Design Document

For

Industrial Data Acquisition System

using PC

Revision History

Version	Date	Prepared By	Reviewed By	Approved By	Reason
1.0	8-10-2014	C C Sreenidhin			

Table of Contents

1 Introduction

1.1 Project Name and ID

Project Name: Industrial Data Acquisition System using PC
Project ID: IDAQPC-SW-08-10-2014

1.2 Scope of the Document

This Document describes the High Level Design for the development of Industrial Data Acquisition System using PC

This document is helpful for understanding the system to user and developer. Here we have abstract, block diagram, different system modules which helps to know better regarding the system. Looking into the datasheets one can clearly know the concept of this system. The extensibility and modifiability helps in further enhancement of this project.

1.3 Audience

The intended audience for this document is the Industrial Data Acquisition System using PC at DUXES.

1.4 Product Overview and Background

The Industrial Data Acquisition System is the embedded software control for the Industrial application to analyze proper condition of industrial environment, electrical supply and controlling any system with varialble voltage for testing or to operate machines in small and large scale industries.

Industrial Data Acquisition System can used in industries for maintaining track of Temperature, pressure, humidity etc. This values are send to Microcontroller. The temperature sensor keeps on monitoring the temperature of the system, feeds it back to the microcontroller and from microcontroller to PC.

1.5 Design Goals

Data acquisition is a term that encompasses a wide range of measurement applications, all of which require some form of characterization, monitoring, or control. No matter what the specific application, all data acquisition systems either

measure a physical parameter (temperature, pressure, flow, etc.) or take a specific action (sound an alarm, turn on a light, etc.) based on the data received. The primary goal of this is to develop Industrial DAQ System Software by designing and implementing the following software components:

- Gathering the Sensor value
- Transfering the data to PC.
- Monitoring the sensor data over PC.

1.6 Definitions, Acronyms, and Abbreviations

DAQ	Data Acquisition System
HLD	High Level Design
ADC	Analog to Digital Converter
UART	Universal Asynchronous Receive & Transmitter
GUI	Graphical User Interface
VCC	High voltage
PWM	Pulse Width Modulation
DAC	Digital to Analog Converter
PC	Personal Computer
USB	Universal Serial Bus
RISC	Reduced Instruction Set Code

1.7 Assumptions and Risks

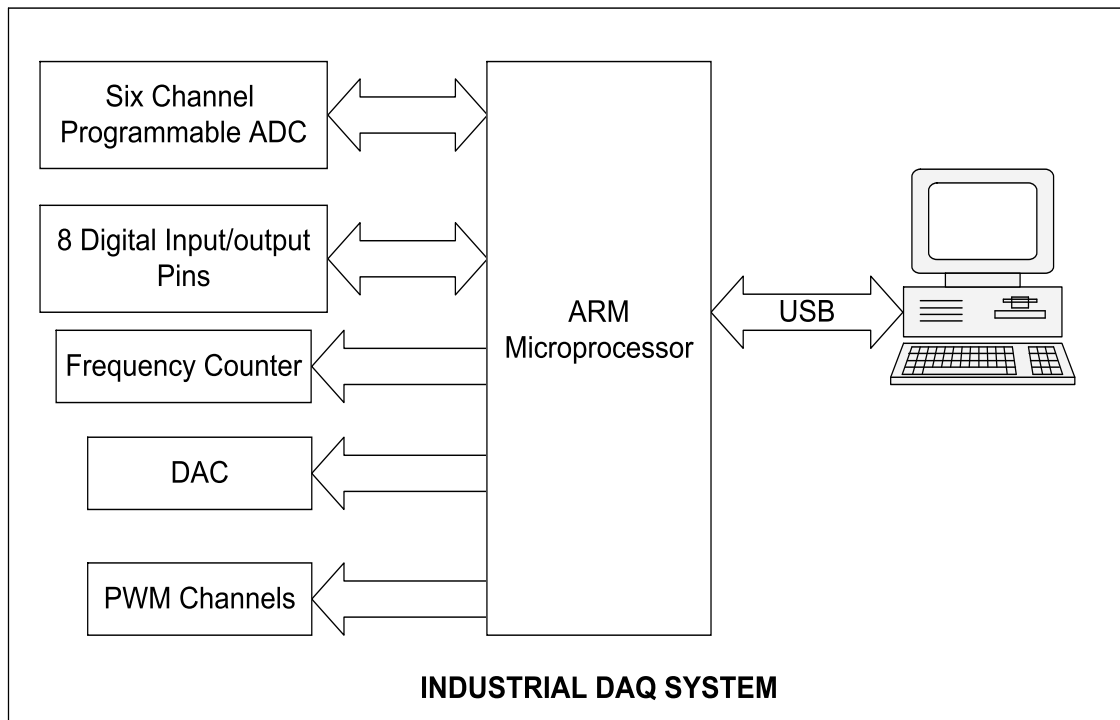The sensors need to be placed protected from extreme industrial conditions.

1.8 References

1) Datasheet – LPC2148.pdf

2) Datasheet – LM1123.pdf

3) Datasheet – MAX232.pdf

2 Block Diagram

Figure shows the architecture of Industrial Data Acquisition System.

3 Module Description

As the Block diagram shows, there will be a temperature Sensors, humidity sensors and pressure sensors, which sends the measured sensor data through ADC to Microcontroller. This value is processed and transmitted through UART port of the microcontroller to the PC using serial to USB converter and the same is displayed on the PC screen. Module description. Based on the aquired sensor values the PWM and DAC channels are controlled.

Industrial Data Acquisition System Project consists of 2 major modules described below:

❖ **ARM 7LPC2148**
❖ **Serial to USB converter FTDI**

ARM LPC2148

LPC2148 is an ARM7TDMI-S based high-performance 32-bit RISC Microcontroller with Thumb extensions 512KB on-chip Flash ROM with In-System

Programming (ISP) and In-Application Programming (IAP), 32KB RAM, Vectored Interrupt Controller, Two 10bit ADCs with 14 channels, USB 2.0 Full Speed Device Controller, Two UARTs, one with full modem interface. Two I2C serial interfaces, Two SPI serial interfaces Two 32-bit timers, Watchdog Timer, PWM unit, Real Time Clock with optional battery backup, Brown out detect circuit General purpose I/O pins. CPU clock up to 60 MHz, On-chip crystal oscillator and On-chip PLL.

LPC2148 used in the project controlls the overall data aquisition process and does the communication to the PC. The PC is connected to the UART port of the microcontroller through DB9 connecter connected to MAX232 level translator IC which inturn is connected to the UART pins of the microcontroller.

The sensors are connected to the ADC channels of the LPC2148 the ADC converts the sensor data to digital signals which inturn is transmitted to the PC. The PC sends control signals to the microcontroller which in turn controls the peripherals
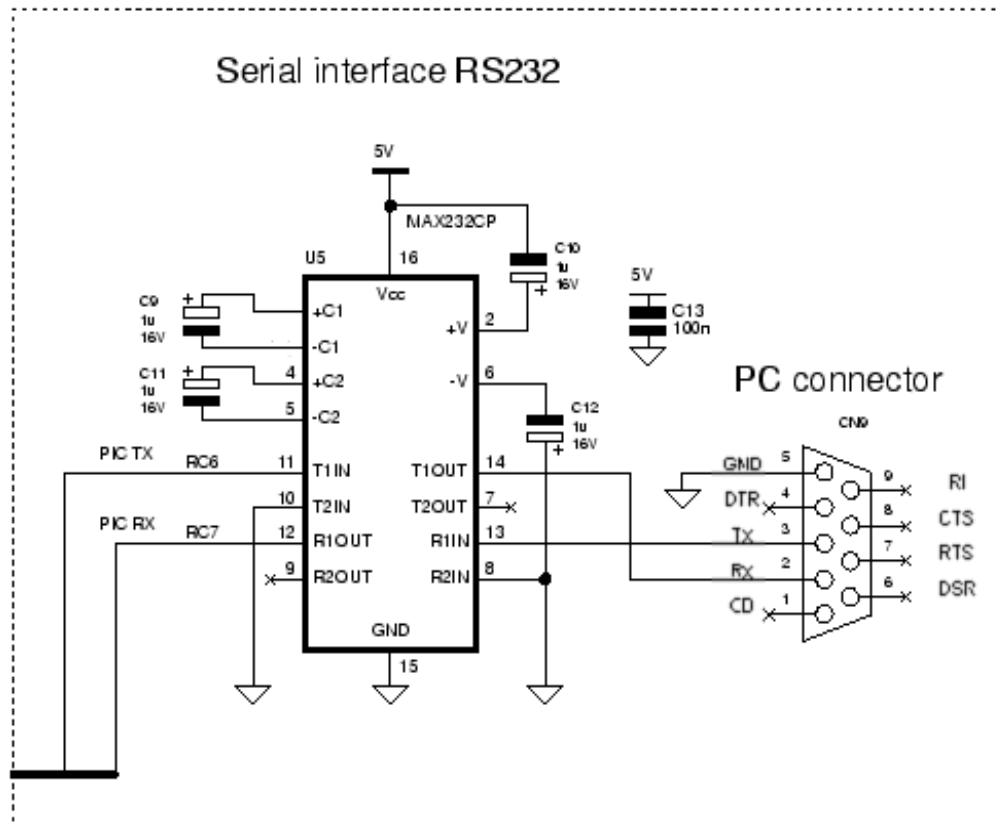
The following diagram shows the power supply for the LPC2148 board
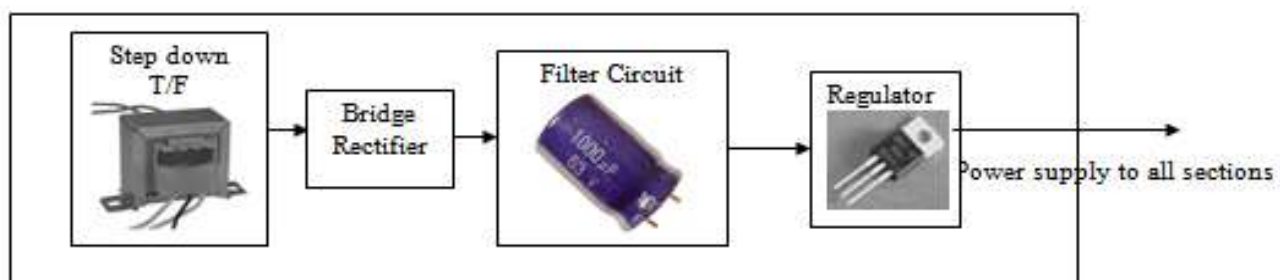
The figure above shows block diagram for power supply to LPC2148
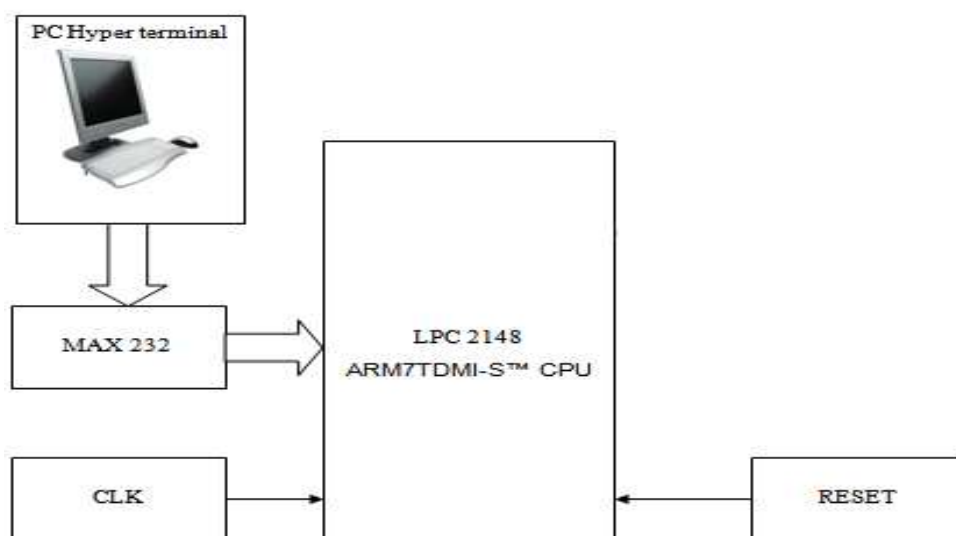
The interfacing diagram of LPC2148 with PC is as shown above

MAX232 Serial interface with microcontroller and PC is as shown above.

Serial to USB converter FTDI

This USB2.0 Full Speed IC offers a compact bridge to basic UART interfaces. The device is a UART, capable of operating up to 3MBaud, with low power consumption (8mA). The FT230X includes the complete FT-X series feature set and enables USB to be added into a system design quickly and easily over a UART interface. One end of the module is connected to PC USB port and other end to the microcontroller board to the DB9 port.

Also Industrial Data Acquisition System uses the following features in ARM7LPC2148 described below:

❖ **ADC**

❖ **DAC**

❖ **TIMER**

❖ **PWM**

❖ **GPIO**

ADC

LPC2148 provides 10 bit successive approximation analog to digital converter. Power-down mode. With measurement range 0 V to V REF (typically 3 V; not to exceed V DDA voltage level). The 10 bit conversion time of 2.44 us. Also the controller provides burst conversion mode for single or multiple inputs and Optional conversion on transition on input pin or Timer Match signal. The adc has a global Start command for converters.

In the project the 3 channels of ADC are used for reading the ADC from 3 different analogue sensors.

DAC

The LPC2148 provides 10 bit digital to analog converter with resistor string architecture and buffered output it also provides power-down mode it hassSelectable speed vs. power **.**

In the project the digital value to be converted is loaded into the register and the output is obtained across the Aout pin of the controller.

TIMER

The LPC2148 provides a 32-bit Timer/Counter with a programmable 32-bit Prescaler. The Timer/Counter is designed to count cycles of the peripheral clock (PCLK) or an externally-supplied clock, and can optionally generate interrupts or perform other actions at specified timer values, based on four match registers. It also includes four capture inputs to trap the timer value when an input signal transitions, optionally generating an interrupt.

The DAQ system uses the timer capture feature for the calculation frequency. The time taken for the capture of the pulse edges are calculated also the no of pulses are calculated and the frequency is calculated using the no of captures and time taken.

PWM

The PWM is based on the standard Timer block and inherits all of its features. Two match registers can be used to provide a single edge controlled PWM output. One match register (PWMMR0) controls the PWM cycle rate, by resetting the count upon match. The other match register controls the PWM edge position. Additional single edge controlled PWM outputs require only one match register each, since the repetition rate is the same for all PWM outputs. Multiple single edge controlled PWM outputs will all have a rising edge at the beginning of each PWM cycle, when an PWMMR0 match occurs.

Three match registers can be used to provide a PWM output with both edges controlled. Again, the PWMMR0 match register controls the PWM cycle rate. The other match registers control the two PWM edge positions. Additional double edge controlled PWM outputs require only two match registers each, since the repetition rate is the same for all PWM outputs. With double edge controlled PWM outputs, specific match registers control the rising and falling edge of the output. This allows both positive going PWM pulses (when the rising edge occurs prior to the falling edge), and negative going PWM pulses (when the falling edge occurs prior to the rising edge).

This feature is used to capture the pulses and calculate the duration.

GPIO

Every physical GPIO port is accessible via either the group of registers providing an enhanced features and accelerated port access or the legacy group of registers. Bit-level set and clear registers allow a single instruction set or clear of any number of bits in one port. Direction control of individual bits are possible and all I/O default to inputs after reset.

The i/o pins are used to interface various sensors and modules in the project based on the type of module the pins are set to input or output and data is read from the input or is written as output to the ports.
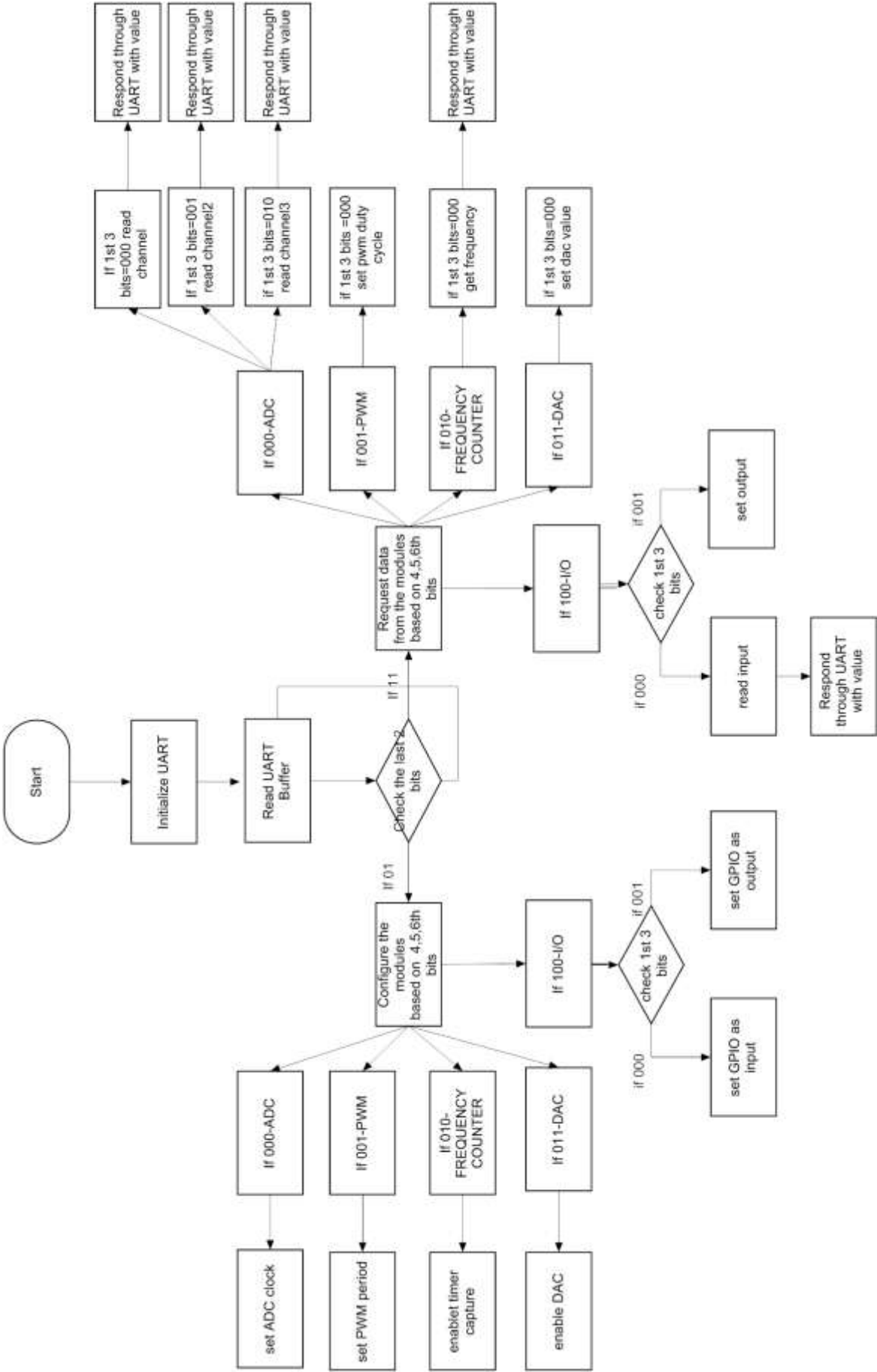
4 Communication Protocol

The protocol used for communication between PC and microcontroller is Serial communication(UART). Serial to USB converter is used to connect with PC   USB port.

5 Graphical User Interface

The GUI is developed using MATLAB and it helps in monitoring the measured parameters.

6 Flow Chart for Program flow

7 Test and Debug

Test cases will be addressed in the test case documents and the debugging is done using Keil uvision software tool.

8 Extensibility

The system can be extended to include more DAQ sensors for various other parameters also the system can be extended to include more control features.

9 Modifiability

The system features and the codes are modifiable.

10   Portability

Target Design Board and application software

11   Applications

1) The Temperature, Pressure and Humidity values can be displayed on the PC at any instant of time.
2) Numerous measurements of air pressure are used within surface weather analysis to help find surface troughs, high pressure systems, and frontal boundaries.
3) Intensely used in Weather forecasting.