ViaSat

Employee Weight Tracker

Prepared for: Dr. Tom Kanneman
ELEC 492
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Executive Summary

The purpose of our project is to create a scale which will allow a user to measure, record and later access their weight. This product will also allow the user to gain access to all of their past weights and see how their weight has changed over time. We hoped to create something which would be able to read in a barcode number, verify the person's identity by way of a PIN number, get the weight from a digital scale, and then record the weight so that it can later be accessed. We used a PIC 18f6722 microprocessor to control the entire system, an ID Tech Omni Barcode reader, and an Agilent Technologies LCD Touch Screen. These major components were integrated with a PCB board of our design, and then contained in a black box which would serve as the display unit. By the end of the project we were unable to get the entire system successfully working but we were able to make certain portions of the system work. The PIC was successfully integrated with the LCD and the Barcode reader but we were unable to integrate the Scale.

Introduction

People throughout America have become educated about how their lifestyle affects their health. Low carbohydrate wraps and meal replacement drinks have become typical meals. Despite this, many people claim to have less time to exercise and maintain a healthy lifestyle. It is rather difficult for the working person to exercise and eat right, but it should not be difficult for them to track their health over a period of time. The goal of this project is to provide an easy and simple method for the working force to keep track of their weight and health over time. A common digital scale will be used to measure a person's weight. Their weight will be recorded and saved for future viewing.

Problem Statement

Many large corporations encourage their employees to stay physically active to improve the individual's health as well as the health of the company as a whole. To promote their employees' health, these companies have constructed gyms and or health centers on location. In order for the individual employee to monitor his or her own health one may use a simple weight scale. Although this may seem easy and accurate, this becomes cumbersome when tracking progress over a long period of time. To keep track of one's progress he or she would need to write down or remember his or her weight every time they leave the gym or health center and manually enter the data into an excel data sheet. One of the largest technology companies in Southern California, ViaSat, has decided to take the initiative to promote its employee's health and well being.

Market and Background Survey

The ViaSat Employee Weight Tracker can be applied to various companies or organizations interested in monitoring its employees,' customers,' or students' weight over a long or short period of time. This system would be able to accurately weigh an individual and record their weight, and analyze their progress towards a particular weight goal. By simply swiping an ID card and then stepping on the scale, the patron's weight is recorded and stored for future viewing or analyzing. For example, a company such as Gold's Gym would give their customers the ability to look at, and monitor, their weight. They will also be able to view graphs and other types of data analysis tools that will allow them to optimally reach their personal goals, which in turn will optimize the company's performance as a whole. We were also thinking that the University of San Diego would want to place a prototype in the Jenny Craig Pavilion weight room so students may be able to monitor their weight. Lastly, companies, like ViaSat, are interested in knowing how healthy their employees are over their tenure with them.

Function

The designed device will be located in a convenient location, maybe the gym, where employees will be able to weigh themselves at the beginning and end of every working day. Each employee currently has a bar code located on their personal identity badge. A bar code scanner will be interfaced with a processor and a scale to keep track of an employee's weight. The data obtained from each weigh in will be sent to a memory device to be stored. A data point containing time, date, and weight will be taken and stored after each and every weight in. When a new employee is recognized by the bar code scanner, the user is asked to enter a four digit PIN so they may view their weight profile.

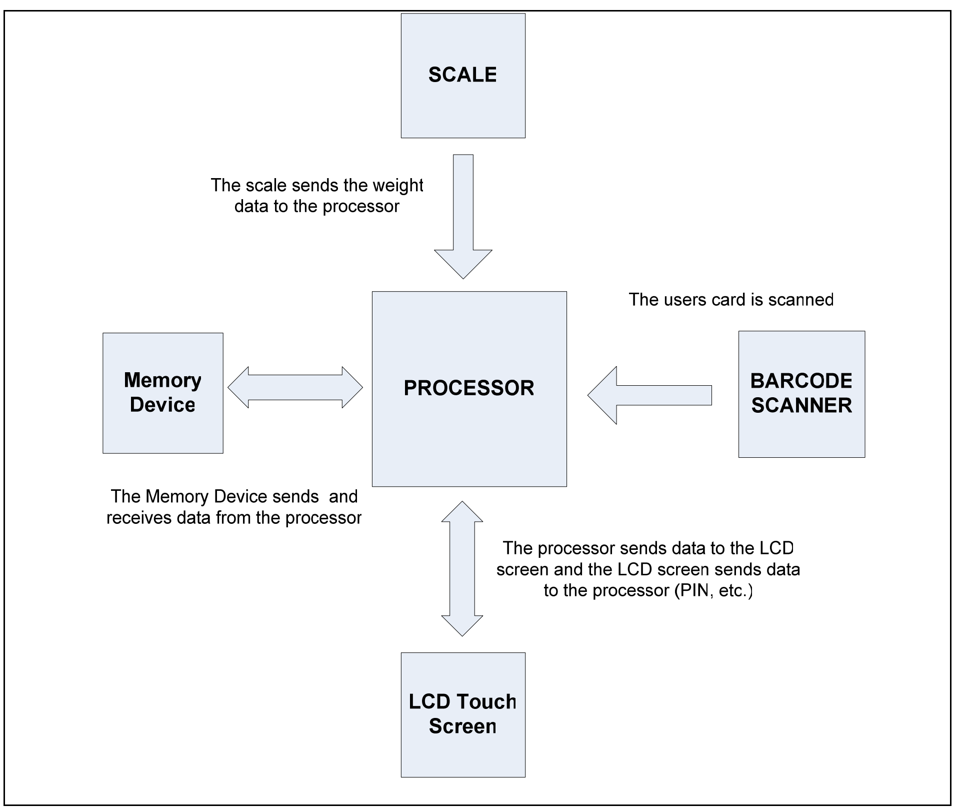


Figure 1: Block Diagram of the ViaSat Employee Weight Tracker

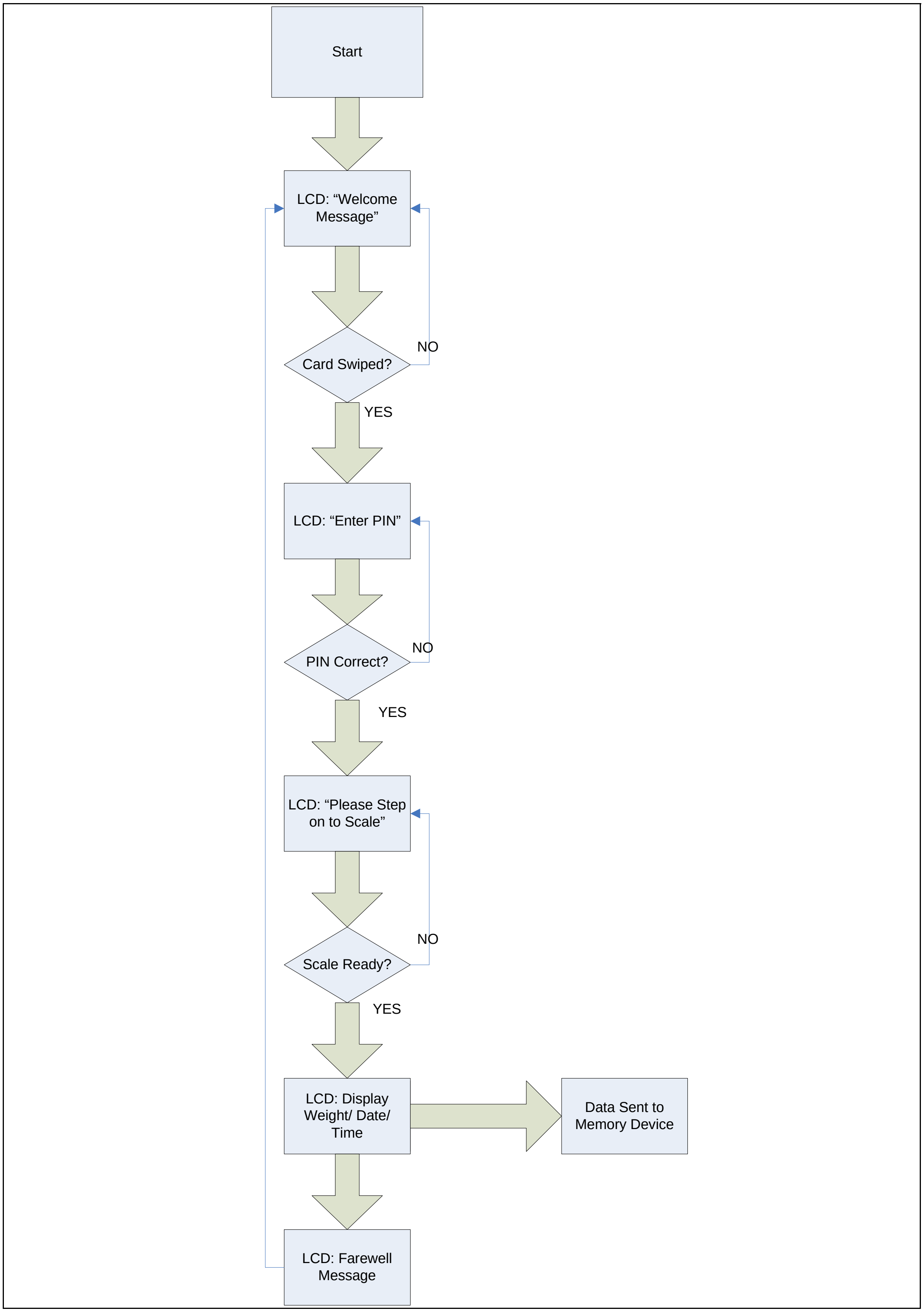


Figure 2: Flow Chart of Working ViaSat Weight Tracker

Technical Survey

This project requires the knowledge and use of certain engineering tools and skills. They are bulleted below.

- The main component of the design is the PIC microprocessor. The PIC must be able to communicate with peripheral devices in order for the project to succeed. Knowledge about interfacing and programming using PIC assembly and C languages is required. A PCB board will be designed to connect the necessary devices.

- Data from the PIC microprocessor will be sent to a serial EEPROM for storage. This requires the knowledge of how the PIC sends information and how data is stored, and read, via the EEPROM. We will also need to know how to interface the EEPROM with the PIC microprocessor and what necessary software is needed.

- One of the peripheral devices is a bar code scanner. The bar scanner was successfully interfaced and programmed in working order through last semester's work. The bar code scanner communicates serially with the PIC via an RS232 interface.

- All data is measured and sent to the PIC using a digital weight scale. The PIC processor needs to be interfaced with the scale appropriately. To do this we will design a load cell interface where the voltage is read across two lines from the scale. A high precision analog to digital converter will need to be interfaced with the PIC and programmed efficiently. The AD converter will need to be accurate to the microvolt.

- A touch screen will be used by the user to input their PIN and view data. The touch screen requires integration with the PIC to detect the correct PIN. The LCD touch screen is also used to display the greeting, the data recorded and the farewell message. This will require that we know how to develop to a GUI (Graphical User Interface) on the LCD touch screen so the user may view their data easily through a line graph. The touch screen used will use Microsoft Front Page to develop a "webpage" like format to program itself.

Constraints

Certain constraints were encountered when designing the ViaSat Weight Tracker. They are bulleted below.

- To simplify our design we chose to run all of our devices at the five volt level. Five volts was chosen to simplify the PCB layout. An entire layer of the board would be dedicated to the five volt level, hence making the PCB board design as a whole much easier. This would also decrease the amount of elements on our PCB board design.

- To make the software portion of our design easier we chose to implement an ICD device with the PIC microcontroller. This would allow us to use the PIC-C compiler software already installed, and partially written, in our senior design laboratory. This would enable to use a previously used programming software where we feel comfortable using.

- Due to the large number of people who would use the ViaSat Employee Weight Tracker, we were constricted to the type of memory device we could choose. A table is listed in the specifications section of this report which shows how and why we chose the specific memory device.

- The scale used, when run at the five volt level, gave off specific voltage levels which correspond to the user's weight. These voltage levels are in micro volts; hence we need a precise analog to digital (AD) converter to capture the data accurately and efficiently. To see the actual voltage levels read in relation to its corresponding weight value (in pounds) a graph may be seen under the specifications section where we show why we chose the specified AD converter.

- Since the LCD touch screen is a typical size of 3.8 inches diagonal and the PCB board is 60mm by 90mm, we had constraints on the size of the enclosure that we could choose. We also will have the peripheral devices itself or its wires enclosed in the package. A drawing is located in the specifications part of this report to show how and why we chose the specified enclosure.

Schematic and PCB Layout

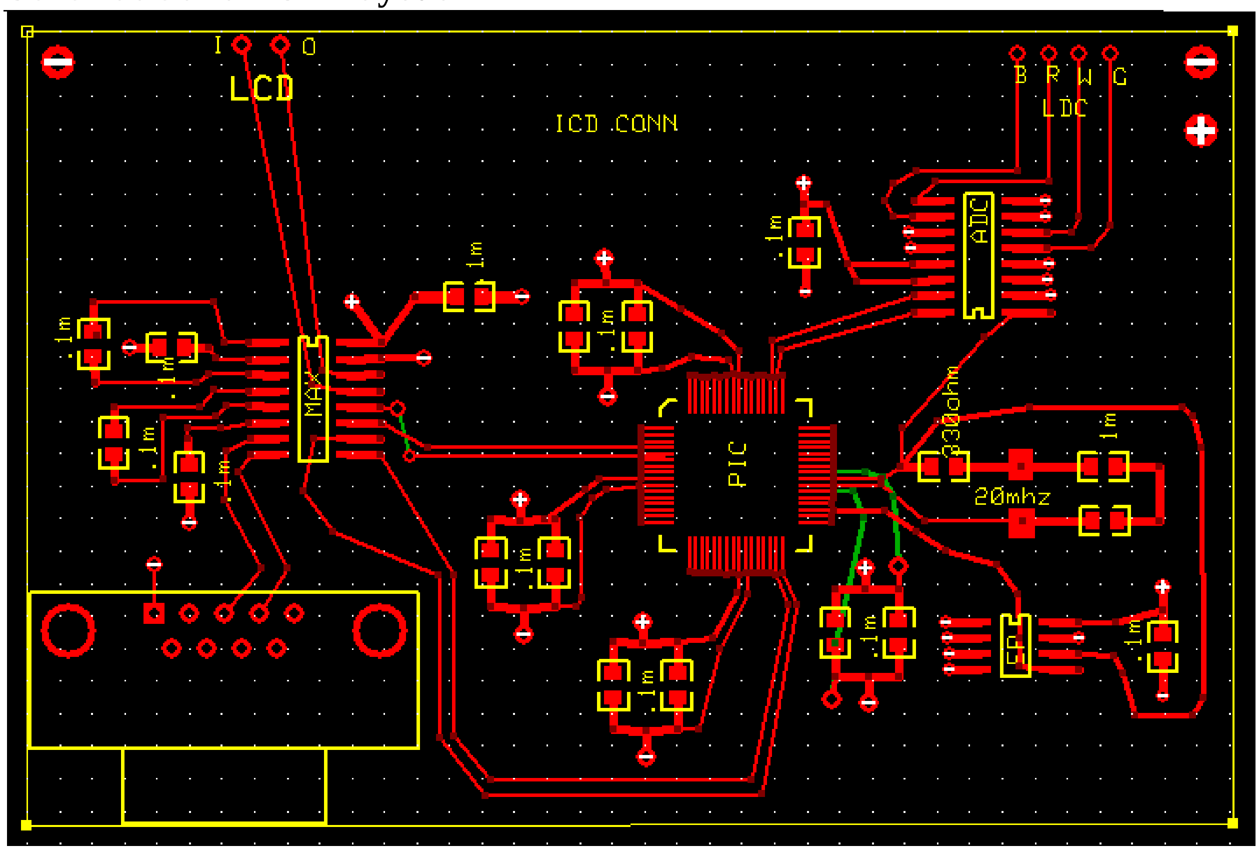


Figure 3: PCB Layout

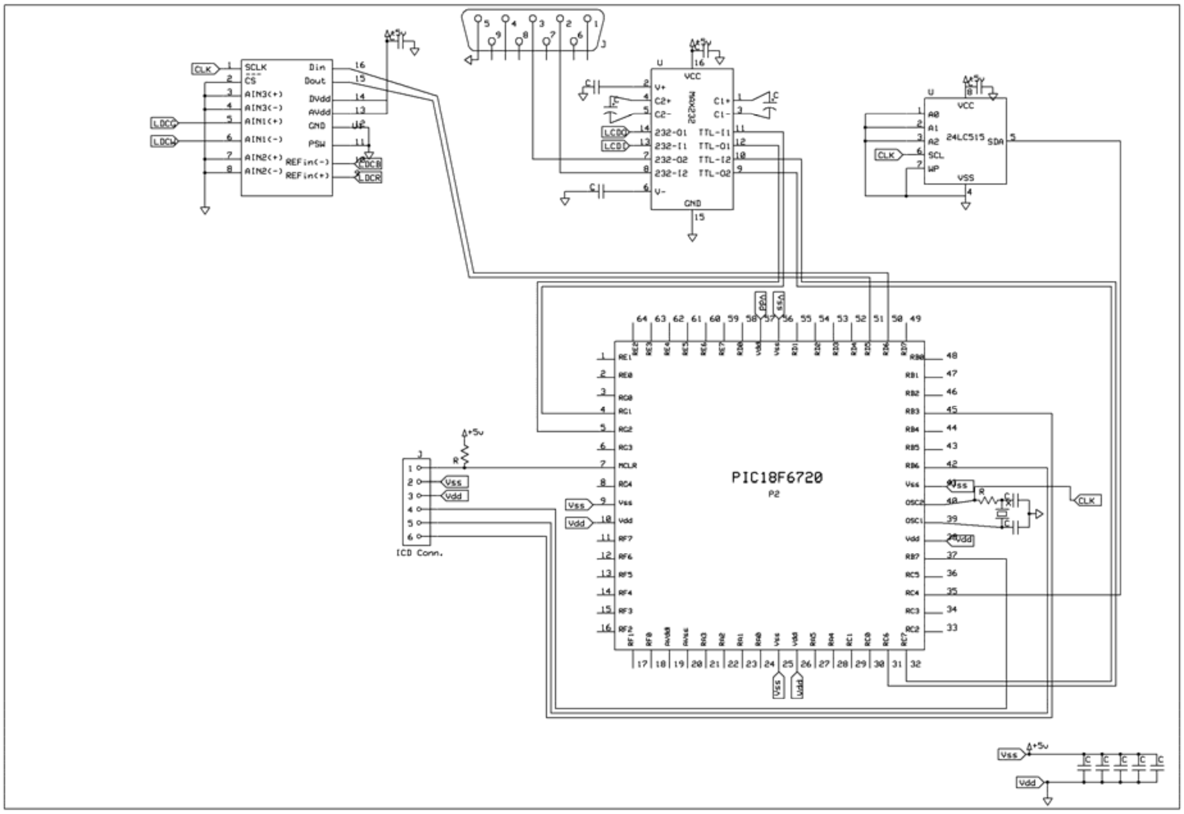


Figure 4: PCB Schematic

Specifications

Processor (PIC 18F6722)

In the initial development stages of this design project we are used an Embedded Internet Development Kit as the base of our system where the PIC 18F6720 was the heart of the board. The heart of the PCB board design we will be using is the PIC 18F6722 microprocessor chip. The PIC 18F6722 is backward compatible, both hardware and software wise, with the PIC 18F6720. This PIC microcontroller is ideal because it can control the necessary serial devices. It has two addressable Universal Synchronous/Asynchronous Receiver Transmitter (USART) modules which will handle our RS-232 interfacing, and Master Synchronous Serial Port (MSSP) modules which support two, three or four wire SPI™ and I^2C™ data communication while also having four programmable external interrupts and four input change interrupts. The PIC 18F6722 also has an idle power-managed mode where the CPU itself will be off, but the peripheral devices will be on.

Weight Scale (American Scale: P2000 Home Health Scale)

Building our own scale would be too difficult and unnecessary because of calibration issues. We chose the P2000 Home Health Scale because it met the power requirements and its maximum capacity was over 550 pounds. The scale gives off a specific voltage level according to the weight that is on the scale (see graph and table in AD converter section below). These voltage levels would be read by a high precision AD converter, which sends a digital word to the PIC corresponding to the weight data. A picture of the four wire bridge output that is used to read these voltage levels is located below.

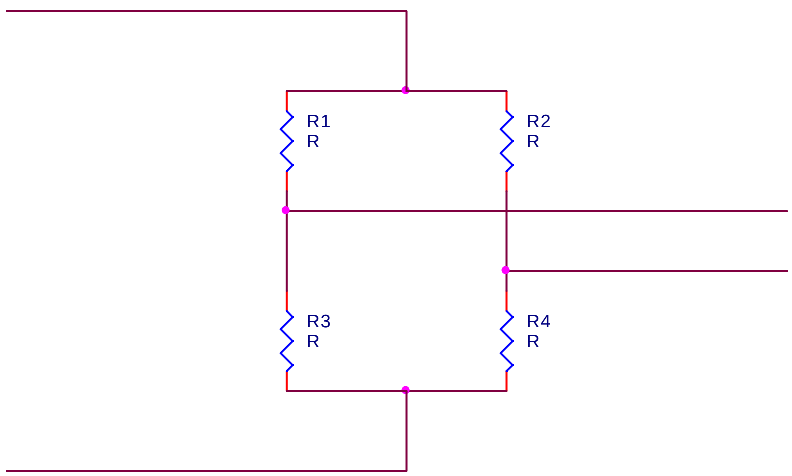


Figure 5: Resistor Bridge in Load Cell

Figure 6: American Scale's P2000 Home Health Scale – 550 pound capacity

Analog to Digital Converter (Analog Devices: AD7739)

We chose Analog Device's AD7739 to send the weight data to our PIC for processing. We chose it because of its high precision and because of it would be easily integrated with the PIC. First of all, the AD7739 is specifically made for weigh applications and high precision measurement applications. It is interfaced with the PIC via a three wire serial interface, using SPI® communication. Below is a table and graph where we show how the weight of the user is represented by a corresponding voltage read across of the four wire bridge output of the scale. These data points are obtained when the scale is run at five volts. The equation in the graph:

$$y = 64.419x - 11.824$$

is obtained by doing these measurements, where y is the weight of the user and x is the voltage read across of the four wire output bridge of the scale.

Weight (lbs)	Voltage (mV)
0	0.18
5	0.26
10	0.34
15	0.41
20	0.49
25	0.57
50	0.96
75	1.36
100	1.74
125	2.13
150	2.51
175	2.9
200	3.29
225	3.68
250	4.07
275	4.44
300	4.83
325	5.23
350	5.62
375	6.01
400	6.39

Table 1: Load Cell Measurements

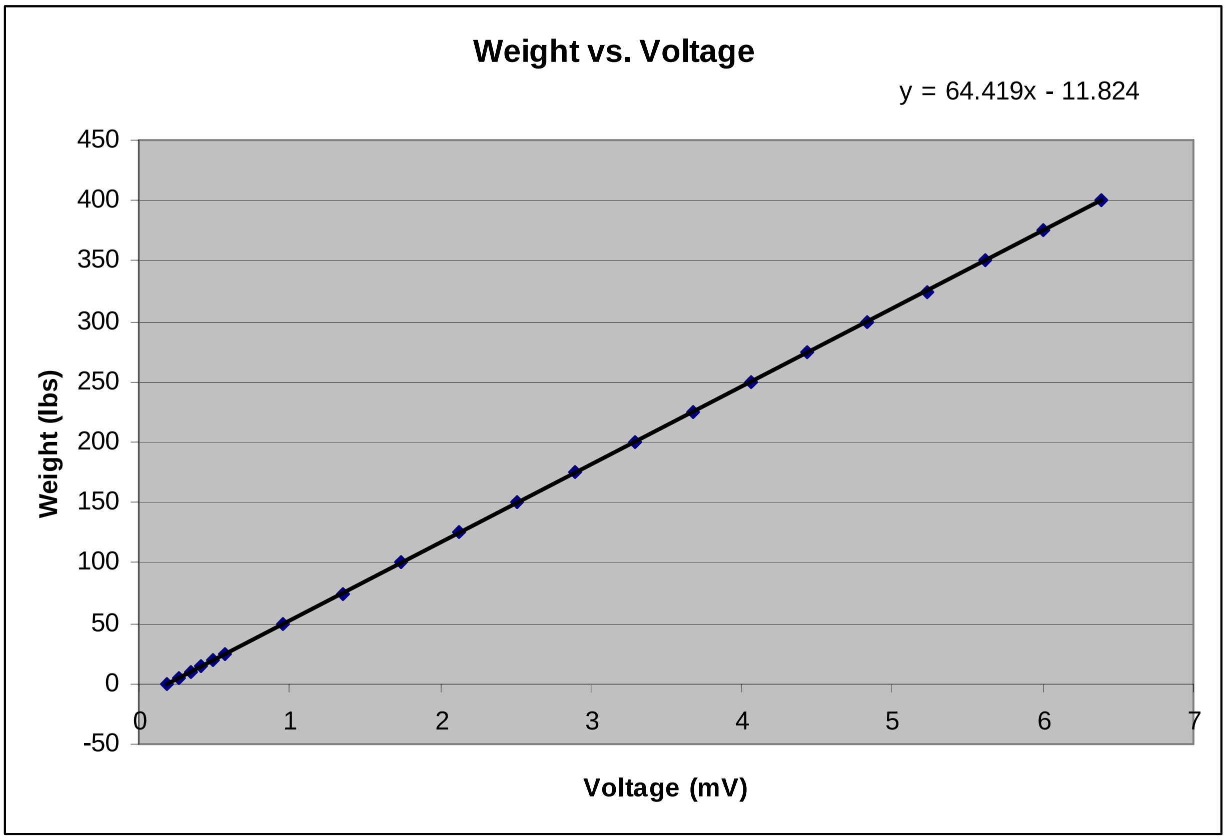


Figure 7: Load Cell

Bar Code Reader (ID TECH: WCR3227-600)

This bar code slot reader was chosen because it has the dimensions necessary to read the bar code that is on the ViaSat employee badge and it can be easily integrated into our design. The reader has an RS232 serial interface and would be interface via one of the USART modules on the PIC. The slot reader is located below.

Figure 8: ID Techs' WCR3227-600 Bar Code Slot Reader

LCD Touch Screen (Amulet Technologies: CB-GT380)

The Amulet CB-GT380 will be used because of its easy programming and interface with the PIC. The LCD touch screen uses Microsoft Front Page as a means to set up a "webpage" like format for programming. Each display will have various hyperlinks that would be set up using Microsoft Front Page. The touch screen is interfaced through two pins on its J2 connector (pins 8 and 10), which will be connected to the other USART module on the PIC. This touch screen also easily allows us to use Microsoft Excel as a means to display a GUI of their weight (weight vs. date) to the user.

Figure 9: Amulet Technologies Starter Kit

ICD Module

Due to the fact that we previously used the PIC-C compiler last semester and have working code available, we chose to implement an ICD module onto our board for ease of programming. This way we can simply manipulate our code in our laboratory where the PIC-C code is already installed and is in working specifications.

Outcomes and Results

At the conclusion of this project we had our system working to a degree. Individually we had all of the components integrated and talking with the PIC, it was however much more complicated to get all of the components operating successfully at the same time. We were able to successfully integrate the barcode reader and LCD touch screen at the same time but were unable to make the scale operate with these two. Problems with the ICD connector for the PIC board as well as the serial ports intended to transfer data from the scale to the board arose at the last minute and forced us to do serious jumping and cutting of traces on our circuit board. This combined with an inability to program the ADC and correctly have that communicate with the PIC forced us to buy a new scale with RS 232 output which we could directly hook up to the PIC. A small programming bug which we were unable to understand or fix prevented us from being able to implement the entire system in the end.

However there were many things with this project which were successes. We were able to learn a lot about PCB design, PIC/C programming as well as the whole engineering design process. We were forced to constantly re-evaluate and change our ways of thinking about how to solve this problem depending on various complications which arose. We also learned much about how to debug and fix PCB boards, since much of our time was spent working to correct problems with our initial board design. We were also able to become very good at using the programming tools available to us on the computer such as the debugger. These tools were very helpful in assisting us to assemble the code and ensure that it was working before we loaded it onto the board.

Conclusions and Recommendations

If we had more time we would have been able to make a much better final product for our presentation. Some of our problems were due to our programmer not starting writing the code until the hardware was entirely done. If the software had been completed earlier in the semester we would have had time to debug it so that it should have been working correctly by the time all other components were integrated. Another major problem we encountered was that the ADC was not operating correctly. Again this problem was part software and part hardware. We initially had the wrong pin out on our PCB board and by the time we realized this it was too late. If given the opportunity to redo this project we would change many different things about it. Firstly we would cut out the entire ADC component. It created too much of an opportunity for things to go wrong. We would have bypassed this system component by using a scale with direct RS 232 interface which we could then feed directly into the PIC. We also would have begun programming much earlier in the semester so that all of our components would have been working properly whence the hardware was finished. We would recommend to anyone else trying this project to make the design of the PCB board one of their first jobs since this proved to be more troublesome than we had originally expected. As well we would recommend using as few chips as possible. The more chips that exist on the board, the more opportunities for something to go wrong.

Budget

Initially, we were given a budget of $500 from ViaSat and an addition $200 from the Associated Students department of the University of San Diego. However, additional funding was made possible through Dr. Pateros' efforts. Below is a Bill of Materials gathered through online research. The total estimated budget at the time of this proposal is approximately $946.14.

ViaSat Weight Tracker Bill of Materials

Description	Chip/Product	Package/Type	Quantity	Price ($)	Total ($)
AD Converter	AD7799	TSSOP 16 pin	2	8.53	17.06
EEPROM (512K)	24LC512	SOIC(D) 8 pin	2	2.3	4.6
PIC Microcontroller	PIC18F6722	TQFP (64 pins)	2	15.93	31.86
Serial Driver	MAX232D	SOIC(D) 14 pin	3	0.84	2.52
Voltage Reference	L4940V5	TO-220	4	2.16	8.64
20Mhz Crystal	300-8101-1-ND(digikey)	SMT	3	1.24	3.72
6 pos. Modular Jack	A4004-ND (digikey)	na	2	5.05	10.1
Rocker Switch	CKN2061-ND(digikey)	na	2	6.51	13.02
Right Angle PCB DB9-Sub conn	152-3309 (mouser)	na	2	0.95	1.9
.1mF Capacitor		0805 SMT	20	0.14	2.8
ICD connector for programming	806-GDL-N-66	NA	2	0.81	1.62
330ohm Resistor		0805 SMT	10	0.088 for 10	0.088
47Kohm Resistor		0805 SMT	10	3.56 for 10	3.56
P2000 Weight Scale	American Weigh	P2000 (550 lb. capacity)	1	295	295
Bar Code Slot Reader	ID TECH OMNI	WCR3227-600	1	109	109
Embedded Internet Development Kit	CCS Engineering	Hardware ONLY Kit	1	180	180
PCB board	Express PCB	na	3	170	170
Enclosure	Fibox	PCM 200/88 XG	1	47.76	47.76
Development Book(s)	Bentham, Jeremy	TCP/IP Lean: Web Servers for Embedded Systems	1	43.12	43.12
				Total Price ($)	**946.368**

Table 3: Estimated Budget

Personnel

The personnel working on ViaSat Weight Tracker project is:

Joshua Martin – Project Lead
Joshua is a senior in Electrical Engineering with a minor in Mathematics at the University of San Diego. His experience with digital design will help lead the team with its design of the ViaSat Weight Tracker. While taking EEE 410 (Microcontrollers) he learned the necessary tools to head the design of the ViaSat Weight Tracker prototype board and effectively guide the team while designing the assigned components as well. Joshua will be redesigning the PIC with a similar 18F series PIC and will be writing the code to integrate the LCD and all other subsystems of the Weight Tracker system. Joshua is integrating an I/O memory to store the weight and customer identification for customer recognition and graphing of the customer's weight on a weight verses time graph on the LCD touch screen. Joshua is also responsible for the Analog to Digital conversion of the Load Cell analog inputs.

Baxter Box – Chief Hardware and Packaging Engineer
Baxter is a senior in Electrical Engineering with a minor in Mathematics. His primary objective is working on the hardware end of the prototype board design. Baxter will use his knowledge gain in Power Electronics and Microcomputers in his design and implementations. Baxter is designing the power supply that will deliver power to the PIC, scale, LCD touch screen, and load cell. Baxter is also in charge of using ExpressPCB to layout the final circuit onto a Printed Circuit Board for final assembly. He is redesigning the TCP/IP PIC for final PCB layout to allow serial inputs and removing the internet capabilities for we will no longer be creating a server interface. After the system has been integrated onto a PCB board, Baxter is in charge of encasing the system.

Brett Chicotka – Chief Load Cell Engineer
Brett is studying to become an Electrical Engineer at the University of San Diego. His enrollment in ELEC 350 (Signals and Systems) and knowledge of hardware design will help him with an ample amount of practice to implement the peripheral devices to the design of the prototype ViaSat Weight Tracker board. Brett is in charge of removing the load cell previously integrated with the scale and designing a look up table in C in order to accurately calculate weight placed on the scale. Brett is also helping on the code to integrate the scale to the PIC. Brett is also helping implement the Analog to Digital Converter.

Bibliography

1. American Weigh
   http://www.americanweigh.com/product_info.php?products_id=28
   We used this internet website to price and find a scale which met our specifications.

2. Point of Sale
   www.posmicro.com
   This website was used to investigate what kind of barcode scanner would work in our proposed design.

3. CSS Engineering
   www.ccsinfo.com/picnet.shtml
   Dr. Pateros referred us to this site, where we found the Embedded Internet Developer Kit with a PIC as the microcontroller of the system.

4. Jameco
   www.jameco.com
   Widely used online website; used to purchase various components that may be used in the design of our project.

5. Apollo Displays Technologies
   www.apollodisplays.com
   This website was used to explore options that may be used as a user interface. The LCD with a touch screen option was found here.

6. ViaSat, Incorporated
   www.viasat.com
   The company website was visited, where vital statistics, such as size, locations, etc. were found.

Resources

We would like the specifically thank the following people for their contributions, advice, and financial assistance without which, we never would have been able to complete as much of this project as we were able to.

Dr. Pateros

ViaSat Corporation

Dr. Kanneman

John Crow

USD Department of Engineering

USD Associated Students

Dr. Morse

Agilent Technologies

Microchip Technologies

Analog Devices

Appendices

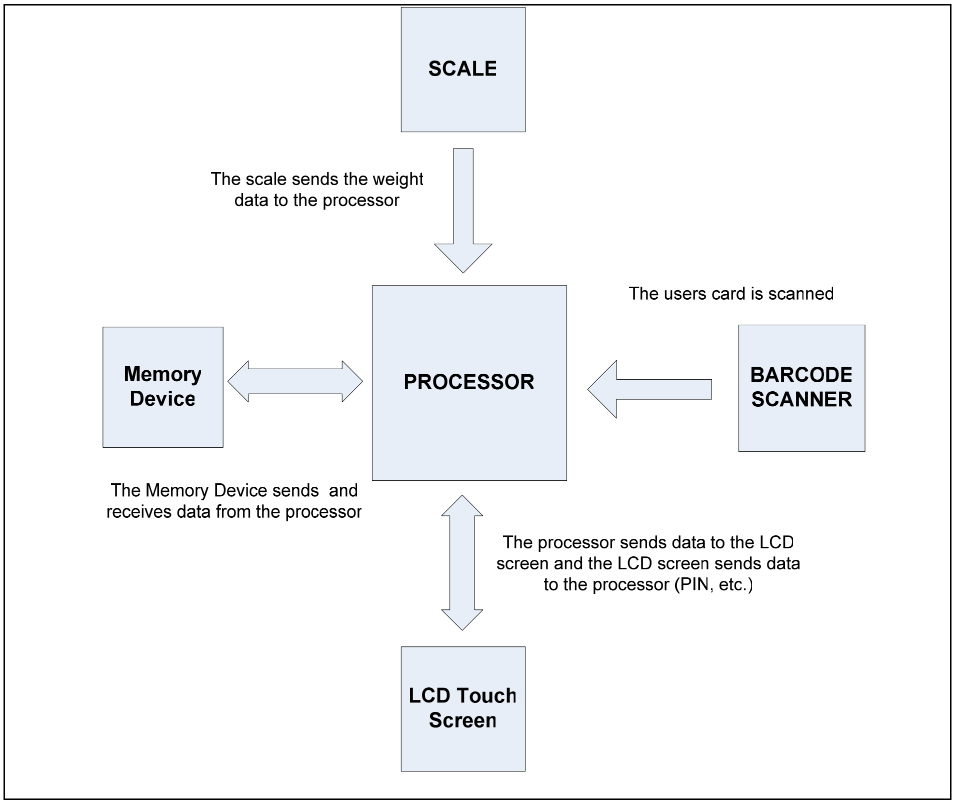


Figure 1: Block Diagram of the ViaSat Employee Weight Tracker

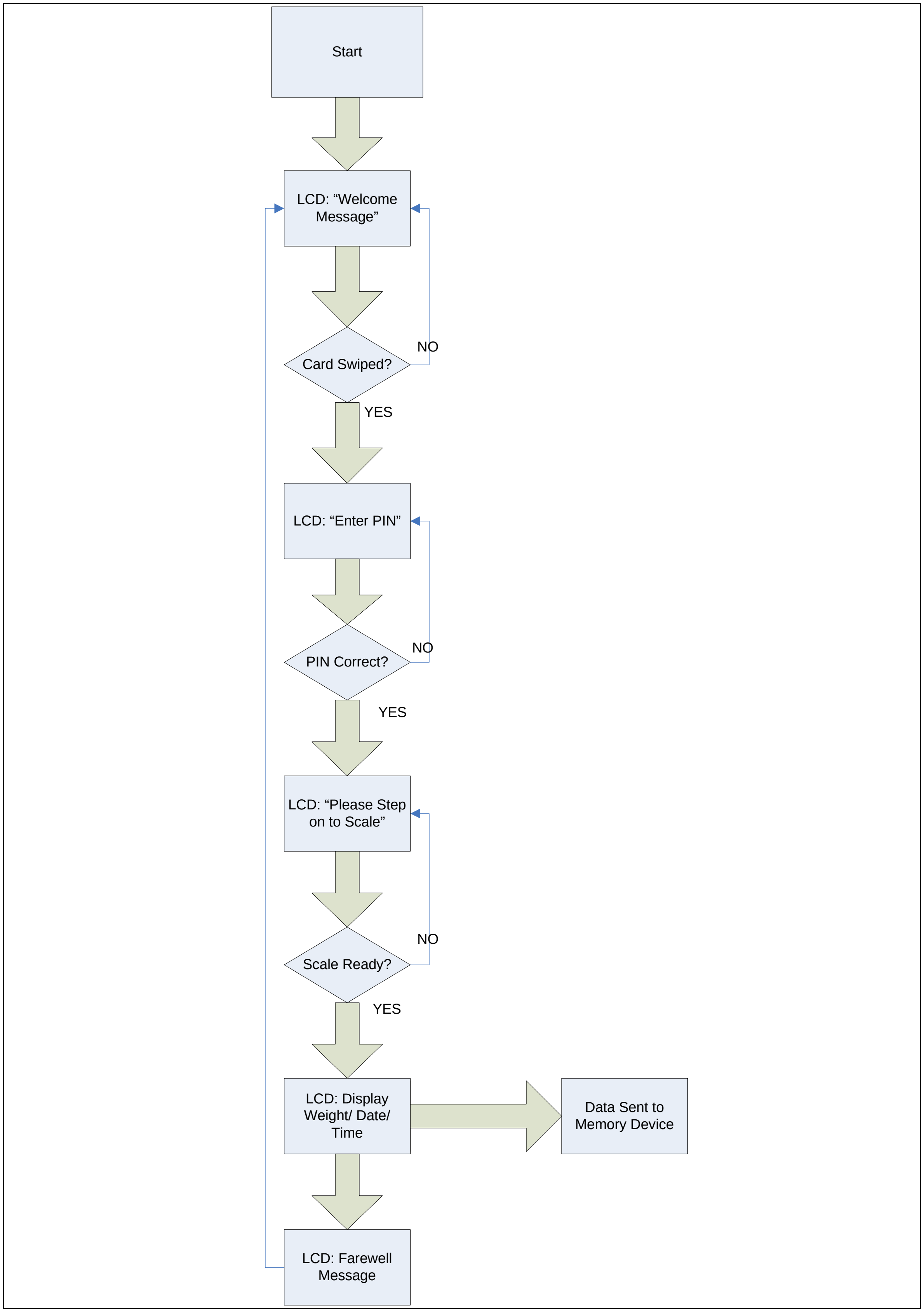
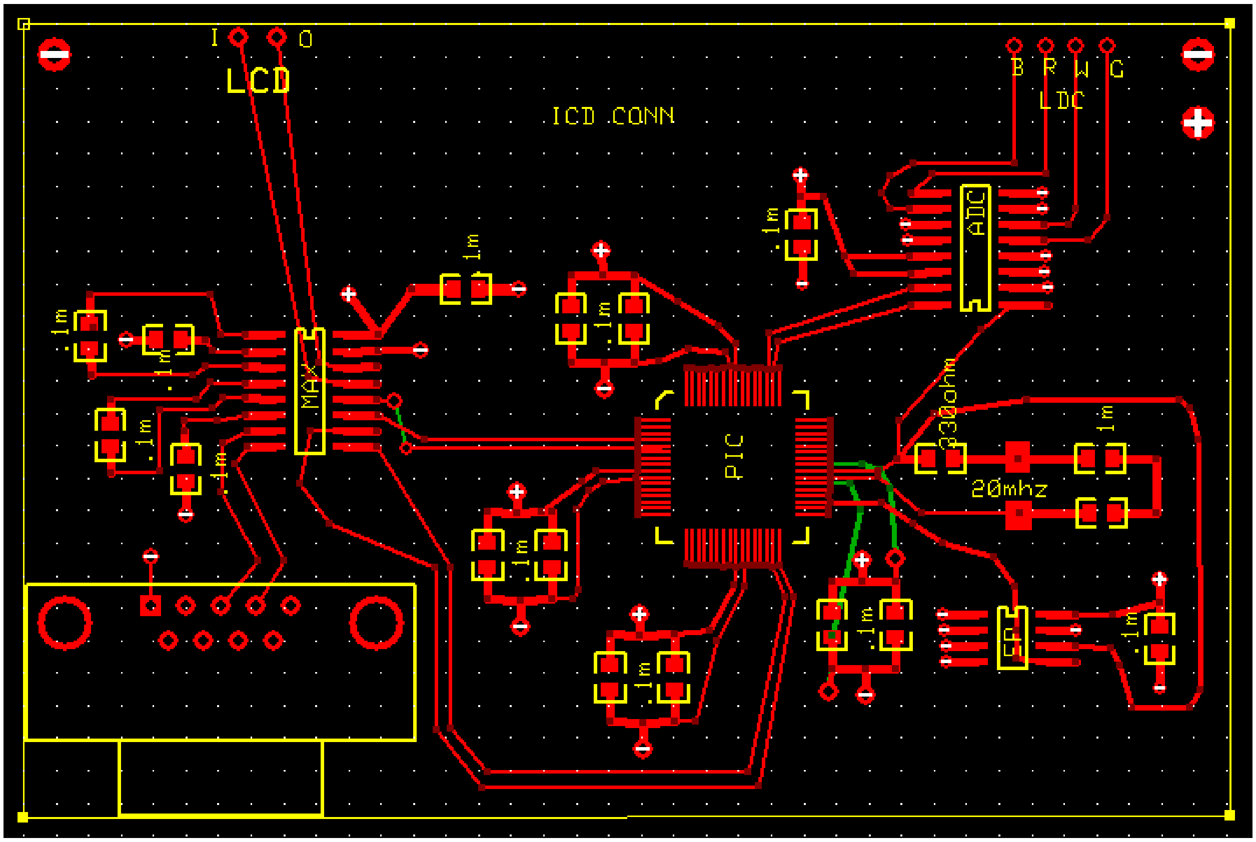


Figure 2: Flow Chart of Working ViaSat Weight Tracker



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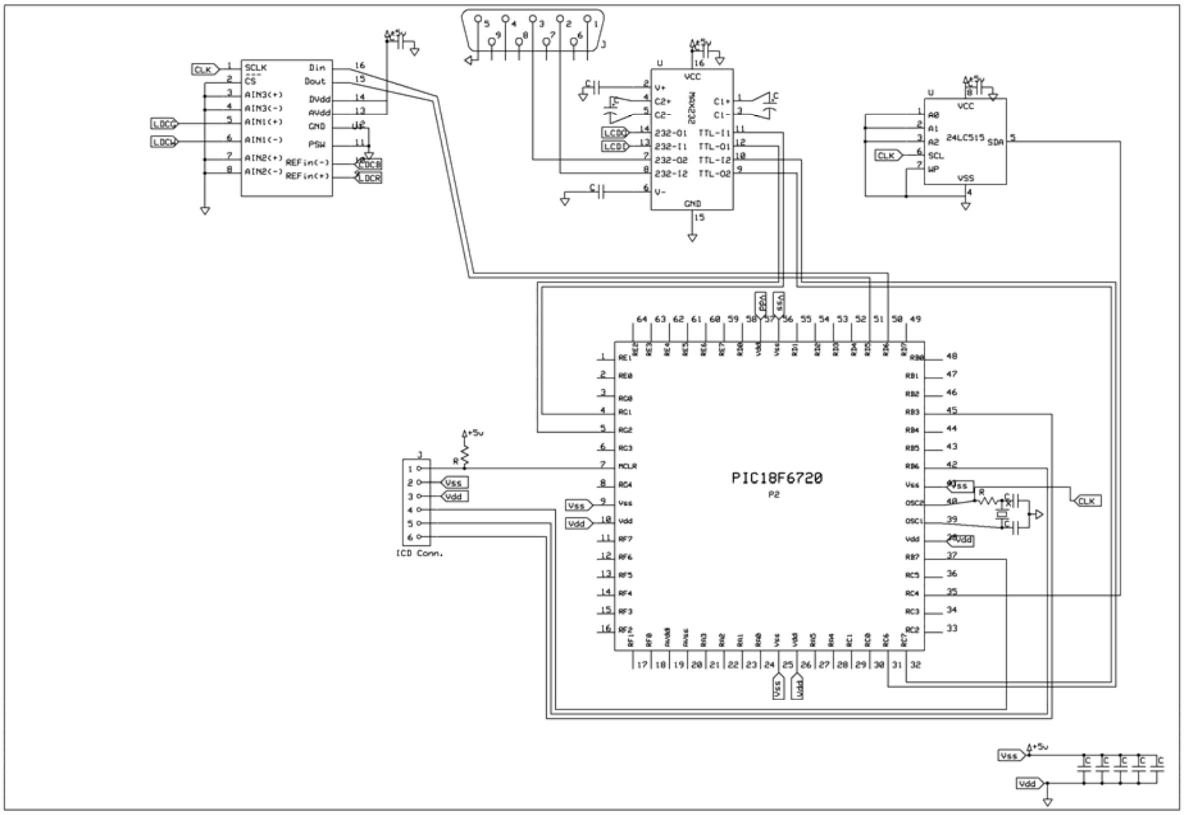

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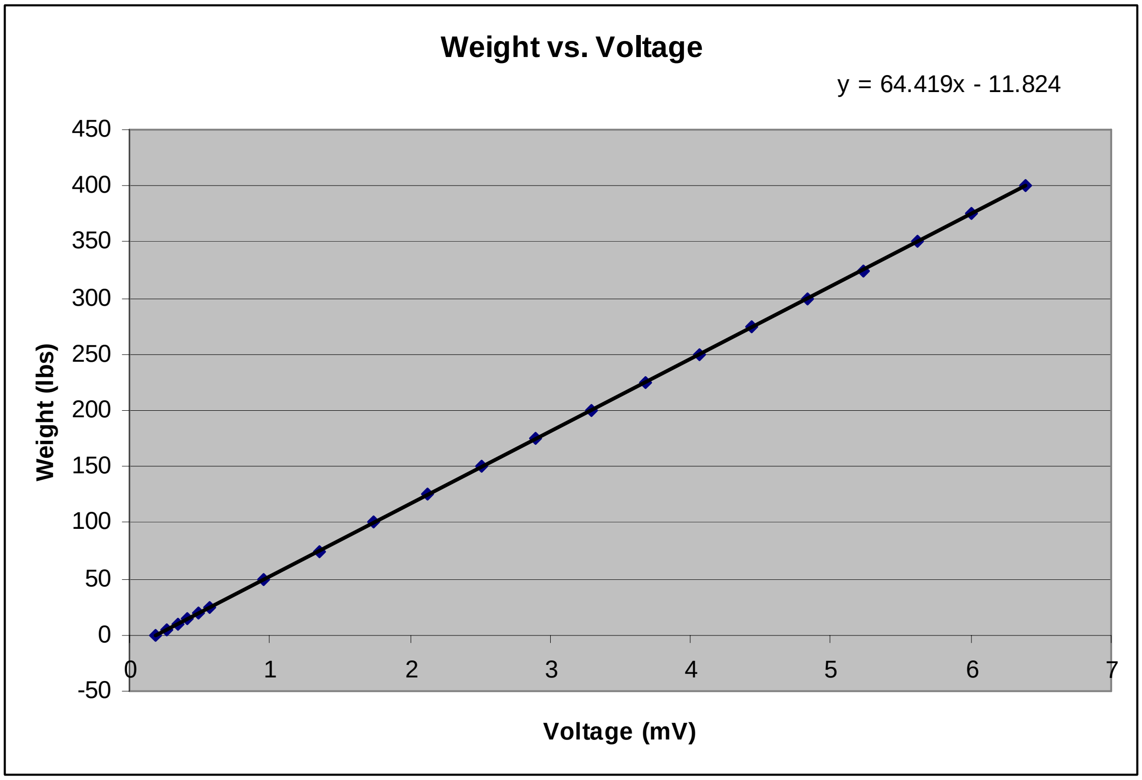

Figure 7: Load Cell