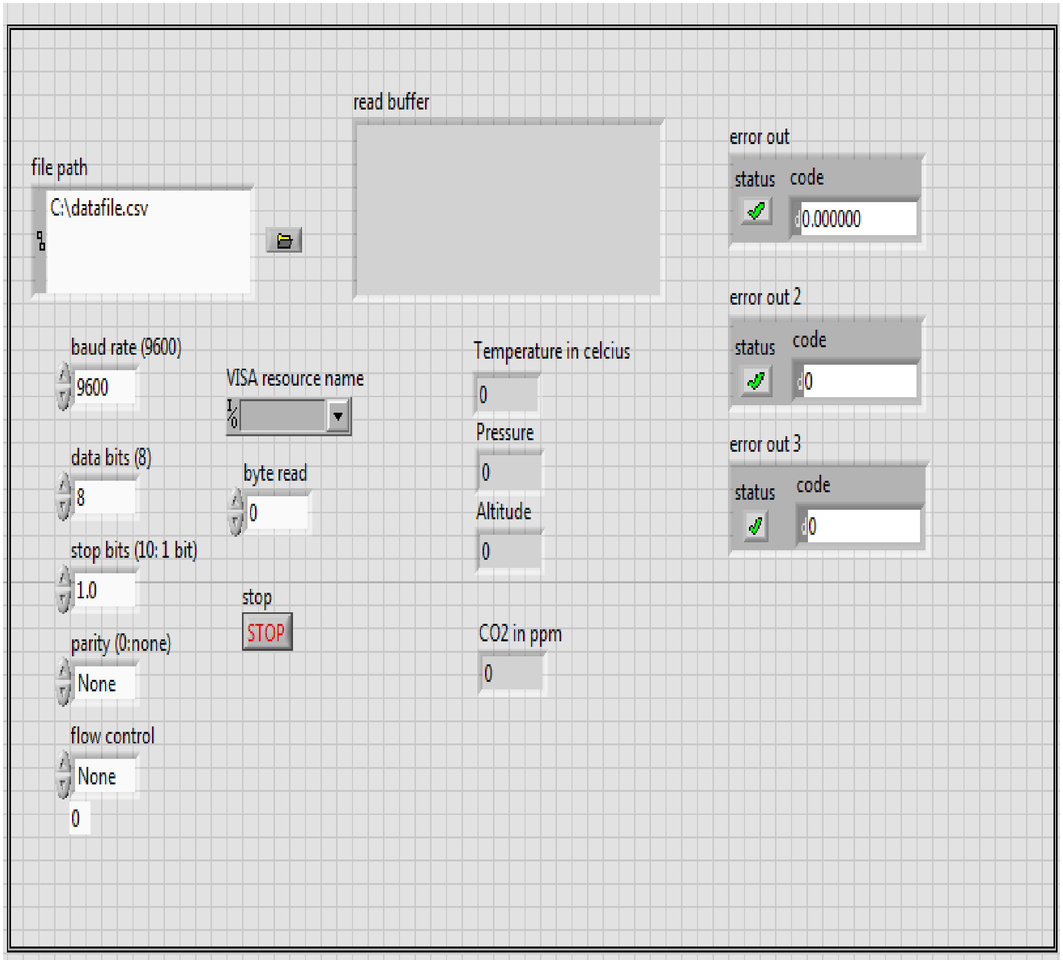

Figure 5.3: LabVIEW front pannel

5.4 Shared Variable configuration for Data Dashboard Android Application for one local wi-fi network

For acquiring the data wirelessly on android based device in a local wi-fi network, LabVIEW provides the network published shared variable deployment on indicators as charts, gauges, textboxes and Led's. Data Dashboard is free android application developed by National Instruments and available for Apple iPad and Android tablets in iTunes and Google Play Store.

5.4.1 Shared Variable configuration Steps

- **Step 1:** Create balnk projecrt and select the shared variable application.
- **Step 2:** Add the Vi to the project and drag the shared variables in the vi, change its access mode and connect it with the number.
- **Step 3:** Deploy the variables on the network and run the project.
- **Step 4:** Now open the data dashboard application in the Android based phone or tablet.Connect to the Shared Variable. Write the deployment IP address and connect. The values will be updated according to the main program in LabVIEW and it can be monitored remotely on the same network.

5.5 Web Publishing tool Application for monitoring and Control the Block digram remotely in one local network

For monitoring and control the Block diagram from remote PC or browser, the LabVIEW provides the Web Publishing tool application. It provides the html view on browser.

Configure the Web publishing tool for the project. It displays the snapshot on browser and updates it continuously according to user configurable time for update in seconds. If Embedded mode is selected then the client view and can access the block diagram from remotely in one local network. For embedded mode, project should be saved on the main server. So web publishing tool provides the monitoring and controlling of the system remotely.

5.6 LabVIEW Application for Internet Protocol

If wireless data acquisition range is increased to acquired data from anywhere on android mobile instead of local network, data should be sent on the server. From where it is fetched to the android device.

LabVIEW provides the access to pass and communicate the data between the LabVIEW application and the local or the remote database. MySQL is a database system that is used on the web and runs on the server. It is developed, distributed and supported by the Oracle Corporation. It is fast, reliable, easy to use and uses the standard SQL(Structured Query Language). By installing WAMP(Windows,Apache,MySQL,PHP) Server that is an environment used for creating PHP(Hypertext Preprocessor) and MySQL web applications, we can save the data from LabVIEW to the local database on the localhost in PhpMyAdmin. From this database the data is fetched when needed or it can be directly accessed through database[19].

5.6.1 Connection to Database From LabVIEW

LabVIEW provides the multiple simultaneous connections to a single or multiple databases through database connectivity toolkit. Database in PhpMyAdmin at localhost or at server is connected through LabVIEW and data can be retrieve or store to it and updated continuously by the time period defined in LabVIEW.The block diagram to connect LabVIEW to the database can be given as in below figure 5.4.

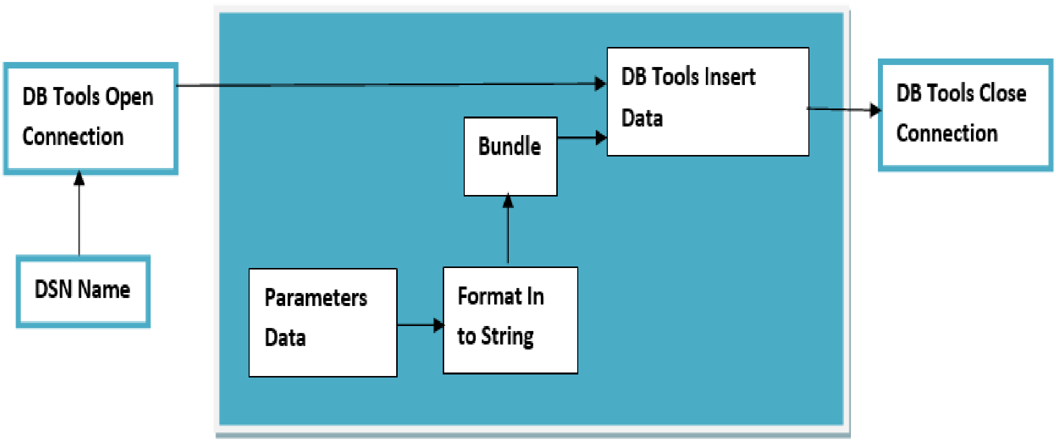

Figure 5.4: Database connectivity block diagram

- **DB Tools open connection**: It is used to open the connection from LabVIEW to database.Connection information path should be set as the DSN(Data Sourse Name) that is used to connect to the database from ODBC(Open database connectivity) driver wizard.

- **DB Tools insert Data**: Adds the new row in the table in the database which is connected through DSN and by given the database name as defined in table. Here all the parameters which are in DBL form are given to the format into string and applied to the bundle which provides the cluster of the data and connected to the DB tools insert data.

- **DB Tools Close connection**: It used to disconnect the connection to the database by destroying the connection reference.

So the data is read from the serial USB-to-UART at receiver side, stored to the excel sheet for locally analyzing in the PC and by using database connectivity toolkit, it will continuously store to the database. If it is send to the remote database it means on server, then it can be analyzed to any other pc or web supporting device at run time from anywhere and by making SQL query it can be manage accordingly.

PHP(Hypertext Preprocessor) is a server side scripting language and executed on the server. PHP is widely used and open source scripting language which is used to connect with database. MySQL and PHP are widely used together. PHP files have the .php extension and contains text,HTML, java scripts and PHP code. This code is executed at server side and returns the plain HTML in the browser. It can add, delete and modify data in the database[19],[20].

By configuring the PHP script using database name, user name, password and host server name, it is connected to the database. By applying the particular query in PHP code, it fetch the data from database and returned the plain HTML page in text form which contains the data.

Android application can be developed to analyze the data from anywhere. Through PHP API it is connected to the database. Android application calls the PHP script by defined time interval. so PHP API runs and connected to the database which fetch the data from database according to the query and returns the data to the android application. So by defined time interval in android application, the most recent data from the database is fetched and accessed to the android application anywhere at real time[20].

5.6.2 LabVIEW Front Panel for connection to Database

For visualizing the data and configuration for connection to the database, the front panel is shown in the figure 5.5.Here in columns tab, columns name should be defined as wanted in database columns in which data are updated. Table tab contains the table name in database in which data are filled. VISA reference and read byte are the configuration to read the data from hardware through the VISA serial.

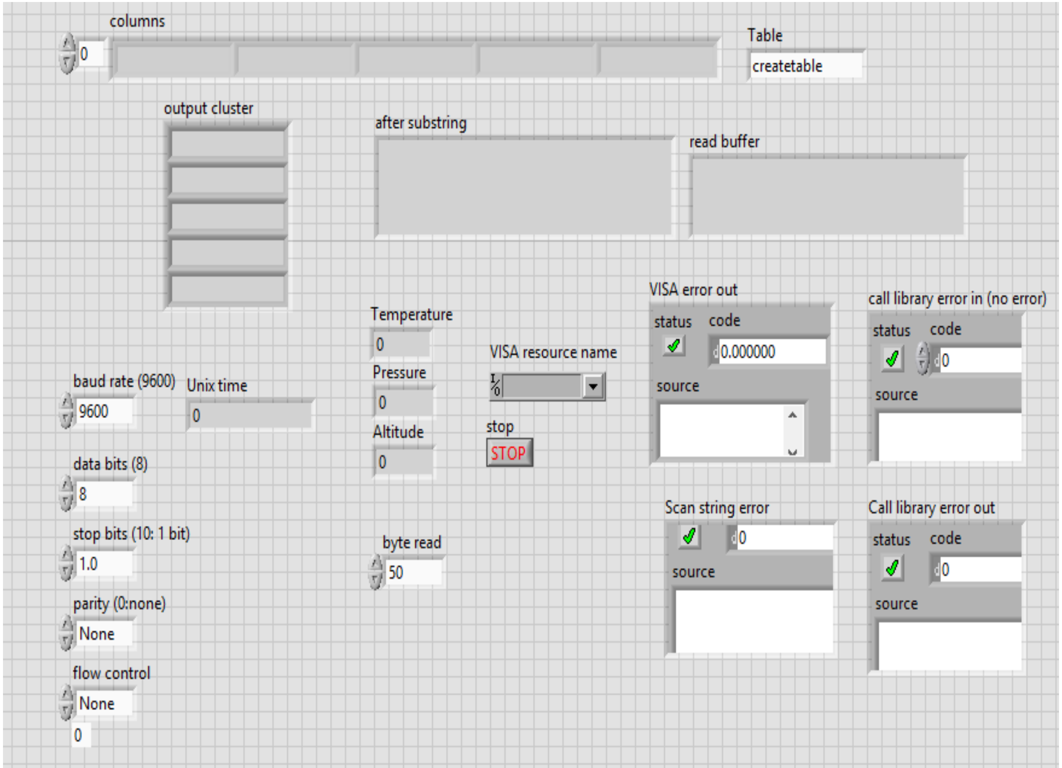

Figure 5.5: Front Panel for Database connectivity

Chapter 6

Conclusion

The hardware is selected for the project consists of the PIC microcontroller, LM1117 Ic for low dropout fixed output voltage of 3.3V, PL-2303HX as the USB to UART controller. The barometric pressure sensor for analysing the pressure, temperature and the altitude data. The CO2 sensor for CO2 concentration in ppm.

The overall conclusion of this project is to develop a system to analyze and store the data from Barometric pressure sensor and CO2 sensor at the receiver module wirelessly. At the receiver module , for storing data, LAbVIEW application is selected. The receiver module and pc communicates with USB to UART Converter PL-2303HX. LabVIEW application uses the VISA Serial communication. The Data is stored in the excel comma separated (.CSV) file for visualization. It can be analyzed later and used as the data log for future use and analyzation.

An android application using the shared variable deployment is developed by data dashboard to monitor the data wirelessly on the same wi-fi network using data dashboard application.Also web publishing tool provides the block diagram monitoring in web browser as html page from remote places in the same local network.

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