USB Data Acquisition and Control System

Functional Description and Complete System Block Diagram

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Objective:

The objective of the USB data acquisition and control system project is to interface a PC to a microcontroller using a USB link to record data taken from the inputs on the microcontroller and output control signals via commands sent over the USB link. If time permits, a GUI user interface will be implemented for easier use of the system for a user. A user, by commands sent over the USB link, controls the data acquisition system which will either take samples from a selected input, or provide an output to a selected output. This is a flexible, general purpose data acquisition and control system solution that can acquire data of almost any type (digital or analog), and can provide control output for several control applications. The typical applications for this system include, but are not limited to: PWM generation, timing and time measurement, and general I/O (digital or analog).

System block diagrams and functional descriptions:

The data acquisition system, shown in Figure 1, consists of a PC with a USB connection, the Silicon Laboratories C8051F340 microcontroller (with USB connection) and 3v-5v, 5v-3v conversion, and digital/analog protection circuitry to protect the microcontroller from harmful signal levels.

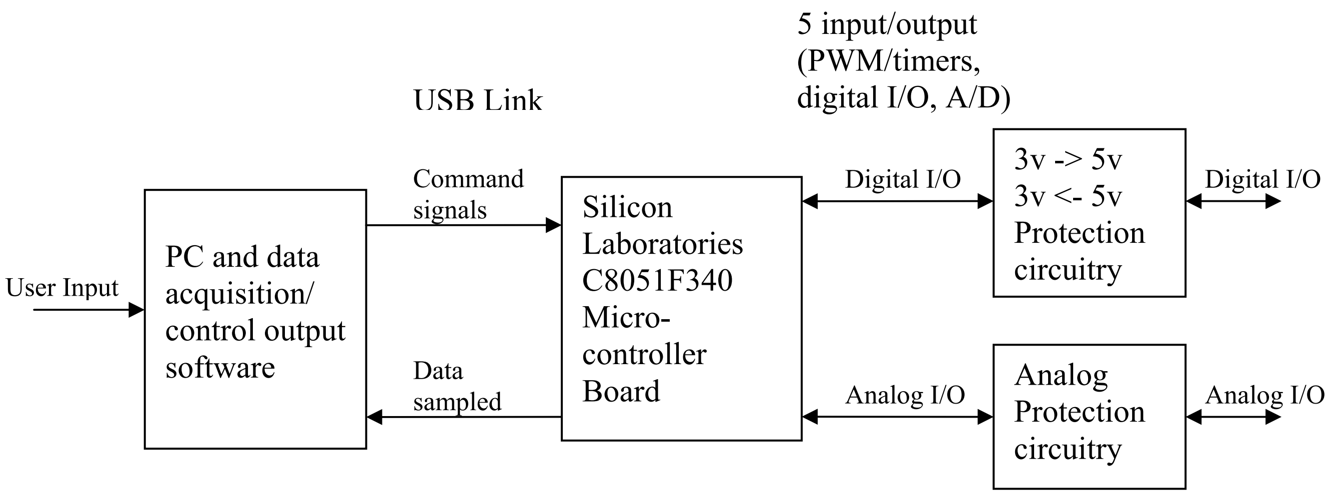

Figure 1. System Block diagram for the USB data acquisition system.

The PC subsystem shown in Figure 2 shows the inputs and outputs to the subsystem, and is described below. The PC subsystem takes commands from user input and sends those as command signals to the target board. Upon receiving acknowledgement from the target board, the PC subsystem retrieves data sampled from the development board.

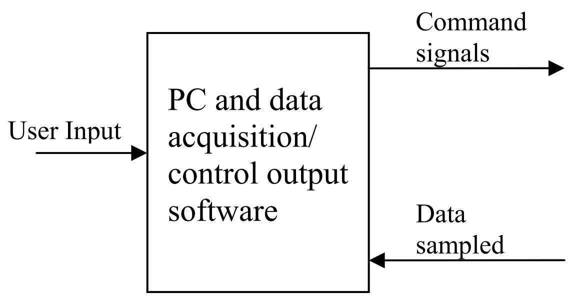

Figure 2. PC Subsystem and inputs/outputs

The Silicon Laboratories C8051F340 Micro-controller board, shown in Figure 3, accepts commands from the user (sent via the USB link). Based on the command sent by the user, the board starts a data acquisition mode or control mode. The data acquisition mode samples data from either the analog input or the digital input, then sends the data back to the PC (over the USB link) as the data sampled output. In control mode, the micro-controller generates control signals (timer pulses, PWM, control bits, etc) out over the digital or analog output.

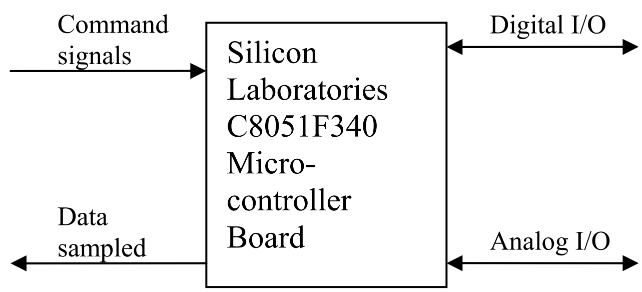

Figure 3. Micro-controller subsystem inputs/outputs

The development board protection subsystem shown in Figure 4 will, simply put, provide protection for the micro-controller board. The subsystem will convert 3v signals send from the micro-controller to 5v TTL-compatible levels, as well as 5v input signals to 3v signals that the micro-controller can handle. Both the analog I/O and digital I/O will contain protection circuitry to prevent the destruction of any input/output pins on the development board.

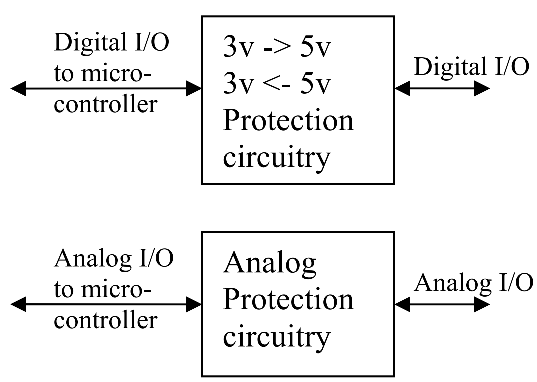

Figure 4. Development board protection subsystem

The PC will send commands to the microcontroller for data acquisition and control. The microcontroller will then start acquiring data from one of its input ports (protected by the protection circuitry), and then return it to the PC for later use. In the case of the micro-controller being used for a control system, rather than acquiring data, it will be sending control signals on specified I/O ports. The command language for communicating between user (PC subsystem) and the microcontroller subsystem will be determined at a later time.

Figure 5 shows a basic high level flow chart of the software design that will be used on the microcontroller. The development board accepts messages sent over the USB link, responds with an acknowledgement, and parses the message to determine what mode the user is requesting the development board be in (Data Acquisition or Control System Mode). The microcontroller will run in the desired mode until requested by the user to stop or switch modes.

Figures 6 and 7 are high level flow charts for the Data Acquisition and Control System modes on the development board. In the Data Acquisition mode, the development board will sample data on a specified port (most likely specified in parsed message to the development board), store the data in a buffer and send the sampled data back to the PC. If the micro-controller board does not receive an acknowledgement from the PC in a timely manner, the buffer will continue to save data samples until full. Once the buffer is full, an error message is generated and sent to the PC, and the micro-controller returns to idle mode.

Control System Mode is much less complicated than the data acquisition mode, since in this mode, the microcontroller does not have to send or receive any information to/from the PC except the acknowledgement. In the Control System Mode, the development board sends control signals out on a specified port (signal and port information will be sent in the parsed message sent over the USB link) and replies to the PC with an acknowledgment. The Control System continues to send output signals unless requested by the user to stop or to switch modes.

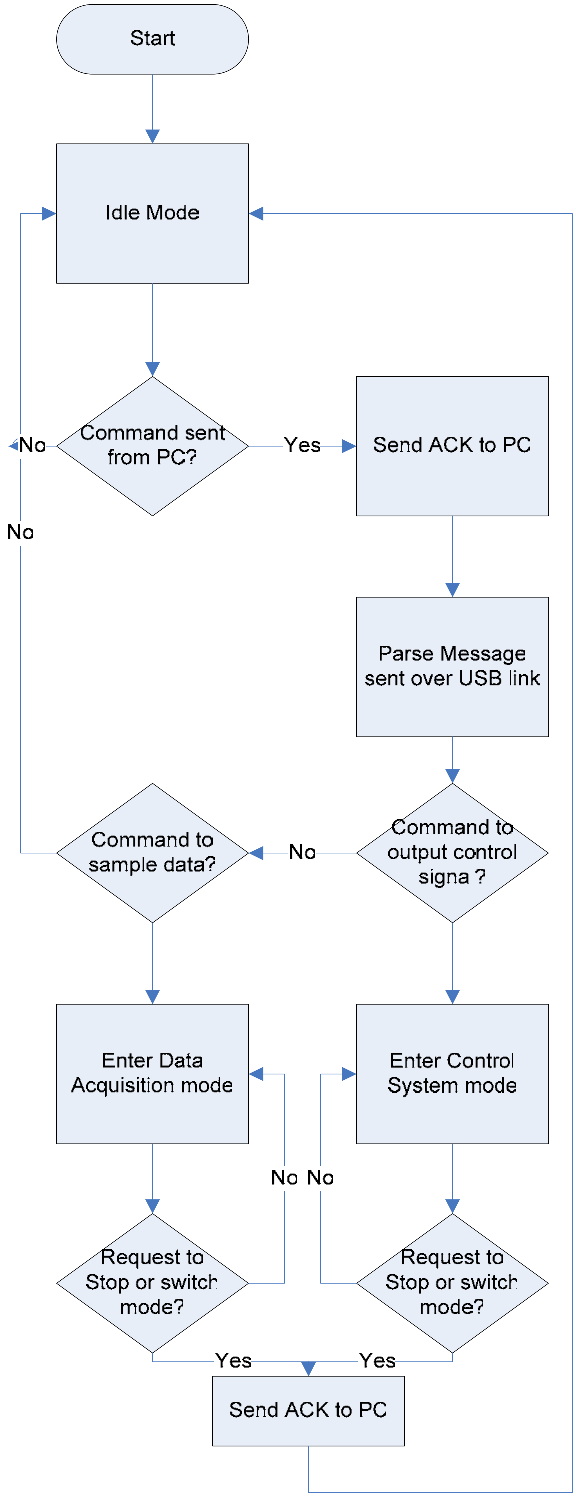

Figure 5. High level software flowchart for microcontroller

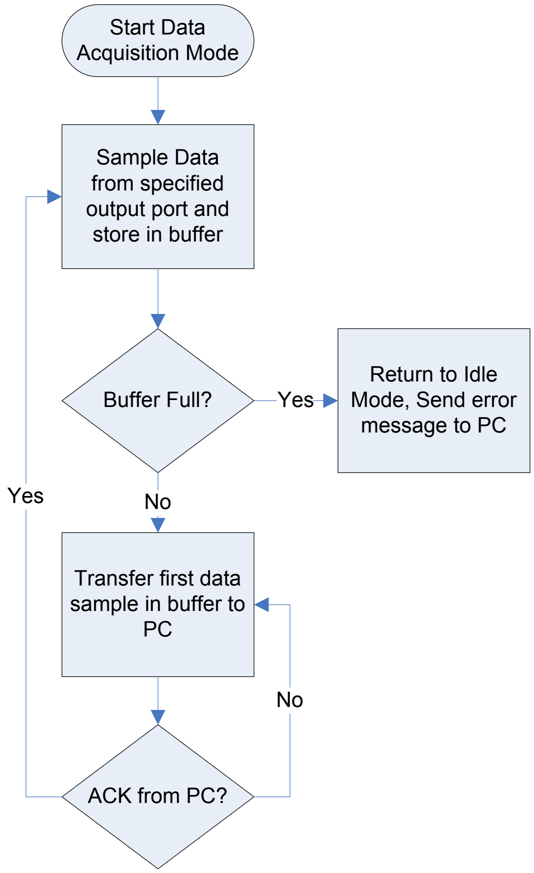

Figure 6. Data Acquisition Mode high level flow chart

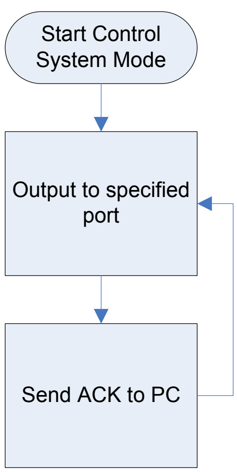

Figure 7. Control System Mode high level flow chart