USB Data Acquisition and Control System

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Outline

- Project Summary
- Functional Description, Block Diagram, Requirements, and Performance Specifications
- Data Sheets
- Preliminary Work
- Equipment and Parts List
- Schedule of Tasks
Project Summary

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.
**Complete System Block Diagram**

- **PC and data acquisition/ control output software**
  - User Input
  - Command signals
  - Data sampled

- **Silicon Laboratories C8051F340 Micro-controller Board**
  - USB Link
  - 5 input/output (PWM/timers, digital I/O, A/D)
  - Digital I/O
  - Analog I/O

- **Protection circuitry**
  - 3v -> 5v
  - 3v <- 5v

- **Analog Protection circuitry**

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- **Silicon Laboratories C8051F340 Micro-controller Board**
- **Command signals**
- **Data sampled**
- **USB Link**
- **5 input/output (PWM/timers, digital I/O, A/D)**
- **3v -> 5v**
- **3v <- 5v**
- **Protection circuitry**
- **Analog Protection circuitry**

PC Subsystem

**Inputs**

**Outputs**

**Specifications (USB Packets and Timing)**

- User Input
- Command signals
- Data sampled

PC and data acquisition/control output software
## Command Packets

<table>
<thead>
<tr>
<th>Task</th>
<th>Command</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Take A/D sample</td>
<td>A(Channel)</td>
<td>A(channel)(value)</td>
</tr>
<tr>
<td>Set PWM Duty Cycle and Period</td>
<td>P(Duty)(Period)</td>
<td>ACK</td>
</tr>
<tr>
<td>Set PWM Duty Cycle</td>
<td>P(Duty)</td>
<td>ACK</td>
</tr>
<tr>
<td>Set Digital Output</td>
<td>DO(port)</td>
<td>ACK</td>
</tr>
<tr>
<td>Take Digital Sample</td>
<td>DI(port)</td>
<td>DI(port)(value)</td>
</tr>
<tr>
<td>Acknowledge</td>
<td>ACK</td>
<td>__________</td>
</tr>
<tr>
<td>Measure Time (period or width)</td>
<td>T(P or W)(port)</td>
<td>T(P or W)(port)(value)</td>
</tr>
</tbody>
</table>
Microcontroller Subsystem

- Inputs
- Outputs
- Specifications (Timing)

Silicon Laboratories C8051F340 Microcontroller Board

Command signals → Digital I/O

Data sampled → Analog I/O
Development Board Protection Circuitry Subsystem

- Inputs
- Outputs
- Specifications

- Digital I/O to micro-controller
  - Analog I/O to micro-controller
  - Analog Protection circuitry
  - 3v -> 5v
  - 3v <- 5v Protection circuitry

- Digital I/O
Data Acquisition and Control
System Inputs/Outputs

- 4 channels of A/D conversion (10-bit, 200Ksps max), 1ms (1Ksps) samples
- 1 PWM Generation Unit (Timer 0)
- 1 Timing and Time Measurement Unit (PCA, period and pulse width measurement)
- 8 Digital Inputs
- 8 Digital Outputs
Software Flowchart – Data Acquisition Mode

Start Data Acquisition Mode

Sample Data from specified output port and store in buffer

Buffer Full?

Yes

Return to Idle Mode, Send error message to PC

Yes

No

Transfer first data sample in buffer to PC

ACK from PC?

Yes

No

Return to Idle Mode, Send error message to PC

No
Software Flowchart – Control System Mode

1. Start Control System Mode
2. Output to specified port
3. Send ACK to PC
Data Sheets - Microcontroller

C8051F340
## Data Sheets - Microcontroller

### Microcontroller Crossbar

![Crossbar Diagram](image-url)

**Figure 15.3. Crossbar Priority Decoder with No Pins Skipped**

- **Note:** Pins potentially available to each peripheral.
- **Caution:** General function signals are not assigned by the Crossbar. When these signals are enabled, the Crossbar must be manually configured to skip their corresponding port pins.
Data Sheets – Protection Circuitry

Texas Instruments 74LVC4245 Octal Bus Transceiver

**DB, DW, OR PW PACKAGE (TOP VIEW)**

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<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
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<th>6</th>
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<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
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<td>(5 V) V&lt;sub&gt;CCA&lt;/sub&gt;</td>
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**FUNCTION TABLE**

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<tr>
<th>INPUTS</th>
<th>OPERATION</th>
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<td>2.7</td>
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</table>
Preliminary Work

Research

- Microcontroller
  - Peripherals
  - Crossbar
  - USB

- IDE
  - Basic Use
  - Port Configuration
  - USB

- Protection Circuitry
  - 74LVC4245
Equipment List

- Silicon Laboratories C8051F340 Microcontroller Development Board
- 741LVC4245 Octal Bus Transceiver – 2
  - $.90 ea. (min. order – 1, Digi-Key)
  - $.399 ea (min. order – 2000, Digi-Key)
Schedule of Tasks

- **Weeks 1-4**
  - Microcontroller Subsystem Software
  - Troubleshooting
- **Weeks 5-9**
  - PC Subsystem Software
  - Troubleshooting
- **Week 10, 11**
  - Integration of PC and Microcontroller Subsystems and Troubleshooting
- **Week 12**
  - Transceiver Implementation
- **Week 13**
  - Oral Presentation
- **Week 14**
  - Final Report
Questions?