BASIC SCHOOL SUPPLIES DISPENSER WITH SINGLE TRANSACTION PAYMENT

by

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A Design Report Submitted to the School of Electrical Engineering, Electronics Engineering, and Computer Engineering in Partial Fulfilment of the Requirements for the Degree

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Approval Sheet

Mapua Institute of Technology
School of EECE

This is to certify that we have supervised the preparation of and read the design report by **Zyner M. Detablan, Mari Alexis Kaye F. Marquez, and Gerome Cristopher P. Refre** entitled **BASIC SCHOOL SUPPLIES DISPENSER WITH SINGLE TRANSACTION PAYMENT** and that the said report has been submitted for final examination by the Oral Examination Committee.

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As members of the Oral Examination Committee, we certify that we have examined this design report, presented before the committee on **December 16, 2011,** and hereby recommended that it be accepted in the fulfillment of the design requirements for the degree in **Bachelor of Science in Computer Engineering.**

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This design report is hereby approved and accepted by the School of Electrical Engineering, Electronics Engineering, and Computer Engineering in partial fulfillment of the requirements for the degree in **Bachelor of Computer Engineering.**

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Zyner M. Detablan
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ABSTRACT

The design's concept is a vending machine that dispenses various school materials. It is intended to provide students faster access buying school supplies rather than purchasing supplies on the bookstore that usually results on too much time wasted and normally, a hassle. When buying a specific school material, the student can itemize the quantity they want and it will be dispense after inserting the necessary amount of coins needed. The whole transaction will only be once—depends on how many items the student bought—since the design is incorporating a single payment. The total number of item obtained with each type of school supply available will also be tallied automatically by the machine. Student inserts an amount of money necessary then specifies the type of school supply and its desired quantity. The vending machine will check the amount of money inserted and process the dispensing of the school material. The vending machine dispenses the desired school material and its quantity.

Keyword: Dispensing, school supplies, vending machine, single payment

Chapter 1

DESIGN BACKGROUND AND INTRODUCTION

Background

Convenience nowadays, plays an essential role in the development of social environment. Purchasing distinct items at ease is one primary technique in selling products. In providing solution to this, different types of vending machines were introduced to provide customers the opportunity to buy items almost any time when necessary. Basically, a vending machine is an apparatus that dispenses merchandise after the customer selects and deposits money. The mechanism of this device is that after paying, a product will be dispensed by either the machine releases it, so that it falls in an open section at the bottom or the turning of a knob to release an item. Vending machines have a money detector which determines if the amount inserted is sufficient to purchase the desired product.

The design is intended to help both students and the bookstore. This vending machine can distribute basic school supply needs especially if the class hours of the students do not fit within the bookstore hours. Convenience as well is brought by this school supply dispenser provided that the students need not any more to go to the bookstore just to buy certain products which can cause hassles and consumption of time. With the aid of this device, the bookstore can effectively distribute school supplies.

The main feature of the vending machine is the single transaction payment. The vending machine that can be seen in airports, streets, and other places can only dispense a single item per transaction or at least one kind of item per transaction. Unlike this new and improved vending machine, different items can be transacted at the same time. This basic school supply vending machine dispenses items such as large yellow booklet with and without lines, small yellow booklet, black ball pen, and a pencil. First, the user selects the type of school supply followed by the number of quantity of each item. After selecting specific items with corresponding quantity, student can now insert appropriate amount of coins into the machine. The cost for each kind of item, the total cost for the whole sale to be purchase, and the total credit will be displayed.

The dispenser will exhibit a keypad for selecting school supplies as well as for entering desired quantity and a 4-liner LCD display for showing the selection of items to be purchased. There will be a 3 coin slot intended for 1-peso, 5-peso, and 10-peso coin. Once the items are chosen and the coins are inserted, the asterisk button should be pressed for the whole transaction to start. The pressing of the said button will send a signal to the relay coming from the microprocessor for the DC motor to dispense the chosen products. In case of a power interruption, a backup battery is installed ensuring that any transaction will be completed and the total sale is saved. Lastly, the outside coating used for the design is acrylic glass.

Statement of the Problem

Nowadays, many facilities around the world uses vending machine, such as airport, canteens, and condominiums, but one of the places that are also essential in having this equipment are universities and institutes. The common problem in different institutes and universities is how to distribute students' school supplies proficiently because accommodating too much students at the same time is formidable. The start of a semester can be considered as an example because many students buy books, index card, fillers, and other miscellaneous items at the same time for their subjects. This incident causes frustration to some students especially if the only product they intend to buy for example is a single ball pen but the queue is extensive forcing them to be late in class. Students whose school hours do not fit within the operating hours of the bookstore will appreciate the machine most considering that the bookstore will close earlier than the class hours of some students. The main problem to solve is how to have effective distribution of basic supplies in universities and institutions.

Objectives of the Design

The main objective of the design is to assist the bookstore in distributing basic school supplies to the students. Furthermore, this project aims to obtain the following objectives:

1. To develop a multi-item dispensing vending machine;
2. To define a new method of transaction in a regular vending machine;
3. To build a dispenser that will help the admin to compute the total sales; and
4. To create a vending machine that will dispense basic school supplies such as quiz booklet, pencil and ball pen.

Significance and Impact of the Design

Basic school supplies dispenser helps school bookstores and students in everyday lives. Nowadays, most of the school bookstores are closed after 5 to 6pm, using the vending machine the bookstores can still distribute basic school supplies after office hours. This also aids the students to have basic school supplies when needed. The common vending machine available in the market dispenses items only one at a time. The dispenser contribution to the advancement of technology is speed and the capacity to dispense multiple items in a single transaction.

The vending machine has a positive impact in terms of manufacturability because the goods will be traded with relative as ease at minimum cost and maximum reliability.

Design Constraints

Many relevant constraints are considered while making this project. First is coin stability, it is an aspect to examine since many coins will eventually became crude due to the fact that it will pass on to various market place, shopping malls, and public transportations. With regard to the first constraints, another issue to consider is the type of material used in the coin; for the 1-peso coin there are two types of materials used, first is the metal and the non-metal. Since there are two types of material used, either one of the two can only be used for the machine depending on the type of coin used in the coin slot sensor. Due to those different reasons, the coin sensor will have a hard time detecting it and sometimes completely not detecting the coin.

Economically, every legal transaction made in the business industry requires a receipt but the vending machine is unable to produce one. Receipt serves as a proof for the product or service that is purchased. An example is a case of product exchange; it serves as a checker of the price of something that is bought and tells you what you bought. If kept, it also maintains warranties and

guarantees, as well as refunds on products if broken or refundable for other reasons.

Slightly slow dispensing of the large examination booklet is another issue to consider; this examination booklet is composed of paper material and friction take into account between two papers in contact are most likely to slide against each other. Measurement of the coefficient of friction has applications in packaging where a high coefficient will indicate that containers such as sacks, bags and paperboard containers will resist sliding in unit loads or on packaging lines.

Definition of Terms

1. **Vending Machine** – a machine that automatically dispenses consumer goods such as cigarettes, food, or petrol, when money is inserted. (*Collins English Dictionary)*

2. **Keypad** – a small keyboard with push buttons, as on a pocket calculator, remote control unit for a television, etc. *(Collins English Dictionary)*

3. **LCD (Liquid Crystal Display)** – an electronic display (as of the time in a digital watch) that consists of segments of a liquid crystal whose reflectivity varies according to the voltage applied to them. *(Merriam-Webster Dictionary)*

4. **PCB (Printed Circuit Board)** – a circuit in which the interconnecting conductors and some of the circuit components have been printed,

etched, etc., onto a sheet or board of dielectric material. *(Random House Dictionary)*

5. **Coin Slot** – a small narrow opening, especially one to receive coins. (*Kenerman English Multilingual Dictionary)*

6. **Microprocessor** – a single integrated circuit performing the basic functions of the central processing unit in a small computer (*Collins English Dictionary)*

7. **Relay** – an electrical device in which a small change in current or voltage controls the switching on or off of circuits or other devices *(Collins English Dictionary)*

8. **DC Motor** – An electric rotating machine energized by direct current and used to convert electric energy to mechanical energy. *(McGraw-Hill Science & Technology Dictionary)*

9. **Acrylic** – of, derived from, or concerned with acrylic acid, a paint or colour containing acrylic resin *(Collins English Dictionary)*

10. **Coefficient of Friction** – The ratio of the force that maintains contact between an object and a surface and the frictional force that resists the motion of the object. *(The American Heritage® Dictionary of the English Language)*

Chapter 2

REVIEW OF RELATED DESIGN LITERATURES AND STUDIES

This chapter comprises researches and studies that are correlated to the design. The compilations in this chapter were used as reference for the advancement of the design. The group used these diverse articles and research works in sorting out the conceivable components to be used in the design by considering the benefits and drawbacks discussed respectively in the reviewed studies. This chapter provides an outline of details congregated during the course of development of the design.

Vending Machine

An article entitled "Today and tomorrow of vending machine and its services in Japan" by *Yokouchi (2010)* talks about how the vending machines expands over the time and how it is successful in their country because of the public security enforced in Japan that they didn't need to worry for any misdemeanor. In Japan, vending machines are not limited to dispensing soft drinks in tin can or coffee; they have this "unique vending machine culture" that is changing its phase from the regular vending machine to a place providing several services such as; a) various kinds of information; b) food supply to disaster area; c) support to emergency patients; d) security service for outskirts;

etc. The article is a foreword of these unique services to public and local society provided with vending machines and can still be further improved in the distant future for more advancement of the vending machine culture.

The article "Vending Machine" by *Williamson, Henry C.* (1934), talks about the vending machine that dispenses school supplies. This vending machine was suggested by the parent-teacher association—commonly known as PTA—that a stock of school supplies should be kept in school to be sold to the students, thus eliminating the need to go the stores outside the school especially if the campus doesn't have a bookstore. Using this vending machine in their school, they could eliminate the excuses of the students to go out and buy school supplies outside the campus, since it sometimes lead to traffic accidents and to the vices of the students. This invention was created in 1934; the materials used in this vending machine were not microprocessor and other electronic materials since the said materials were not yet invented. The design of this vending machine was mostly created using levers and rods. The article also specified the problem regarding the vending of the design.

In a case study entitled, "Automatic Chocolate Vending Machine using MUCOS RTOS" by *Yadav, S.G. Shiva Prasad* (2003), tackles about a vending machine that dispenses assorted chocolates. The design uses a 3-liner LCD display, microcontroller based hardware, mechanical coin sorter, and coin inlet.

This Automatic Chocolate Vending machine uses microcontroller based dispensing unit, at the start of the transaction the LCD display will show welcome messages for the customer and after inserting the necessary amount of coins into the inlet, it will display a string of messages saying "Wait for a moment" and "Collecting a nice chocolate soon". It is also possible for the customer to retrieve or refund his money if he inserts too much coin. This machine also uses RTOS—Real-time Operating System, it schedules the processes or the tasks for buying from start to finish. The device can be reprogrammed and relocate the codes in the system ROM of flash or EPROM whenever the price of the chocolate increases, the message lines need to be changed or if the machine features needs to be change.

"Reverse Vending Machine Simplifies Recycling" by *Smith, Thomas* (2009), discussed about vending machines that have become a staple in society as a convenient way to overpay for a soda or snack. These contraptions look similar to average vending machines, but they are designed to accept, clean and crush recyclable materials. Individuals who recycle, say a plastic bottle, will receive coupons, cash credit or vouchers from the machine to be used at neighboring shops. The machines hold up to 3,000 containers and accept PET, HDPE, PVC, plastic, brown, clear and green glass and aluminum cans. In addition, they're said to reduce carbon emissions by preparing the recycled materials for direct shipment to a recycling depot, bypassing waste processing facilities. These

devices are being deployed throughout Australia. If those work out, expect to see recycling machines on street corners everywhere in the very near future.

The project entitled "Vending Machine" by *Singh, Virdi Sabegh* (2003), discussed about the design, simulation, realization and demonstration of a vending machine system using a Field Programmable Gate Array. This project is somewhat similar to the other vending machines; the difference is that it is more flexible in terms of changes in the product demands as it is also very powerful, and relatively low-cost.

On "A Wireless Vending Machine System Based on GSM" by *Hong Gu, Shuang Qiao,* and *Jiang Tian* (2006), it was said that several methods by which we may realize wireless data communication of GSM network are analyzed and compared, the overall structure of vending machine system based on USSD is given an in-depth introduction. Furthermore, control modules which realize data transmission and control function of terminal device, middleware which connects application and BOSS (business operation support system), and transaction software embedded in USSD platform, are also developed respectively. Finally, the operating support system of wireless vending machine system is formed, which can not only integrate vending machines, USSD platform and payment system together, but also manage sale information, logistic information and consumer information on-line.

The paper "Automatic mobile payment on a non-connected vending machine" by *Azami, S.B.Z, Tanabian, M.* (2004), addresses a mobile payment solution where there is no connection required for the vending machine, and while the local means of communication is through infrared (IR). It is assumed that the cellular phone has the IR feature. All the user has to do is to select the item, and point the infrared enabled cellular phone to the vending machine. The vending machine will detect the presence of the cellular phone through IR, and the communication will take place by sending a message to the back-end server. Detailed inventory and telemetric information can be added to the transaction data. Data compression, segmentation and reassembly schemes are implemented. The message gets decoded in the back-end server where the transaction is processed, billing is done, and inventory information is sent to the vending machine operators. Another program in the vending machine operator side optimizes the route management of the truck fleet, responsible for replenishing the vending machines. An intelligent route management saves on the operational costs, by reducing the number of times each vending machine needs to be visited. The proposal is a hybrid of three payment methods: currency (coin), manual mobile and infrared mobile.

Currently in Dublin the system of public transport ticketing is under review and there are plans to introduce a multi-modal, multi-operator ticketing system. It is planned that this system, "Passenger requirements of a public transport

ticketing system" by Caulfield and O'Mahony (2005), would be operated via smart card technology, whereby passengers can pass between mode and operator with ease of use. The purpose of this paper is to examine what passengers require from their ticketing system with regard to the means and method of payment and the kind of information they require from an at-stop ticketing vending machine. Between January and February 2004 a detailed survey of a representative sample of 1,005 adults aged 15 and over in Dublin was completed using face-to-face at home interviews. With the format of the ticketing system decided upon (contact-less smart cards) the research focused upon the payment options and the design of the at-stop/station ticket vending machines. The first section of the paper looks at international examples of ticketing systems and how intelligent transport systems (ITS) applications have been used to aid passengers' comprehension of the ticketing system and ease of use of the system. The second section describes the methodology used in the data collection. The third section details the passenger requirements from a ticketing system based upon the data collected from the Dublin survey. The final section of the paper details the conclusions that can be drawn from the data gathered in the Dublin study.

A new approach to prepayment schemes could make it easier for UK consumers to shop around for the best value gas and electricity. The "Paying for energy the smart way" article of *Cowburn, J.,* proposed approach to smart

prepayment uses the same building blocks as a traditional budget scheme. For each day of the week, the meter records the energy used in each half hour period and calculates average usage over a specified period which can be monthly, quarterly etc. The majority of consumers will fall into a small number of profiles, so matching the consumption pattern to one of a number of preprogrammed profiles downloaded from the vending system via the smart card or communications channel would take up less storage space. When the customer wants to top up their gas or electricity credit they visit a vending machine which uses the consumption data stored on their card to allocate a tariff and calculates how much energy to offer the consumer for their money. A multi-supplier machine could even compare the different tariffs available to a customer with a particular profile and offer the cheapest. Once the transaction is complete, the card is credited with the amount of energy purchased for downloading to the meter. The meter would be capable of interrupting the supply when credit has been used, although there would probably have to be an emergency credit facility-paid back at the next transaction-to provide a period of grace.

These articles can serve as an inspiration for us that the vending machines are becoming more and more unique as time passes by.

Microcontrollers

The article "Workhorses of the electronic era [microcontrollers]" by *Khan, AR.,* discussed about microcontrollers and how it is always around us embedded in the machines and different appliances. Controllers are embedded in cordless and portable telephones, point-of-sale retail electronic cash registers, scanners of all kinds, security systems, automobiles and gas pumps, automated tellers, computers, and compact disks and disk drives, not to mention phone-answering, fax, vending, and washing machines. Here, the author describes how today's microcontrollers are performing better than ever through their use of high-level languages and multitasking techniques.

In an article entitled "Network model based automation of thermal processes using an embedded digital controller", by *Ganesh, A.B. Sangeetha, A.L. Ravi, V.R.* issued last Dec. 2009 from IEEE, a microcontroller is used. The article describes the network architectures of both WAN and LAN based real time control and monitoring of thermal process station using an embedded digital controller. The function of the microcontroller in this design is a temperature controller that communicates directly with the temperature transmitter. The design uses the PIC16F877A microcontroller.

Coin

In this paper, "Efficient coin recognition using a statistical approach" by *Al-Zoubi, H.R.,* the author proposed a coin recognition system using a statistical approach and apply it to the recognition of Jordanian coins. The proposed method depends on two features in the recognition process: the color of the coin, and its area. Although the proposed recognition approach is applied to Jordanian coins, it can be applied to the recognition of any coins.

Through this article, we could use it as a guide in implementing the coin slot in the group's design project.

Chapter 3

DESIGN PROCEDURES

This chapter discusses the step-by-step procedures that were followed in making and developing the design. This section includes both the hardware and software development. The hardware development is composed of the block conceptual diagram, block diagram, and schematic diagram. Conversely, the software development consists of system flowchart.

Hardware Development

Conceptual Diagram

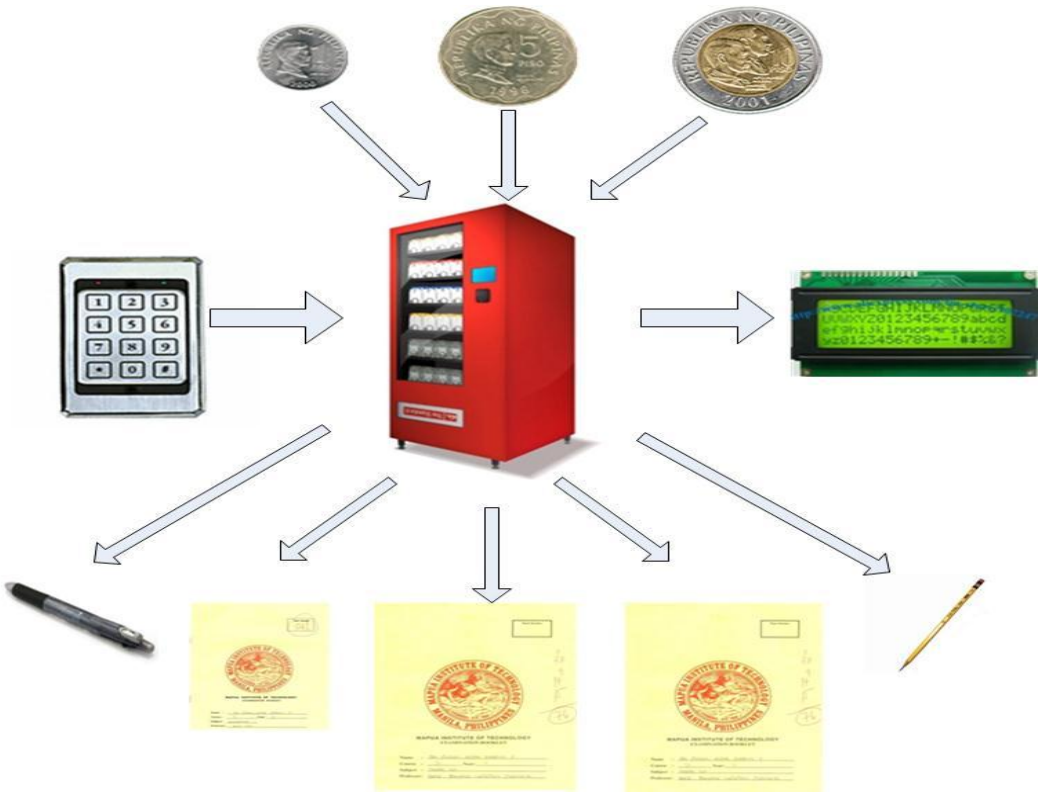

Figure 3.1 Conceptual Diagram

Figure 3.1 shows the conceptual diagram and the whole flow of the design. As shown, the school supplies dispenser accepts three different kinds of coins, and once inserted the credits will be automatically stored and displayed. The keypad then will determine the type and quantity of item that will be dispensed off. A 4-liner LCD display will show the current transaction; shown in the display are the unit price of each item, quantity to be purchase, current credit, and total cost.

Block Diagram

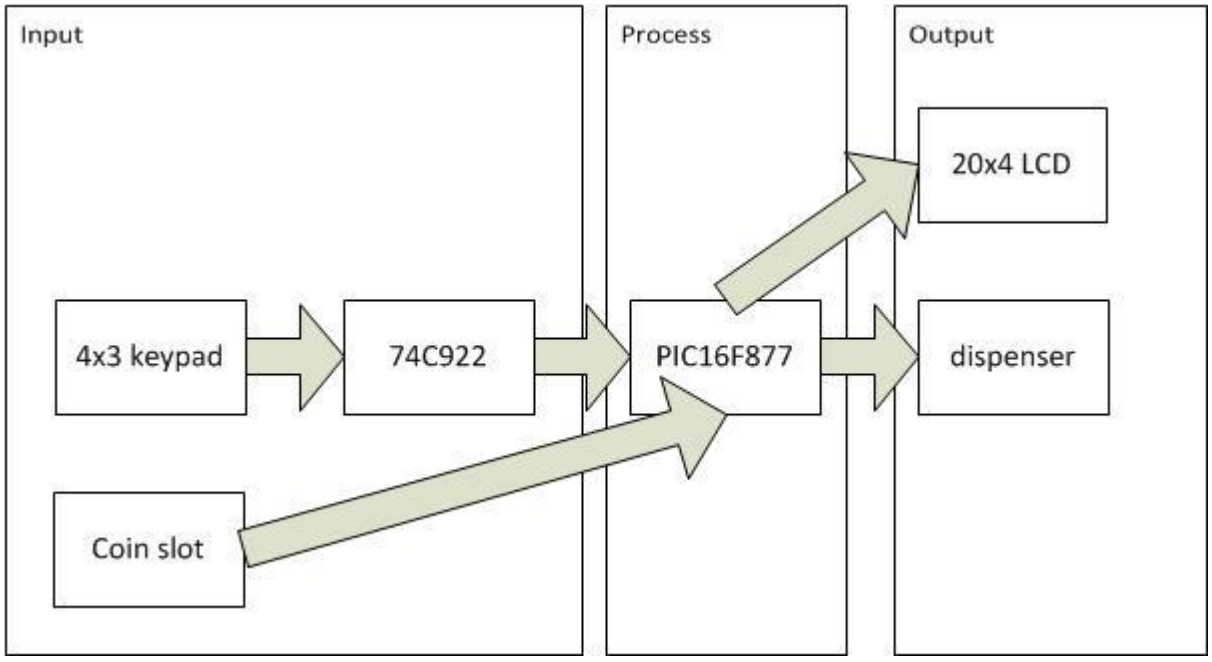

Figure 3.2 Block Diagram

Figure 3.2 illustrates the basic diagram and interconnection of the main parts of the design. The design is divided between the input, process and output. The input of the system will be coming primarily from the 4x3 keypad that will go

directly to the 74C922(16-key encoder) to provide the necessary logic to encode the array of the SPST (single pole, single throw) switches, this is mainly for sending the appropriate instructions to the PIC16F877. The coin as well is provided in the input to count the number of credits entering the machine.

The primary output of the system is composed of the 20x4 LCD display and the dispensers. The LCD display provides the complete information about the whole transaction while the dispenser is for the output delivery of the purchase materials.

Schematic Diagram

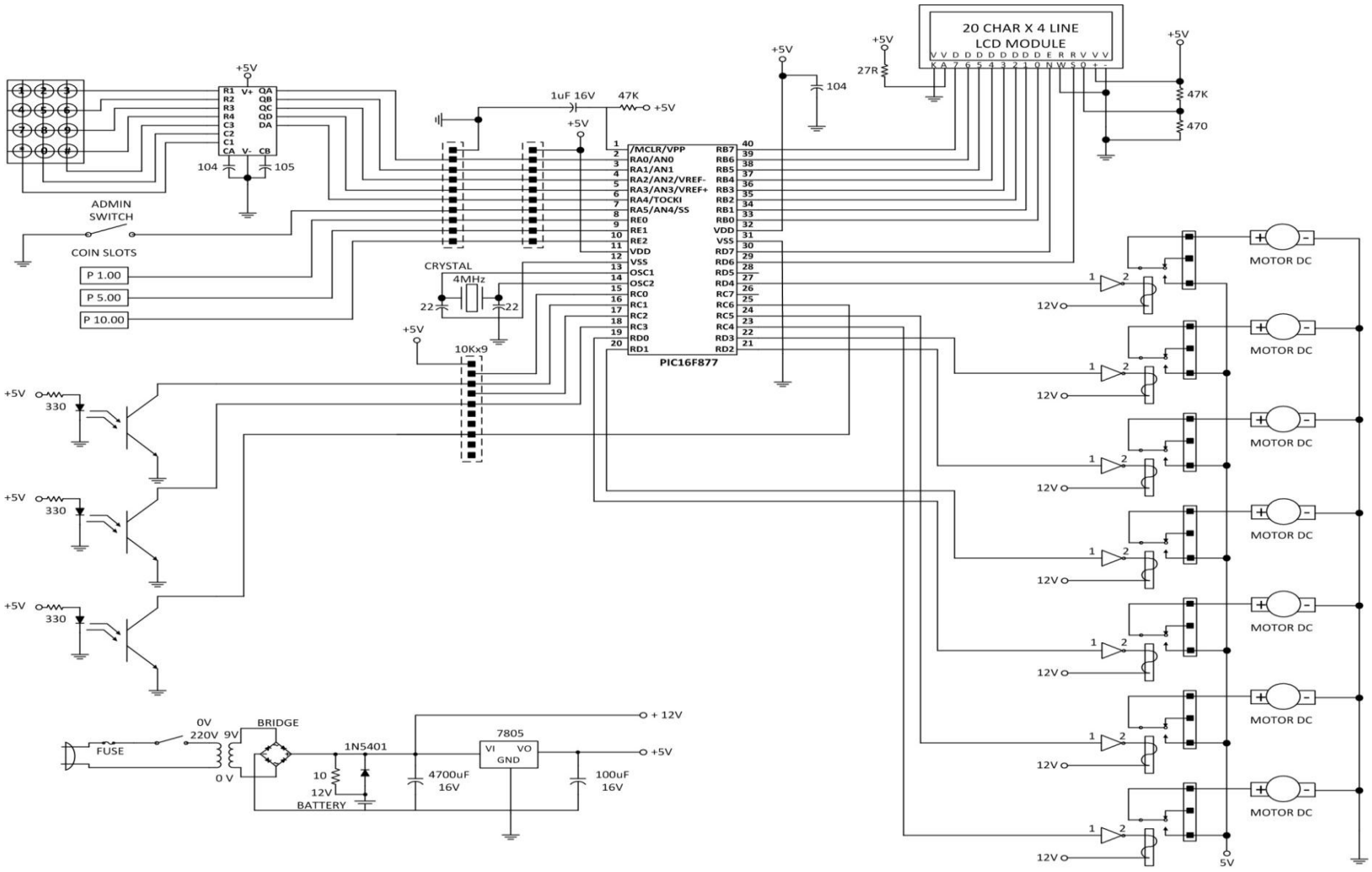

Figure 3.3 Schematic Diagram

SOFTWARE DEVELOPMENT

System Flowchart

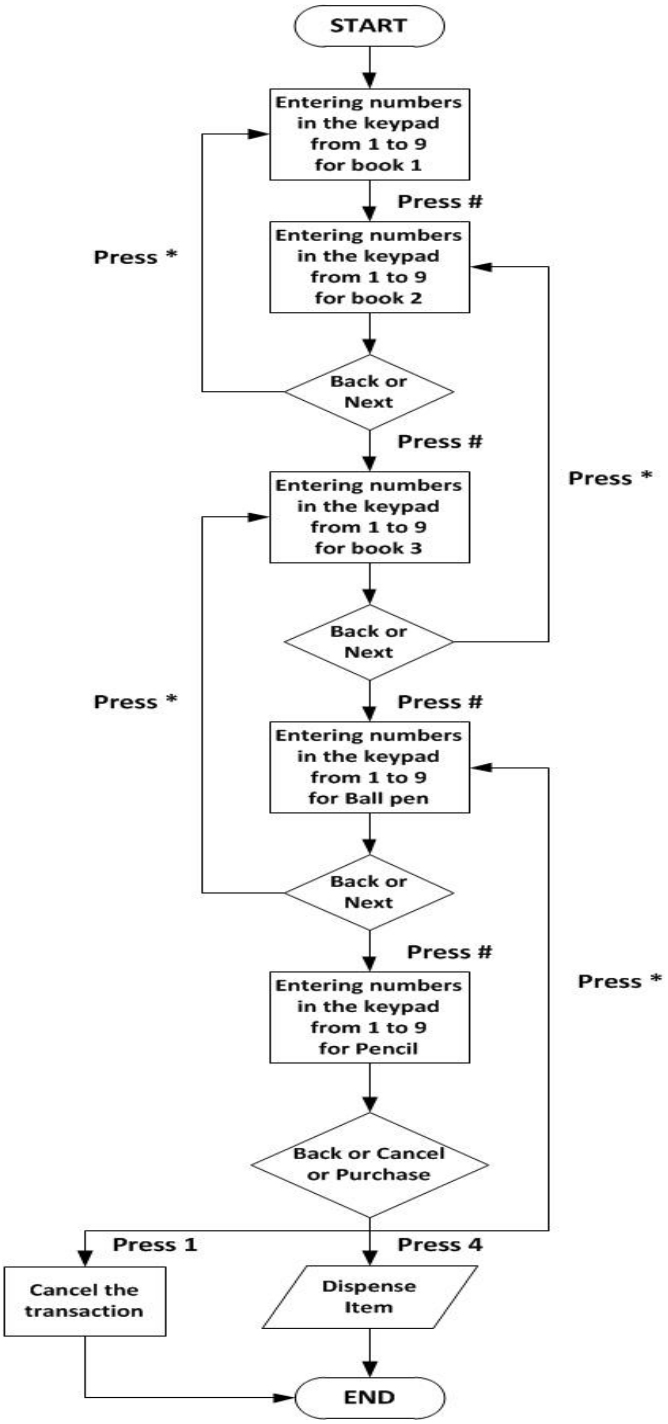

Figure 3.4 System Flowchart

Figure 3.4 shows the system flowchart of the Basic School supplies dispenser with single transaction payment. The micro controller checks what keys you pressed in the keypads. This also shows that when you pressed asterisk (*) the program will back to the previous items except for the Book 1 that will do nothing if you press *. Number sign (#) will go to the next item except for the final part that will do nothing because instead of pressing # the dispenser require you to press 4. The last part, when you cancel the transaction the machine will automatically give the coins that you insert.

Program Flowchart

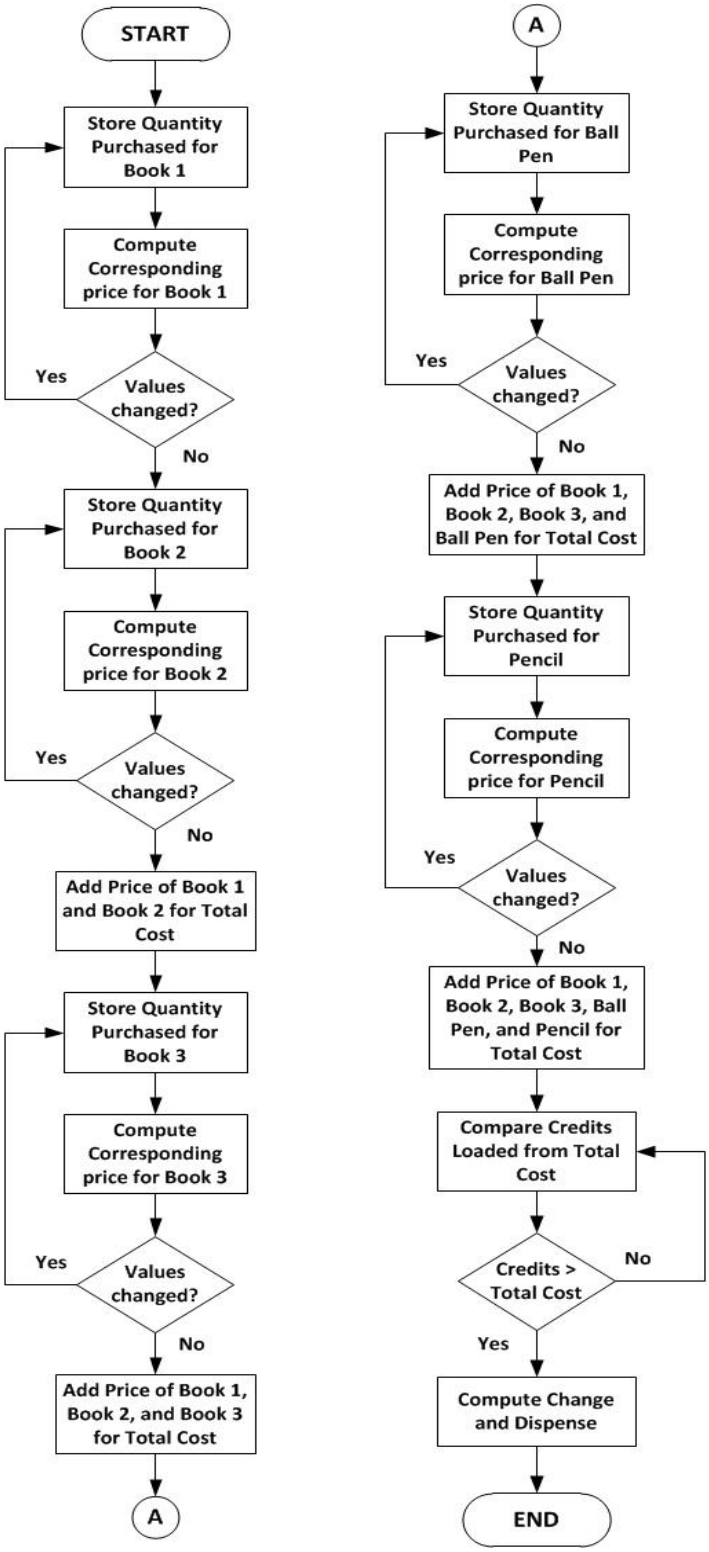

Figure 3.5 Program Flowchart

Figure 3.5 illustrates the program flowchart of the design. As shown from the figure, the program stores the quantity and price of each of item that will be purchased. As the user proceed to the next transaction page, the price of the previous item will be carried over and be added to the price of the current transaction page. This flow will be continuous and the same for all the items until the program reaches the finalize transaction page wherein the total cost for all the items to be purchased will be computed. As the credits are loaded in the machine, the change are computed and dispensed.

Prototype Development

The design procedure shows the step-by-step procedure on how the design was built by the researcher. Detailed information will be described about the conceptualization of the design project.

1. Conceptualization

After knowing the design will work as a whole, the conceptualization of the input and output devices part must be equated to simplify the design hardware and software.

2. Simplified Design Requirement

It is also important to create initial drafting of materials required as the development of the project proceeds. This gives the researchers the overview of

the project.

3. Illustrate the Block Diagram

Defines the major composition of the block and shows how each block is related with each other. The block diagram for the input which consist of the keypad, 74C922 16-key encoder and coin slot. The output which consists of the 20x4 LCD and dispensers.

4. Draw schematic diagram

Schematic diagram of this design shows how each device was interconnected, it contains components such as Microcontroller (PIC), DC motors, 20 x 4 Line LCD, Keypad, Coin slot, power supply, sensors, and battery. In developing the design, the following materials are used:

PIC16F877A

This type of microcontroller is used in the design primarily because of its many inputs. PIC16F877A has a maximum of 40 I/O pins which is very much suitable for the design. It has a maximum of 256 bytes for its register which is also much appropriate for the design to be possible.

74C922

The 74C922 key encoders provide all the necessary logic to fully encode an array of SPST switches. The keyboard scan can be implemented by either an external clock or external capacitor. We used this to encode the keypads.

20x4 Line LCD

The 20x4 LCD Module makes it easy to add an alphanumeric display module to your design. It requires only a 5V power supply and two data connections for either mode, freeing up pins on your processor. Many useful texts

formatting functions are provided, including the ability to create custom characters.

ULN2003

The ULN2003 is a monolithic high voltage and high current Darlington transistor arrays. It consists of seven NPN Darlington pairs that feature high-voltage outputs with common-cathode clamp diode for switching inductive loads. The collector-current rating of a single Darlington pair is 500mA. The Darlington pairs may be paralleled for higher current capability. Applications include relay drivers, hammer drivers, lamp drivers, display drivers (LED gas discharge), line drivers, and logic buffers.

LIST OF MATERIALS

Name of Material	Unit Price
4x20 LCD w/ ribbon wire	1,900
Coin slot	1,200
Numerical keypad w/ 74C922 IC	650
PIC16F877	530
10k array resistor	12
7805 voltage regulator	15
Heat sink	20
1000 uF/16v electrolytic capacitor	8
100uF / 25v electrolytic capacitor	3
2 pins terminal block	12
¼ W resistor	0.25
105 mylar capacitor	2
22pF ceramic capacitor	0.5
4 MHz crystal	35
W10G rectifier diode	12
12v relay	30
3 pins terminal block	15
Power supply module	150
4x4 relay module	490
Coins dispenser	950
Limit switch	38
DC motor	315
Paper dispenser	1350
Rocker switch	25
Fuse w/ holder	10
Transformer	290
Backup battery	800
Tubular aluminum	388
Acrylic	2,300
AC cord	30
ULN2003	28
Quiz booklet large	8
Quiz booklet small	7
Pencil	7
Ball pen	7

Table 3.1 List of Materials

Chapter 4

TESTING, PRESENTATION AND INTERPRETATION OF DATA

This chapter presents various tests performed by designers to determine the effectiveness of the design. These tests were done considering the objectives given in the first chapter of this documentation.

Dispenser Accuracy Test

The researchers conducted an accuracy test to determine if the design can dispense an accurate number of items such as booklets, ball pen and pencil. The following table sum up the results gathered based on the test that the designers performed.

Trials	1pc	2pcs	3pcs	4pcs	5pcs	6pcs	7pcs	8pcs	9pcs
Book 1	OK	OK	OK	OK	OK	OK	OK	OK	OK
Book 2	OK	OK	OK	OK	OK	OK	OK	OK	OK
Book 3	OK	OK	OK	OK	OK	OK	OK	OK	OK
Ball Pen	OK	OK	OK	OK	OK	OK	OK	OK	OK
Pencil	OK	OK	OK	OK	OK	OK	OK	OK	OK

Table 4.1 Product Dispensing Test Result

Table 4.1 shows the dispenser can dispense the item. The test confirms that the correct quantity of items will be distributed depending on the number specified by the customer. The word "OK" means that the vending machine can dispense the items accurately.

Coin Slot Test

The researchers conducted a test on the design's coin slots. There are three kinds of coin slots in this design; the ten-peso coin slot, five-peso coin slot, and one-peso coin slot. The researcher tests if the one peso coin slot will accept the five peso coin or ten peso coin and so as for the other two. The first attempt on this test, the 10-peso coin slot accepts the 5-peso coin because it checks the material of the coin and there are some minor similarities between the composition of the 5 peso and 10 peso coin. In the second attempt, the 10-peso coin slot already did not accept the five peso coin because the knob inside the 10 peso coin slot was adjusted. The following table shows the results of the tests.

Trials	**Coin Slot**	**COIN INSERTED**		
		P1	**P5**	**P10**
1	**P1**	Accept	Reject	Reject
2	**P1**	Accept	Reject	Reject
3	**P1**	Reject	Reject	Reject
4	**P1**	Accept	Reject	Reject

5	**P1**	Reject	Reject	Reject
6	**P1**	Accept	Reject	Reject
7	**P1**	Accept	Reject	Reject
8	**P1**	Accept	Reject	Reject
9	**P1**	Accept	Reject	Reject
10	**P1**	Accept	Reject	Reject
11	**P5**	Reject	Accept	Reject
12	**P5**	Reject	Accept	Reject
13	**P5**	Reject	Accept	Reject
14	**P5**	Reject	Accept	Reject
15	**P5**	Reject	Accept	Reject
16	**P5**	Reject	Reject	Reject
17	**P5**	Reject	Accept	Reject
18	**P5**	Reject	Accept	Reject
19	**P5**	Reject	Accept	Reject
20	**P5**	Reject	Accept	Reject
21	**P10**	Reject	Reject	Accept
22	**P10**	Reject	Reject	Accept
23	**P10**	Reject	Accept	Accept
24	**P10**	Reject	Accept	Accept
25	**P10**	Reject	Reject	Accept

26	**P10**	Reject	Reject	Accept
27	**P10**	Reject	Reject	Accept
28	**P10**	Reject	Reject	Accept
29	**P10**	Reject	Reject	Accept
30	**P10**	Reject	Reject	Accept

Table 4.2 Coin Slot Test Result

Table 4.2 shows the results on what will happen if a certain coin is inserted to a specific coin slot. This test confirms that only the appropriate coin will be accepted in their respective coin slots and those inserted in the wrong coin slot will be rejected. In the 3rd trial and 5th trial, the 1 peso coin slot also rejects the 1 peso coin because the coin that was inserted is the new 1-peso coin. The old 1 peso coin has a different material composition compare to the new one. The sensor in the coin slot compares the material of the given coin sample with regards to the coin inserted. If the material composition is the same, the coin slot will accept the coin inserted otherwise rejects it. Based on the 23rd and 24th trial, the 10-peso coin slot accepts the 5 peso coin because the one that we used is the old 5 peso coin. The material used in the 10 peso coin, the one that looks like a 5 peso in the middle has the same material composition as the old 5 peso coin that's why the coin slot accepts it. But when the new 5 peso coin was used, the coin slot rejects it because it has a different material.

Change for Purchased items test

The researchers conducted a test to determine if the dispenser accurately gives change to the customers upon purchasing school supplies. The following table sum up the results gathered based on the test that the designers performed.

Trials	Amount Inserted (Php)	Total Amount Purchased (Php)	Change (Php)
1	**10**	7	3
2	**10**	14	Invalid
3	**20**	14	6
4	**20**	21	Invalid
5	**16**	14	2
6	**16**	23	Invalid
7	**19**	25	Invalid
8	**50**	42	8
9	**50**	75	Invalid
10	**36**	35	1
11	**36**	42	invalid
12	**8**	7	1
13	**8**	8	0
14	**14**	14	0

15	**21**	21	0
16	**30**	28	2
17	**30**	21	9
18	**30**	14	16
19	**24**	14	10
20	**17**	18	Invalid
21	**17**	14	3
22	**25**	14	11
23	**25**	18	7
24	**35**	29	6
25	**28**	24	4
26	**28**	35	Invalid
27	**28**	28	0
28	**25**	23	2
29	**25**	24	1
30	**1**	20	Invalid

Table 4.3 Change Test Result

Table 4.3 shows the results on what will happen if a certain amount of coins is inserted to the machine satisfying the condition that this amount is not equal to the total amount purchased. The results showed that correct amount of

change will be dispense automatically after the confirming the transaction. In the 4th column there are results which are invalid, these indicates that the amount inserted by the user is less than the amount he wants to purchase. As a result, the machine will not dispense the items.

LCD Display and Keypad and Administrator Button

The researchers conducted a test to the four liner LCD display and keypad to verify if the buttons pressed will correctly display the output and perform its desired instruction. The following table sums up the results gathered based on the test that the designers performed.

Key Pressed	Output
1 (item quantity selection)	1
2 (item quantity selection)	2
3 (item quantity selection)	3
4 (item quantity selection)	4
5 (item quantity selection)	5
6 (item quantity selection)	6
7 (item quantity selection)	7
8 (item quantity selection)	8
9 (item quantity selection)	9
0 (item quantity selection)	0
*****	Previous

#	Next
1 (finalize transaction page)	Cancel all transaction
4 (finalize transaction page)	Dispense ordered items
Admin button + #	Display total sales

Table 4.4 Keypad input and LCD output test result

Table 4.4 shows the result if a corresponding key on the keypad is pressed and what are its effects on the display and how does it affects the operation of the system. As shown, this test confirms that each of the buttons in the keypad is correctly performing its intended operation. These table shows that when the user press the button 1 the dispenser displays number 1. Button 2, 3, 4, 5, 6, 7, 8, 9, and 0 displays on the LCD 2, 3, 4, 5, 6, 7, 8, 9, and 0 respectively. When the user press the * the machine will go to the previous item except if the user is currently on the Book 1 page, because it will not do a thing since there are no previous items before book 1. When the user press the # the machine will go to the next item except if the user is currently on the transaction page, because it will not do a thing since there are no items beyond the transaction page. In the transaction page when the user presses 1, it will cancel the transaction and give back the coins inserted by the user. In the transaction page when the user presses 4, it will begin the transaction. The vending machine also helps the administrator in calculating the total sales of each item and the total sales of all the items included by holding the admin button simultaneously with the # button. This automatically displays the total sales.

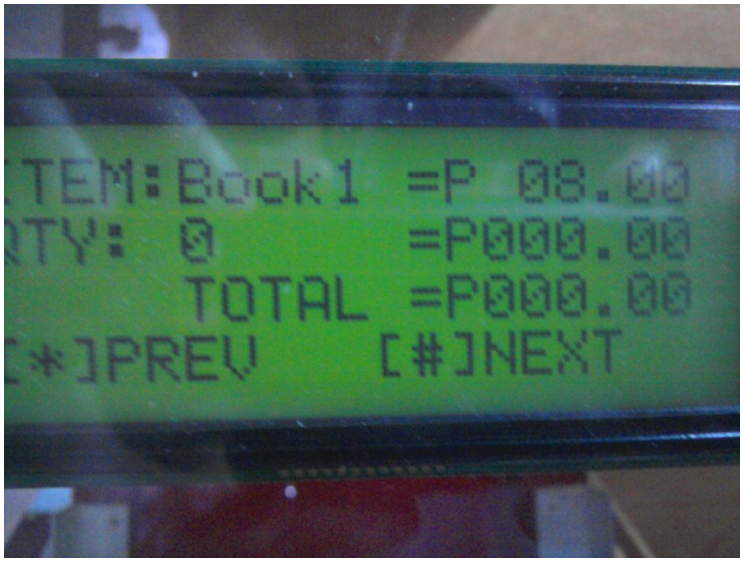

Figure 4.1 Sample Display when keypad 0 is pressed

These figure shows that when the user presses 0 button, it will display 0 in the LCD display.

Figure 4.2 Sample Display when keypad 9 is pressed

These figure shows that when the user presses 9 button, it will display 9 in the LCD display.

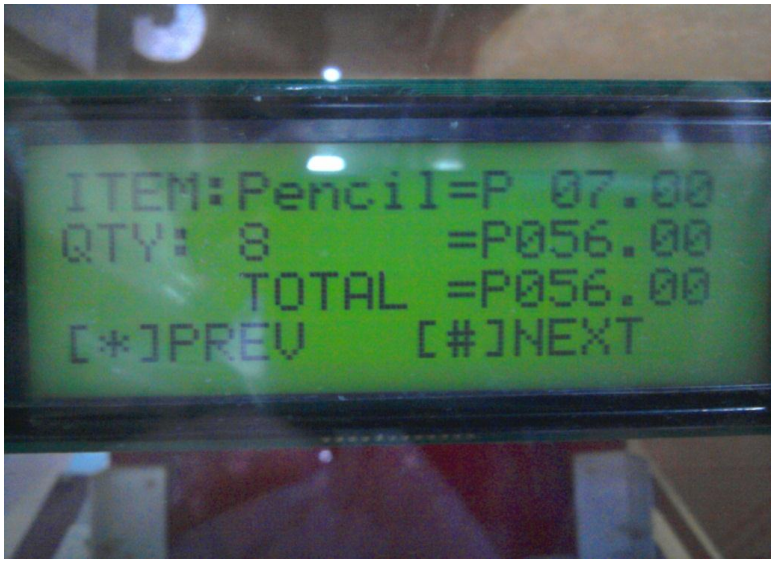

Figure 4.3 Sample Display when keypad 8 is pressed

These figure shows that when the user presses 8 button, it will display 8 in the LCD display.

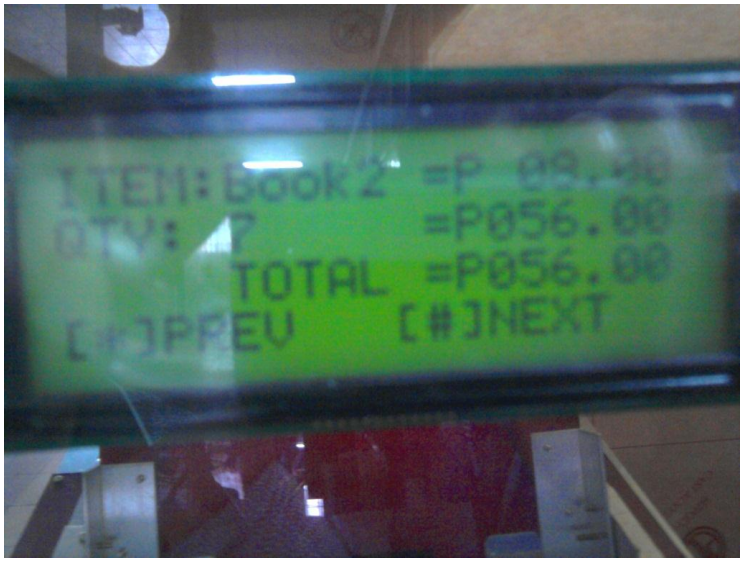

Figure 4.4 Sample Display when keypad 7 is pressed

These figure shows that when the user presses 7 button, it will display 7 in the LCD display.

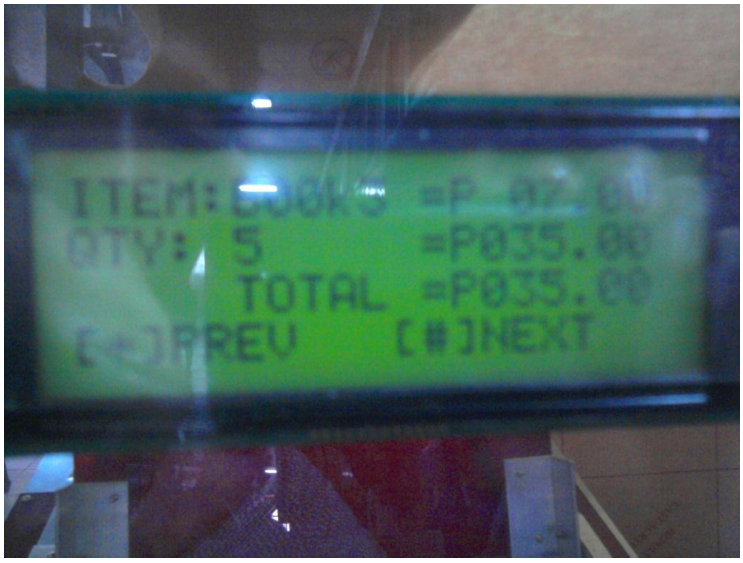

Figure 4.5 Sample Display when keypad 5 is pressed

These figure shows that when the user presses 5 button, it will display 5 in the LCD display.

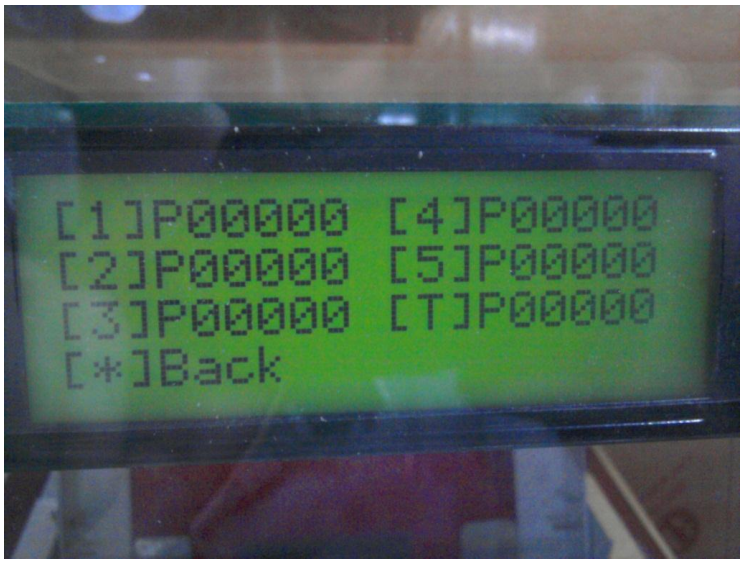

Figure 4.6 Sample Display when admin and keypad # is pressed

These figure shows that when the user simultaneously presses the admin button and the * button, the total sales will be displayed.

Empty Sensor Test

The researchers conducted a test to check if the sensors installed on the design can detect if the dispenser of each item is already empty. The following table sum up the results gathered based on the test that the designers performed.

Trials	Items	No. of items in the Dispenser	Output of the LED indicator (ON or OFF)
1	**Book 1**	5	OFF
2	**Book 1**	4	OFF
3	**Book 1**	3	OFF
4	**Book 1**	2	OFF
5	**Book 1**	1	OFF
6	**Book 1**	0	ON
7	**Book 2**	5	OFF
8	**Book 2**	4	OFF
9	**Book 2**	3	OFF
10	**Book 2**	2	OFF
11	**Book 2**	1	OFF
12	**Book 2**	0	ON
13	**Book 3**	5	OFF
14	**Book 3**	4	OFF

15	**Book 3**	3	OFF
16	**Book 3**	2	OFF
17	**Book 3**	1	OFF
18	**Book 3**	0	ON
19	**Ball pen**	5	OFF
20	**Ball pen**	4	OFF
21	**Ball pen**	3	OFF
22	**Ball pen**	2	OFF
23	**Ball pen**	1	OFF
24	**Ball pen**	0	ON
25	**Pencil**	5	OFF
26	**Pencil**	4	OFF
27	**Pencil**	3	OFF
28	**Pencil**	2	OFF
29	**Pencil**	1	OFF
30	**Pencil**	0	ON

Table 4.5 Empty dispenser detection test

Table 4.5 shows the results when a certain items had run out of supplies. As the result implies, the red light indicator turns ON when the sensor detects that no items is currently on the top of the dispenser, but if there are at least one piece of each item above it the LED indicator will turn OFF.

Figure 4.7 Sample Indicator display when the dispenser is empty

This figure shows that the when the dispenser is empty, the LEDs will automatically turn ON.

Chapter 5

CONCLUSION AND RECOMMENDATION

This chapter gives the overall conclusion of the development of the design in relation to its objectives. The results of the various tests performed are also clearly defined in this chapter. Recommendations for the improvement of the design are also specified to indicate the need for further studies, with reference to the design constraints.

Conclusion

In the *Basic School Supplies Dispenser with Single Transaction Payment*, the designers were able to develop a device that would dispense basic school supplies such as quiz booklet, pencil and ball pen. This device also helps the administrator to compute the total sales. One of the additional advancement of this device with the others is that it can detect the dispenser if it is empty by having a red light indicator.

The design is incorporated with a new way of purchasing items, which is by multiple items at a single transaction. Multiple items in the sense that not only a single kind of item can be purchase with different quantity but also with the ability to purchase multiple kind of items with multiple quantity. Due to this innovation, the school materials can now be distributed faster and effectively.

Recommendation

Certain enhancements and modifications can be made to the design in order to develop it into a more sustainable mechanism from latent users. The following are the recommendations to consider:

1. Improvement on the tube capacity for the 1 peso and 5 peso coins for the change;
2. Implementation on the design to accept bills as credits for purchasing items;
3. Additional kinds of school supplies to dispense;
4. Implementation of the receipt for the customers to check their transaction records; and
5. Enhancements on the outer covering of the design; either use fiber glass or steel to add more security to the inventory.

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APPENDIX A

Operations Manual

1. System Requirement

a. At least Windows XP Operating System

b. At least 512MB Memory RAM

c. Installed MPASM

2. Installation Procedure

a. Place the different school materials in their respective dispenser.

b. Place the 64 pieces one peso coin and five peso coin in their corresponding tube.

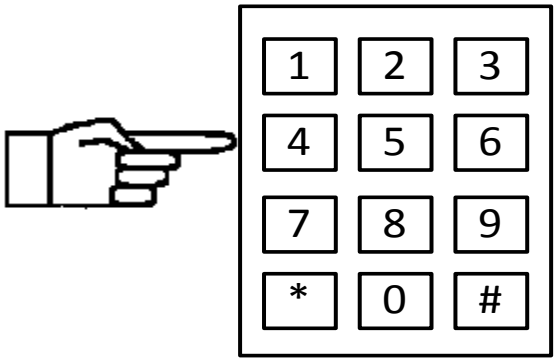
c. Plug the dispenser into a power source.

d. Install battery when necessary to provide continuous power supply to the machine. Connect the red clip to positive and black clip to ground.

e. Switch on the device.

3. User's Manual

a. Enter the desired quantity of the item by pressing the numbers from 0 to 9 in the keypad, afterwards press # to proceed to next item and * to return from previous item.

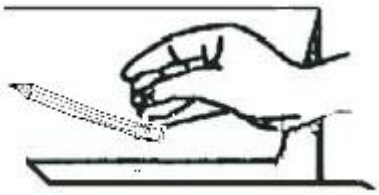


Note: 0 denotes that no quantity of this item will be purchased or cancellation of the previous amount to take; this also has the same effect as leaving the quantity blank. Same concept applies for all school materials.

b. After reaching the finalize transaction page, it will display the total cost of all the items to be purchased. Insert coins sufficient to the amount of the total cost shown. After inserting the coins, the credits will be displayed.

c. To complete and process the transaction press button 4, to cancel all transactions press button 1.

d. After the transaction is completed, pick up purchased school supplies at the designated dispenser location.



e. Admin use only: Hold the admin button and press # to see the total sales (when power supply is interrupted the total saved total sales will be lost).

4. Troubleshooting Guides and Procedures

Problem: Power supply interruption

a. Check if the power cable is properly connected to an appropriate power outlet.
b. Replace battery as it might be already be drained or out of charge.

Problem: No/insufficient change is supplied after transaction

a. Check if the five peso and one peso tube still contain coins.

b. Refill the tubes with appropriate amount of coins preferably until it's full.

5. Error Definitions

a. Undetected coins – the vending machine only accepts new one peso coins. Several vending machines exhibit the same problem.

b. Total sales wipeout – in case of a power supply interruption the vending machine does not save the admin's total sales.

APPENDIX B

Pictures of Prototype

Figure 6.1 Front view of the design

Figure 6.2 Side view of the design

APPENDIX C

Program Listing

```
LOC OBJECT CODE       LINE SOURCE       TEXT
      VALUE

                      INCLUDE        <P16F877A.INC>
                      00001         LIST
                      00002 ; P16F877A.INC  Standard Header File, Version 1.00
                              Microchip Technology, Inc.
                      00400         LIST
2007   3F32           00005     __CONFIG  _HS_OSC & _WDT_OFF & _PWRTE_ON &
_LVP_OFF & _BODEN_OFF
                      00006 ;*****************************************************
                      00007 ;                     Variable Declaration
  00000020            00008 PORTC_NEW     EQU   H'20'          ;
  00000021            00009 PORTC_PREV    EQU   H'21'          ;
  00000022            00010 PORTE_NEW     EQU   H'22'          ;
  00000023            00011 PORTE_PREV    EQU   H'23'          ;
  00000024            00012 KEY_NEW       EQU   H'24'          ;
  00000025            00013 KEY_PREV      EQU   H'25'          ;
  00000026            00014 KEY_VAL       EQU   H'26'          ;
  00000027            00015 KEY_CTR       EQU   H'27'          ;
  00000028            00016 KEY_BUFR      EQU   H'28'          ;
  00000029            00017 CARRY         EQU   H'29'          ;
  0000002A            00018 THOUSND10     EQU   H'2A'          ;
  0000002B            00019 THOUSAND      EQU   H'2B'          ;
  0000002C            00020 HUNDRED       EQU   H'2C'          ;
  0000002D            00021 TEN           EQU   H'2D'          ;
  0000002E            00022 UNIT          EQU   H'2E'          ;
  0000002F            00023 COIN_VAL      EQU   H'2F'          ;
                      00024                                    ;
  00000030            00025 SEL1_QTY      EQU   H'30'          ;
  00000031            00026 SEL2_QTY      EQU   H'31'          ;
  00000032            00027 SEL3_QTY      EQU   H'32'          ;
  00000033            00028 SEL4_QTY      EQU   H'33'          ;
  00000034            00029 SEL5_QTY      EQU   H'34'          ;
  00000035            00030 SEL1_AMT      EQU   H'35'          ;
  00000036            00031 SEL2_AMT      EQU   H'36'          ;
  00000037            00032 SEL3_AMT      EQU   H'37'          ;
  00000038            00033 SEL4_AMT      EQU   H'38'          ;
  00000039            00034 SEL5_AMT      EQU   H'39'          ;
  0000003A            00035 SEL_TOTALHI   EQU   H'3A'          ;
  0000003B            00036 SEL_TOTALLO   EQU   H'3B'          ;
  0000003C            00037 SEL_QTY       EQU   H'3C'          ;
  0000003D            00038 SEL_AMT       EQU   H'3D'          ;
                      00039                                    ;
  00000040            00040 AMOUNT        EQU   H'40'          ;
  00000041            00041 COIN_HI       EQU   H'41'          ;
  00000042            00042 CHANGE        EQU   H'42'          ;
  00000043            00043 CHANGE_HI     EQU   H'43'          ;
  00000044            00044 ITEM_SEL      EQU   H'44'          ;
  00000045            00045 ITEM_VALUE    EQU   H'45'          ;
  00000046            00046 ITEM1_QTY     EQU   H'46'          ;
  00000047            00047 ITEM2_QTY     EQU   H'47'          ;
  00000048            00048 ITEM3_QTY     EQU   H'48'          ;
  00000049            00049 ITEM4_QTY     EQU   H'49'          ;
  0000004A            00050 ITEM5_QTY     EQU   H'4A'          ;
```

```
LOC  OBJECT CODE     LINE SOURCE TEXT
  VALUE

  0000004B            00051 VALUE1        EQU   H'4B'          ;
  0000004C            00052 VALUE2        EQU   H'4C'          ;
  0000004D            00053 VALUE3        EQU   H'4D'          ;
  0000004E            00054 VALUE4        EQU   H'4E'          ;
  0000004F            00055 VALUE5        EQU   H'4F'          ;
                      00056                                    ;
  00000050            00057 TMR1_SEC      EQU   H'50'          ;
  00000051            00058 TMR1_PRES     EQU   H'51'          ;
  00000052            00059 TMR2_SEC      EQU   H'52'          ;
  00000053            00060 TMR2_PRES     EQU   H'53'          ;
  00000054            00061 TMR3_SEC      EQU   H'54'          ;
  00000055            00062 TMR3_PRES     EQU   H'55'          ;
  00000056            00063 TMR4_SEC      EQU   H'56'          ;
  00000057            00064 TMR4_PRES     EQU   H'57'          ;
  00000058            00065 TMR5_SEC      EQU   H'58'          ;
  00000059            00066 TMR5_PRES     EQU   H'59'          ;
  0000005A            00067 TMR6_SEC      EQU   H'5A'          ;
  0000005B            00068 TMR6_PRES     EQU   H'5B'          ;
  0000005C            00069 TMR7_SEC      EQU   H'5C'          ;
  0000005D            00070 TMR7_PRES     EQU   H'5D'          ;
                      00071                                    ;
  00000060            00072 SEL1_SALEHI   EQU   H'60'          ;
  00000061            00073 SEL1_SALELO   EQU   H'61'          ;
  00000062            00074 SEL2_SALEHI   EQU   H'62'          ;
  00000063            00075 SEL2_SALELO   EQU   H'63'          ;
  00000064            00076 SEL3_SALEHI   EQU   H'64'          ;
  00000065            00077 SEL3_SALELO   EQU   H'65'          ;
  00000066            00078 SEL4_SALEHI   EQU   H'66'          ;
  00000067            00079 SEL4_SALELO   EQU   H'67'          ;
  00000068            00080 SEL5_SALEHI   EQU   H'68'          ;
  00000069            00081 SEL5_SALELO   EQU   H'69'          ;
  0000006A            00082 TOTALSALEHI   EQU   H'6A'          ;
  0000006B            00083 TOTALSALELO   EQU   H'6B'          ;
                      00084                                    ;
                      00085                                    ;
  00000070            00086 DATA_HI       EQU   H'70'          ;
  00000071            00087 DATA_LO       EQU   H'71'          ;
  00000072            00088 WAIT1_VAL     EQU   H'72'          ;
  00000073            00089 WAIT2_VAL     EQU   H'73'          ;
  00000074            00090 MSG_NUM       EQU   H'74'          ;
                      00091                                    ;
  00000079            00092 TEMP1         EQU   H'79'          ; temporary
variable.
  0000007A            00093 TEMP2         EQU   H'7A'          ;
  0000007B            00094 TEMP3         EQU   H'7B'          ;
  0000007C            00095 TEMP4         EQU   H'7C'          ;
  0000007D            00096 W_TEMP        EQU   H'7D'          ; temporary
variable for W.
  0000007E            00097 STAT_TEMP     EQU   H'7E'          ; temporary
variable for STATUS.
  0000007F            00098 PCLATH_TEMP   EQU   H'7F'          ;
                      00099 ;--------------------------------------------------
-------------------------
  00000020            00100 LCD_RAM_BUF   EQU   H'20'          ; Bank 1
                      00101
;*****************************************************************************
```

```
                     00102 ;             Reset Vector Starts at Address
0x0000.
                     00103
;*******************************************************************************


LOC  OBJECT CODE     LINE SOURCE TEXT
  VALUE

0000                 00104               ORG   0X0000         ; start of reset
vector.
0000   2805          00105               GOTO  INITIALIZE     ;
                     00106                                    ;
0004                 00107               ORG   0X0004         ; start of
interrupt service routine.
0004   281F          00108               GOTO  ISR_ROUTINE    ;
                     00109
;*******************************************************************************
                     00110 ;             Initialization Routine.
                     00111
;*******************************************************************************
0005   018B          00112 INITIALIZE:   CLRF  INTCON         ; Disable
Interrupts and clear T0IF
0006   1303          00113               BCF   STATUS,RP1     ;
0007   1683          00114               BSF   STATUS,RP0     ; Select Bank 1
0008   30C3          00115               MOVLW B'11000011'    ;
Message[302]: Register in operand not in bank 0.  Ensure that bank bits are
correct.
0009   0081          00116               MOVWF OPTION_REG     ; prescaler of
1:16
                     00117                                    ;
000A   3086          00118               MOVLW B'10000110'    ; PortA all
Digital Input
Message[302]: Register in operand not in bank 0.  Ensure that bank bits are
correct.
000B   009F          00119               MOVWF ADCON1         ;
                     00120                                    ;
000C   30FF          00121               MOVLW B'11111111'    ;         0=OUT
1=IN
Message[302]: Register in operand not in bank 0.  Ensure that bank bits are
correct.
000D   0085          00122               MOVWF TRISA          ; Port A. 11xx
xxxx:TTL
                     00123                                    ;
000E   3000          00124               MOVLW B'00000000'    ;         0=OUT
1=IN
Message[302]: Register in operand not in bank 0.  Ensure that bank bits are
correct.
000F   0086          00125               MOVWF TRISB          ; Port B. xxxx
xxxx:TTL
                     00126                                    ;
0010   30CF          00127               MOVLW B'11001111'    ;         0=OUT
1=IN
Message[302]: Register in operand not in bank 0.  Ensure that bank bits are
correct.
0011   0087          00128               MOVWF TRISC          ; Port C. xxxx
xxxx:schmitt
                     00129                                    ;
0012   3000          00130               MOVLW B'00000000'    ;         0=OUT
1=IN
Message[302]: Register in operand not in bank 0.  Ensure that bank bits are
correct.
```

```
0013   0088           00131               MOVWF TRISD          ; Port D. xxxx
xxxx:schmitt
                      00132                                    ;
0014   3007           00133               MOVLW B'00000111'    ;         0=OUT
1=IN
Message[302]: Register in operand not in bank 0.  Ensure that bank bits are
correct.
0015   0089           00134               MOVWF TRISE          ; Port E. 0000
0xxx:schmitt
                      00135                                    ;
0016   1283           00136               BCF   STATUS,RP0     ; Select Bank 0
                      00137                                    ;
0017   2053           00138               CALL  INIT_VAR       ;
0018   2607           00139               CALL  INIT_LCD       ;
0019   2633           00140               CALL  DISP_LCD       ;
                      00141                                    ;
001A   168B           00142               BSF   INTCON,T0IE    ; Enable TMR0
Interrupt.
001B   178B           00143               BSF   INTCON,GIE     ; Enable All
Interrupts.
001C   0181           00144               CLRF  TMR0           ; Clear TMR0
                      00145
;*****************************************************************************
                      00146 ;             Main Program Starts Here.
                      00147
;*****************************************************************************
001D   0000           00148 MAIN:         NOP                  ;
001E   281D           00149               GOTO  MAIN           ;


LOC  OBJECT CODE     LINE SOURCE TEXT
  VALUE

                      00150
;*****************************************************************************
                      00151 ;             The Interrupt Service Routine.
                      00152
;*****************************************************************************
001F                  00153 ISR_ROUTINE:                       ; Save Registers
001F   00FD           00154               MOVWF W_TEMP         ;      W ->
W_TEMP
0020   0803           00155               MOVF  STATUS,W       ; STATUS -> W
0021   00FE           00156               MOVWF STAT_TEMP      ;      W ->
STAT_TEMP
0022   1283           00157               BCF   STATUS,RP0     ; Bank 0
                      00158                                    ; Check which
interrupt has occurred.
0023   190B           00159               BTFSC INTCON,T0IF    ; Timer0
Interrupt ?
0024   2829           00160               GOTO  TMR0INT        ;
                      00161                                    ; Other causes,
disregard!
0025                  00162 RESTOREREG:                        ; Restore
Registers
0025   087E           00163               MOVF  STAT_TEMP,W    ; STAT_TEMP -> W
0026   0083           00164               MOVWF STATUS         ;         W ->
STATUS
0027   087D           00165               MOVF  W_TEMP,W       ;    W_TEMP -> W
                      00166                                    ;
0028   0009           00167               RETFIE               ; Return from
Interrupt.
```

```
                        00168
;*****************************************************************************
                        00169 ;             TIMER 0 (TMR0) Interrupt Service
Routine.
                        00170
;*****************************************************************************
0029   110B             00171 TMR0INT:      BCF    INTCON,T0IF   ; Reset TMR0
Overflow Flag.
002A   3006             00172               MOVLW  D'06'         ; store value to
TMR0
002B   0781             00173               ADDWF  TMR0,F        ;
                        00174                                    ;
002C   0807             00175               MOVF   PORTC,W       ;
002D   00A0             00176               MOVWF  PORTC_NEW     ;
002E   2251             00177               CALL   READ_KEY      ;
002F   2382             00178               CALL   READ_SW       ;
0030   226D             00179               CALL   COMP_ITEMS    ;
0031   22A7             00180               CALL   DO_MSG0       ;
0032   22F1             00181               CALL   DO_MSG1       ;
0033   233F             00182               CALL   DO_MSG2       ;
0034   256E             00183               CALL   DO_TMR1       ;
0035   257C             00184               CALL   DO_TMR2       ;
0036   25A5             00185               CALL   DO_TMR3       ;
0037   25B1             00186               CALL   DO_TMR4       ;
0038   25BD             00187               CALL   DO_TMR5       ;
0039   25C9             00188               CALL   DO_TMR6       ;
003A   25E4             00189               CALL   DO_TMR7       ;
003B   0820             00190               MOVF   PORTC_NEW,W   ;
003C   00A1             00191               MOVWF  PORTC_PREV    ;
003D   240E             00192               CALL   DISP_DAT0     ;
003E   2457             00193               CALL   DISP_DAT1     ;
003F   248E             00194               CALL   DISP_DAT2     ;
0040   2633             00195               CALL   DISP_LCD      ;
                        00196                                    ;
0041   2825             00197               GOTO   RESTOREREG    ; done! Restore
registers & exit.
                        00198
;*****************************************************************************
0042   0782             00199 KEY_TABLE:    ADDWF  PCL,F              ;
0043   3401 3402 3403 00200                DT     H'1', H'2', H'3', H'F'
       340F
0047   3404 3405 3406 00201                DT     H'4', H'5', H'6', H'F'


LOC  OBJECT CODE     LINE SOURCE TEXT
  VALUE

       340F
004B   3407 3408 3409 00202                DT     H'7', H'8', H'9', H'F'
       340F
004F   340A 3400 340B 00203                DT     H'A', H'0', H'B', H'F'
       340F
                        00204
0053   01F4             00205 INIT_VAR:     CLRF   MSG_NUM           ;
0054   268B             00206               CALL   LD_MSG2RAM        ;
0055   0186             00207               CLRF   PORTB             ;
0056   0187             00208               CLRF   PORTC             ;
0057   0188             00209               CLRF   PORTD             ;
                        00210                                        ;
0058   0807             00211               MOVF   PORTC,W           ;
0059   00A0             00212               MOVWF  PORTC_NEW         ;
005A   00A1             00213               MOVWF  PORTC_PREV        ;
```

```
                     00214                                          ;
005B   0809          00215              MOVF   PORTE,W              ;
005C   00A2          00216              MOVWF  PORTE_NEW            ;
005D   00A3          00217              MOVWF  PORTE_PREV           ;
                     00218                                          ;
005E   01C0          00219              CLRF   AMOUNT               ;
005F   01C1          00220              CLRF   COIN_HI              ;
0060   01C2          00221              CLRF   CHANGE               ;
0061   01C3          00222              CLRF   CHANGE_HI            ;
0062   0805          00223              MOVF   PORTA,W              ;
0063   00A4          00224              MOVWF  KEY_NEW              ;
0064   00A5          00225              MOVWF  KEY_PREV             ;
0065   300F          00226              MOVLW  H'F'                 ;
0066   00A6          00227              MOVWF  KEY_VAL              ;
0067   01C4          00228              CLRF   ITEM_SEL             ;
0068   01C5          00229              CLRF   ITEM_VALUE           ;
0069   01C6          00230              CLRF   ITEM1_QTY            ;
006A   01C7          00231              CLRF   ITEM2_QTY            ;
006B   01C8          00232              CLRF   ITEM3_QTY            ;
006C   01C9          00233              CLRF   ITEM4_QTY            ;
006D   01CA          00234              CLRF   ITEM5_QTY            ;
006E   01A7          00235              CLRF   KEY_CTR              ;
                     00236                                          ;
006F   01D0          00237              CLRF   TMR1_SEC             ;
0070   01D1          00238              CLRF   TMR1_PRES            ;
0071   01D2          00239              CLRF   TMR2_SEC             ;
0072   01D3          00240              CLRF   TMR2_PRES            ;
0073   01D4          00241              CLRF   TMR3_SEC             ;
0074   01D5          00242              CLRF   TMR3_PRES            ;
0075   01D6          00243              CLRF   TMR4_SEC             ;
0076   01D7          00244              CLRF   TMR4_PRES            ;
0077   01D8          00245              CLRF   TMR5_SEC             ;
0078   01D9          00246              CLRF   TMR5_PRES            ;
0079   01DA          00247              CLRF   TMR6_SEC             ;
007A   01DB          00248              CLRF   TMR6_PRES            ;
007B   01DC          00249              CLRF   TMR7_SEC             ;
007C   01DD          00250              CLRF   TMR7_PRES            ;
                     00251                                          ;

LOC  OBJECT CODE     LINE SOURCE TEXT
  VALUE

007D   3008          00252              MOVLW  D'8'                 ;
007E   00CB          00253              MOVWF  VALUE1               ;
007F   3008          00254              MOVLW  D'8'                 ;
0080   00CC          00255              MOVWF  VALUE2               ;
0081   3007          00256              MOVLW  D'7'                 ;
0082   00CD          00257              MOVWF  VALUE3               ;
0083   3007          00258              MOVLW  D'7'                 ;
0084   00CE          00259              MOVWF  VALUE4               ;
0085   3007          00260              MOVLW  D'7'                 ;
0086   00CF          00261              MOVWF  VALUE5               ;
                     00262                                          ;
0087   01B0          00263              CLRF   SEL1_QTY             ;
0088   01B1          00264              CLRF   SEL2_QTY             ;
0089   01B2          00265              CLRF   SEL3_QTY             ;
008A   01B3          00266              CLRF   SEL4_QTY             ;
008B   01B4          00267              CLRF   SEL5_QTY             ;
008C   01B5          00268              CLRF   SEL1_AMT             ;
008D   01B6          00269              CLRF   SEL2_AMT             ;
008E   01B7          00270              CLRF   SEL3_AMT             ;
008F   01B8          00271              CLRF   SEL4_AMT             ;
```

```
0090   01B9           00272              CLRF   SEL5_AMT          ;
0091   01BC           00273              CLRF   SEL_QTY           ;
                      00274                                       ;
0092   01E0           00275              CLRF   SEL1_SALEHI        ;
0093   01E1           00276              CLRF   SEL1_SALELO        ;
0094   01E2           00277              CLRF   SEL2_SALEHI        ;
0095   01E3           00278              CLRF   SEL2_SALELO        ;
0096   01E4           00279              CLRF   SEL3_SALEHI        ;
0097   01E5           00280              CLRF   SEL3_SALELO        ;
0098   01E6           00281              CLRF   SEL4_SALEHI        ;
0099   01E7           00282              CLRF   SEL4_SALELO        ;
009A   01E8           00283              CLRF   SEL5_SALEHI        ;
009B   01E9           00284              CLRF   SEL5_SALELO        ;
009C   01EA           00285              CLRF   TOTALSALEHI        ;
009D   01EB           00286              CLRF   TOTALSALELO        ;
                      00287                                       ;
009E   0008           00288              RETURN                    ;
                      00289
;*********************************************************************************
0100                  00290              ORG    0X0100             ;
0100   0782           00291 MSG0:        ADDWF  PCL,F              ;
                      00292                    ;0123456789012345678 9"
0101   3449 3454 3445 00293              DT     "ITEM:      =P 00.00 "
       344D 343A 3420
       3420 3420 3420
       3420 3420 343D
       3450 3420 3430
       3430 342E 3430
       3430 3420
0115   3451 3454 3459 00294              DT     "QTY: _     =P000.00 "
       343A 3420 345F
       3420 3420 3420
       3420 3420 343D
       3450 3430 3430


LOC  OBJECT CODE     LINE SOURCE TEXT
  VALUE

       3430 342E 3430
       3430 3420
0129   3420 3420 3420 00295              DT     "     TOTAL =P000.00 "
       3420 3420 3454
       344F 3454 3441
       344C 3420 343D
       3450 3430 3430
       3430 342E 3430
       3430 3420
013D   345B 342A 345D 00296              DT     "[*]PREV   [#]NEXT   "
       3450 3452 3445
       3456 3420 3420
       3420 345B 3423
       345D 344E 3445
       3458 3454 3420
       3420 3420
                      00297
                      00298                    ;0123456789012345678 9"
0151   345B 3431 345D 00299 MSG1:        DT     "[1]CANCEL [4]OK     "
       3443 3441 344E
       3443 3445 344C
       3420 345B 3434
       345D 344F 344B
```

```
       3420 3420 3420
       3420 3420
0165   3420 3420 3420 00300              DT    "     CREDIT=P000.00 "
       3420 3420 3443
       3452 3445 3444
       3449 3454 343D
       3450 3430 3430
       3430 342E 3430
       3430 3420
0179   3420 3420 3420 00301              DT    "     TOTAL =P000.00 "
       3420 3420 3454
       344F 3454 3441
       344C 3420 343D
       3450 3430 3430
       3430 342E 3430
       3430 3420
018D   345B 342A 345D 00302              DT    "[*]PREV             "
       3450 3452 3445
       3456 3420 3420
       3420 3420 3420
       3420 3420 3420
       3420 3420 3420
       3420 3420
                     00303
                     00304                    ;0123456789012345678 9"
01A1   345B 3431 345D 00305 MSG2:        DT    "[1]P      [4]P      "
       3450 3420 3420
       3420 3420 3420
       3420 345B 3434
       345D 3450 3420


LOC  OBJECT CODE     LINE SOURCE TEXT
  VALUE

       3420 3420 3420
       3420 3420
01B5   345B 3432 345D 00306              DT    "[2]P      [5]P      "
       3450 3420 3420
       3420 3420 3420
       3420 345B 3435
       345D 3450 3420
       3420 3420 3420
       3420 3420
01C9   345B 3433 345D 00307              DT    "[3]P      [T]P      "
       3450 3420 3420
       3420 3420 3420
       3420 345B 3454
       345D 3450 3420
       3420 3420 3420
       3420 3420
01DD   345B 342A 345D 00308              DT    "[*]Back             "
       3442 3461 3463
       346B 3420 3420
       3420 3420 3420
       3420 3420 3420
       3420 3420 3420
       3420 3420
                     00309
0200                 00310              ORG    0X0200            ;
0200   0782          00311 MSG3:        ADDWF  PCL,F             ;
                     00312                    ;0123456789012345678 9"
```

```
0201   3449 3454 3445 00313              DT    "ITEM:      =P 00.00 "
       344D 343A 3420
       3420 3420 3420
       3420 3420 343D
       3450 3420 3430
       3430 342E 3430
       3430 3420
0215   3420 3420 3420 00314              DT    "     EDIT> =P __.00 "
       3420 3420 3445
       3444 3449 3454
       343E 3420 343D
       3450 3420 345F
       345F 342E 3430
       3430 3420
0229   3420 3420 3420 00315              DT    "                    "
       3420 3420 3420
       3420 3420 3420
       3420 3420 3420
       3420 3420 3420
       3420 3420
023D   345B 342A 345D 00316              DT    "[*]SAVE   [#]NEXT   "
       3453 3441 3456
       3445 3420 3420
       3420 345B 3423
       345D 344E 3445


LOC  OBJECT CODE     LINE SOURCE TEXT
  VALUE

       3458 3454 3420
       3420 3420
                    00317
                    00318                    ;01234567890123456789"
                    00319 ;                   dt    "1.Book1   4.BallPen "
                    00320 ;                   dt    "2.Book2   5.Pencil  "
                    00321 ;                   dt    "3.Book3             "
                    00322 ;                   dt    "   N.SELECT         "
                    00323
                    00324
;*****************************************************************************
0251   0805          00325 READ_KEY:     MOVF   PORTA,W          ;
0252   00A4          00326               MOVWF  KEY_NEW          ;
0253   390F          00327               ANDLW  H'0F'            ;
0254   2042          00328               CALL   KEY_TABLE        ;
0255   00F9          00329               MOVWF  TEMP1            ;
0256   3010          00330               MOVLW  H'10'            ;
0257   05A4          00331               ANDWF  KEY_NEW,F        ;
0258   0879          00332               MOVF   TEMP1,W          ;
0259   04A4          00333               IORWF  KEY_NEW,F        ;
025A   1E24          00334               BTFSS  KEY_NEW,4        ;
025B   2A61          00335               GOTO   READ_KEYX        ;
025C   1A25          00336               BTFSC  KEY_PREV,4       ;
025D   2A61          00337               GOTO   READ_KEYX        ;
025E   0824          00338               MOVF   KEY_NEW,W        ;
025F   390F          00339               ANDLW  H'0F'            ;
0260   00A6          00340               MOVWF  KEY_VAL          ;
0261   0824          00341 READ_KEYX:    MOVF   KEY_NEW,W        ;
0262   00A5          00342               MOVWF  KEY_PREV         ;
0263   0008          00343               RETURN                  ;
```

```
                     00344
;*******************************************************************************
0264   01FB          00345 COMP_ITEM:    CLRF   TEMP3             ;
0265   0879          00346 COMP_ITEMLP:  MOVF   TEMP1,W           ;
0266   1903          00347               BTFSC  STATUS,Z          ;
0267   2A6C          00348               GOTO   COMP_ITEMX        ;
0268   087A          00349               MOVF   TEMP2,W           ;
0269   07FB          00350               ADDWF  TEMP3,F           ;
026A   03F9          00351               DECF   TEMP1,F           ;
026B   2A65          00352               GOTO   COMP_ITEMLP       ;
026C   0008          00353 COMP_ITEMX:   RETURN                   ;
                     00354                                        ;
026D   01BA          00355 COMP_ITEMS:   CLRF   SEL_TOTALHI       ;
026E   01BB          00356               CLRF   SEL_TOTALLO       ;
                     00357                                        ;
026F   0830          00358 COMP_ITEM1:   MOVF   SEL1_QTY,W        ;
0270   00F9          00359               MOVWF  TEMP1             ;
0271   084B          00360               MOVF   VALUE1,W          ;
0272   00FA          00361               MOVWF  TEMP2             ;
0273   2264          00362               CALL   COMP_ITEM         ;
0274   087B          00363               MOVF   TEMP3,W           ;
0275   00B5          00364               MOVWF  SEL1_AMT          ;
0276   0835          00365               MOVF   SEL1_AMT,W        ;
0277   07BB          00366               ADDWF  SEL_TOTALLO,F     ;
0278   1803          00367               BTFSC  STATUS,C          ;


LOC  OBJECT CODE     LINE SOURCE TEXT
  VALUE

0279   0ABA          00368               INCF   SEL_TOTALHI,F     ;
                     00369                                        ;
027A   0831          00370 COMP_ITEM2:   MOVF   SEL2_QTY,W        ;
027B   00F9          00371               MOVWF  TEMP1             ;
027C   084C          00372               MOVF   VALUE2,W          ;
027D   00FA          00373               MOVWF  TEMP2             ;
027E   2264          00374               CALL   COMP_ITEM         ;
027F   087B          00375               MOVF   TEMP3,W           ;
0280   00B6          00376               MOVWF  SEL2_AMT          ;
0281   0836          00377               MOVF   SEL2_AMT,W        ;
0282   07BB          00378               ADDWF  SEL_TOTALLO,F     ;
0283   1803          00379               BTFSC  STATUS,C          ;
0284   0ABA          00380               INCF   SEL_TOTALHI,F     ;
                     00381                                        ;
0285   0832          00382 COMP_ITEM3:   MOVF   SEL3_QTY,W        ;
0286   00F9          00383               MOVWF  TEMP1             ;
0287   084D          00384               MOVF   VALUE3,W          ;
0288   00FA          00385               MOVWF  TEMP2             ;
0289   2264          00386               CALL   COMP_ITEM         ;
028A   087B          00387               MOVF   TEMP3,W           ;
028B   00B7          00388               MOVWF  SEL3_AMT          ;
028C   0837          00389               MOVF   SEL3_AMT,W        ;
028D   07BB          00390               ADDWF  SEL_TOTALLO,F     ;
028E   1803          00391               BTFSC  STATUS,C          ;
028F   0ABA          00392               INCF   SEL_TOTALHI,F     ;
                     00393                                        ;
0290   0833          00394 COMP_ITEM4:   MOVF   SEL4_QTY,W        ;
0291   00F9          00395               MOVWF  TEMP1             ;
0292   084E          00396               MOVF   VALUE4,W          ;
0293   00FA          00397               MOVWF  TEMP2             ;
0294   2264          00398               CALL   COMP_ITEM         ;
0295   087B          00399               MOVF   TEMP3,W           ;
```

```
0296   00B8           00400                MOVWF  SEL4_AMT          ;
0297   0838           00401                MOVF   SEL4_AMT,W        ;
0298   07BB           00402                ADDWF  SEL_TOTALLO,F     ;
0299   1803           00403                BTFSC  STATUS,C          ;
029A   0ABA           00404                INCF   SEL_TOTALHI,F     ;
                      00405                                         ;
029B   0834           00406 COMP_ITEM5:    MOVF   SEL5_QTY,W        ;
029C   00F9           00407                MOVWF  TEMP1             ;
029D   084F           00408                MOVF   VALUE5,W          ;
029E   00FA           00409                MOVWF  TEMP2             ;
029F   2264           00410                CALL   COMP_ITEM         ;
02A0   087B           00411                MOVF   TEMP3,W           ;
02A1   00B9           00412                MOVWF  SEL5_AMT          ;
02A2   0839           00413                MOVF   SEL5_AMT,W        ;
02A3   07BB           00414                ADDWF  SEL_TOTALLO,F     ;
02A4   1803           00415                BTFSC  STATUS,C          ;
02A5   0ABA           00416                INCF   SEL_TOTALHI,F     ;
                      00417                                         ;
02A6   0008           00418                RETURN                   ;
                      00419
;*********************************************************************
02A7   3000           00420 DO_MSG0:       MOVLW  D'0'              ;


LOC  OBJECT CODE     LINE SOURCE TEXT
  VALUE

02A8   0274           00421                SUBWF  MSG_NUM,W         ;
02A9   1D03           00422                BTFSS  STATUS,Z          ;
02AA   2ADC           00423                GOTO   DO_MSG0X          ;
                      00424                                         ;
02AB   3006           00425                MOVLW  D'6'              ;
02AC   0244           00426                SUBWF  ITEM_SEL,W        ;
02AD   1803           00427                BTFSC  STATUS,C          ;
02AE   01C4           00428                CLRF   ITEM_SEL          ;
02AF   0844           00429                MOVF   ITEM_SEL,W        ;
02B0   1903           00430                BTFSC  STATUS,Z          ;
02B1   0AC4           00431                INCF   ITEM_SEL,F        ;
                      00432                                         ;
02B2   0344           00433                DECF   ITEM_SEL,W        ;
02B3   3E4B           00434                ADDLW  VALUE1            ;
02B4   0084           00435                MOVWF  FSR               ;
02B5   0800           00436                MOVF   INDF,W            ;
02B6   00C5           00437                MOVWF  ITEM_VALUE        ;
                      00438                                         ;
02B7   0344           00439                DECF   ITEM_SEL,W        ;
02B8   3E30           00440                ADDLW  SEL1_QTY          ;
02B9   0084           00441                MOVWF  FSR               ;
02BA   0800           00442                MOVF   INDF,W            ;
02BB   00BC           00443                MOVWF  SEL_QTY           ;
                      00444                                         ;
02BC   0344           00445                DECF   ITEM_SEL,W        ;
02BD   3E35           00446                ADDLW  SEL1_AMT          ;
02BE   0084           00447                MOVWF  FSR               ;
02BF   0800           00448                MOVF   INDF,W            ;
02C0   00BD           00449                MOVWF  SEL_AMT           ;
                      00450                                         ;
02C1   239B           00451                CALL   DISP_ITEM         ;
                      00452                                         ;
02C2   300C           00453                MOVLW  H'C'              ;
02C3   0226           00454                SUBWF  KEY_VAL,W         ;
02C4   1803           00455                BTFSC  STATUS,C          ;
```

```
02C5   2ADC           00456               GOTO   DO_MSG0X          ;
                      00457                                         ;
02C6   300A           00458               MOVLW  H'A'              ;
02C7   0226           00459               SUBWF  KEY_VAL,W         ;
02C8   1903           00460               BTFSC  STATUS,Z          ;
02C9   2ADD           00461               GOTO   DO_MSG0_A         ;
                      00462                                         ;
02CA   300B           00463               MOVLW  H'B'              ;
02CB   0226           00464               SUBWF  KEY_VAL,W         ;
02CC   1903           00465               BTFSC  STATUS,Z          ;
02CD   2AE2           00466               GOTO   DO_MSG0_B         ;
                      00467                                         ;
02CE   0344           00468               DECF   ITEM_SEL,W        ;
02CF   3E30           00469               ADDLW  SEL1_QTY          ;
02D0   0084           00470               MOVWF  FSR               ;
02D1   0826           00471               MOVF   KEY_VAL,W         ;
02D2   0080           00472               MOVWF  INDF              ;
                      00473                                         ;


LOC  OBJECT CODE     LINE SOURCE TEXT
  VALUE

02D3   3020           00474               MOVLW  LCD_RAM_BUF       ;
02D4   3E19           00475               ADDLW  D'25'             ;
02D5   0084           00476               MOVWF  FSR               ;
02D6   1784           00477               BSF    FSR,7             ;
                      00478                                         ;
02D7   0826           00479               MOVF   KEY_VAL,W         ;
02D8   3E30           00480               ADDLW  H'30'             ;
02D9   0080           00481               MOVWF  INDF              ;
                      00482                                         ;
02DA   300F           00483 DO_MSG0_X:    MOVLW  H'0F'             ;
02DB   00A6           00484               MOVWF  KEY_VAL           ;
02DC   0008           00485 DO_MSG0X:     RETURN                   ;
                      00486                                         ;
02DD   3002           00487 DO_MSG0_A:    MOVLW  D'2'              ;
02DE   0244           00488               SUBWF  ITEM_SEL,W        ;
02DF   1803           00489               BTFSC  STATUS,C          ;
02E0   03C4           00490               DECF   ITEM_SEL,F        ;
02E1   2ADA           00491 DO_MSG0_AX:   GOTO   DO_MSG0_X         ;
                      00492                                         ;
02E2   1E85           00493 DO_MSG0_B:    BTFSS  PORTA,5           ;
02E3   2AED           00494               GOTO   DO_MSG0_B1        ;
02E4   0AC4           00495               INCF   ITEM_SEL,F        ;
02E5   3006           00496               MOVLW  D'6'              ;
02E6   0244           00497               SUBWF  ITEM_SEL,W        ;
02E7   1C03           00498               BTFSS  STATUS,C          ;
02E8   2AF0           00499               GOTO   DO_MSG0_BX        ;
02E9   3001           00500               MOVLW  D'1'              ;
02EA   00F4           00501               MOVWF  MSG_NUM           ;
02EB   268B           00502               CALL   LD_MSG2RAM        ;
02EC   2AF0           00503               GOTO   DO_MSG0_BX        ;
02ED   3002           00504 DO_MSG0_B1:   MOVLW  D'2'              ;
02EE   00F4           00505               MOVWF  MSG_NUM           ;
02EF   268B           00506               CALL   LD_MSG2RAM        ;
02F0   2ADA           00507 DO_MSG0_BX:   GOTO   DO_MSG0_X         ;
                      00508
;*****************************************************************************
02F1   0874           00509 DO_MSG1:      MOVF   MSG_NUM,W         ;
02F2   3C01           00510               SUBLW  D'1'              ;
02F3   1D03           00511               BTFSS  STATUS,Z          ;
```

```
02F4   2B0B           00512                GOTO   DO_MSG1X          ;
                      00513                                         ;
02F5   300C           00514                MOVLW  H'C'              ;
02F6   0226           00515                SUBWF  KEY_VAL,W         ;
02F7   1803           00516                BTFSC  STATUS,C          ;
02F8   2B0B           00517                GOTO   DO_MSG1X          ;
                      00518                                         ;
02F9   300B           00519                MOVLW  H'B'              ; Next
02FA   0226           00520                SUBWF  KEY_VAL,W         ;
02FB   1903           00521                BTFSC  STATUS,Z          ;
02FC   2B3D           00522                GOTO   DO_MSG1B          ;
                      00523                                         ;
02FD   300A           00524                MOVLW  H'A'              ; Prev
02FE   0226           00525                SUBWF  KEY_VAL,W         ;
02FF   1903           00526                BTFSC  STATUS,Z          ;LOC  OBJECT
CODE     LINE SOURCE TEXT
  VALUE

0300   2B38           00527                GOTO   DO_MSG1A          ;
                      00528                                         ;
0301   3001           00529                MOVLW  H'1'              ; Cancel
0302   0226           00530                SUBWF  KEY_VAL,W         ;
0303   1903           00531                BTFSC  STATUS,Z          ;
0304   2B0C           00532                GOTO   DO_MSG11          ;
                      00533                                         ;
0305   3004           00534                MOVLW  H'4'              ; OK
0306   0226           00535                SUBWF  KEY_VAL,W         ;
0307   1903           00536                BTFSC  STATUS,Z          ;
0308   2B1B           00537                GOTO   DO_MSG14          ;
                      00538                                         ;
                      00539                                         ;
0309   300F           00540 DO_MSG1_X:     MOVLW  H'0F'             ;
030A   00A6           00541                MOVWF  KEY_VAL           ;
030B   0008           00542 DO_MSG1X:      RETURN                   ;
                      00543                                         ;
030C   01F4           00544 DO_MSG11:      CLRF   MSG_NUM           ; Cancel
030D   268B           00545                CALL   LD_MSG2RAM        ;
030E   01C3           00546                CLRF   CHANGE_HI         ;
030F   0840           00547                MOVF   AMOUNT,W          ;
0310   07C2           00548                ADDWF  CHANGE,F          ;
0311   01C0           00549                CLRF   AMOUNT            ;
0312   01C1           00550                CLRF   COIN_HI           ;
0313   01B0           00551                CLRF   SEL1_QTY          ;
0314   01B1           00552                CLRF   SEL2_QTY          ;
0315   01B2           00553                CLRF   SEL3_QTY          ;
0316   01B3           00554                CLRF   SEL4_QTY          ;
0317   01B4           00555                CLRF   SEL5_QTY          ;
0318   3001           00556                MOVLW  D'1'              ;
0319   00C4           00557                MOVWF  ITEM_SEL          ;
031A   2B09           00558                GOTO   DO_MSG1_X         ;
                      00559                                         ;
031B   083B           00560 DO_MSG14:      MOVF   SEL_TOTALLO,W     ; Sel_Total
031C   0240           00561                SUBWF  AMOUNT,W          ; Coin
Amount
031D   1C03           00562                BTFSS  STATUS,C          ;
031E   2B37           00563                GOTO   DO_MSG14X         ;
031F   07C2           00564                ADDWF  CHANGE,F          ;
0320   01C0           00565                CLRF   AMOUNT            ;
0321   01C3           00566                CLRF   CHANGE_HI         ;
0322   01C1           00567                CLRF   COIN_HI           ;
                      00568                                         ;
0323   0830           00569                MOVF   SEL1_QTY,W        ;
```

```
0324   07C6          00570              ADDWF  ITEM1_QTY,F       ;
0325   0831          00571              MOVF   SEL2_QTY,W        ;
0326   07C7          00572              ADDWF  ITEM2_QTY,F       ;
0327   0832          00573              MOVF   SEL3_QTY,W        ;
0328   07C8          00574              ADDWF  ITEM3_QTY,F       ;
0329   0833          00575              MOVF   SEL4_QTY,W        ;
032A   07C9          00576              ADDWF  ITEM4_QTY,F       ;
032B   0834          00577              MOVF   SEL5_QTY,W        ;
032C   07CA          00578              ADDWF  ITEM5_QTY,F       ;
                     00579                                       ;
```

```
 LOC  OBJECT CODE     LINE SOURCE TEXT
  VALUE

032D   2358          00580               CALL   ADD2SALE          ;
                     00581                                         ;
032E   01B0          00582               CLRF   SEL1_QTY          ;
032F   01B1          00583               CLRF   SEL2_QTY          ;
0330   01B2          00584               CLRF   SEL3_QTY          ;
0331   01B3          00585               CLRF   SEL4_QTY          ;
0332   01B4          00586               CLRF   SEL5_QTY          ;
0333   3001          00587               MOVLW  D'1'              ;
0334   00C4          00588               MOVWF  ITEM_SEL          ;
0335   01F4          00589               CLRF   MSG_NUM           ;
0336   268B          00590               CALL   LD_MSG2RAM        ;
0337   2B09          00591 DO_MSG14X:    GOTO   DO_MSG1_X         ;
                     00592                                         ;
0338   01F4          00593 DO_MSG1A:     CLRF   MSG_NUM           ;
0339   268B          00594               CALL   LD_MSG2RAM        ;
033A   3005          00595               MOVLW  D'5'              ;
033B   00C4          00596               MOVWF  ITEM_SEL          ;
033C   2B09          00597               GOTO   DO_MSG1_X         ;
                     00598                                         ;
033D   0000          00599 DO_MSG1B:     NOP                      ;
033E   2B09          00600               GOTO   DO_MSG1_X         ;
                     00601
;*****************************************************************************
033F   3002          00602 DO_MSG2:      MOVLW  D'2'              ;
0340   0274          00603               SUBWF  MSG_NUM,W         ;
0341   1D03          00604               BTFSS  STATUS,Z          ;
0342   2B51          00605               GOTO   DO_MSG2X          ;
                     00606                                         ;
0343   300C          00607               MOVLW  H'C'              ;
0344   0226          00608               SUBWF  KEY_VAL,W         ;
0345   1803          00609               BTFSC  STATUS,C          ;
0346   2B51          00610               GOTO   DO_MSG2X          ;
                     00611                                         ;
0347   300A          00612               MOVLW  H'A'              ;
0348   0226          00613               SUBWF  KEY_VAL,W         ;
0349   1903          00614               BTFSC  STATUS,Z          ;
034A   2B52          00615               GOTO   DO_MSG2_A         ;
                     00616                                         ;
034B   300B          00617               MOVLW  H'B'              ;
034C   0226          00618               SUBWF  KEY_VAL,W         ;
034D   1903          00619               BTFSC  STATUS,Z          ;
034E   2B56          00620               GOTO   DO_MSG2_B         ;
                     00621                                         ;
034F   300F          00622 DO_MSG2_X:    MOVLW  H'0F'             ;
0350   00A6          00623               MOVWF  KEY_VAL           ;
0351   0008          00624 DO_MSG2X:     RETURN                   ;
                     00625                                         ;
0352   3000          00626 DO_MSG2_A:    MOVLW  D'0'              ;
0353   00F4          00627               MOVWF  MSG_NUM           ;
0354   268B          00628               CALL   LD_MSG2RAM        ;
0355   2B4F          00629 DO_MSG2_AX:   GOTO   DO_MSG2_X         ;
                     00630                                         ;
0356   0000          00631 DO_MSG2_B:    NOP                      ;
0357   2ADA          00632 DO_MSG2_BX:   GOTO   DO_MSG0_X         ;
```

```
LOC  OBJECT CODE     LINE SOURCE TEXT
  VALUE

                     00633
;*********************************************************************
0358   0000          00634 ADD2SALE:     NOP                     ;
                     00635                                       ;
0359   0835          00636 ADDSALE1:     MOVF   SEL1_AMT,W       ;
035A   07E1          00637               ADDWF  SEL1_SALELO,F    ;
035B   1803          00638               BTFSC  STATUS,C         ;
035C   0AE0          00639               INCF   SEL1_SALEHI,F    ;
035D   0835          00640               MOVF   SEL1_AMT,W       ;
035E   07EB          00641               ADDWF  TOTALSALELO,F    ;
035F   1803          00642               BTFSC  STATUS,C         ;
0360   0AEA          00643               INCF   TOTALSALEHI,F    ;
                     00644                                       ;
0361   0836          00645 ADDSALE2:     MOVF   SEL2_AMT,W       ;
0362   07E3          00646               ADDWF  SEL2_SALELO,F    ;
0363   1803          00647               BTFSC  STATUS,C         ;
0364   0AE2          00648               INCF   SEL2_SALEHI,F    ;
0365   0836          00649               MOVF   SEL2_AMT,W       ;
0366   07EB          00650               ADDWF  TOTALSALELO,F    ;
0367   1803          00651               BTFSC  STATUS,C         ;
0368   0AEA          00652               INCF   TOTALSALEHI,F    ;
                     00653                                       ;
0369   0837          00654 ADDSALE3:     MOVF   SEL3_AMT,W       ;
036A   07E5          00655               ADDWF  SEL3_SALELO,F    ;
036B   1803          00656               BTFSC  STATUS,C         ;
036C   0AE4          00657               INCF   SEL3_SALEHI,F    ;
036D   0837          00658               MOVF   SEL3_AMT,W       ;
036E   07EB          00659               ADDWF  TOTALSALELO,F    ;
036F   1803          00660               BTFSC  STATUS,C         ;
0370   0AEA          00661               INCF   TOTALSALEHI,F    ;
                     00662                                       ;
0371   0838          00663 ADDSALE4:     MOVF   SEL4_AMT,W       ;
0372   07E7          00664               ADDWF  SEL4_SALELO,F    ;
0373   1803          00665               BTFSC  STATUS,C         ;
0374   0AE6          00666               INCF   SEL4_SALEHI,F    ;
0375   0838          00667               MOVF   SEL4_AMT,W       ;
0376   07EB          00668               ADDWF  TOTALSALELO,F    ;
0377   1803          00669               BTFSC  STATUS,C         ;
0378   0AEA          00670               INCF   TOTALSALEHI,F    ;
                     00671                                       ;
0379   0839          00672 ADDSALE5:     MOVF   SEL5_AMT,W       ;
037A   07E9          00673               ADDWF  SEL5_SALELO,F    ;
037B   1803          00674               BTFSC  STATUS,C         ;
037C   0AE8          00675               INCF   SEL5_SALEHI,F    ;
037D   0839          00676               MOVF   SEL5_AMT,W       ;
037E   07EB          00677               ADDWF  TOTALSALELO,F    ;
037F   1803          00678               BTFSC  STATUS,C         ;
0380   0AEA          00679               INCF   TOTALSALEHI,F    ;
                     00680                                       ;
0381   0008          00681               RETURN                  ;
                     00682
;*********************************************************************
0382   0809          00683 READ_SW:      MOVF   PORTE,W          ;
0383   00A2          00684               MOVWF  PORTE_NEW        ;
                     00685                                       ;


LOC  OBJECT CODE     LINE SOURCE TEXT
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```
  VALUE

0384   1822           00686 RD_SW0:       BTFSC  PORTE_NEW,0       ;
0385   2B89           00687               GOTO   RD_SW0X           ;
0386   1C23           00688               BTFSS  PORTE_PREV,0      ;
0387   2B89           00689               GOTO   RD_SW0X           ;
0388   0AC0           00690               INCF   AMOUNT,F          ;
0389   0000           00691 RD_SW0X:      NOP                      ;
                      00692                                        ;
038A   18A2           00693 RD_SW1:       BTFSC  PORTE_NEW,1       ;
038B   2B90           00694               GOTO   RD_SW1X           ;
038C   1CA3           00695               BTFSS  PORTE_PREV,1      ;
038D   2B90           00696               GOTO   RD_SW1X           ;
038E   3005           00697               MOVLW  D'5'              ;
038F   07C0           00698               ADDWF  AMOUNT,F          ;
0390   0000           00699 RD_SW1X:      NOP                      ;
                      00700                                        ;
0391   1922           00701 RD_SW2:       BTFSC  PORTE_NEW,2       ;
0392   2B97           00702               GOTO   RD_SW2X           ;
0393   1D23           00703               BTFSS  PORTE_PREV,2      ;
0394   2B97           00704               GOTO   RD_SW2X           ;
0395   300A           00705               MOVLW  D'10'             ;
0396   07C0           00706               ADDWF  AMOUNT,F          ;
0397   0000           00707 RD_SW2X:      NOP                      ;
                      00708                                        ;
0398   0822           00709 READ_SWX:     MOVF   PORTE_NEW,W       ;
0399   00A3           00710               MOVWF  PORTE_PREV        ;
039A   0008           00711               RETURN                   ;
                      00712
;*********************************************************************
039B   3020           00713 DISP_ITEM:    MOVLW  LCD_RAM_BUF       ;
039C   3E05           00714               ADDLW  D'5'              ;
039D   0084           00715               MOVWF  FSR               ;
039E   1784           00716               BSF    FSR,7             ;
                      00717                                        ;
039F   0844           00718 DISP_ITEM1:   MOVF   ITEM_SEL,W        ;
03A0   3C01           00719               SUBLW  D'1'              ;
03A1   1D03           00720               BTFSS  STATUS,Z          ;
03A2   2BB4           00721               GOTO   DISP_ITEM1X       ;
03A3   3042           00722               MOVLW  "B"               ;
03A4   0080           00723               MOVWF  INDF              ;
03A5   0A84           00724               INCF   FSR,F             ;
03A6   306F           00725               MOVLW  "o"               ;
03A7   0080           00726               MOVWF  INDF              ;
03A8   0A84           00727               INCF   FSR,F             ;
03A9   306F           00728               MOVLW  "o"               ;
03AA   0080           00729               MOVWF  INDF              ;
03AB   0A84           00730               INCF   FSR,F             ;
03AC   306B           00731               MOVLW  "k"               ;
03AD   0080           00732               MOVWF  INDF              ;
03AE   0A84           00733               INCF   FSR,F             ;
03AF   3031           00734               MOVLW  "1"               ;
03B0   0080           00735               MOVWF  INDF              ;
03B1   0A84           00736               INCF   FSR,F             ;
03B2   3020           00737               MOVLW  " "               ;
LOC  OBJECT CODE     LINE SOURCE TEXT
  VALUE

03B4   0000           00739 DISP_ITEM1X:  NOP                      ;
                      00740                                        ;
03B5   0844           00741 DISP_ITEM2:   MOVF   ITEM_SEL,W        ;
03B6   3C02           00742               SUBLW  D'2'              ;
```

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03B7   1D03           00743                BTFSS  STATUS,Z          ;
03B8   2BCA           00744                GOTO   DISP_ITEM2X       ;
03B9   3042           00745                MOVLW  "B"               ;
03BA   0080           00746                MOVWF  INDF              ;
03BB   0A84           00747                INCF   FSR,F             ;
03BC   306F           00748                MOVLW  "o"               ;
03BD   0080           00749                MOVWF  INDF              ;
03BE   0A84           00750                INCF   FSR,F             ;
03BF   306F           00751                MOVLW  "o"               ;
03C0   0080           00752                MOVWF  INDF              ;
03C1   0A84           00753                INCF   FSR,F             ;
03C2   306B           00754                MOVLW  "k"               ;
03C3   0080           00755                MOVWF  INDF              ;
03C4   0A84           00756                INCF   FSR,F             ;
03C5   3032           00757                MOVLW  "2"               ;
03C6   0080           00758                MOVWF  INDF              ;
03C7   0A84           00759                INCF   FSR,F             ;
03C8   3020           00760                MOVLW  " "               ;
03C9   0080           00761                MOVWF  INDF              ;
03CA   0000           00762 DISP_ITEM2X:   NOP                      ;
                      00763                                         ;
03CB   0844           00764 DISP_ITEM3:    MOVF   ITEM_SEL,W        ;
03CC   3C03           00765                SUBLW  D'3'              ;
03CD   1D03           00766                BTFSS  STATUS,Z          ;
03CE   2BE0           00767                GOTO   DISP_ITEM3X       ;
03CF   3042           00768                MOVLW  "B"               ;
03D0   0080           00769                MOVWF  INDF              ;
03D1   0A84           00770                INCF   FSR,F             ;
03D2   3030           00771                MOVLW  "0"               ;
03D3   0080           00772                MOVWF  INDF              ;
03D4   0A84           00773                INCF   FSR,F             ;
03D5   3030           00774                MOVLW  "0"               ;
03D6   0080           00775                MOVWF  INDF              ;
03D7   0A84           00776                INCF   FSR,F             ;
03D8   306B           00777                MOVLW  "k"               ;
03D9   0080           00778                MOVWF  INDF              ;
03DA   0A84           00779                INCF   FSR,F             ;
03DB   3033           00780                MOVLW  "3"               ;
03DC   0080           00781                MOVWF  INDF              ;
03DD   0A84           00782                INCF   FSR,F             ;
03DE   3020           00783                MOVLW  " "               ;
03DF   0080           00784                MOVWF  INDF              ;
03E0   0000           00785 DISP_ITEM3X:   NOP                      ;
                      00786                                         ;
03E1   0844           00787 DISP_ITEM4:    MOVF   ITEM_SEL,W        ;
03E2   3C04           00788                SUBLW  D'4'              ;
03E3   1D03           00789                BTFSS  STATUS,Z          ;
03E4   2BF6           00790                GOTO   DISP_ITEM4X       ;
03E5   3042           00791                MOVLW  "B"               ;
```

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LOC  OBJECT CODE     LINE SOURCE TEXT
  VALUE

03E6   0080           00792                MOVWF  INDF              ;
03E7   0A84           00793                INCF   FSR,F             ;
03E8   302E           00794                MOVLW  "."               ;
```

```
03E9   0080           00795                MOVWF  INDF              ;
03EA   0A84           00796                INCF   FSR,F              ;
03EB   3050           00797                MOVLW  "P"               ;
03EC   0080           00798                MOVWF  INDF              ;
03ED   0A84           00799                INCF   FSR,F              ;
03EE   3065           00800                MOVLW  "e"               ;
03EF   0080           00801                MOVWF  INDF              ;
03F0   0A84           00802                INCF   FSR,F              ;
03F1   306E           00803                MOVLW  "n"               ;
03F2   0080           00804                MOVWF  INDF              ;
03F3   0A84           00805                INCF   FSR,F              ;
03F4   3020           00806                MOVLW  " "               ;
03F5   0080           00807                MOVWF  INDF              ;
03F6   0000           00808 DISP_ITEM4X:   NOP                      ;
                      00809                                         ;
03F7   0844           00810 DISP_ITEM5:    MOVF   ITEM_SEL,W        ;
03F8   3C05           00811                SUBLW  D'5'              ;
03F9   1D03           00812                BTFSS  STATUS,Z          ;
03FA   2C0C           00813                GOTO   DISP_ITEM5X       ;
03FB   3050           00814                MOVLW  "P"               ;
03FC   0080           00815                MOVWF  INDF              ;
03FD   0A84           00816                INCF   FSR,F              ;
03FE   3065           00817                MOVLW  "e"               ;
03FF   0080           00818                MOVWF  INDF              ;
0400   0A84           00819                INCF   FSR,F              ;
0401   306E           00820                MOVLW  "n"               ;
0402   0080           00821                MOVWF  INDF              ;
0403   0A84           00822                INCF   FSR,F              ;
0404   3063           00823                MOVLW  "c"               ;
0405   0080           00824                MOVWF  INDF              ;
0406   0A84           00825                INCF   FSR,F              ;
0407   3069           00826                MOVLW  "i"               ;
0408   0080           00827                MOVWF  INDF              ;
0409   0A84           00828                INCF   FSR,F              ;
040A   306C           00829                MOVLW  "l"               ;
040B   0080           00830                MOVWF  INDF              ;
040C   0000           00831 DISP_ITEM5X:   NOP                      ;
                      00832                                         ;
040D   0008           00833 DISP_ITEMX:    RETURN                   ;
                      00834
;*****************************************************************************
040E   0874           00835 DISP_DAT0:     MOVF   MSG_NUM,W         ;
040F   3C00           00836                SUBLW  D'0'              ;
0410   1D03           00837                BTFSS  STATUS,Z          ;
0411   2C56           00838                GOTO   DISP_DAT0X        ;
                      00839                                         ;
0412   3020           00840                MOVLW  LCD_RAM_BUF       ;
0413   3E0E           00841                ADDLW  D'14'             ;
0414   0084           00842                MOVWF  FSR               ;
0415   1784           00843                BSF    FSR,7             ;
```

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LOC  OBJECT CODE     LINE SOURCE TEXT
  VALUE

0416   0845          00845              MOVF   ITEM_VALUE,W      ;
0417   00FA          00846              MOVWF  TEMP2             ;
0418   24E8          00847              CALL   BIN2BCD           ;
                     00848                                       ;
0419   082D          00849              MOVF   TEN,W             ;
041A   390F          00850              ANDLW  H'0F'             ;
041B   3E30          00851              ADDLW  H'30'             ;
041C   0080          00852              MOVWF  INDF              ;
041D   0A84          00853              INCF   FSR,F             ;
041E   082E          00854              MOVF   UNIT,W            ;
041F   390F          00855              ANDLW  H'0F'             ;
0420   3E30          00856              ADDLW  H'30'             ;
0421   0080          00857              MOVWF  INDF              ;
                     00858                                       ;
0422   3020          00859              MOVLW  LCD_RAM_BUF       ;
0423   3E19          00860              ADDLW  D'25'             ;
0424   0084          00861              MOVWF  FSR               ;
0425   1784          00862              BSF    FSR,7             ;
                     00863                                       ;
0426   083C          00864              MOVF   SEL_QTY,W         ;
0427   390F          00865              ANDLW  H'0F'             ;
0428   3E30          00866              ADDLW  H'30'             ;
0429   0080          00867              MOVWF  INDF              ;
                     00868                                       ;
042A   3020          00869              MOVLW  LCD_RAM_BUF       ;
042B   3E21          00870              ADDLW  D'33'             ;
042C   0084          00871              MOVWF  FSR               ;
042D   1784          00872              BSF    FSR,7             ;
                     00873                                       ;
042E   083D          00874              MOVF   SEL_AMT,W         ;
042F   00FA          00875              MOVWF  TEMP2             ;
0430   24E8          00876              CALL   BIN2BCD           ;
                     00877                                       ;
0431   082C          00878              MOVF   HUNDRED,W         ;
0432   390F          00879              ANDLW  H'0F'             ;
0433   3E30          00880              ADDLW  H'30'             ;
0434   0080          00881              MOVWF  INDF              ;
0435   0A84          00882              INCF   FSR,F             ;
0436   082D          00883              MOVF   TEN,W             ;
0437   390F          00884              ANDLW  H'0F'             ;
0438   3E30          00885              ADDLW  H'30'             ;
0439   0080          00886              MOVWF  INDF              ;
043A   0A84          00887              INCF   FSR,F             ;
043B   082E          00888              MOVF   UNIT,W            ;
043C   390F          00889              ANDLW  H'0F'             ;
043D   3E30          00890              ADDLW  H'30'             ;
043E   0080          00891              MOVWF  INDF              ;
                     00892                                       ;
043F   3020          00893              MOVLW  LCD_RAM_BUF       ;
0440   3E35          00894              ADDLW  D'53'             ;
0441   0084          00895              MOVWF  FSR               ;
0442   1784          00896              BSF    FSR,7             ;
                     00897                                       ;
```

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LOC  OBJECT CODE     LINE SOURCE TEXT
  VALUE

0443   083A          00898               MOVF   SEL_TOTALHI,W     ;
0444   00F0          00899               MOVWF  DATA_HI          ;
0445   083B          00900               MOVF   SEL_TOTALLO,W     ;
0446   00F1          00901               MOVWF  DATA_LO          ;
0447   24FC          00902               CALL   BIN2DEC16        ;
                     00903                                       ;
0448   082C          00904               MOVF   HUNDRED,W        ;
0449   390F          00905               ANDLW  H'0F'            ;
044A   3E30          00906               ADDLW  H'30'            ;
044B   0080          00907               MOVWF  INDF             ;
044C   0A84          00908               INCF   FSR,F            ;
                     00909                                       ;
044D   082D          00910               MOVF   TEN,W            ;
044E   390F          00911               ANDLW  H'0F'            ;
044F   3E30          00912               ADDLW  H'30'            ;
0450   0080          00913               MOVWF  INDF             ;
0451   0A84          00914               INCF   FSR,F            ;
0452   082E          00915               MOVF   UNIT,W           ;
0453   390F          00916               ANDLW  H'0F'            ;
0454   3E30          00917               ADDLW  H'30'            ;
0455   0080          00918               MOVWF  INDF             ;
                     00919                                       ;
0456   0008          00920 DISP_DAT0X:   RETURN                  ;
                     00921
;*********************************************************************************
0457   0874          00922 DISP_DAT1:    MOVF   MSG_NUM,W        ;
0458   3C01          00923               SUBLW  D'1'             ;
0459   1D03          00924               BTFSS  STATUS,Z         ;
045A   2C8D          00925               GOTO   DISP_DAT1X       ;
                     00926                                       ;
045B   3020          00927               MOVLW  LCD_RAM_BUF      ;
045C   3E0E          00928               ADDLW  D'14'            ;
045D   0084          00929               MOVWF  FSR              ;
045E   1784          00930               BSF    FSR,7            ;
                     00931                                       ;
045F   3020          00932               MOVLW  LCD_RAM_BUF      ;
0460   3E21          00933               ADDLW  D'33'            ;
0461   0084          00934               MOVWF  FSR              ;
0462   1784          00935               BSF    FSR,7            ;
                     00936                                       ;
0463   0841          00937               MOVF   COIN_HI,W        ;
0464   00F0          00938               MOVWF  DATA_HI          ;
0465   0840          00939               MOVF   AMOUNT,W         ;
0466   00F1          00940               MOVWF  DATA_LO          ;
0467   24FC          00941               CALL   BIN2DEC16        ;
                     00942                                       ;
0468   082C          00943               MOVF   HUNDRED,W        ;
0469   390F          00944               ANDLW  H'0F'            ;
046A   3E30          00945               ADDLW  H'30'            ;
046B   0080          00946               MOVWF  INDF             ;
046C   0A84          00947               INCF   FSR,F            ;
046D   082D          00948               MOVF   TEN,W            ;
046E   390F          00949               ANDLW  H'0F'            ;
046F   3E30          00950               ADDLW  H'30'            ;
```

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LOC  OBJECT CODE     LINE SOURCE TEXT
  VALUE

0470   0080          00951              MOVWF  INDF             ;
0471   0A84          00952              INCF   FSR,F            ;
0472   082E          00953              MOVF   UNIT,W           ;
0473   390F          00954              ANDLW  H'0F'            ;
0474   3E30          00955              ADDLW  H'30'            ;
0475   0080          00956              MOVWF  INDF             ;
                     00957                                      ;
0476   3020          00958              MOVLW  LCD_RAM_BUF      ;
0477   3E35          00959              ADDLW  D'53'            ;
0478   0084          00960              MOVWF  FSR              ;
0479   1784          00961              BSF    FSR,7            ;
                     00962                                      ;
047A   083A          00963              MOVF   SEL_TOTALHI,W    ;
047B   00F0          00964              MOVWF  DATA_HI          ;
047C   083B          00965              MOVF   SEL_TOTALLO,W    ;
047D   00F1          00966              MOVWF  DATA_LO          ;
047E   24FC          00967              CALL   BIN2DEC16        ;
                     00968                                      ;
047F   082C          00969              MOVF   HUNDRED,W        ;
0480   390F          00970              ANDLW  H'0F'            ;
0481   3E30          00971              ADDLW  H'30'            ;
0482   0080          00972              MOVWF  INDF             ;
0483   0A84          00973              INCF   FSR,F            ;
0484   082D          00974              MOVF   TEN,W            ;
0485   390F          00975              ANDLW  H'0F'            ;
0486   3E30          00976              ADDLW  H'30'            ;
0487   0080          00977              MOVWF  INDF             ;
0488   0A84          00978              INCF   FSR,F            ;
0489   082E          00979              MOVF   UNIT,W           ;
048A   390F          00980              ANDLW  H'0F'            ;
048B   3E30          00981              ADDLW  H'30'            ;
048C   0080          00982              MOVWF  INDF             ;
                     00983                                      ;
048D   0008          00984 DISP_DAT1X:  RETURN                  ;
                     00985
;*********************************************************************
048E   0874          00986 DISP_DAT2:   MOVF   MSG_NUM,W        ;
048F   3C02          00987              SUBLW  D'2'             ;
0490   1D03          00988              BTFSS  STATUS,Z         ;
0491   2CCE          00989              GOTO   DISP_DAT2X       ;
                     00990                                      ;
0492   3020          00991              MOVLW  LCD_RAM_BUF      ;
0493   3E04          00992              ADDLW  D'4'             ;
0494   0084          00993              MOVWF  FSR              ;
0495   1784          00994              BSF    FSR,7            ;
                     00995                                      ;
0496   0860          00996              MOVF   SEL1_SALEHI,W    ;
0497   00F0          00997              MOVWF  DATA_HI          ;
0498   0861          00998              MOVF   SEL1_SALELO,W    ;
0499   00F1          00999              MOVWF  DATA_LO          ;
049A   24FC          01000              CALL   BIN2DEC16        ;
049B   24CF          01001              CALL   DISP_DEC         ;
                     01002                                      ;
049C   3020          01003              MOVLW  LCD_RAM_BUF      ;
```

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LOC  OBJECT CODE     LINE SOURCE TEXT
  VALUE

049D   3E0E          01004              ADDLW  D'14'             ;
049E   0084          01005              MOVWF  FSR               ;
049F   1784          01006              BSF    FSR,7             ;
                     01007                                       ;
04A0   0866          01008              MOVF   SEL4_SALEHI,W     ;
04A1   00F0          01009              MOVWF  DATA_HI           ;
04A2   0867          01010              MOVF   SEL4_SALELO,W     ;
04A3   00F1          01011              MOVWF  DATA_LO           ;
04A4   24FC          01012              CALL   BIN2DEC16         ;
04A5   24CF          01013              CALL   DISP_DEC          ;
                     01014                                       ;
04A6   3020          01015              MOVLW  LCD_RAM_BUF       ;
04A7   3E18          01016              ADDLW  D'24'             ;
04A8   0084          01017              MOVWF  FSR               ;
04A9   1784          01018              BSF    FSR,7             ;
                     01019                                       ;
04AA   0862          01020              MOVF   SEL2_SALEHI,W     ;
04AB   00F0          01021              MOVWF  DATA_HI           ;
04AC   0863          01022              MOVF   SEL2_SALELO,W     ;
04AD   00F1          01023              MOVWF  DATA_LO           ;
04AE   24FC          01024              CALL   BIN2DEC16         ;
04AF   24CF          01025              CALL   DISP_DEC          ;
                     01026                                       ;
04B0   3020          01027              MOVLW  LCD_RAM_BUF       ;
04B1   3E22          01028              ADDLW  D'34'             ;
04B2   0084          01029              MOVWF  FSR               ;
04B3   1784          01030              BSF    FSR,7             ;
                     01031                                       ;
04B4   0868          01032              MOVF   SEL5_SALEHI,W     ;
04B5   00F0          01033              MOVWF  DATA_HI           ;
04B6   0869          01034              MOVF   SEL5_SALELO,W     ;
04B7   00F1          01035              MOVWF  DATA_LO           ;
04B8   24FC          01036              CALL   BIN2DEC16         ;
04B9   24CF          01037              CALL   DISP_DEC          ;
                     01038                                       ;
04BA   3020          01039              MOVLW  LCD_RAM_BUF       ;
04BB   3E2C          01040              ADDLW  D'44'             ;
04BC   0084          01041              MOVWF  FSR               ;
04BD   1784          01042              BSF    FSR,7             ;
                     01043                                       ;
04BE   0864          01044              MOVF   SEL3_SALEHI,W     ;
04BF   00F0          01045              MOVWF  DATA_HI           ;
04C0   0865          01046              MOVF   SEL3_SALELO,W     ;
04C1   00F1          01047              MOVWF  DATA_LO           ;
04C2   24FC          01048              CALL   BIN2DEC16         ;
04C3   24CF          01049              CALL   DISP_DEC          ;
                     01050                                       ;
04C4   3020          01051              MOVLW  LCD_RAM_BUF       ;
04C5   3E36          01052              ADDLW  D'54'             ;
04C6   0084          01053              MOVWF  FSR               ;
04C7   1784          01054              BSF    FSR,7             ;
                     01055                                       ;
04C8   086A          01056              MOVF   TOTALSALEHI,W     ;
```

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LOC  OBJECT CODE     LINE SOURCE TEXT
  VALUE

04C9   00F0           01057                MOVWF  DATA_HI           ;
04CA   086B           01058                MOVF   TOTALSALELO,W     ;
04CB   00F1           01059                MOVWF  DATA_LO           ;
04CC   24FC           01060                CALL   BIN2DEC16         ;
04CD   24CF           01061                CALL   DISP_DEC          ;
                      01062                                         ;
04CE   0008           01063 DISP_DAT2X:    RETURN                   ;
                      01064                                         ;
04CF   082A           01065 DISP_DEC:      MOVF   THOUSND10,W       ;
04D0   390F           01066                ANDLW  H'0F'             ;
04D1   3E30           01067                ADDLW  H'30'             ;
04D2   0080           01068                MOVWF  INDF              ;
04D3   0A84           01069                INCF   FSR,F             ;
04D4   082B           01070                MOVF   THOUSAND,W        ;
04D5   390F           01071                ANDLW  H'0F'             ;
04D6   3E30           01072                ADDLW  H'30'             ;
04D7   0080           01073                MOVWF  INDF              ;
04D8   0A84           01074                INCF   FSR,F             ;
04D9   082C           01075                MOVF   HUNDRED,W         ;
04DA   390F           01076                ANDLW  H'0F'             ;
04DB   3E30           01077                ADDLW  H'30'             ;
04DC   0080           01078                MOVWF  INDF              ;
04DD   0A84           01079                INCF   FSR,F             ;
04DE   082D           01080                MOVF   TEN,W             ;
04DF   390F           01081                ANDLW  H'0F'             ;
04E0   3E30           01082                ADDLW  H'30'             ;
04E1   0080           01083                MOVWF  INDF              ;
04E2   0A84           01084                INCF   FSR,F             ;
04E3   082E           01085                MOVF   UNIT,W            ;
04E4   390F           01086                ANDLW  H'0F'             ;
04E5   3E30           01087                ADDLW  H'30'             ;
04E6   0080           01088                MOVWF  INDF              ;
04E7   0008           01089                RETURN                   ;
                      01090                                         ;
                      01091
;*********************************************************************
04E8   01AC           01092 BIN2BCD:       CLRF   HUNDRED           ;
04E9   01AD           01093                CLRF   TEN               ;
04EA   01AE           01094                CLRF   UNIT              ;
                      01095                                         ;
04EB   3064           01096 BCD_100:       MOVLW  D'100'            ;
04EC   027A           01097                SUBWF  TEMP2,W           ;
04ED   1C03           01098                BTFSS  STATUS,C          ;
04EE   2CF2           01099                GOTO   BCD_010           ;
04EF   00FA           01100                MOVWF  TEMP2             ;
04F0   0AAC           01101                INCF   HUNDRED,F         ;
04F1   2CEB           01102                GOTO   BCD_100           ;
                      01103                                         ;
04F2   300A           01104 BCD_010:       MOVLW  D'10'             ;
04F3   027A           01105                SUBWF  TEMP2,W           ;
04F4   1C03           01106                BTFSS  STATUS,C          ;
04F5   2CF9           01107                GOTO   BCD_001           ;
04F6   00FA           01108                MOVWF  TEMP2             ;
04F7   0AAD           01109                INCF   TEN,F             ;
```

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LOC  OBJECT CODE     LINE SOURCE TEXT
  VALUE

04F8   2CF2           01110               GOTO   BCD_010          ;
                      01111                                        ;
04F9   087A           01112 BCD_001:      MOVF   TEMP2,W           ;
04FA   00AE           01113               MOVWF  UNIT              ;
04FB   0008           01114               RETURN                   ;
                      01115
;*********************************************************************
04FC   01AE           01116 BIN2DEC16:    CLRF   UNIT              ;
04FD   01AD           01117               CLRF   TEN               ;
04FE   01AC           01118               CLRF   HUNDRED           ;
04FF   01AB           01119               CLRF   THOUSAND          ;
0500   01AA           01120               CLRF   THOUSND10         ;
                      01121                                        ;
0501   1BF0           01122               BTFSC  DATA_HI,7         ;
0502   0AAE           01123               INCF   UNIT,F            ;
                      01124                                        ;
0503   2530           01125               CALL   DATAX2            ;
0504   1B70           01126               BTFSC  DATA_HI,6         ;
0505   0AAE           01127               INCF   UNIT,F            ;
                      01128                                        ;
0506   2530           01129               CALL   DATAX2            ;
0507   1AF0           01130               BTFSC  DATA_HI,5         ;
0508   0AAE           01131               INCF   UNIT,F            ;
                      01132                                        ;
0509   2530           01133               CALL   DATAX2            ;
050A   1A70           01134               BTFSC  DATA_HI,4         ;
050B   0AAE           01135               INCF   UNIT,F            ;
                      01136                                        ;
050C   19F0           01137               BTFSC  DATA_HI,3         ;
050D   0AAE           01138               INCF   UNIT,F            ;
                      01139                                        ;
050E   2530           01140               CALL   DATAX2            ;
050F   1970           01141               BTFSC  DATA_HI,2         ;
0510   0AAE           01142               INCF   UNIT,F            ;
                      01143                                        ;
0511   2530           01144               CALL   DATAX2            ;
0512   18F0           01145               BTFSC  DATA_HI,1         ;
0513   0AAE           01146               INCF   UNIT,F            ;
                      01147                                        ;
0514   2530           01148               CALL   DATAX2            ;
0515   1870           01149               BTFSC  DATA_HI,0         ;
0516   0AAE           01150               INCF   UNIT,F            ;
                      01151                                        ;
0517   2530           01152               CALL   DATAX2            ;
0518   1BF1           01153               BTFSC  DATA_LO,7         ;
0519   0AAE           01154               INCF   UNIT,F            ;
                      01155                                        ;
051A   2530           01156               CALL   DATAX2            ;
051B   1B71           01157               BTFSC  DATA_LO,6         ;
051C   0AAE           01158               INCF   UNIT,F            ;
                      01159                                        ;
051D   2530           01160               CALL   DATAX2            ;
051E   1AF1           01161               BTFSC  DATA_LO,5         ;
051F   0AAE           01162               INCF   UNIT,F            ;
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LOC  OBJECT CODE     LINE SOURCE TEXT
  VALUE

                     01163                                          ;
0520   2530          01164                CALL   DATAX2             ;
0521   1A71          01165                BTFSC  DATA_LO,4          ;
0522   0AAE          01166                INCF   UNIT,F             ;
                     01167                                          ;
0523   2530          01168                CALL   DATAX2             ;
0524   19F1          01169                BTFSC  DATA_LO,3          ;
0525   0AAE          01170                INCF   UNIT,F             ;
                     01171                                          ;
0526   2530          01172                CALL   DATAX2             ;
0527   1971          01173                BTFSC  DATA_LO,2          ;
0528   0AAE          01174                INCF   UNIT,F             ;
                     01175                                          ;
0529   2530          01176                CALL   DATAX2             ;
052A   18F1          01177                BTFSC  DATA_LO,1          ;
052B   0AAE          01178                INCF   UNIT,F             ;
                     01179                                          ;
052C   2530          01180                CALL   DATAX2             ;
052D   1871          01181                BTFSC  DATA_LO,0          ;
052E   0AAE          01182                INCF   UNIT,F             ;
                     01183                                          ;
052F   0008          01184                RETURN                    ;
                     01185
;*******************************************************************************
0530   01A9          01186 DATAX2:        CLRF   CARRY              ;
                     01187                                          ;
0531   082E          01188 DOUBLE_001:    MOVF   UNIT,W             ;
0532   07AE          01189                ADDWF  UNIT,F             ;
0533   0829          01190                MOVF   CARRY,W            ;
0534   07AE          01191                ADDWF  UNIT,F             ;
0535   01A9          01192                CLRF   CARRY              ;
0536   300A          01193                MOVLW  D'10'              ;
0537   022E          01194                SUBWF  UNIT,W             ;
0538   1C03          01195                BTFSS  STATUS,C           ;
0539   2D3C          01196                GOTO   DOUBLE_001X        ;
053A   00AE          01197                MOVWF  UNIT               ;
053B   1429          01198                BSF    CARRY,0            ;
053C   0000          01199 DOUBLE_001X:   NOP                       ;
                     01200                                          ;
053D   082D          01201 DOUBLE_010:    MOVF   TEN,W              ;
053E   07AD          01202                ADDWF  TEN,F              ;
053F   0829          01203                MOVF   CARRY,W            ;
0540   07AD          01204                ADDWF  TEN,F              ;
0541   01A9          01205                CLRF   CARRY              ;
0542   300A          01206                MOVLW  D'10'              ;
0543   022D          01207                SUBWF  TEN,W              ;
0544   1C03          01208                BTFSS  STATUS,C           ;
0545   2D48          01209                GOTO   DOUBLE_010X        ;
0546   00AD          01210                MOVWF  TEN                ;
0547   1429          01211                BSF    CARRY,0            ;
0548   0000          01212 DOUBLE_010X:   NOP                       ;
                     01213                                          ;
0549   082C          01214 DOUBLE_100:    MOVF   HUNDRED,W          ;
054A   07AC          01215                ADDWF  HUNDRED,F          ;
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LOC  OBJECT CODE     LINE SOURCE TEXT
  VALUE

054B   0829           01216                MOVF   CARRY,W          ;
054C   07AC           01217                ADDWF  HUNDRED,F        ;
054D   01A9           01218                CLRF   CARRY            ;
054E   300A           01219                MOVLW  D'10'            ;
054F   022C           01220                SUBWF  HUNDRED,W        ;
0550   1C03           01221                BTFSS  STATUS,C         ;
0551   2D54           01222                GOTO   DOUBLE_100X      ;
0552   00AC           01223                MOVWF  HUNDRED          ;
0553   1429           01224                BSF    CARRY,0          ;
0554   0000           01225 DOUBLE_100X:   NOP                     ;
                      01226                                        ;
0555   082B           01227 DOUBLE_1K:     MOVF   THOUSAND,W       ;
0556   07AB           01228                ADDWF  THOUSAND,F       ;
0557   0829           01229                MOVF   CARRY,W          ;
0558   07AB           01230                ADDWF  THOUSAND,F       ;
0559   01A9           01231                CLRF   CARRY            ;
055A   300A           01232                MOVLW  D'10'            ;
055B   022B           01233                SUBWF  THOUSAND,W       ;
055C   1C03           01234                BTFSS  STATUS,C         ;
055D   2D60           01235                GOTO   DOUBLE_1KX       ;
055E   00AB           01236                MOVWF  THOUSAND         ;
055F   1429           01237                BSF    CARRY,0          ;
0560   0000           01238 DOUBLE_1KX:    NOP                     ;
                      01239                                        ;
0561   082A           01240 DOUBLE_10K:    MOVF   THOUSND10,W      ;
0562   07AA           01241                ADDWF  THOUSND10,F      ;
0563   0829           01242                MOVF   CARRY,W          ;
0564   07AA           01243                ADDWF  THOUSND10,F      ;
0565   01A9           01244                CLRF   CARRY            ;
0566   300A           01245                MOVLW  D'10'            ;
0567   022A           01246                SUBWF  THOUSND10,W      ;
0568   1C03           01247                BTFSS  STATUS,C         ;
0569   2D6C           01248                GOTO   DOUBLE_10KX      ;
056A   00AA           01249                MOVWF  THOUSND10        ;
056B   1429           01250                BSF    CARRY,0          ;
056C   0000           01251 DOUBLE_10KX:   NOP                     ;
                      01252                                        ;
056D   0008           01253                RETURN                   ;
                      01254
;*************************************************************************
                      01255                INCLUDE <SKULVENDLCD.INC>
                      00001
;*************************************************************************
056E   0850           00002 DO_TMR1:       MOVF   TMR1_SEC,W       ;
056F   1903           00003                BTFSC  STATUS,Z         ;
0570   2D79           00004                GOTO   DO_TMR1Z         ;
                      00005                                        ;
0571   0AD1           00006 INC_TMR1P:     INCF   TMR1_PRES,F      ;
0572   30FA           00007                MOVLW  D'250'           ; 1 sec rate
0573   0251           00008                SUBWF  TMR1_PRES,W      ;
0574   1C03           00009                BTFSS  STATUS,C         ;
0575   2D7B           00010                GOTO   DO_TMR1X         ;
0576   01D1           00011                CLRF   TMR1_PRES        ;
0577   03D0           00012                DECF   TMR1_SEC,F       ;
0578   2D7B           00013                GOTO   DO_TMR1X         ;
```

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LOC  OBJECT CODE     LINE SOURCE TEXT
  VALUE

                     00014                                          ;
0579   01D0          00015 DO_TMR1Z:     CLRF   TMR1_SEC            ;
057A   01D1          00016               CLRF   TMR1_PRES           ;
                     00017                                          ;
057B   0008          00018 DO_TMR1X:     RETURN                     ;
                     00019
;*********************************************************************
057C   0842          00020 DO_TMR2:      MOVF   CHANGE,W            ;
057D   1903          00021               BTFSC  STATUS,Z            ;
057E   2DA2          00022               GOTO   CHANGE_OK           ;
                     00023                                          ;
057F   0852          00024               MOVF   TMR2_SEC,W          ; Changer
0580   1D03          00025               BTFSS  STATUS,Z            ;
0581   2D8F          00026               GOTO   DO_TMR2A            ;
                     00027                                          ;
0582   3019          00028               MOVLW  D'25'               ;
0583   00D2          00029               MOVWF  TMR2_SEC            ;
                     00030                                          ;
0584   3005          00031 MOTORP5:      MOVLW  D'5'                ;
0585   0242          00032               SUBWF  CHANGE,W            ;
0586   1C03          00033               BTFSS  STATUS,C            ;
0587   2D8C          00034               GOTO   MOTORP1             ;
0588   1687          00035               BSF    PORTC,5             ;
0589   3005          00036               MOVLW  D'5'                ;
058A   00AF          00037               MOVWF  COIN_VAL            ;
058B   2D8F          00038               GOTO   DO_TMR2A            ;
                     00039                                          ;
058C   1607          00040 MOTORP1:      BSF    PORTC,4             ;
058D   3001          00041               MOVLW  D'1'                ;
058E   00AF          00042               MOVWF  COIN_VAL            ;
                     00043                                          ;
058F   3014          00044 DO_TMR2A:     MOVLW  D'20'               ;
0590   0252          00045               SUBWF  TMR2_SEC,W          ;
0591   1803          00046               BTFSC  STATUS,C            ;
0592   2D95          00047               GOTO   DO_TMR2B            ;
0593   1207          00048               BCF    PORTC,4             ;
0594   1287          00049               BCF    PORTC,5             ;
                     00050                                          ;
0595   0AD3          00051 DO_TMR2B:     INCF   TMR2_PRES,F         ;
0596   300A          00052               MOVLW  D'10'               ;
0597   0253          00053               SUBWF  TMR2_PRES,W         ;
0598   1C03          00054               BTFSS  STATUS,C            ;
0599   2DA4          00055               GOTO   DO_TMR2X            ;
059A   01D3          00056               CLRF   TMR2_PRES           ;
059B   03D2          00057               DECF   TMR2_SEC,F          ;
059C   0852          00058               MOVF   TMR2_SEC,W          ;
059D   1D03          00059               BTFSS  STATUS,Z            ;
059E   2DA4          00060               GOTO   DO_TMR2X            ;
059F   082F          00061               MOVF   COIN_VAL,W          ;
05A0   02C2          00062               SUBWF  CHANGE,F            ;
05A1   2DA4          00063               GOTO   DO_TMR2X            ;
                     00064                                          ;
05A2   1207          00065 CHANGE_OK:    BCF    PORTC,4             ;
05A3   1287          00066               BCF    PORTC,5             ;
```

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LOC  OBJECT CODE     LINE SOURCE TEXT
  VALUE

                     00067                                          ;
05A4   0008          00068 DO_TMR2X:     RETURN                     ;
                     00069
;*********************************************************************
05A5   0846          00070 DO_TMR3:      MOVF   ITEM1_QTY,W         ; Book1
05A6   1903          00071               BTFSC  STATUS,Z            ;
05A7   2DAF          00072               GOTO   ITEM1_OK            ;
05A8   1408          00073               BSF    PORTD,0             ;
                     00074                                          ;
05A9   18A0          00075               BTFSC  PORTC_NEW,1         ;
05AA   2DB0          00076               GOTO   DO_TMR3X            ;
05AB   1CA1          00077               BTFSS  PORTC_PREV,1        ;
05AC   2DB0          00078               GOTO   DO_TMR3X            ;
05AD   03C6          00079               DECF   ITEM1_QTY,F         ;
05AE   2DB0          00080               GOTO   DO_TMR3X            ;
                     00081                                          ;
05AF   1008          00082 ITEM1_OK:     BCF    PORTD,0             ;
                     00083                                          ;
05B0   0008          00084 DO_TMR3X:     RETURN                     ;
                     00085
;*********************************************************************
05B1   0847          00086 DO_TMR4:      MOVF   ITEM2_QTY,W         ; Book2
05B2   1903          00087               BTFSC  STATUS,Z            ;
05B3   2DBB          00088               GOTO   ITEM2_OK            ;
05B4   1488          00089               BSF    PORTD,1             ;
                     00090                                          ;
05B5   19A0          00091               BTFSC  PORTC_NEW,3         ;
05B6   2DBC          00092               GOTO   DO_TMR4X            ;
05B7   1DA1          00093               BTFSS  PORTC_PREV,3        ;
05B8   2DBC          00094               GOTO   DO_TMR4X            ;
05B9   03C7          00095               DECF   ITEM2_QTY,F         ;
05BA   2DBC          00096               GOTO   DO_TMR4X            ;
                     00097                                          ;
05BB   1088          00098 ITEM2_OK:     BCF    PORTD,1             ;
                     00099                                          ;
05BC   0008          00100 DO_TMR4X:     RETURN                     ;
                     00101
;*********************************************************************
05BD   0848          00102 DO_TMR5:      MOVF   ITEM3_QTY,W         ; Book3
05BE   1903          00103               BTFSC  STATUS,Z            ;
05BF   2DC7          00104               GOTO   ITEM3_OK            ;
05C0   1508          00105               BSF    PORTD,2             ;
                     00106                                          ;
05C1   1B20          00107               BTFSC  PORTC_NEW,6         ;
05C2   2DC8          00108               GOTO   DO_TMR5X            ;
05C3   1F21          00109               BTFSS  PORTC_PREV,6        ;
05C4   2DC8          00110               GOTO   DO_TMR5X            ;
05C5   03C8          00111               DECF   ITEM3_QTY,F         ;
05C6   2DC8          00112               GOTO   DO_TMR5X            ;
                     00113                                          ;
05C7   1108          00114 ITEM3_OK:     BCF    PORTD,2             ;
                     00115                                          ;
05C8   0008          00116 DO_TMR5X:     RETURN                     ;
                     00117
;*********************************************************************
05C9   085A          00118 DO_TMR6:      MOVF   TMR6_SEC,W          ; Ball Pen
```

```
LOC  OBJECT CODE     LINE SOURCE TEXT
  VALUE

05CB   2DD2           00120               GOTO   DO_TMR6A          ;

05CC   0849           00122               MOVF   ITEM4_QTY,W       ;
05CD   1903           00123               BTFSC  STATUS,Z          ;
05CE   2DE2           00124               GOTO   ITEM4_OK          ;
                      00125                                        ;
05CF   3032           00126               MOVLW  D'50'             ;
05D0   00DA           00127               MOVWF  TMR6_SEC          ;
05D1   1588           00128               BSF    PORTD,3           ;
                      00129                                        ;
05D2   301E           00130 DO_TMR6A:     MOVLW  D'30'             ;
05D3   025A           00131               SUBWF  TMR6_SEC,W        ;
05D4   1C03           00132               BTFSS  STATUS,C          ;
05D5   1188           00133               BCF    PORTD,3           ;
05D6   0ADB           00134 DO_TMR6B:     INCF   TMR6_PRES,F       ;
05D7   3019           00135               MOVLW  D'25'             ;
05D8   025B           00136               SUBWF  TMR6_PRES,W       ;
05D9   1C03           00137               BTFSS  STATUS,C          ;
05DA   2DE3           00138               GOTO   DO_TMR6X          ;
05DB   01DB           00139               CLRF   TMR6_PRES         ;
05DC   03DA           00140               DECF   TMR6_SEC,F        ;
05DD   085A           00141               MOVF   TMR6_SEC,W        ;
05DE   1D03           00142               BTFSS  STATUS,Z          ;
05DF   2DE3           00143               GOTO   DO_TMR6X          ;
05E0   03C9           00144               DECF   ITEM4_QTY,F       ;
05E1   2DE3           00145               GOTO   DO_TMR6X          ;
                      00146                                        ;
05E2   1188           00147 ITEM4_OK:     BCF    PORTD,3           ;
                      00148                                        ;
05E3   0008           00149 DO_TMR6X:     RETURN                   ;
                      00150
;*************************************************************************
05E4   085C           00151 DO_TMR7:      MOVF   TMR7_SEC,W        ; Pencil
05E5   1D03           00152               BTFSS  STATUS,Z          ;
05E6   2DED           00153               GOTO   DO_TMR7A          ;
                      00154                                        ;
05E7   084A           00155               MOVF   ITEM5_QTY,W       ;
05E8   1903           00156               BTFSC  STATUS,Z          ;
05E9   2DFD           00157               GOTO   ITEM5_OK          ;
                      00158                                        ;
05EA   3032           00159               MOVLW  D'50'             ;
05EB   00DC           00160               MOVWF  TMR7_SEC          ;
05EC   1608           00161               BSF    PORTD,4           ;
                      00162                                        ;
05ED   301E           00163 DO_TMR7A:     MOVLW  D'30'             ;
05EE   025C           00164               SUBWF  TMR7_SEC,W        ;
05EF   1C03           00165               BTFSS  STATUS,C          ;
05F0   1208           00166               BCF    PORTD,4           ;
05F1   0ADD           00167 DO_TMR7B:     INCF   TMR7_PRES,F       ;
05F2   3019           00168               MOVLW  D'25'             ;
05F3   025D           00169               SUBWF  TMR7_PRES,W       ;
05F4   1C03           00170               BTFSS  STATUS,C          ;
05F5   2DFE           00171               GOTO   DO_TMR7X          ;
05F6   01DD           00172               CLRF   TMR7_PRES         ;
```

```
LOC  OBJECT CODE     LINE SOURCE TEXT
  VALUE

05F7   03DC           00173               DECF   TMR7_SEC,F        ;
05F8   085C           00174               MOVF   TMR7_SEC,W        ;
05F9   1D03           00175               BTFSS  STATUS,Z          ;
05FA   2DFE           00176               GOTO   DO_TMR7X          ;
05FB   03CA           00177               DECF   ITEM5_QTY,F       ;
05FC   2DFE           00178               GOTO   DO_TMR7X          ;
                      00179                                        ;
05FD   1208           00180 ITEM5_OK:     BCF    PORTD,4           ;
                      00181                                        ;
05FE   0008           00182 DO_TMR7X:     RETURN                   ;
                      00183
;***********************************************************************
                      00184 ;             LCD Subroutine           ;
                      00185
;***********************************************************************
                      00186 ;VARIABLE USED                         ;
                      00187 ;Wait1_Val                             ;
                      00188 ;Wait2_Val                             ;
                      00189 ;Msg_Num                               ;
                      00190 ;Temp1                                 ;
                      00191 ;Temp2                                 ;
                      00192 ;Temp3                                 ;
                      00193 ;Temp4                                 ;
                      00194                                        ;
  00000006            00195 LCD_DPORT     EQU    PORTB             ;
  00000008            00196 LCD_CPORT     EQU    PORTD             ;
  00000007            00197 LCD_EN        EQU    7                 ;
  00000006            00198 LCD_RS        EQU    6                 ;
                      00199                                        ;
  00000004            00200 LCD_LINE_MAX  EQU    D'4'              ;
  00000014            00201 LCD_CHAR_MAX  EQU    D'20'             ;
  00000080            00202 LCD_L1_ADDR   EQU    D'00' +H'80'       ; = H'80'
  000000A8            00203 LCD_L2_ADDR   EQU    LCD_L1_ADDR +D'40' ; = H'A8'
  00000094            00204 LCD_L3_ADDR   EQU    LCD_L1_ADDR +D'20' ; = H'94'
  000000D4            00205 LCD_L4_ADDR   EQU    LCD_L1_ADDR +H'54' ; = H'D4'
                      00206                                        ;
                      00207 SET_RS0:      MACRO                    ;
                      00208               BCF    LCD_CPORT,LCD_RS  ;
                      00209               ENDM                     ;
                      00210                                        ;
                      00211 SET_RS1:      MACRO                    ;
                      00212               BSF    LCD_CPORT,LCD_RS  ;
                      00213               ENDM                     ;
                      00214                                        ;
05FF   1788           00215 PULSE_EN:     BSF    LCD_CPORT,LCD_EN  ;
0600   0000           00216               NOP                      ;
0601   0000           00217               NOP                      ;
0602   0000           00218               NOP                      ;
0603   0000           00219               NOP                      ;
0604   1388           00220               BCF    LCD_CPORT,LCD_EN  ;
0605   2627           00221               CALL   WAIT1             ;
0606   0008           00222               RETURN                   ;
                      00223                                        ;
                      00224
;***********************************************************************
                      00225 INIT_LCD:     SET_RS0                  ;set RS to 0
```

```
LOC  OBJECT CODE     LINE SOURCE TEXT
  VALUE

0607   1308               M               BCF    LCD_CPORT,LCD_RS  ;
0608   30C8           00226               MOVLW  D'200'            ;load 10mS
delay
0609   262D           00227               CALL   WAIT2             ;
060A   30C8           00228               MOVLW  D'200'            ;load 10mS
delay
060B   262D           00229               CALL   WAIT2             ;
                      00230                                        ;
060C   3038           00231               MOVLW  H'38'             ;set LCD to
8 Bit Data, 2 line display
060D   0086           00232               MOVWF  LCD_DPORT         ;
060E   25FF           00233               CALL   PULSE_EN          ;
060F   3064           00234               MOVLW  D'100'            ;load 5mS
delay
0610   262D           00235               CALL   WAIT2             ;
                      00236                                        ;
0611   25FF           00237               CALL   PULSE_EN          ;
0612   3064           00238               MOVLW  D'100'            ;load 5mS
delay
0613   262D           00239               CALL   WAIT2             ;
                      00240                                        ;
0614   25FF           00241               CALL   PULSE_EN          ;
0615   3064           00242               MOVLW  D'100'            ;load 5mS
delay
0616   262D           00243               CALL   WAIT2             ;
                      00244                                        ;
0617   3006           00245               MOVLW  H'06'             ;set Display
Increment, No Shift
0618   0086           00246               MOVWF  LCD_DPORT         ;
0619   25FF           00247               CALL   PULSE_EN          ;
                      00248                                        ;
061A   300F           00249               MOVLW  H'0F'             ;set
Disp=ON, Cursor=ON, Blink=ON
061B   300C           00250               MOVLW  H'0C'             ;set
Disp=ON, Cursor=OFF, Blink=OFF
061C   0086           00251               MOVWF  LCD_DPORT         ;
061D   25FF           00252               CALL   PULSE_EN          ;
                      00253                                        ;
061E   3014           00254               MOVLW  H'14'             ;set
CursorMove, Shift to Right
061F   0086           00255               MOVWF  LCD_DPORT         ;
0620   25FF           00256               CALL   PULSE_EN          ;
                      00257                                        ;
0621   3001           00258               MOVLW  H'01'             ;Clear LCD
Display
0622   0086           00259               MOVWF  LCD_DPORT         ;
0623   25FF           00260               CALL   PULSE_EN          ;
                      00261                                        ;
0624   3064           00262               MOVLW  D'100'            ;load 5mS
delay
0625   262D           00263               CALL   WAIT2             ;
                      00264                                        ;
0626   0008           00265               RETURN                   ;
                      00266                                        ;
0627   3010           00267 WAIT1:        MOVLW  H'10'             ;approx.
50uS delay
0628   00F2           00268               MOVWF  WAIT1_VAL         ;
0629   03F2           00269 WAIT1_LOOP:   DECF   WAIT1_VAL,F       ;
```

```
062A   1D03           00270               BTFSS  STATUS,Z          ;
062B   2E29           00271               GOTO   WAIT1_LOOP        ;
062C   0008           00272               RETURN                   ;
                      00273                                        ;
062D   00F3           00274 WAIT2:        MOVWF  WAIT2_VAL         ;N x 50uS
delay
062E   2627           00275 WAIT2_LOOP    CALL   WAIT1             ;
062F   03F3           00276               DECF   WAIT2_VAL,F       ;
0630   1D03           00277               BTFSS  STATUS,Z          ;


LOC  OBJECT CODE     LINE SOURCE TEXT
  VALUE

0631   2E2E           00278               GOTO   WAIT2_LOOP        ;
0632   0008           00279               RETURN                   ;
                      00280
;*****************************************************************************
0633   0000           00281 DISP_LCD:     NOP                      ;
                      00282                                        ;
                      00283 DISP_LCD1:    SET_RS0                  ;
0634   1308               M               BCF    LCD_CPORT,LCD_RS  ;
0635   3080           00284               MOVLW  LCD_L1_ADDR       ;
0636   0086           00285               MOVWF  LCD_DPORT         ;
0637   25FF           00286               CALL   PULSE_EN          ;
                      00287               SET_RS1                  ;
0638   1708               M               BSF    LCD_CPORT,LCD_RS  ;
0639   01F9           00288               CLRF   TEMP1             ;
063A   3014           00289 RAM2LCD1:     MOVLW  LCD_CHAR_MAX      ;
063B   0279           00290               SUBWF  TEMP1,W           ;
063C   1903           00291               BTFSC  STATUS,Z          ;
063D   2E47           00292               GOTO   RAM2LCD1X         ;
063E   3020           00293               MOVLW  LCD_RAM_BUF       ;
063F   0779           00294               ADDWF  TEMP1,W           ;
0640   0084           00295               MOVWF  FSR               ;
0641   1784           00296               BSF    FSR,7             ;Ind_Addr
Select Bank 1
0642   0800           00297               MOVF   INDF,W            ;
0643   0086           00298               MOVWF  LCD_DPORT         ;
0644   25FF           00299               CALL   PULSE_EN          ;
0645   0AF9           00300               INCF   TEMP1,F           ;
0646   2E3A           00301               GOTO   RAM2LCD1          ;
0647   0000           00302 RAM2LCD1X:    NOP                      ;
                      00303                                        ;
                      00304 DISP_LCD2:    SET_RS0                  ;
0648   1308               M               BCF    LCD_CPORT,LCD_RS  ;
0649   30A8           00305               MOVLW  LCD_L2_ADDR       ;
064A   0086           00306               MOVWF  LCD_DPORT         ;
064B   25FF           00307               CALL   PULSE_EN          ;
                      00308               SET_RS1                  ;
064C   1708               M               BSF    LCD_CPORT,LCD_RS  ;
064D   01F9           00309               CLRF   TEMP1             ;
064E   3014           00310 RAM2LCD2:     MOVLW  LCD_CHAR_MAX      ;
064F   0279           00311               SUBWF  TEMP1,W           ;
0650   1903           00312               BTFSC  STATUS,Z          ;
0651   2E5C           00313               GOTO   RAM2LCD2X         ;
0652   3020           00314               MOVLW  LCD_RAM_BUF       ;
0653   3E14           00315               ADDLW  LCD_CHAR_MAX      ;
0654   0779           00316               ADDWF  TEMP1,W           ;
0655   0084           00317               MOVWF  FSR               ;
0656   1784           00318               BSF    FSR,7             ;Ind_Addr
Select Bank 1
```

```
0657   0800           00319                MOVF   INDF,W            ;
0658   0086           00320                MOVWF  LCD_DPORT         ;
0659   25FF           00321                CALL   PULSE_EN          ;
065A   0AF9           00322                INCF   TEMP1,F           ;
065B   2E4E           00323                GOTO   RAM2LCD2          ;
065C   0000           00324 RAM2LCD2X:     NOP                      ;
                      00325                                         ;
                      00326 DISP_LCD3:     SET_RS0                  ;

LOC  OBJECT CODE     LINE SOURCE TEXT
  VALUE

065D   1308               M                BCF    LCD_CPORT,LCD_RS  ;
065E   3094           00327                MOVLW  LCD_L3_ADDR       ;
065F   0086           00328                MOVWF  LCD_DPORT         ;
0660   25FF           00329                CALL   PULSE_EN          ;
                      00330                SET_RS1                  ;
0661   1708               M                BSF    LCD_CPORT,LCD_RS  ;
0662   01F9           00331                CLRF   TEMP1             ;
0663   3014           00332 RAM2LCD3:      MOVLW  LCD_CHAR_MAX      ;
0664   0279           00333                SUBWF  TEMP1,W           ;
0665   1903           00334                BTFSC  STATUS,Z          ;
0666   2E72           00335                GOTO   RAM2LCD3X         ;
0667   3020           00336                MOVLW  LCD_RAM_BUF       ;
0668   3E14           00337                ADDLW  LCD_CHAR_MAX      ;
0669   3E14           00338                ADDLW  LCD_CHAR_MAX      ;
066A   0779           00339                ADDWF  TEMP1,W           ;
066B   0084           00340                MOVWF  FSR               ;
066C   1784           00341                BSF    FSR,7             ;Ind_Addr
Select Bank 1
066D   0800           00342                MOVF   INDF,W            ;
066E   0086           00343                MOVWF  LCD_DPORT         ;
066F   25FF           00344                CALL   PULSE_EN          ;
0670   0AF9           00345                INCF   TEMP1,F           ;
0671   2E63           00346                GOTO   RAM2LCD3          ;
0672   0000           00347 RAM2LCD3X:     NOP                      ;
                      00348                                         ;
                      00349 DISP_LCD4:     SET_RS0                  ;
0673   1308               M                BCF    LCD_CPORT,LCD_RS  ;
0674   30D4           00350                MOVLW  LCD_L4_ADDR       ;
0675   0086           00351                MOVWF  LCD_DPORT         ;
0676   25FF           00352                CALL   PULSE_EN          ;
                      00353                SET_RS1                  ;
0677   1708               M                BSF    LCD_CPORT,LCD_RS  ;
0678   01F9           00354                CLRF   TEMP1             ;
0679   3014           00355 RAM2LCD4:      MOVLW  LCD_CHAR_MAX      ;
067A   0279           00356                SUBWF  TEMP1,W           ;
067B   1903           00357                BTFSC  STATUS,Z          ;
067C   2E89           00358                GOTO   RAM2LCD4X         ;
067D   3020           00359                MOVLW  LCD_RAM_BUF       ;
067E   3E14           00360                ADDLW  LCD_CHAR_MAX      ;
067F   3E14           00361                ADDLW  LCD_CHAR_MAX      ;
0680   3E14           00362                ADDLW  LCD_CHAR_MAX      ;
0681   0779           00363                ADDWF  TEMP1,W           ;
0682   0084           00364                MOVWF  FSR               ;
0683   1784           00365                BSF    FSR,7             ;Ind_Addr
Select Bank 1
0684   0800           00366                MOVF   INDF,W            ;
0685   0086           00367                MOVWF  LCD_DPORT         ;
0686   25FF           00368                CALL   PULSE_EN          ;
0687   0AF9           00369                INCF   TEMP1,F           ;
0688   2E79           00370                GOTO   RAM2LCD4          ;
```

```
0689   0000           00371 RAM2LCD4X:    NOP                     ;
                      00372                                        ;
068A   0008           00373               RETURN                  ;
                      00374
;*********************************************************************
068B   01F9           00375 LD_MSG2RAM:   CLRF   TEMP1            ;

LOC  OBJECT CODE     LINE SOURCE TEXT
  VALUE

068C   01FB           00376               CLRF   TEMP3            ;
068D   0874           00377               MOVF   MSG_NUM,W        ;
068E   00F9           00378               MOVWF  TEMP1            ;
068F   3003           00379               MOVLW  D'3'             ;
0690   0279           00380               SUBWF  TEMP1,W          ;
0691   1C03           00381               BTFSS  STATUS,C         ;
0692   2E95           00382               GOTO   LD_MSG_ADR       ;skip if
greater than or equal
0693   3003           00383               MOVLW  D'3'             ;
0694   02F9           00384               SUBWF  TEMP1,F          ;
                      00385                                       ;
0695   0879           00386 LD_MSG_ADR:   MOVF   TEMP1,W          ;
0696   1903           00387               BTFSC  STATUS,Z         ;
0697   2E9C           00388               GOTO   LD_MSGLOOP       ;
0698   3050           00389               MOVLW  D'80'            ;
0699   07FB           00390               ADDWF  TEMP3,F          ;
069A   03F9           00391               DECF   TEMP1,F          ;
069B   2E95           00392               GOTO   LD_MSG_ADR       ;
                      00393                                       ;
069C   3050           00394 LD_MSGLOOP:   MOVLW  D'80'            ;
069D   0279           00395               SUBWF  TEMP1,W          ;
069E   1903           00396               BTFSC  STATUS,Z         ;
069F   2EB2           00397               GOTO   LD_MSGDONE       ;
                      00398                                       ;
06A0   080A           00399 LD_MSG0_2:    MOVF   PCLATH,W         ;
06A1   00FC           00400               MOVWF  TEMP4            ;
06A2   3001           00401               MOVLW  HIGH MSG0        ;
06A3   008A           00402               MOVWF  PCLATH           ;
06A4   0879           00403               MOVF   TEMP1,W          ;
06A5   077B           00404               ADDWF  TEMP3,W          ;
06A6   2100           00405               CALL   MSG0             ;
06A7   00FA           00406               MOVWF  TEMP2            ;
06A8   087C           00407               MOVF   TEMP4,W          ;
06A9   008A           00408               MOVWF  PCLATH           ;
                      00409                                       ;
06AA   3020           00410 LD_MSG_CHAR:  MOVLW  LCD_RAM_BUF      ;
06AB   0779           00411               ADDWF  TEMP1,W          ;
06AC   0084           00412               MOVWF  FSR              ;
06AD   1784           00413               BSF    FSR,7            ;Ind_Addr
Select Bank 1
06AE   087A           00414               MOVF   TEMP2,W          ;
06AF   0080           00415               MOVWF  INDF             ;
06B0   0AF9           00416               INCF   TEMP1,F          ;
06B1   2E9C           00417               GOTO   LD_MSGLOOP       ;
06B2   0008           00418 LD_MSGDONE:   RETURN                  ;
                      00419
;*********************************************************************
                      01256
;*********************************************************************
                      01257               END                     ;

SYMBOL TABLE
```

LABEL	VALUE
ACKDT	00000005
ACKEN	00000004
ACKSTAT	00000006
ADCON0	0000001F
ADCON1	0000009F
ADCS0	00000006
ADCS1	00000007
ADCS2	00000006
ADD2SALE	00000358
ADDEN	00000003
ADDSALE1	00000359
ADDSALE2	00000361
ADDSALE3	00000369
ADDSALE4	00000371
ADDSALE5	00000379
ADFM	00000007
ADIE	00000006
ADIF	00000006
ADON	00000000
ADRESH	0000001E
ADRESL	0000009E
AMOUNT	00000040
BCD_001	000004F9
BCD_010	000004F2
BCD_100	000004EB
BCLIE	00000003
BCLIF	00000003
BF	00000000
BIN2BCD	000004E8
BIN2DEC16	000004FC
BRGH	00000002
C	00000000
C1INV	00000004
C1OUT	00000006
C2INV	00000005
C2OUT	00000007
CARRY	00000029
CCP1CON	00000017
CCP1IE	00000002
CCP1IF	00000002
CCP1M0	00000000
CCP1M1	00000001
CCP1M2	00000002
CCP1M3	00000003
CCP1X	00000005
CCP1Y	00000004
CCP2CON	0000001D
CCP2IE	00000000
CCP2IF	00000000
CCP2M0	00000000
CCP2M1	00000001
CCP2M2	00000002
CCP2M3	00000003

SYMBOL TABLE

LABEL	VALUE
CCP2X	00000005
CCP2Y	00000004
CCPR1H	00000016

```
CCPR1L                            00000015
CCPR2H                            0000001C
CCPR2L                            0000001B
CHANGE                            00000042
CHANGE_HI                         00000043
CHANGE_OK                         000005A2
CHS0                              00000003
CHS1                              00000004
CHS2                              00000005
CIS                               00000003
CKE                               00000006
CKP                               00000004
CM0                               00000000
CM1                               00000001
CM2                               00000002
CMCON                             0000009C
CMIE                              00000006
CMIF                              00000006
COIN_HI                           00000041
COIN_VAL                          0000002F
COMP_ITEM                         00000264
COMP_ITEM1                        0000026F
COMP_ITEM2                        0000027A
COMP_ITEM3                        00000285
COMP_ITEM4                        00000290
COMP_ITEM5                        0000029B
COMP_ITEMLP                       00000265
COMP_ITEMS                        0000026D
COMP_ITEMX                        0000026C
CREN                              00000004
CSRC                              00000007
CVR0                              00000000
CVR1                              00000001
CVR2                              00000002
CVR3                              00000003
CVRCON                            0000009D
CVREN                             00000007
CVROE                             00000006
CVRR                              00000005
D                                 00000005
DATAX2                            00000530
DATA_ADDRESS                      00000005
DATA_HI                           00000070
DATA_LO                           00000071
DC                                00000001
DISP_DAT0                         0000040E
DISP_DAT0X                        00000456
DISP_DAT1                         00000457
DISP_DAT1X                        0000048D
SYMBOL TABLE
  LABEL                             VALUE

DISP_DAT2X                        000004CE
DISP_DEC                          000004CF
DISP_ITEM                         0000039B
DISP_ITEM1                        0000039F
DISP_ITEM1X                       000003B4
DISP_ITEM2                        000003B5
DISP_ITEM2X                       000003CA
DISP_ITEM3                        000003CB
DISP_ITEM3X                       000003E0
DISP_ITEM4                        000003E1
```

DISP_ITEM4X	000003F6
DISP_ITEM5	000003F7
DISP_ITEM5X	0000040C
DISP_ITEMX	0000040D
DISP_LCD	00000633
DISP_LCD1	00000634
DISP_LCD2	00000648
DISP_LCD3	0000065D
DISP_LCD4	00000673
DOUBLE_001	00000531
DOUBLE_001X	0000053C
DOUBLE_010	0000053D
DOUBLE_010X	00000548
DOUBLE_100	00000549
DOUBLE_100X	00000554
DOUBLE_10K	00000561
DOUBLE_10KX	0000056C
DOUBLE_1K	00000555
DOUBLE_1KX	00000560
DO_MSG0	000002A7
DO_MSG0X	000002DC
DO_MSG0_A	000002DD
DO_MSG0_AX	000002E1
DO_MSG0_B	000002E2
DO_MSG0_B1	000002ED
DO_MSG0_BX	000002F0
DO_MSG0_X	000002DA
DO_MSG1	000002F1
DO_MSG11	0000030C
DO_MSG14	0000031B
DO_MSG14X	00000337
DO_MSG1A	00000338
DO_MSG1B	0000033D
DO_MSG1X	0000030B
DO_MSG1_X	00000309
DO_MSG2	0000033F
DO_MSG2X	00000351
DO_MSG2_A	00000352
DO_MSG2_AX	00000355
DO_MSG2_B	00000356
DO_MSG2_BX	00000357
DO_MSG2_X	0000034F
DO_TMR1	0000056E

SYMBOL TABLE

LABEL	VALUE
DO_TMR1X	0000057B
DO_TMR1Z	00000579
DO_TMR2	0000057C
DO_TMR2A	0000058F
DO_TMR2B	00000595
DO_TMR2X	000005A4
DO_TMR3	000005A5
DO_TMR3X	000005B0
DO_TMR4	000005B1
DO_TMR4X	000005BC
DO_TMR5	000005BD
DO_TMR5X	000005C8
DO_TMR6	000005C9
DO_TMR6A	000005D2
DO_TMR6B	000005D6
DO_TMR6X	000005E3
DO_TMR7	000005E4
DO_TMR7A	000005ED
DO_TMR7B	000005F1
DO_TMR7X	000005FE
D_A	00000005
EEADR	0000010D
EEADRH	0000010F
EECON1	0000018C
EECON2	0000018D
EEDATA	0000010C
EEDATH	0000010E
EEIE	00000004
EEIF	00000004
EEPGD	00000007
F	00000001
FERR	00000002
FSR	00000004
GCEN	00000007
GIE	00000007
GO	00000002
GO_DONE	00000002
HUNDRED	0000002C
I2C_DATA	00000005
I2C_READ	00000002
I2C_START	00000003
I2C_STOP	00000004
IBF	00000007
IBOV	00000005
INC_TMR1P	00000571
INDF	00000000
INITIALIZE	00000005
INIT_LCD	00000607
INIT_VAR	00000053
INTCON	0000000B
INTE	00000004
INTEDG	00000006
INTF	00000001

SYMBOL TABLE

LABEL	VALUE
IRP	00000007
ISR_ROUTINE	0000001F
ITEM1_OK	000005AF
ITEM1_QTY	00000046
ITEM2_OK	000005BB
ITEM2_QTY	00000047
ITEM3_OK	000005C7
ITEM3_QTY	00000048
ITEM4_OK	000005E2
ITEM4_QTY	00000049
ITEM5_OK	000005FD
ITEM5_QTY	0000004A
ITEM_SEL	00000044
ITEM_VALUE	00000045
KEY_BUFR	00000028
KEY_CTR	00000027
KEY_NEW	00000024
KEY_PREV	00000025
KEY_TABLE	00000042
KEY_VAL	00000026
LCD_CHAR_MAX	00000014
LCD_CPORT	00000008
LCD_DPORT	00000006
LCD_EN	00000007
LCD_L1_ADDR	00000080
LCD_L2_ADDR	000000A8
LCD_L3_ADDR	00000094
LCD_L4_ADDR	000000D4
LCD_LINE_MAX	00000004
LCD_RAM_BUF	00000020
LCD_RS	00000006
LD_MSG0_2	000006A0
LD_MSG2RAM	0000068B
LD_MSGDONE	000006B2
LD_MSGLOOP	0000069C
LD_MSG_ADR	00000695
LD_MSG_CHAR	000006AA
MAIN	0000001D
MOTORP1	0000058C
MOTORP5	00000584
MSG0	00000100
MSG1	00000151
MSG2	000001A1
MSG3	00000200
MSG_NUM	00000074
NOT_A	00000005
NOT_ADDRESS	00000005
NOT_BO	00000000
NOT_BOR	00000000
NOT_DONE	00000002
NOT_PD	00000003
NOT_POR	00000001
NOT_RBPU	00000007

```
SYMBOL TABLE
  LABEL                             VALUE

NOT_RC8                           00000006
NOT_T1SYNC                        00000002
NOT_TO                            00000004
NOT_TX8                           00000006
NOT_W                             00000002
NOT_WRITE                         00000002
OBF                               00000006
OERR                              00000001
OPTION_REG                        00000081
P                                 00000004
PCFG0                             00000000
PCFG1                             00000001
PCFG2                             00000002
PCFG3                             00000003
PCL                               00000002
PCLATH                            0000000A
PCLATH_TEMP                       0000007F
PCON                              0000008E
PEIE                              00000006
PEN                               00000002
PIE1                              0000008C
PIE2                              0000008D
PIR1                              0000000C
PIR2                              0000000D
PORTA                             00000005
PORTB                             00000006
PORTC                             00000007
PORTC_NEW                         00000020
PORTC_PREV                        00000021
PORTD                             00000008
PORTE                             00000009
PORTE_NEW                         00000022
PORTE_PREV                        00000023
PR2                               00000092
PS0                               00000000
PS1                               00000001
PS2                               00000002
PSA                               00000003
PSPIE                             00000007
PSPIF                             00000007
PSPMODE                           00000004
PULSE_EN                          000005FF
R                                 00000002
RAM2LCD1                          0000063A
RAM2LCD1X                         00000647
RAM2LCD2                          0000064E
RAM2LCD2X                         0000065C
RAM2LCD3                          00000663
RAM2LCD3X                         00000672
RAM2LCD4                          00000679
RAM2LCD4X                         00000689
RBIE                              00000003
RBIF                              00000000
```

SYMBOL TABLE

LABEL	VALUE
RC8_9	00000006
RC9	00000006
RCD8	00000000
RCEN	00000003
RCIE	00000005
RCIF	00000005
RCREG	0000001A
RCSTA	00000018
RD	00000000
RD_SW0	00000384
RD_SW0X	00000389
RD_SW1	0000038A
RD_SW1X	00000390
RD_SW2	00000391
RD_SW2X	00000397
READ_KEY	00000251
READ_KEYX	00000261
READ_SW	00000382
READ_SWX	00000398
READ_WRITE	00000002
RESTOREREG	00000025
RP0	00000005
RP1	00000006
RSEN	00000001
RX9	00000006
RX9D	00000000
R_W	00000002
S	00000003
SEL1_AMT	00000035
SEL1_QTY	00000030
SEL1_SALEHI	00000060
SEL1_SALELO	00000061
SEL2_AMT	00000036
SEL2_QTY	00000031
SEL2_SALEHI	00000062
SEL2_SALELO	00000063
SEL3_AMT	00000037
SEL3_QTY	00000032
SEL3_SALEHI	00000064
SEL3_SALELO	00000065
SEL4_AMT	00000038
SEL4_QTY	00000033
SEL4_SALEHI	00000066
SEL4_SALELO	00000067
SEL5_AMT	00000039
SEL5_QTY	00000034
SEL5_SALEHI	00000068
SEL5_SALELO	00000069
SEL_AMT	0000003D
SEL_QTY	0000003C
SEL_TOTALHI	0000003A
SEL_TOTALLO	0000003B
SEN	00000000

LABEL	VALUE

```
SET_RS0
SET_RS1
SMP                             00000007
SPBRG                           00000099
SPEN                            00000007
SREN                            00000005
SSPADD                          00000093
SSPBUF                          00000013
SSPCON                          00000014
SSPCON2                         00000091
SSPEN                           00000005
SSPIE                           00000003
SSPIF                           00000003
SSPM0                           00000000
SSPM1                           00000001
SSPM2                           00000002
SSPM3                           00000003
SSPOV                           00000006
SSPSTAT                         00000094
STATUS                          00000003
STAT_TEMP                       0000007E
SYNC                            00000004
T0CS                            00000005
T0IE                            00000005
T0IF                            00000002
T0SE                            00000004
T1CKPS0                         00000004
T1CKPS1                         00000005
T1CON                           00000010
T1INSYNC                        00000002
T1OSCEN                         00000003
T1SYNC                          00000002
T2CKPS0                         00000000
T2CKPS1                         00000001
T2CON                           00000012
TEMP1                           00000079
TEMP2                           0000007A
TEMP3                           0000007B
TEMP4                           0000007C
TEN                             0000002D
THOUSAND                        0000002B
THOUSND10                       0000002A
TMR0                            00000001
TMR0IE                          00000005
TMR0IF                          00000002
TMR0INT                         00000029
TMR1CS                          00000001
TMR1H                           0000000F
TMR1IE                          00000000
TMR1IF                          00000000
TMR1L                           0000000E
TMR1ON                          00000000
TMR1_PRES                       00000051
TMR1_SEC                        00000050
TMR2                            00000011
TMR2IE                          00000001
TMR2IF                          00000001
TMR2ON                          00000002
TMR2_PRES                       00000053
TMR2_SEC                        00000052
TMR3_PRES                       00000055
TMR3_SEC                        00000054
```

```
TMR4_PRES                       00000057
TMR4_SEC                        00000056
TMR5_PRES                       00000059
TMR5_SEC                        00000058
TMR6_PRES                       0000005B
TMR6_SEC                        0000005A
TMR7_PRES                       0000005D
TMR7_SEC                        0000005C
TOTALSALEHI                     0000006A
TOTALSALELO                     0000006B
TOUTPS0                         00000003
TOUTPS1                         00000004
TOUTPS2                         00000005
TOUTPS3                         00000006
TRISA                           00000085
TRISB                           00000086
TRISC                           00000087
TRISD                           00000088
TRISE                           00000089
TRISE0                          00000000
TRISE1                          00000001
TRISE2                          00000002
TRMT                            00000001
TX8_9                           00000006
TX9                             00000006
TX9D                            00000000
TXD8                            00000000
TXEN                            00000005
TXIE                            00000004
TXIF                            00000004
TXREG                           00000019
TXSTA                           00000098
UA                              00000001
UNIT                            0000002E
VALUE1                          0000004B
VALUE2                          0000004C
VALUE3                          0000004D
VALUE4                          0000004E
VALUE5                          0000004F
W                               00000000
WAIT1                           00000627
WAIT1_LOOP                      00000629
WAIT1_VAL                       00000072
WAIT2                           0000062D

SYMBOL TABLE
  LABEL                           VALUE

WAIT2_LOOP                      0000062E
WAIT2_VAL                       00000073
WCOL                            00000007
WR                              00000001
WREN                            00000002
WRERR                           00000003
W_TEMP                          0000007D
Z                               00000002
_BODEN_OFF                      00003FBF
_BODEN_ON                       00003FFF
_CPD_OFF                        00003FFF
_CPD_ON                         00003EFF
_CP_ALL                         00001FFF
_CP_OFF                         00003FFF
```

```
_DEBUG_OFF                      00003FFF
_DEBUG_ON                       000037FF
_HS_OSC                         00003FFE
_LP_OSC                         00003FFC
_LVP_OFF                        00003F7F
_LVP_ON                         00003FFF
_PWRTE_OFF                      00003FFF
_PWRTE_ON                       00003FF7
_RC_OSC                         00003FFF
_WDT_OFF                        00003FFB
_WDT_ON                         00003FFF
_WRT_1FOURTH                    00003BFF
_WRT_256                        00003DFF
_WRT_HALF                       000039FF
_WRT_OFF                        00003FFF
_XT_OSC                         00003FFD
__16F877A                       00000001


MEMORY USAGE MAP ('X' = Used,  '-' = Unused)

0000 : X---XXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX
0040 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX
0080 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXX- ---------------- ----------------
0100 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX
0140 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX
0180 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX
01C0 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX X---------------
0200 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX
0240 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX
0280 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX
02C0 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX

MEMORY USAGE MAP ('X' = Used,  '-' = Unused)


0300 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX
0340 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX
0380 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX
03C0 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX
0400 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX
0440 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX
0480 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX
04C0 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX
0500 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX
0540 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX
0580 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX
05C0 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX
0600 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX
0640 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX
0680 : XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXX XXX-------------
2000 : -------X-------- ---------------- ---------------- ----------------
```

APPENDIX D

DATA SHEETS

National Semiconductor

February 1995

LM78XX Series Voltage Regulators

General Description

The LM78XX series of three terminal regulators is available with several fixed output voltages making them useful in a wide range of applications. One of these is local on card regulation, eliminating the distribution problems associated with single point regulation. The voltages available allow these regulators to be used in logic systems, instrumentation, HiFi, and other solid state electronic equipment. Although designed primarily as fixed voltage regulators these devices can be used with external components to obtain adjustable voltages and currents.

The LM78XX series is available in an aluminum TO-3 package which will allow over 1.0A load current if adequate heat sinking is provided. Current limiting is included to limit the peak output current to a safe value. Safe area protection for the output transistor is provided to limit internal power dissipation. If internal power dissipation becomes too high for the heat sinking provided, the thermal shutdown circuit takes over preventing the IC from overheating.

Considerable effort was expanded to make the LM78XX series of regulators easy to use and mininize the number of external components. It is not necessary to bypass the output, although this does improve transient response. Input bypassing is needed only if the regulator is located far from the filter capacitor of the power supply.

For output voltage other than 5V, 12V and 15V the LM117 series provides an output voltage range from 1.2V to 57V.

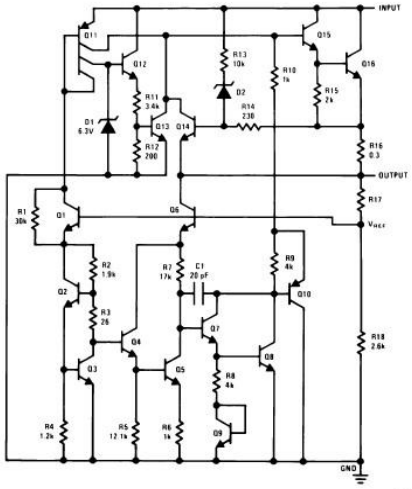
Features

- Output current in excess of 1A
- Internal thermal overload protection
- No external components required
- Output transistor safe area protection
- Internal short circuit current limit
- Available in the aluminum TO-3 package

Voltage Range

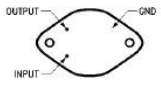
LM7805C	5V
LM7812C	12V
LM7815C	15V

Schematic and Connection Diagrams



TL/H/7746–1

Metal Can Package
TO-3 (K)
Aluminum

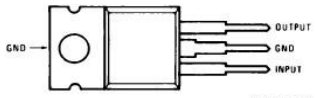


TL/H/7746–2

Bottom View

Order Number LM7805CK,
LM7812CK or LM7815CK
See NS Package Number KC02A

Plastic Package
TO-220 (T)



TL/H/7746–3

Top View

Order Number LM7805CT,
LM7812CT or LM7815CT
See NS Package Number T03B

RRD-B30M115/Printed in U. S. A.

Absolute Maximum Ratings

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Input Voltage (V_O = 5V, 12V and 15V)	35V
Internal Power Dissipation (Note 1)	Internally Limited
Operating Temperature Range (T_A)	0°C to +70°C
Maximum Junction Temperature	
(K Package)	150°C
(T Package)	150°C
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 10 sec.)	
TO-3 Package K	300°C
TO-220 Package T	230°C

Electrical Characteristics LM78XXC (Note 2) 0°C ≤ Tj ≤ 125°C unless otherwise noted.

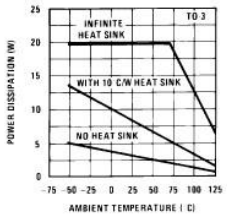
Output Voltage				5V			12V			15V			Units
Input Voltage (unless otherwise noted)				10V			19V			23V			
Symbol	Parameter	Conditions		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
V_O	Output Voltage	Tj = 25°C, 5 mA ≤ I_O ≤ 1A		4.8	5	5.2	11.5	12	12.5	14.4	15	15.6	V
		P_D ≤ 15W, 5 mA ≤ I_O ≤ 1A		4.75		5.25	11.4		12.6	14.25		15.75	V
		V_{MIN} ≤ V_{IN} ≤ V_{MAX}		(7.5 ≤ V_{IN} ≤ 20)			(14.5 ≤ V_{IN} ≤ 27)			(17.5 ≤ V_{IN} ≤ 30)			V
ΔV_O	Line Regulation	I_O = 500 mA	Tj = 25°C		3	50		4	120		4	150	mV
			ΔV_{IN}	(7 ≤ V_{IN} ≤ 25)			14.5 ≤ V_{IN} ≤ 30)			(17.5 ≤ V_{IN} ≤ 30)			V
			0°C ≤ Tj ≤ +125°C			50			120			150	mV
			ΔV_{IN}	(8 ≤ V_{IN} ≤ 20)			(15 ≤ V_{IN} ≤ 27)			(18.5 ≤ V_{IN} ≤ 30)			V
		I_O ≤ 1A	Tj = 25°C			50			120			150	mV
			ΔV_{IN}	(7.5 ≤ V_{IN} ≤ 20)			(14.6 ≤ V_{IN} ≤ 27)			(17.7 ≤ V_{IN} ≤ 30)			V
			0°C ≤ Tj ≤ +125°C			25			60			75	mV
			ΔV_{IN}	(8 ≤ V_{IN} ≤ 12)			(16 ≤ V_{IN} ≤ 22)			(20 ≤ V_{IN} ≤ 26)			V
ΔV_O	Load Regulation	Tj = 25°C	5 mA ≤ I_O ≤ 1.5A		10	50		12	120		12	150	mV
			250 mA ≤ I_O ≤ 750 mA			25			60			75	mV
		5 mA ≤ I_O ≤ 1A, 0°C ≤ Tj ≤ +125°C				50			120			150	mV
I_Q	Quiescent Current	I_O ≤ 1A	Tj = 25°C			8			8			8	mA
			0°C ≤ Tj ≤ +125°C			8.5			8.5			8.5	mA
ΔI_Q	Quiescent Current Change	5 mA ≤ I_O ≤ 1A				0.5			0.5			0.5	mA
		Tj = 25°C, I_O ≤ 1A				1.0			1.0			1.0	mA
		V_{MIN} ≤ V_{IN} ≤ V_{MAX}		(7.5 ≤ V_{IN} ≤ 20)			(14.8 ≤ V_{IN} ≤ 27)			(17.9 ≤ V_{IN} ≤ 30)			V
		I_O ≤ 500 mA, 0°C ≤ Tj ≤ +125°C				1.0			1.0			1.0	mA
		V_{MIN} ≤ V_{IN} ≤ V_{MAX}		(7 ≤ V_{IN} ≤ 25)			(14.5 ≤ V_{IN} ≤ 30)			(17.5 ≤ V_{IN} ≤ 30)			V
V_N	Output Noise Voltage	T_A = 25°C, 10 Hz ≤ f ≤ 100 kHz			40			75			90		μV
$\frac{\Delta V_{IN}}{\Delta V_{OUT}}$	Ripple Rejection	f = 120 Hz	I_O ≤ 1A, Tj = 25°C or	62	80		55	72		54	70		dB
			I_O ≤ 500 mA	62			55			54			dB
			0°C ≤ Tj ≤ +125°C										
		V_{MIN} ≤ V_{IN} ≤ V_{MAX}		(8 ≤ V_{IN} ≤ 18)			(15 ≤ V_{IN} ≤ 25)			(18.5 ≤ V_{IN} ≤ 28.5)			V
R_O	Dropout Voltage	Tj = 25°C, I_{OUT} = 1A			2.0			2.0			2.0		V
	Output Resistance	f = 1 kHz			8			18			19		mΩ
	Short-Circuit Current	Tj = 25°C			2.1			1.5			1.2		A
	Peak Output Current	Tj = 25°C			2.4			2.4			2.4		A
	Average TC of V_{OUT}	0°C ≤ Tj ≤ +125°C, I_O = 5 mA			0.6			1.5			1.8		mV/°C
V_{IN}	Input Voltage Required to Maintain Line Regulation	Tj = 25°C, I_O ≤ 1A			7.5		14.6			17.7			V

Note 1: Thermal resistance of the TO-3 package (K, KC) is typically 4°C/W junction to case and 35°C/W case to ambient. Thermal resistance of the TO-220 package (T) is typically 4°C/W junction to case and 50°C/W case to ambient.

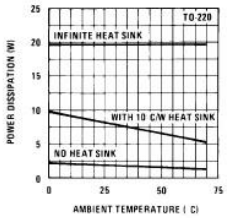
Note 2: All characteristics are measured with capacitor across the input of 0.22 μF, and a capacitor across the output of 0.1μF. All characteristics except noise voltage and ripple rejection ratio are measured using pulse techniques (t_w ≤ 10 ms, duty cycle ≤ 5%). Output voltage changes due to changes in internal temperature must be taken into account separately.

Typical Performance Characteristics

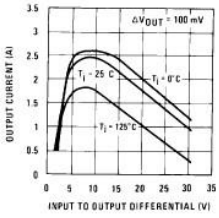
Maximum Average Power Dissipation



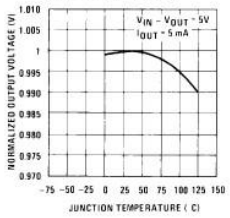
Maximum Average Power Dissipation



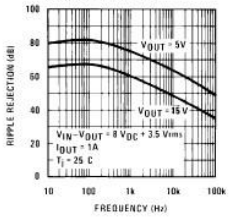
Peak Output Current



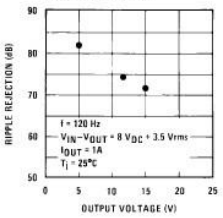
Output Voltage (Normalized to 1V at Tj = 25°C)



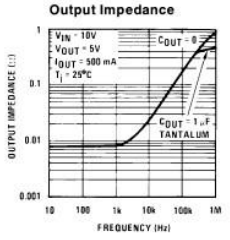
Ripple Rejection



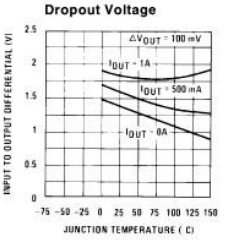
Ripple Rejection



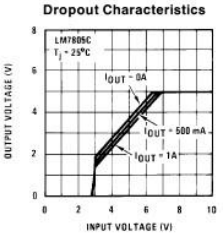
Output Impedance



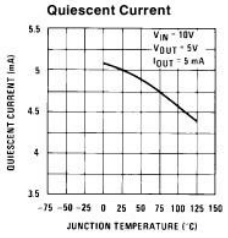
Dropout Voltage



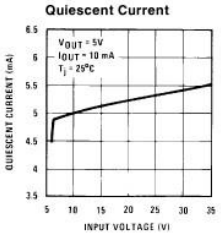
Dropout Characteristics



Quiescent Current

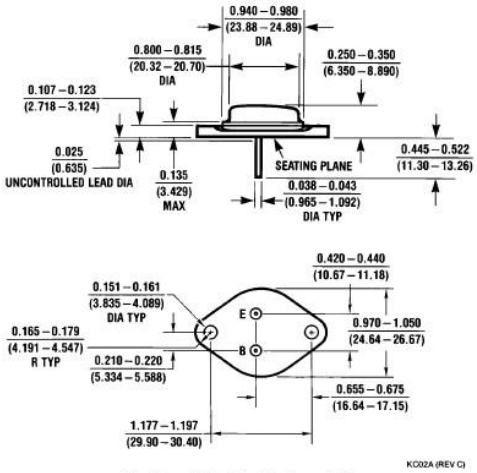


Quiescent Current



TL/H/7746–4

Physical Dimensions inches (millimeters)



Aluminum Metal Can Package (KC)
Order Number LM7805CK, LM7812CK or LM7815CK
NS Package Number KC02A

FAIRCHILD SEMICONDUCTOR®

1N5400 - 1N5408

Features

- 3.0 ampere operation at T_A = 75°C with no thermal runaway.
- High current capability.
- Low leakage.

DO-201AD
COLOR BAND DENOTES CATHODE

General Purpose Rectifiers

Absolute Maximum Ratings*

T_A = 25°C unless otherwise noted

Symbol	Parameter	Value									Units
		5400	5401	5402	5403	5404	5405	5406	5407	5408	
V_{RRM}	Maximum Repetitive Reverse Voltage	50	100	200	300	400	500	600	800	1000	V
$I_{F(AV)}$	Average Rectified Forward Current, .375 " lead length @ T_A = 75°C	3.0									A
I_{FSM}	Non-repetitive Peak Forward Surge Current 8.3 ms Single Half-Sine-Wave	200									A
T_{stg}	Storage Temperature Range	-55 to +150									°C
T_J	Operating Junction Temperature	-55 to +150									°C

* These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

Thermal Characteristics

Symbol	Parameter	Value	Units
P_D	Power Dissipation	6.25	W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	20	°C/W

Electrical Characteristics

T_A = 25°C unless otherwise noted

Symbol	Parameter	Device									Units
		5400	5401	5402	5403	5404	5405	5406	5407	5408	
V_F	Forward Voltage @ 3.0 A	1.2									V
I_{rr}	Maximum Full Load Reverse Current, Full Cycle T_A= 105°C	0.5									mA
I_R	Reverse Current @ rated V_R T_A= 25°C T_A= 100°C	5.0 500									µA µA
C_T	Toatal Capacitance V_R = 4.0 V, f = 1.0 MHz	30									pF

Typical Characteristics

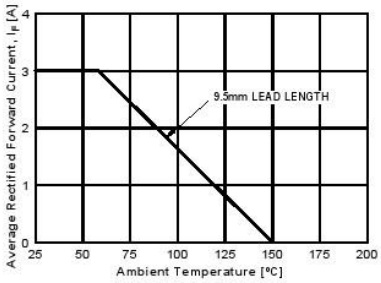


Figure 1. Forward Current Derating Curve

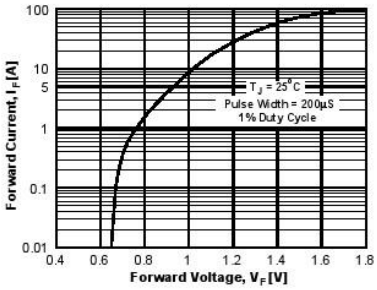


Figure 2. Forward Voltage Characteristics

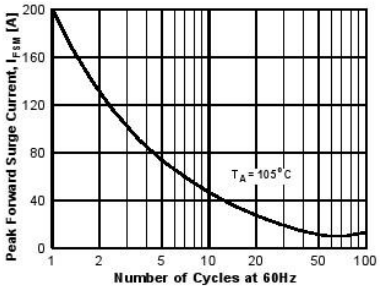


Figure 3. Non-Repetitive Surge Current

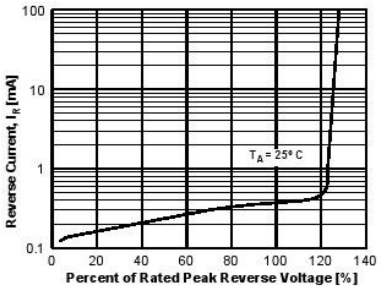


Figure 4. Reverse Current vs Reverse Voltage

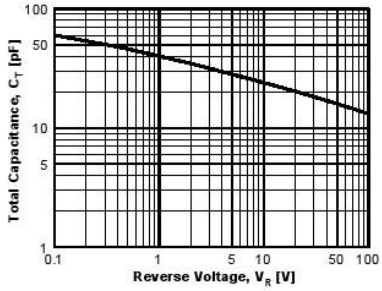


Figure 5. Total Capacitance

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DOME™	HiSeC™	PowerTrench®	SuperSOT™-8	
EcoSPARK™	ISOPLANAR™	QFET™	SyncFET™	
E²CMOS™	LittleFET™	QS™	TinyLogic™	
EnSigna™	MicroFET™	QT Optoelectronics™	TruTranslation™	
FACT™	MicroPak™	Quiet Series™	UHC™	
FACT Quiet Series™	MICROWIRE™	SILENT SWITCHER®	UltraFET®	

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As used herein:

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2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

PRODUCT STATUS DEFINITIONS

Definition of Terms

Datasheet Identification	Product Status	Definition
Advance Information	Formative or In Design	This datasheet contains the design specifications for product development. Specifications may change in any manner without notice.
Preliminary	First Production	This datasheet contains preliminary data, and supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design.
No Identification Needed	Full Production	This datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design.
Obsolete	Not In Production	This datasheet contains specifications on a product that has been discontinued by Fairchild semiconductor. The datasheet is printed for reference information only.

Rev. H4

FAIRCHILD SEMICONDUCTOR™

October 1987
Revised January 1999

MM74C922 • MM74C923
16-Key Encoder • 20-Key Encoder

General Description

The MM74C922 and MM74C923 CMOS key encoders provide all the necessary logic to fully encode an array of SPST switches. The keyboard scan can be implemented by either an external clock or external capacitor. These encoders also have on-chip pull-up devices which permit switches with up to 50 kΩ on resistance to be used. No diodes in the switch array are needed to eliminate ghost switches. The internal debounce circuit needs only a single external capacitor and can be defeated by omitting the capacitor. A Data Available output goes to a high level when a valid keyboard entry has been made. The Data Available output returns to a low level when the entered key is released, even if another key is depressed. The Data Available will return high to indicate acceptance of the new key after a normal debounce period; this two-key roll-over is provided between any two switches.

An internal register remembers the last key pressed even after the key is released. The 3-STATE outputs provide for easy expansion and bus operation and are LPTTL compatible.

Features

- 50 kΩ maximum switch on resistance
- On or off chip clock
- On-chip row pull-up devices
- 2 key roll-over
- Keybounce elimination with single capacitor
- Last key register at outputs
- 3-STATE output LPTTL compatible
- Wide supply range: 3V to 15V
- Low power consumption

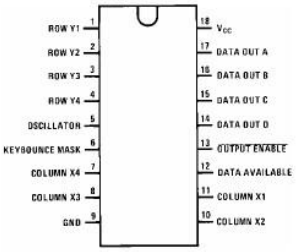
Ordering Code:

Order Number	Package Number	Package Description
MM74C922N	N18A	18-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide
MM74C922WM	M20B	20-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-013, 0.300" Wide
MM74C923WM	M20B	20-Lead Small Outline Integrated Circuit (SOIC), JEDEC MS-013, 0.300" Wide
MM74C923N	N20A	20-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide

Device also available in Tape and Reel. Specify by appending suffix letter "X" to the ordering code.

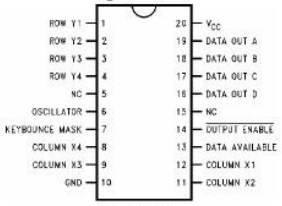
Connection Diagrams

Pin Assignment for DIP



Top View
MM94C922

Pin Assignment for SOIC

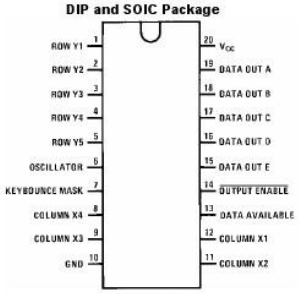


Top View
MM74C922

 DS006037.prf www.fairchildsemi.com

Connection Diagrams (Continued)

Pin Assignment for DIP and SOIC Package



Top View
MM74C923

Truth Tables

(Pins 0 through 11)

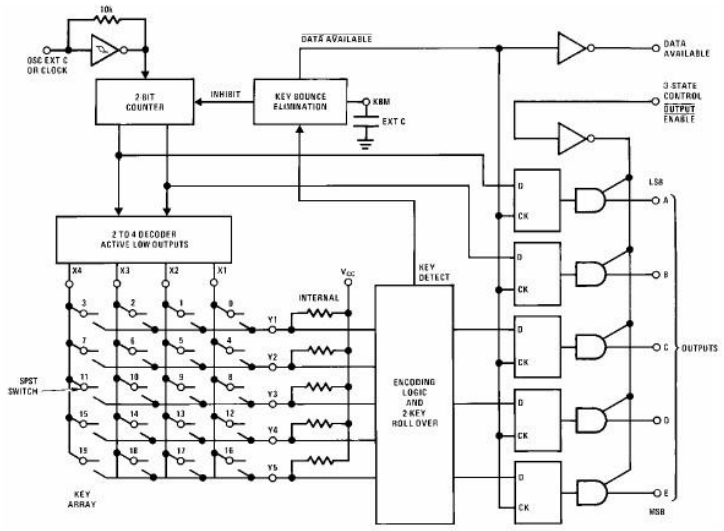
Switch Position		0 Y1,X1	1 Y1,X2	2 Y1,X3	3 Y1,X4	4 Y2,X1	5 Y2,X2	6 Y2,X3	7 Y2,X4	8 Y3,X1	9 Y3,X2	10 Y3,X3	11 Y3,X4
DATA OUT	A	0	1	0	1	0	1	0	1	0	1	0	1
	B	0	0	1	1	0	0	1	1	0	0	1	1
	C	0	0	0	0	1	1	1	1	0	0	0	0
	D	0	0	0	0	0	0	0	0	1	1	1	1
	E (Note 1)	0	0	0	0	0	0	0	0	0	0	0	0

(Pins 12 through 19)

Switch Position		12 Y4,X1	13 Y4,X2	14 Y4,X3	15 Y4,X4	16 Y5(Note 1), X1	17 Y5 (Note 1), X2	18 Y5 (Note 1), X3	19 Y5 (Note 1), X4
DATA OUT	A	0	1	0	1	0	1	0	1
	B	0	0	1	1	0	0	1	1
	C	1	1	1	1	0	0	0	0
	D	1	1	1	1	0	0	0	0
	E (Note 1)	0	0	0	0	1	1	1	1

Note 1: Omit for MM74C922

Block Diagram



Absolute Maximum Ratings (Note 2)

Voltage at Any Pin	V_{CC} − 0.3V to V_{CC} + 0.3V
Operating Temperature Range	
MM74C922, MM74C923	−40°C to +85°C
Storage Temperature Range	−65°C to +150°C
Power Dissipation (P_D)	
Dual-In-Line	700 mW
Small Outline	500 mW
Operating V_{CC} Range	3V to 15V
V_{CC}	18V
Lead Temperature	
(Soldering, 10 seconds)	260°C

Note 2: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

DC Electrical Characteristics

Min/Max limits apply across temperature range unless otherwise specified

Symbol	Parameter	Conditions	Min	Typ	Max	Units
CMOS TO CMOS						
V_{T+}	Positive-Going Threshold Voltage at Osc and KBM Inputs	V_{CC} = 5V, $I_{IN} \geq$ 0.7 mA	3.0	3.6	4.3	V
		V_{CC} = 10V, $I_{IN} \geq$ 1.4 mA	6.0	6.8	8.6	V
		V_{CC} = 15V, $I_{IN} \geq$ 2.1 mA	9.0	10	12.9	V
V_{T-}	Negative-Going Threshold Voltage at Osc and KBM Inputs	V_{CC} = 5V, $I_{IN} \geq$ 0.7 mA	0.7	1.4	2.0	V
		V_{CC} = 10V, $I_{IN} \geq$ 1.4 mA	1.4	3.2	4.0	V
		V_{CC} = 15V, $I_{IN} \geq$ 2.1 mA	2.1	5	6.0	V
$V_{IN(1)}$	Logical "1" Input Voltage, Except Osc and KBM Inputs	V_{CC} = 5V	3.5	4.5		V
		V_{CC} = 10V	8.0	9		V
		V_{CC} = 15V	12.5	13.5		V
$V_{IN(0)}$	Logical "0" Input Voltage, Except Osc and KBM Inputs	V_{CC} = 5V		0.5	1.5	V
		V_{CC} = 10V		1	2	V
		V_{CC} = 15V		1.5	2.5	V
I_{rp}	Row Pull-Up Current at Y1, Y2, Y3, Y4 and Y5 Inputs	V_{CC} = 5V, V_{IN} = 0.1 V_{CC}		−2	−5	µA
		V_{CC} = 10V		−10	−20	µA
		V_{CC} = 15V		−22	−45	µA
$V_{OUT(1)}$	Logical "1" Output Voltage	V_{CC} = 5V, I_O = −10 µA	4.5			V
		V_{CC} = 10V, I_O = −10 µA	9			V
		V_{CC} = 15V, I_O = −10 µA	13.5			V
$V_{OUT(0)}$	Logical "0" Output Voltage	V_{CC} = 5V, I_O = 10 µA			0.5	V
		V_{CC} = 10V, I_O = 10 µA			1	V
		V_{CC} = 15V, I_O = 10 µA			1.5	V
R_{on}	Column "ON" Resistance at X1, X2, X3 and X4 Outputs	V_{CC} = 5V, V_O = 0.5V		500	1400	Ω
		V_{CC} = 10V, V_O = 1V		300	700	Ω
		V_{CC} = 15V, V_O = 1.5V		200	500	Ω
I_{CC}	Supply Current Osc at 0V, (one Y low)	V_{CC} = 5V		0.55	1.1	mA
		V_{CC} = 10V		1.1	1.9	mA
		V_{CC} = 15V		1.7	2.6	mA
$I_{IN(1)}$	Logical "1" Input Current at $\overline{\text{Output Enable}}$	V_{CC} = 15V, V_{IN} = 15V		0.005	1.0	µA
$I_{IN(0)}$	Logical "0" Input Current at $\overline{\text{Output Enable}}$	V_{CC} = 15V, V_{IN} = 0V	−1.0	−0.005		µA
CMOS/LPTTL INTERFACE						
$V_{IN(1)}$	Except Osc and KBM Inputs	V_{CC} = 4.75V	V_{CC} − 1.5			V
$V_{IN(0)}$	Except Osc and KBM Inputs	V_{CC} = 4.75V			0.8	V
$V_{OUT(1)}$	Logical "1" Output Voltage	I_O = −360 µA, V_{CC} = 4.75V, I_O = −360 µA	2.4			V
$V_{OUT(0)}$	Logical "0" Output Voltage	I_O = −360 µA, V_{CC} = 4.75V, I_O = −360 µA			0.4	V

DC Electrical Characteristics (Continued)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
OUTPUT DRIVE (See Family Characteristics Data Sheet) (Short Circuit Current)						
I_{SOURCE}	Output Source Current (P-Channel)	V_{CC} = 5V, V_{OUT} = 0V, T_A = 25°C	−1.75	−3.3		mA
I_{SOURCE}	Output Source Current (P-Channel)	V_{CC} = 10V, V_{OUT} = 0V, T_A = 25°C	−8	−15		mA
I_{SINK}	Output Sink Current (N-Channel)	V_{CC} = 5V, V_{OUT} = V_{CC}, T_A = 25°C	1.75	3.6		mA
I_{SINK}	Output Sink Current (N-Channel)	V_{CC} = 10V, V_{OUT} = V_{CC}, T_A = 25°C	8	16		mA

AC Electrical Characteristics (Note 3)

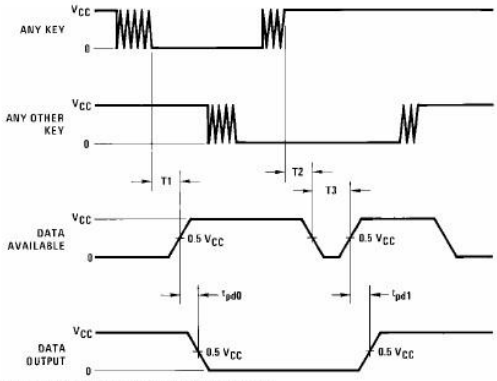
T_A = 25°C, C_L = 50 pF, unless otherwise noted

Symbol	Parameter	Conditions	Min	Typ	Max	Units
t_{pdO}, t_{pd1}	Propagation Delay Time to Logical "0" or Logical "1" from D.A.	C_L = 50 pF (Figure 1)				
		V_{CC} = 5V		60	150	ns
		V_{CC} = 10V		35	80	ns
		V_{CC} = 15V		25	60	ns
t_{OH}, t_{1H}	Propagation Delay Time from Logical "0" or Logical "1" into High Impedance State	R_L = 10k, C_L = 10 pF (Figure 2)				
		V_{CC} = 5V, R_L = 10k		80	200	ns
		V_{CC} = 10V, C_L = 10 pF		65	150	ns
		V_{CC} = 15V		50	110	ns
t_{HO}, t_{H1}	Propagation Delay Time from High Impedance State to a Logical "0" or Logical "1"	R_L = 10k, C_L = 50 pF (Figure 2)				
		V_{CC} = 5V, R_L = 10k		100	250	ns
		V_{CC} = 10V, C_L = 50 pF		55	125	ns
		V_{CC} = 15V		40	90	ns
C_{IN}	Input Capacitance	Any Input (Note 4)		5	7.5	pF
C_{OUT}	3-STATE Output Capacitance	Any Output (Note 4)		10		pF

Note 3: AC Parameters are guaranteed by DC correlated testing.

Note 4: Capacitance is guaranteed by periodic testing.

Switching Time Waveforms



T1 ≈ T2 ≈ RC, T3 ≈ 0.7 RC, where R ≈ 10k and C is external capacitor at KBM input.

FIGURE 1.

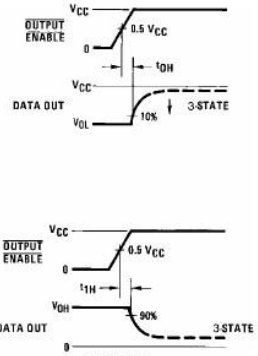
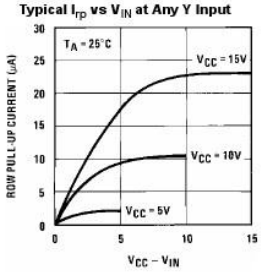


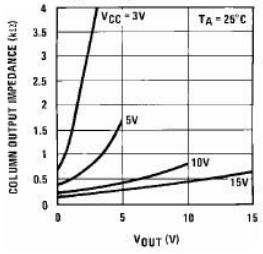
FIGURE 2.

Typical Performance Characteristics

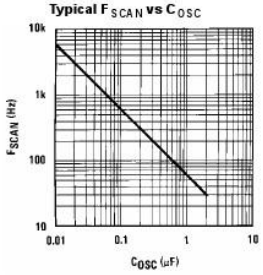
Typical I_{rp} vs V_{IN} at Any Y Input



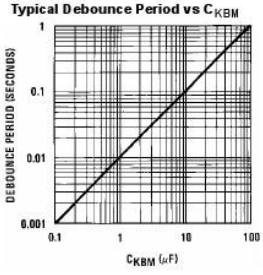
Typical R_{on} vs V_{OUT} at Any X Output



Typical F_{SCAN} vs C_{OSC}

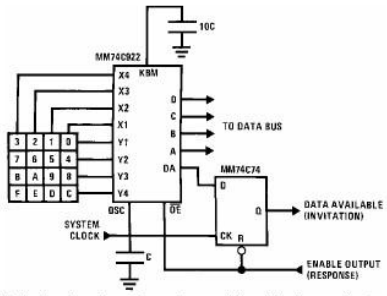


Typical Debounce Period vs C_{KBM}



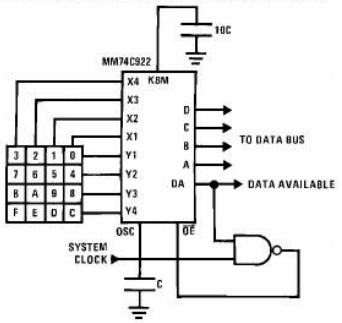
Typical Applications

Synchronous Handshake (MM74C922)



The keyboard may be synchronously scanned by omitting the capacitor at osc. and driving osc. directly if the system clock rate is lower than 10 kHz

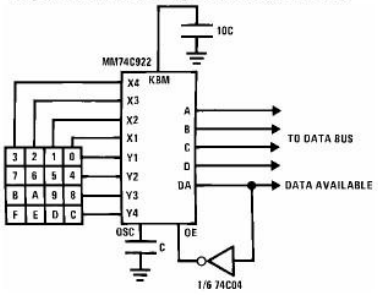
Synchronous Data Entry Onto Bus (MM74C922)



Outputs are enabled when valid entry is made and go into 3-STATE when key is released.

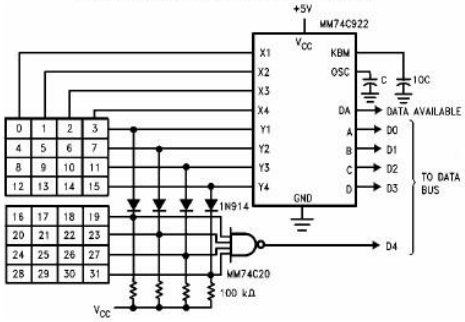
The keyboard may be synchronously scanned by omitting the capacitor at osc. and driving osc. directly if the system clock rate is lower than 10 kHz

Asynchronous Data Entry Onto Bus (MM74C922)



Outputs are in 3-STATE until key is pressed, then data is placed on bus. When key is released, outputs return to 3-STATE.

Expansion to 32 Key Encoder (MM74C922)



Theory of Operation

The MM74C922/MM74C923 Keyboard Encoders implement all the logic necessary to interface a 16 or 20 SPST key switch matrix to a digital system. The encoder will convert a key switch closer to a 4(MM74C922) or 5(MM74C923) bit nibble. The designer can control both the keyboard scan rate and the key debounce period by altering the oscillator capacitor, C_{OSE}, and the key bounce mask capacitor, C_{MSK}. Thus, the MM74C922/MM74C923's performance can be optimized for many keyboards.

The keyboard encoders connect to a switch matrix that is 4 rows by 4 columns (MM74C922) or 5 rows by 4 columns (MM74C923). When no keys are depressed, the row inputs are pulled high by internal pull-ups and the column outputs sequentially output a logic "0". These outputs are open drain and are therefore low for 25% of the time and otherwise off. The column scan rate is controlled by the oscillator input, which consists of a Schmitt trigger oscillator, a 2-bit counter, and a 2–4-bit decoder.

When a key is depressed, key 0, for example, nothing will happen when the X1 input is off, since Y1 will remain high. When the X1 column is scanned, X1 goes low and Y1 will go low. This disables the counter and keeps X1 low. Y1 going low also initiates the key bounce circuit timing and locks out the other Y inputs. The key code to be output is a combination of the frozen counter value and the decoded Y inputs. Once the key bounce circuit times out, the data is latched, and the Data Available (DAV) output goes high.

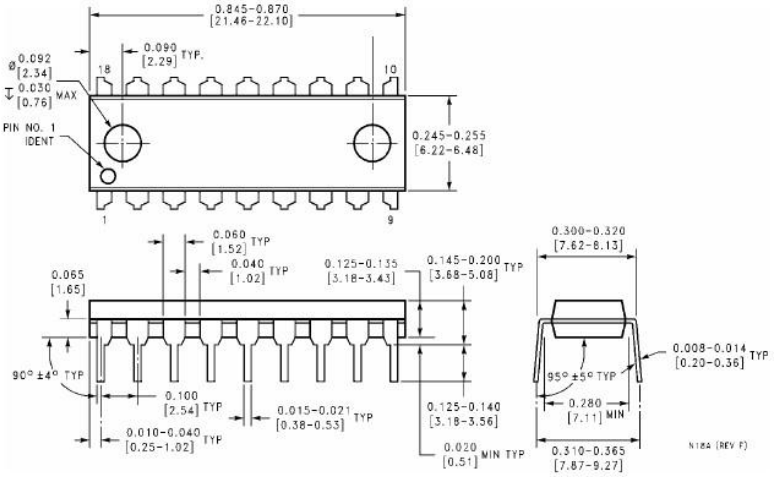
If, during the key closure the switch bounces, Y1 input will go high again, restarting the scan and resetting the key bounce circuitry. The key may bounce several times, but as soon as the switch stays low for a debounce period, the closure is assumed valid and the data is latched.

A key may also bounce when it is released. To ensure that the encoder does not recognize this bounce as another key closure, the debounce circuit must time out before another closure is recognized.

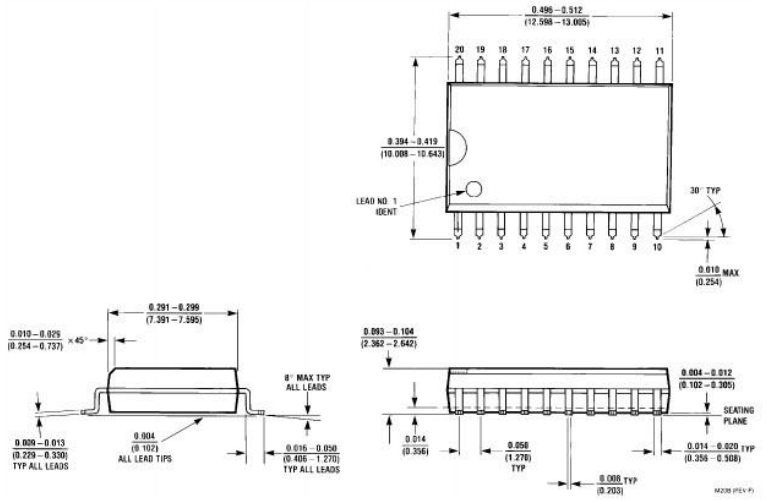
The two-key roll-over feature can be illustrated by assuming a key is depressed, and then a second key is depressed. Since all scanning has stopped, and all other Y inputs are disabled, the second key is not recognized until the first key is lifted and the key bounce circuitry has reset.

The output latches feed 3-STATE, which is enabled when the Output Enable ($\overline{OE}$) input is taken low.

Physical Dimensions inches (millimeters) unless otherwise noted

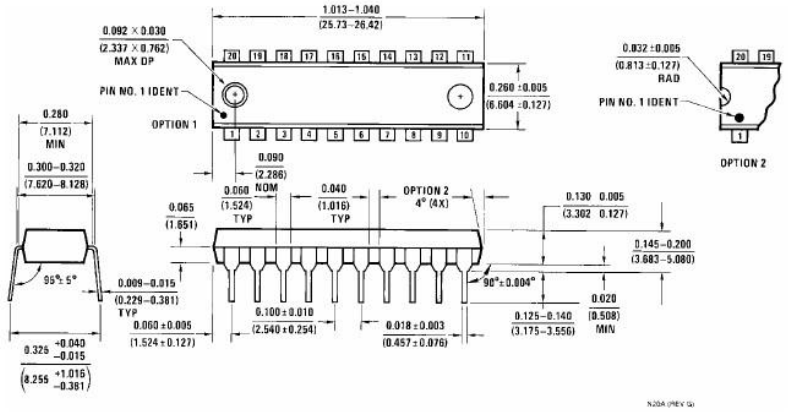


18-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide
Package Number N18A



20-Lead Plastic Small Outline I.C. Package (M)
Package Number M20B

Physical Dimensions inches (millimeters) unless otherwise noted (Continued)



20-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide
Package Number N20A

PIC16F87XA
Data Sheet

28/40/44-Pin Enhanced Flash Microcontrollers

Pin Diagrams (Continued)

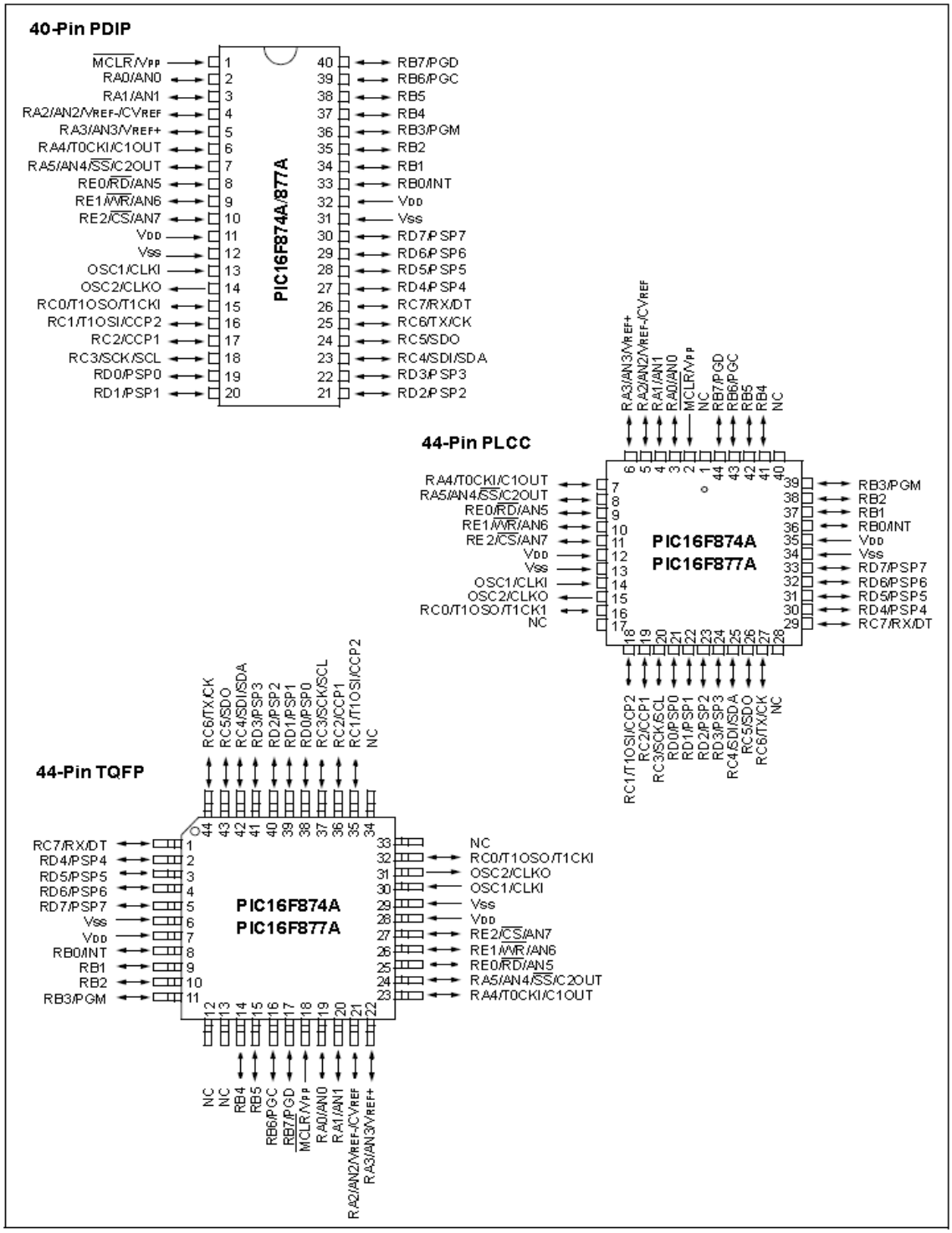


TABLE 1-3: PIC16F874A/877A PINOUT DESCRIPTION

Pin Name	PDIP Pin#	PLCC Pin#	TQFP Pin#	QFN Pin#	I/O/P Type	Buffer Type	Description
OSC1/CLKI	13	14	30	32		ST/CMOS(4)	Oscillator crystal or external clock input.
OSC1					I		Oscillator crystal input or external clock source input. ST buffer when configured in RC mode; otherwise CMOS.
CLKI					I		External clock source input. Always associated with pin function OSC1 (see OSC1/CLKI, OSC2/CLKO pins).
OSC2/CLKO	14	15	31	33		—	Oscillator crystal or clock output.
OSC2					O		Oscillator crystal output. Connects to crystal or resonator in Crystal Oscillator mode.
CLKO					O		In RC mode, OSC2 pin outputs CLKO, which has 1/4 the frequency of OSC1 and denotes the instruction cycle rate.
$\overline{MCLR}$/VPP	1	2	18	18		ST	Master Clear (input) or programming voltage (output).
$\overline{MCLR}$					I		Master Clear (Reset) input. This pin is an active low Reset to the device.
VPP					P		Programming voltage input.
							PORTA is a bidirectional I/O port.
RA0/AN0	2	3	19	19		TTL	
RA0					I/O		Digital I/O.
AN0					I		Analog input 0.
RA1/AN1	3	4	20	20		TTL	
RA1					I/O		Digital I/O.
AN1					I		Analog input 1.
RA2/AN2/VREF-/CVREF	4	5	21	21		TTL	
RA2					I/O		Digital I/O.
AN2					I		Analog input 2.
VREF-					I		A/D reference voltage (Low) input.
CVREF					O		Comparator VREF output.
RA3/AN3/VREF+	5	6	22	22		TTL	
RA3					I/O		Digital I/O.
AN3					I		Analog input 3.
VREF+					I		A/D reference voltage (High) input.
RA4/T0CKI/C1OUT	6	7	23	23		ST	
RA4					I/O		Digital I/O – Open-drain when configured as output.
T0CKI					I		Timer0 external clock input.
C1OUT					O		Comparator 1 output.
RA5/AN4/$\overline{SS}$/C2OUT	7	8	24	24		TTL	
RA5					I/O		Digital I/O.
AN4					I		Analog input 4.
$\overline{SS}$					I		SPI slave select input.
C2OUT					O		Comparator 2 output.

Legend: I = input O = output I/O = input/output P = power
— = Not used TTL = TTL input ST = Schmitt Trigger input

Note 1: This buffer is a Schmitt Trigger input when configured as the external interrupt.
2: This buffer is a Schmitt Trigger input when used in Serial Programming mode.
3: This buffer is a Schmitt Trigger input when configured in RC Oscillator mode and a CMOS input otherwise.

TABLE 1-3: PIC16F874A/877A PINOUT DESCRIPTION (CONTINUED)

Pin Name	PDIP Pin#	PLCC Pin#	TQFP Pin#	QFN Pin#	I/O/P Type	Buffer Type	Description
							PORTB is a bidirectional I/O port. PORTB can be software programmed for internal weak pull-up on all inputs.
RB0/INT	33	36	8	9		TTL/ST(1)	
RB0					I/O		Digital I/O.
INT					I		External interrupt.
RB1	34	37	9	10	I/O	TTL	Digital I/O.
RB2	35	38	10	11	I/O	TTL	Digital I/O.
RB3/PGM	36	39	11	12		TTL	
RB3					I/O		Digital I/O.
PGM					I		Low-voltage ICSP programming enable pin.
RB4	37	41	14	14	I/O	TTL	Digital I/O.
RB5	38	42	15	15	I/O	TTL	Digital I/O.
RB6/PGC	39	43	16	16		TTL/ST(2)	
RB6					I/O		Digital I/O.
PGC					I		In-circuit debugger and ICSP programming clock.
RB7/PGD	40	44	17	17		TTL/ST(2)	
RB7					I/O		Digital I/O.
PGD					I/O		In-circuit debugger and ICSP programming data.

Legend: I = input O = output I/O = input/output P = power
— = Not used TTL = TTL input ST = Schmitt Trigger input

Note 1: This buffer is a Schmitt Trigger input when configured as the external interrupt.
2: This buffer is a Schmitt Trigger input when used in Serial Programming mode.
3: This buffer is a Schmitt Trigger input when configured in RC Oscillator mode and a CMOS input otherwise.

TABLE 1-3: PIC16F874A/877A PINOUT DESCRIPTION (CONTINUED)

Pin Name	PDIP Pin#	PLCC Pin#	TQFP Pin#	QFN Pin#	I/O/P Type	Buffer Type	Description
							PORTC is a bidirectional I/O port.
RC0/T1OSO/T1CKI	15	16	32	34		ST	
RC0					I/O		Digital I/O.
T1OSO					O		Timer1 oscillator output.
T1CKI					I		Timer1 external clock input.
RC1/T1OSI/CCP2	16	18	35	35		ST	
RC1					I/O		Digital I/O.
T1OSI					I		Timer1 oscillator input.
CCP2					I/O		Capture2 input, Compare2 output, PWM2 output.
RC2/CCP1	17	19	36	36		ST	
RC2					I/O		Digital I/O.
CCP1					I/O		Capture1 input, Compare1 output, PWM1 output.
RC3/SCK/SCL	18	20	37	37		ST	
RC3					I/O		Digital I/O.
SCK					I/O		Synchronous serial clock input/output for SPI mode.
SCL					I/O		Synchronous serial clock input/output for I^2C mode.
RC4/SDI/SDA	23	25	42	42		ST	
RC4					I/O		Digital I/O.
SDI					I		SPI data in.
SDA					I/O		I^2C data I/O.
RC5/SDO	24	26	43	43		ST	
RC5					I/O		Digital I/O.
SDO					O		SPI data out.
RC6/TX/CK	25	27	44	44		ST	
RC6					I/O		Digital I/O.
TX					O		USART asynchronous transmit.
CK					I/O		USART1 synchronous clock.
RC7/RX/DT	26	29	1	1		ST	
RC7					I/O		Digital I/O.
RX					I		USART asynchronous receive.
DT					I/O		USART synchronous data.

Legend: I = input O = output I/O = input/output P = power
— = Not used TTL = TTL input ST = Schmitt Trigger input

Note 1: This buffer is a Schmitt Trigger input when configured as the external interrupt.
2: This buffer is a Schmitt Trigger input when used in Serial Programming mode.
3: This buffer is a Schmitt Trigger input when configured in RC Oscillator mode and a CMOS input otherwise.

TABLE 1-3: PIC16F874A/877A PINOUT DESCRIPTION (CONTINUED)

Pin Name	PDIP Pin#	PLCC Pin#	TQFP Pin#	QFN Pin#	I/O/P Type	Buffer Type	Description
							PORTD is a bidirectional I/O port or Parallel Slave Port when interfacing to a microprocessor bus.
RD0/PSP0	19	21	38	38		ST/TTL(3)	
RD0					I/O		Digital I/O.
PSP0					I/O		Parallel Slave Port data.
RD1/PSP1	20	22	39	39		ST/TTL(3)	
RD1					I/O		Digital I/O.
PSP1					I/O		Parallel Slave Port data.
RD2/PSP2	21	23	40	40		ST/TTL(3)	
RD2					I/O		Digital I/O.
PSP2					I/O		Parallel Slave Port data.
RD3/PSP3	22	24	41	41		ST/TTL(3)	
RD3					I/O		Digital I/O.
PSP3					I/O		Parallel Slave Port data.
RD4/PSP4	27	30	2	2		ST/TTL(3)	
RD4					I/O		Digital I/O.
PSP4					I/O		Parallel Slave Port data.
RD5/PSP5	28	31	3	3		ST/TTL(3)	
RD5					I/O		Digital I/O.
PSP5					I/O		Parallel Slave Port data.
RD6/PSP6	29	32	4	4		ST/TTL(3)	
RD6					I/O		Digital I/O.
PSP6					I/O		Parallel Slave Port data.
RD7/PSP7	30	33	5	5		ST/TTL(3)	
RD7					I/O		Digital I/O.
PSP7					I/O		Parallel Slave Port data.
							PORTE is a bidirectional I/O port.
RE0/$\overline{RD}$/AN5	8	9	25	25		ST/TTL(3)	
RE0					I/O		Digital I/O.
$\overline{RD}$					I		Read control for Parallel Slave Port.
AN5					I		Analog input 5.
RE1/$\overline{WR}$/AN6	9	10	26	26		ST/TTL(3)	
RE1					I/O		Digital I/O.
$\overline{WR}$					I		Write control for Parallel Slave Port.
AN6					I		Analog input 6.
RE2/$\overline{CS}$/AN7	10	11	27	27		ST/TTL(3)	
RE2					I/O		Digital I/O.
$\overline{CS}$					I		Chip select control for Parallel Slave Port.
AN7					I		Analog input 7.
Vss	12, 31	13, 34	6, 29	6, 30, 31	P	—	Ground reference for logic and I/O pins.
VDD	11, 32	12, 35	7, 28	7, 8, 28, 29	P	—	Positive supply for logic and I/O pins.
NC	—	1, 17, 28, 40	12,13, 33, 34	13	—	—	These pins are not internally connected. These pins should be left unconnected.

Legend: I = input O = output I/O = input/output P = power
— = Not used TTL = TTL input ST = Schmitt Trigger input

Note 1: This buffer is a Schmitt Trigger input when configured as the external interrupt.
2: This buffer is a Schmitt Trigger input when used in Serial Programming mode.
3: This buffer is a Schmitt Trigger input when configured in RC Oscillator mode and a CMOS input otherwise.

10.0 ADDRESSABLE UNIVERSAL SYNCHRONOUS ASYNCHRONOUS RECEIVER TRANSMITTER (USART)

The Universal Synchronous Asynchronous Receiver Transmitter (USART) module is one of the two serial I/O modules. (USART is also known as a Serial Communications Interface or SCI.) The USART can be configured as a full-duplex asynchronous system that can communicate with peripheral devices, such as CRT terminals and personal computers, or it can be configured as a half-duplex synchronous system that can communicate with peripheral devices, such as A/D or D/A integrated circuits, serial EEPROMs, etc.

The USART can be configured in the following modes:

- Asynchronous (full-duplex)
- Synchronous – Master (half-duplex)
- Synchronous – Slave (half-duplex)

Bit SPEN (RCSTA<7>) and bits TRISC<7:6> have to be set in order to configure pins RC6/TX/CK and RC7/RX/DT as the Universal Synchronous Asynchronous Receiver Transmitter.

The USART module also has a multi-processor communication capability using 9-bit address detection.

REGISTER 10-1: TXSTA: TRANSMIT STATUS AND CONTROL REGISTER (ADDRESS 98h)

R/W-0	R/W-0	R/W-0	R/W-0	U-0	R/W-0	R-1	R/W-0
CSRC	TX9	TXEN	SYNC	—	BRGH	TRMT	TX9D
bit 7							bit 0

bit 7 CSRC: Clock Source Select bit

Asynchronous mode:
Don't care.

Synchronous mode:
1 = Master mode (clock generated internally from BRG)
0 = Slave mode (clock from external source)

bit 6 TX9: 9-bit Transmit Enable bit
1 = Selects 9-bit transmission
0 = Selects 8-bit transmission

bit 5 TXEN: Transmit Enable bit
1 = Transmit enabled
0 = Transmit disabled

Note: SREN/CREN overrides TXEN in Sync mode.

bit 4 SYNC: USART Mode Select bit
1 = Synchronous mode
0 = Asynchronous mode

bit 3 Unimplemented: Read as '0'

bit 2 BRGH: High Baud Rate Select bit

Asynchronous mode:
1 = High speed
0 = Low speed

Synchronous mode:
Unused in this mode.

bit 1 TRMT: Transmit Shift Register Status bit
1 = TSR empty
0 = TSR full

bit 0 TX9D: 9th bit of Transmit Data, can be Parity bit

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
- n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

REGISTER 10-2: RCSTA: RECEIVE STATUS AND CONTROL REGISTER (ADDRESS 18h)

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R-0	R-0	R-x
SPEN	RX9	SREN	CREN	ADDEN	FERR	OERR	RX9D
bit 7							bit 0

bit 7 SPEN: Serial Port Enable bit
1 = Serial port enabled (configures RC7/RX/DT and RC6/TX/CK pins as serial port pins)
0 = Serial port disabled

bit 6 RX9: 9-bit Receive Enable bit
1 = Selects 9-bit reception
0 = Selects 8-bit reception

bit 5 SREN: Single Receive Enable bit
Asynchronous mode:
Don't care.
Synchronous mode – Master:
1 = Enables single receive
0 = Disables single receive
This bit is cleared after reception is complete.
Synchronous mode – Slave:
Don't care.

bit 4 CREN: Continuous Receive Enable bit
Asynchronous mode:
1 = Enables continuous receive
0 = Disables continuous receive
Synchronous mode:
1 = Enables continuous receive until enable bit CREN is cleared (CREN overrides SREN)
0 = Disables continuous receive

bit 3 ADDEN: Address Detect Enable bit
Asynchronous mode 9-bit (RX9 = 1):
1 = Enables address detection, enables interrupt and load of the receive bufferwhen RSR<8> is set
0 = Disables address detection, all bytes are received and ninth bit can be used as parity bit

bit 2 FERR: Framing Error bit
1 = Framing error (can be updated by reading RCREG register and receive next valid byte)
0 = No framing error

bit 1 OERR: Overrun Error bit
1 = Overrun error (can be cleared by clearing bit CREN)
0 = No overrun error

bit 0 RX9D: 9th bit of Received Data (can be parity bit but must be calculated by user firmware)

Legend:			
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'	
- n = Value at POR	'1' = Bit is set	'0' = Bit is cleared	x = Bit is unknown

10.1 USART Baud Rate Generator (BRG)

The BRG supports both the Asynchronous and Synchronous modes of the USART. It is a dedicated 8-bit baud rate generator. The SPBRG register controls the period of a free running 8-bit timer. In Asynchronous mode, bit BRGH (TXSTA<2>) also controls the baud rate. In Synchronous mode, bit BRGH is ignored. Table 10-1 shows the formula for computation of the baud rate for different USART modes which only apply in Master mode (internal clock).

Given the desired baud rate and FOSC, the nearest integer value for the SPBRG register can be calculated using the formula in Table 10-1. From this, the error in baud rate can be determined.

It may be advantageous to use the high baud rate (BRGH = 1) even for slower baud clocks. This is because the FOSC/(16 (X + 1)) equation can reduce the baud rate error in some cases.

Writing a new value to the SPBRG register causes the BRG timer to be reset (or cleared). This ensures the BRG does not wait for a timer overflow before outputting the new baud rate.

10.1.1 SAMPLING

The data on the RC7/RX/DT pin is sampled three times by a majority detect circuit to determine if a high or a low level is present at the RX pin.

TABLE 10-1: BAUD RATE FORMULA

SYNC	BRGH = 0 (Low Speed)	BRGH = 1 (High Speed)
0	(Asynchronous) Baud Rate = FOSC/(64 (X + 1))	Baud Rate = FOSC/(16 (X + 1))
1	(Synchronous) Baud Rate = FOSC/(4 (X + 1))	N/A

Legend: X = value in SPBRG (0 to 255)

TABLE 10-2: REGISTERS ASSOCIATED WITH BAUD RATE GENERATOR

Address	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value on: POR, BOR	Value on all other Resets
98h	TXSTA	CSRC	TX9	TXEN	SYNC	—	BRGH	TRMT	TX9D	0000 -010	0000 -010
18h	RCSTA	SPEN	RX9	SREN	CREN	ADDEN	FERR	OERR	RX9D	0000 000x	0000 000x
99h	SPBRG	Baud Rate Generator Register								0000 0000	0000 0000

Legend: x = unknown, - = unimplemented, read as '0'. Shaded cells are not used by the BRG.

TABLE 10-3: BAUD RATES FOR ASYNCHRONOUS MODE (BRGH = 0)

BAUD RATE (K)	Fosc = 20 MHz			Fosc = 16 MHz			Fosc = 10 MHz		
	KBAUD	% ERROR	SPBRG value (decimal)	KBAUD	% ERROR	SPBRG value (decimal)	KBAUD	% ERROR	SPBRG value (decimal)
0.3	-	-	-	-	-	-	-	-	-
1.2	1.221	1.75	255	1.202	0.17	207	1.202	0.17	129
2.4	2.404	0.17	129	2.404	0.17	103	2.404	0.17	64
9.6	9.766	1.73	31	9.615	0.16	25	9.766	1.73	15
19.2	19.531	1.72	15	19.231	0.16	12	19.531	1.72	7
28.8	31.250	8.51	9	27.778	3.55	8	31.250	8.51	4
33.6	34.722	3.34	8	35.714	6.29	6	31.250	6.99	4
57.6	62.500	8.51	4	62.500	8.51	3	52.083	9.58	2
HIGH	1.221	-	255	0.977	-	255	0.610	-	255
LOW	312.500	-	0	250.000	-	0	156.250	-	0

BAUD RATE (K)	Fosc = 4 MHz			Fosc = 3.6864 MHz		
	KBAUD	% ERROR	SPBRG value (decimal)	KBAUD	% ERROR	SPBRG value (decimal)
0.3	0.300	0	207	0.3	0	191
1.2	1.202	0.17	51	1.2	0	47
2.4	2.404	0.17	25	2.4	0	23
9.6	8.929	6.99	6	9.6	0	5
19.2	20.833	8.51	2	19.2	0	2
28.8	31.250	8.51	1	28.8	0	1
33.6	-	-	-	-	-	-
57.6	62.500	8.51	0	57.6	0	0
HIGH	0.244	-	255	0.225	-	255
LOW	62.500	-	0	57.6	-	0

TABLE 10-4: BAUD RATES FOR ASYNCHRONOUS MODE (BRGH = 1)

BAUD RATE (K)	Fosc = 20 MHz			Fosc = 16 MHz			Fosc = 10 MHz		
	KBAUD	% ERROR	SPBRG value (decimal)	KBAUD	% ERROR	SPBRG value (decimal)	KBAUD	% ERROR	SPBRG value (decimal)
0.3	-	-	-	-	-	-	-	-	-
1.2	-	-	-	-	-	-	-	-	-
2.4	-	-	-	-	-	-	2.441	1.71	255
9.6	9.615	0.16	129	9.615	0.16	103	9.615	0.16	64
19.2	19.231	0.16	64	19.231	0.16	51	19.531	1.72	31
28.8	29.070	0.94	42	29.412	2.13	33	28.409	1.36	21
33.6	33.784	0.55	36	33.333	0.79	29	32.895	2.10	18
57.6	59.524	3.34	20	58.824	2.13	16	56.818	1.36	10
HIGH	4.883	-	255	3.906	-	255	2.441	-	255
LOW	1250.000	-	0	1000.000		0	625.000	-	0

BAUD RATE (K)	Fosc = 4 MHz			Fosc = 3.6864 MHz		
	KBAUD	% ERROR	SPBRG value (decimal)	KBAUD	% ERROR	SPBRG value (decimal)
0.3	-	-	-	-	-	-
1.2	1.202	0.17	207	1.2	0	191
2.4	2.404	0.17	103	2.4	0	95
9.6	9.615	0.16	25	9.6	0	23
19.2	19.231	0.16	12	19.2	0	11
28.8	27.798	3.55	8	28.8	0	7
33.6	35.714	6.29	6	32.9	2.04	6
57.6	62.500	8.51	3	57.6	0	3
HIGH	0.977	-	255	0.9	-	255
LOW	250.000	-	0	230.4	-	0

14.2 Oscillator Configurations

14.2.1 OSCILLATOR TYPES

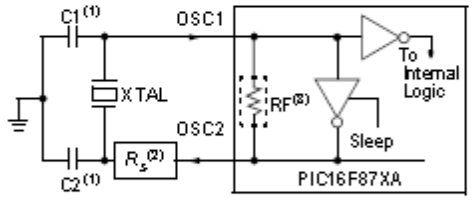
The PIC16F87XA can be operated in four different oscillator modes. The user can program two configuration bits (FOSC1 and FOSC0) to select one of these four modes:

- LP Low-Power Crystal
- XT Crystal/Resonator
- HS High-Speed Crystal/Resonator
- RC Resistor/Capacitor

14.2.2 CRYSTAL OSCILLATOR/CERAMIC RESONATORS

In XT, LP or HS modes, a crystal or ceramic resonator is connected to the OSC1/CLKI and OSC2/CLKO pins to establish oscillation (Figure 14-1). The PIC16F87XA oscillator design requires the use of a parallel cut crystal. Use of a series cut crystal may give a frequency out of the crystal manufacturer's specifications. When in XT, LP or HS modes, the device can have an external clock source to drive the OSC1/CLKI pin (Figure 14-2).

FIGURE 14-1: CRYSTAL/CERAMIC RESONATOR OPERATION (HS, XT OR LP OSC CONFIGURATION)



Note 1: See Table 14-1 and Table 14-2 for recommended values of C1 and C2.
2: A series resistor (R_S) may be required for AT strip cut crystals.
3: RF varies with the crystal chosen.

FIGURE 14-2: EXTERNAL CLOCK INPUT OPERATION (HS, XT OR LP OSC CONFIGURATION)

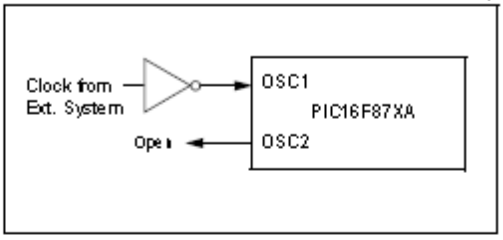


TABLE 14-1: CERAMIC RESONATORS

Ranges Tested:			
Mode	Freq.	OSC1	OSC2
XT	455 kHz 2.0 MHz 4.0 MHz	68-100 pF 15-68 pF 15-68 pF	68-100 pF 15-68 pF 15-68 pF
HS	8.0 MHz 16.0 MHz	10-68 pF 10-22 pF	10-68 pF 10-22 pF
These values are for design guidance only. See notes following Table 14-2.			
Resonators Used:			
2.0 MHz	Murata Erie CSA2.00MG	± 0.5%	
4.0 MHz	Murata Erie CSA4.00MG	± 0.5%	
8.0 MHz	Murata Erie CSA8.00MT	± 0.5%	
16.0 MHz	Murata Erie CSA16.00MX	± 0.5%	
All resonators used did not have built-in capacitors.			

TABLE 14-2: CAPACITOR SELECTION FOR CRYSTAL OSCILLATOR

Osc Type	Crystal Freq.	Cap. Range C1	Cap. Range C2
LP	32 kHz	33 pF	33 pF
	200 kHz	15 pF	15 pF
XT	200 kHz	47-68 pF	47-68 pF
	1 MHz	15 pF	15 pF
	4 MHz	15 pF	15 pF
HS	4 MHz	15 pF	15 pF
	8 MHz	15-33 pF	15-33 pF
	20 MHz	15-33 pF	15-33 pF
These values are for design guidance only. See notes following this table.			
Crystals Used			
32 kHz	Epson C-001R32.768K-A	± 20 PPM	
200 kHz	STD XTL 200.000KHz	± 20 PPM	
1 MHz	ECS ECS-10-13-1	± 50 PPM	
4 MHz	ECS ECS-40-20-1	± 50 PPM	
8 MHz	EPSON CA-301 8.000M-C	± 30 PPM	
20 MHz	EPSON CA-301 20.000M-C	± 30 PPM	

Note 1: Higher capacitance increases the stability of oscillator but also increases the start-up time.

2: Since each resonator/crystal has its own characteristics, the user should consult the resonator/crystal manufacturer for appropriate values of external components.

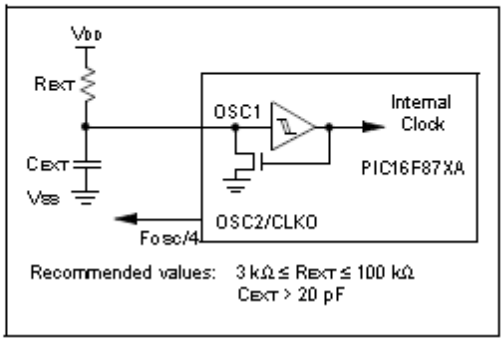
3: R_S may be required in HS mode, as well as XT mode, to avoid overdriving crystals with low drive level specification.

4: When migrating from other PICmicro® devices, oscillator performance should be verified.

14.2.3 RC OSCILLATOR

For timing insensitive applications, the "RC" device option offers additional cost savings. The RC oscillator frequency is a function of the supply voltage, the resistor (REXT) and capacitor (CEXT) values and the operating temperature. In addition to this, the oscillator frequency will vary from unit to unit due to normal process parameter variation. Furthermore, the difference in lead frame capacitance between package types will also affect the oscillation frequency, especially for low CEXT values. The user also needs to take into account variation due to tolerance of external R and C components used. Figure 14-3 shows how the R/C combination is connected to the PIC16F87XA.

FIGURE 14-3: RC OSCILLATOR MODE



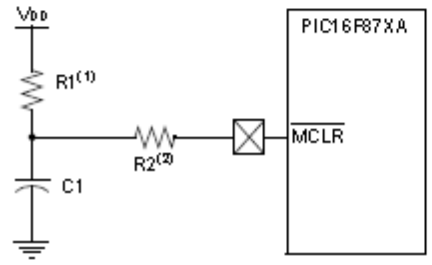
14.4 MCLR

PIC16F87XA devices have a noise filter in the MCLR Reset path. The filter will detect and ignore small pulses.

It should be noted that a WDT Reset does not drive MCLR pin low.

The behavior of the ESD protection on the MCLR pin differs from previous devices of this family. Voltages applied to the pin that exceed its specification can result in both Resets and current consumption outside of device specification during the Reset event. For this reason, Microchip recommends that the MCLR pin no longer be tied directly to VDD. The use of an RCR network, as shown in Figure 14-5, is suggested.

FIGURE 14-5: RECOMMENDED MCLR CIRCUIT



Note 1: R1 < 40 kΩ is recommended to make sure that the voltage drop across R does not violate the device's electrical specification.

2: R2 > than 1K will limit any current flowing into MCLR from the external capacitor C, in the event of MCLR/VPP breakdown due to Electrostatic Discharge (ESD) or Electrical Overstress (EOS).

14.5 Power-on Reset (POR)

A Power-on Reset pulse is generated on-chip when VDD rise is detected (in the range of 1.2V-1.7V). To take advantage of the POR, tie the MCLR pin to VDD through an RC network, as described in Section 14.4 "MCLR". A maximum rise time for VDD is specified. See Section 17.0 "Electrical Characteristics" for details.

When the device starts normal operation (exits the Reset condition), device operating parameters (voltage, frequency, temperature, etc.) must be met to ensure operation. If these conditions are not met, the device must be held in Reset until the operating conditions are met. Brown-out Reset may be used to meet the start-up conditions. For additional information, refer to application note, *AN607, "Power-up Trouble Shooting"* (DS00607).

14.6 Power-up Timer (PWRT)

The Power-up Timer provides a fixed 72 ms nominal time-out on power-up only from the POR. The Power-up Timer operates on an internal RC oscillator. The chip is kept in Reset as long as the PWRT is active. The PWRT's time delay allows VDD to rise to an acceptable level. A configuration bit is provided to enable or disable the PWRT.

The power-up time delay will vary from chip to chip due to VDD, temperature and process variation. See Section 17.0 "Electrical Characteristics" for details (TPWRT, parameter #33).

14.7 Oscillator Start-up Timer (OST)

The Oscillator Start-up Timer (OST) provides a delay of 1024 oscillator cycles (from OSC1 input) after the PWRT delay is over (if PWRT is enabled). This helps to ensure that the crystal oscillator or resonator has started and stabilized.

The OST time-out is invoked only for XT, LP and HS modes and only on Power-on Reset or wake-up from Sleep.

14.8 Brown-out Reset (BOR)

The configuration bit, BODEN, can enable or disable the Brown-out Reset circuit. If VDD falls below VBOR (parameter D005, about 4V) for longer than TBOR (parameter #35, about 100 µS), the brown-out situation will reset the device. If VDD falls below VBOR for less than TBOR, a Reset may not occur.

Once the brown-out occurs, the device will remain in Brown-out Reset until VDD rises above VBOR. The Power-up Timer then keeps the device in Reset for TPWRT (parameter #33, about 72 mS). If VDD should fall below VBOR during TPWRT, the Brown-out Reset process will restart when VDD rises above VBOR with the Power-up Timer Reset. The Power-up Timer is always enabled when the Brown-out Reset circuit is enabled, regardless of the state of the PWRT configuration bit.

14.9 Time-out Sequence

On power-up, the time-out sequence is as follows: the PWRT delay starts (if enabled) when a POR Reset occurs. Then, OST starts counting 1024 oscillator cycles when PWRT ends (LP, XT, HS). When the OST ends, the device comes out of Reset.

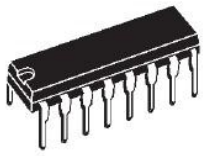
If MCLR is kept low long enough, the time-outs will expire. Bringing MCLR high will begin execution immediately. This is useful for testing purposes or to synchronize more than one PIC16F87XA device operating in parallel.

Table 14-5 shows the Reset conditions for the Status, PCON and PC registers, while Table 14-6 shows the Reset conditions for all the registers.

ULN2001A-ULN2002A
ULN2003A-ULN2004A

SEVEN DARLINGTON ARRAYS

- SEVEN DARLINGTONS PER PACKAGE
- OUTPUT CURRENT 500mA PER DRIVER (600mA PEAK)
- OUTPUT VOLTAGE 50V
- INTEGRATED SUPPRESSION DIODES FOR INDUCTIVE LOADS
- OUTPUTS CAN BE PARALLELED FOR HIGHER CURRENT
- TTL/CMOS/PMOS/DTL COMPATIBLE INPUTS
- INPUTS PINNED OPPOSITE OUTPUTS TO SIMPLIFY LAYOUT



DIP16

ORDERING NUMBERS: ULN2001A/2A/3A/4A

SO16

ORDERING NUMBERS: ULN2001D/2D/3D/4D

DESCRIPTION

The ULN2001A, ULN2002A, ULN2003 and ULN2004A are high voltage, high current darlington arrays each containing seven open collector darlington pairs with common emitters. Each channel rated at 500mA and can withstand peak currents of 600mA. Suppression diodes are included for inductive load driving and the inputs are pinned opposite the outputs to simplify board layout.

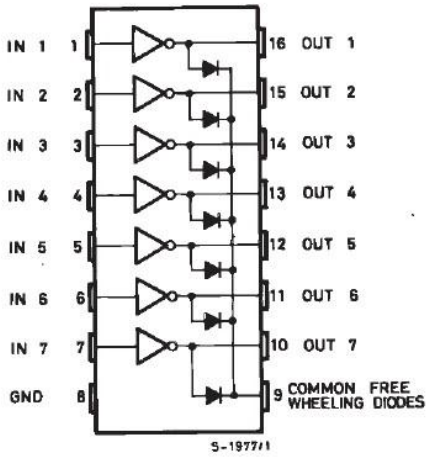
The four versions interface to all common logic families :

ULN2001A	General Purpose, DTL, TTL, PMOS, CMOS
ULN2002A	14-25V PMOS
ULN2003A	5V TTL, CMOS
ULN2004A	6–15V CMOS, PMOS

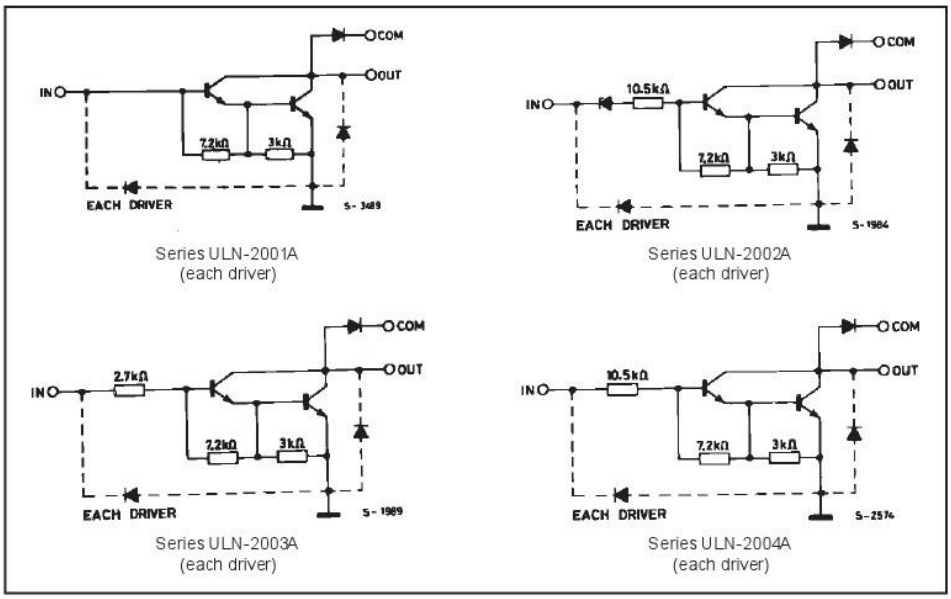
These versatile devices are useful for driving a wide range of loads including solenoids, relays DC motors, LED displays filament lamps, thermal printheads and high power buffers.

The ULN2001A/2002A/2003A and 2004A are supplied in 16 pin plastic DIP packages with a copper leadframe to reduce thermal resistance. They are available also in small outline package (SO-16) as ULN2001D/2002D/2003D/2004D.

PIN CONNECTION



SCHEMATIC DIAGRAM



Series ULN-2001A (each driver)

Series ULN-2002A (each driver)

Series ULN-2003A (each driver)

Series ULN-2004A (each driver)

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_o	Output Voltage	50	V
V_{in}	Input Voltage (for ULN2002A/D - 2003A/D - 2004A/D)	30	V
I_c	Continuous Collector Current	500	mA
I_b	Continuous Base Current	25	mA
T_{amb}	Operating Ambient Temperature Range	– 20 to 85	°C
T_{stg}	Storage Temperature Range	– 55 to 150	°C
T_j	Junction Temperature	150	°C

THERMAL DATA

Symbol	Parameter		DIP16	SO16	Unit
$R_{th\ j\text{-}amb}$	Thermal Resistance Junction-ambient	Max.	70	100	°C/W

ELECTRICAL CHARACTERISTICS (T_{amb} = 25°C unless otherwise specified)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit	Fig.
I_{CEX}	Output Leakage Current	V_{CE} = 50V T_{amb} = 70°C, V_{CE} = 50V T_{amb} = 70°C for ULN2002A V_{CE} = 50V, V_i = 6V for ULN2004A V_{CE} = 50V, V_i = 1V			50 100 500 500	µA µA µA µA	1a 1a 1b 1b
$V_{CE(sat)}$	Collector-emitter Saturation Voltage	I_C = 100mA, I_B = 250µA I_C = 200 mA, I_B = 350µA I_C = 350mA, I_B = 500µA		0.9 1.1 1.3	1.1 1.3 1.6	V V V	2 2 2
$I_{i(on)}$	Input Current	for ULN2002A, V_i = 17V for ULN2003A, V_i = 3.85V for ULN2004A, V_i = 5V V_i = 12V		0.82 0.93 0.35 1	1.25 1.35 0.5 1.45	mA mA mA mA	3 3 3 3
$I_{i(off)}$	Input Current	T_{amb} = 70°C, I_C = 500µA	50	65		µA	4
$V_{i(on)}$	Input Voltage	V_{CE} = 2V for ULN2002A I_C = 300mA for ULN2003A I_C = 200mA I_C = 250mA I_C = 300mA for ULN2004A I_C = 125mA I_C = 200mA I_C = 275mA I_C = 350mA			 13 2.4 2.7 3 5 6 7 8	V	5
h_{FE}	DC Forward Current Gain	for ULN2001A V_{CE} = 2V, I_C = 350mA	1000				2
C_i	Input Capacitance			15	25	pF	
t_{PLH}	Turn-on Delay Time	0.5 V_i to 0.5 V_o		0.25	1	µs	
t_{PHL}	Turn-off Delay Time	0.5 V_i to 0.5 V_o		0.25	1	µs	
I_R	Clamp Diode Leakage Current	V_R = 50V T_{amb} = 70°C, V_R = 50V			50 100	µA µA	6 6
V_F	Clamp Diode Forward Voltage	I_F = 350mA		1.7	2	V	7

TEST CIRCUITS

Figure 1a.

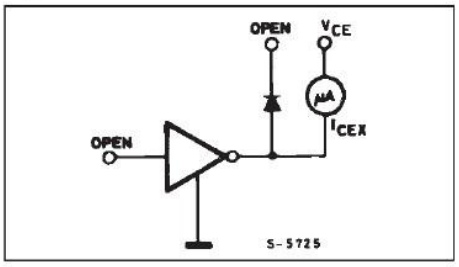


Figure 1b.

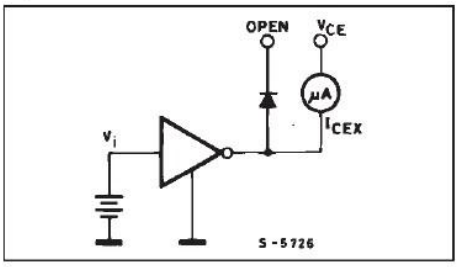


Figure 2.

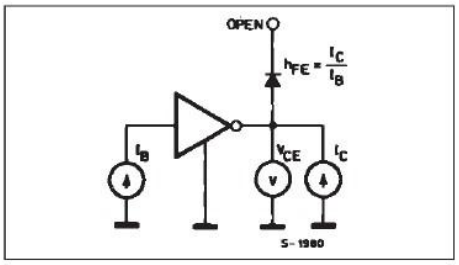


Figure 3.

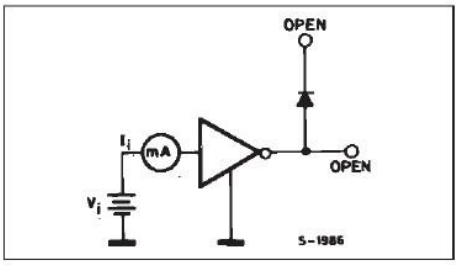


Figure 4.

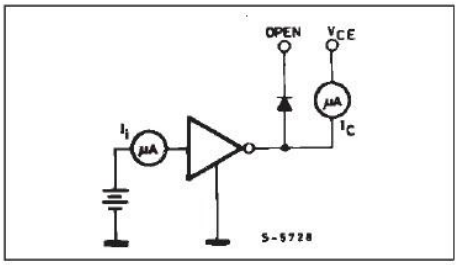


Figure 5.

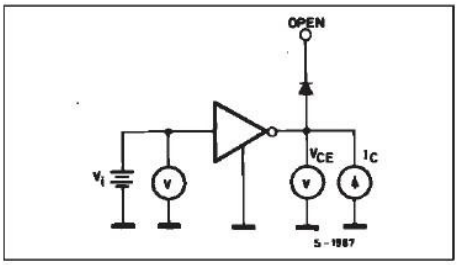


Figure 6.

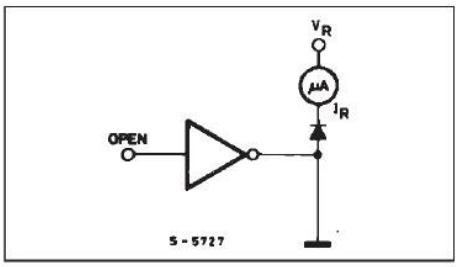


Figure 7.

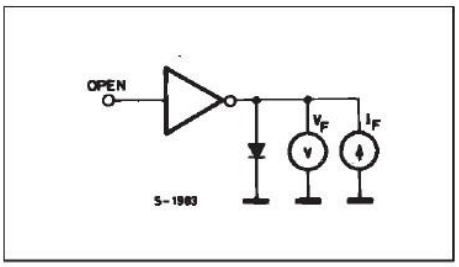


Figure 8: Collector Current versus Input Current

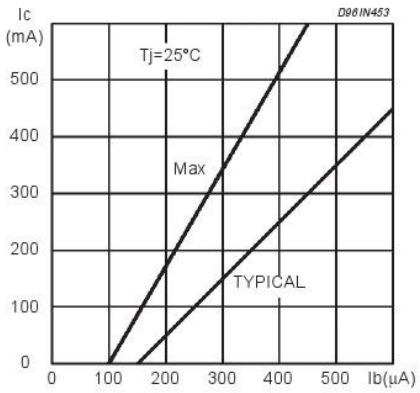


Figure 9: Collector Current versus Saturation Voltage

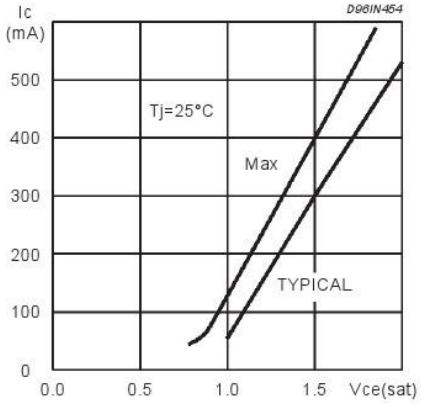


Figure 10: Peak Collector Current versus Duty Cycle

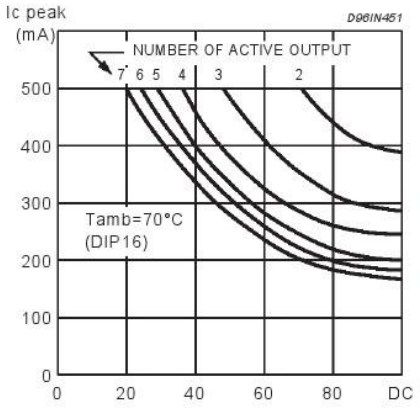
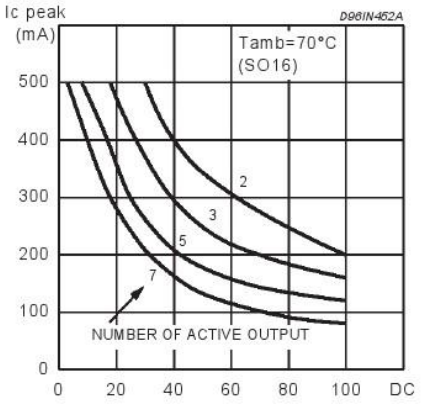
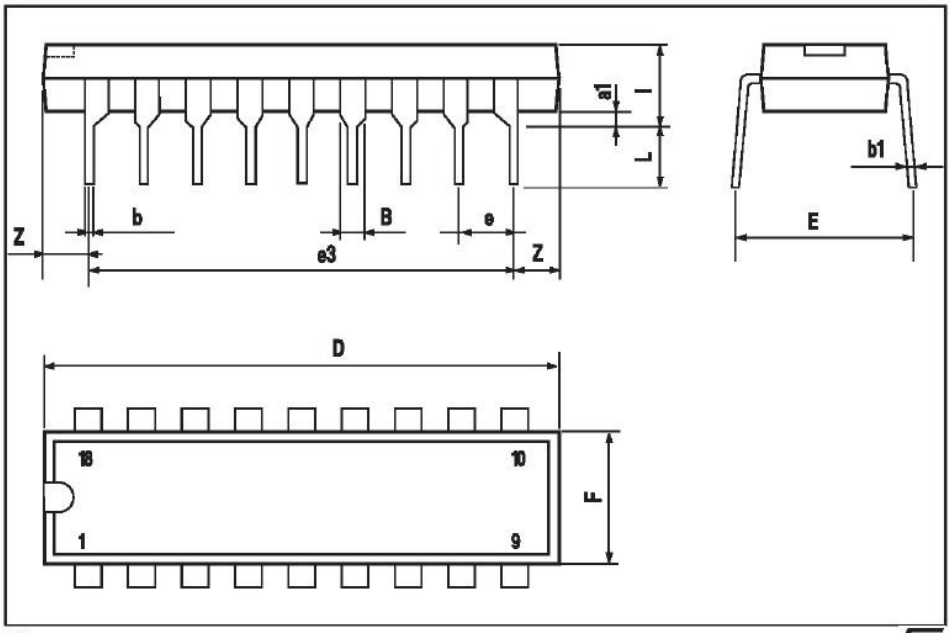


Figure 11: Peak Collector Current versus Duty Cycle



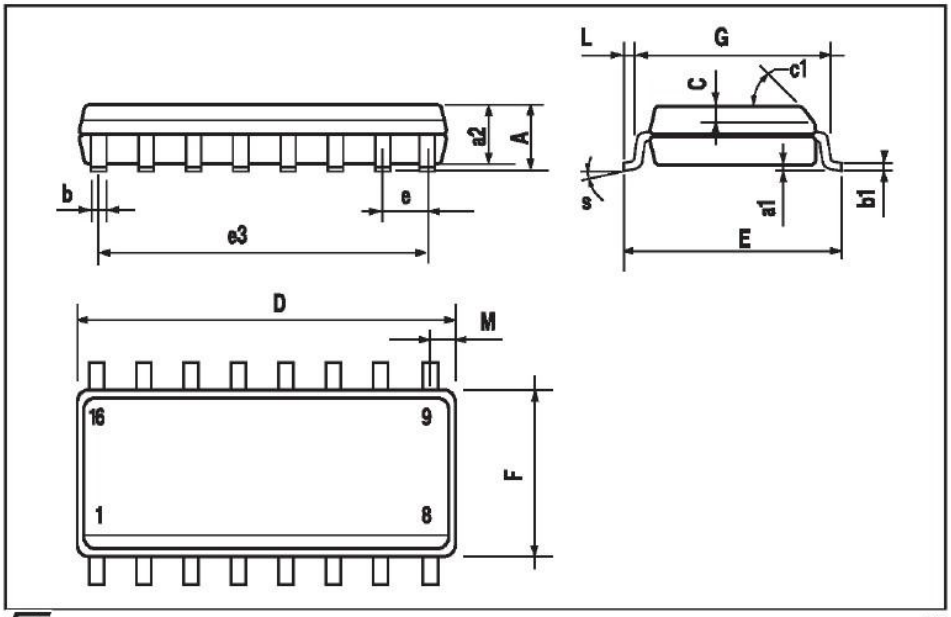
DIP16 PACKAGE MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
a1	0.51			0.020		
B	0.77		1.65	0.030		0.065
b		0.5			0.020	
b1		0.25			0.010	
D			20			0.787
E		8.5			0.335	
e		2.54			0.100	
e3		17.78			0.700	
F			7.1			0.280
I			5.1			0.201
L		3.3			0.130	
Z			1.27			0.050



SO16 PACKAGE MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			1.75			0.069
a1	0.1		0.25	0.004		0.009
a2			1.6			0.063
b	0.35		0.46	0.014		0.018
b1	0.19		0.25	0.007		0.010
C		0.5			0.020	
c1	45 (typ.)					
D	9.8		10	0.386		0.394
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		8.89			0.350	
F	3.8		4.0	0.150		0.157
L	0.4		1.27	0.016		0.050
M			0.62			0.024
S	8 (max.)					



Keypad board datasheet
EB014-00-1

Contents

1. About this document

This document concerns the E-blocks Keypad board code EB014 version 1.

The order code for this product is EB014.

1. Trademarks and copyright

PIC and PICmicro are registered trademarks of Arizona Microchip Inc.
E-blocks is a trademark of Matrix Multimedia Limited.

2. Other sources of information

There are various other documents and sources that you may find useful:

Getting started with E-Blocks.pdf

This describes the E-blocks system and how it can be used to develop complete systems for learning electronics and for PICmicro programming.

PPP Help file

This describes the PPP software and its functionality. PPP software is used for transferring hex code to a PICmicro microcontroller.

C and assembly strategies

This is available as a free download from our web site.

3. Disclaimer

The information in this document is correct at the time of going to press. Matrix Multimedia reserves the right to change specifications from time to time. This product is for development purposes only and should not be used for any life-critical application.

4. Technical support

If you have any problems operating this product then please refer to the troubleshooting section of this document first. You will find the latest software updates, FAQs and other information on our web site: www.matrixmultimedia.com . If you still have problems please email us at: support@matrixmultimedia.co.uk.

2. General information

1. Description

A simple 4x3 keyboard that allows data entry into bus based systems. Flowcode macros for driving this E-block are available.

2. Features

- 4 by 3 keypad for E-blocks
- Flowcode macros available

3. Block schematic

Not supplied.

3. Board layout

EB015-74-1.cdr

1) 9 Way D-type Plug
2) Matrixed 3x4 data keypad

4. Testing this product

The following program will test the circuit. The test file can be downloaded from www.matrixmultimedia.com.

1. System Setup

Multi-programmer board (EB006) with:

EB006 Options	Setting
Power supply	External, 14V
PICmicro device	16F877A
SW1 (Fast/Slow)	Don't care
SW2 (RC/Xtal)	Xtal
Xtal frequency	19.6608MHz
Port A	LED board EB004
Port B	Keypad board EB014
Port C	
Port D	
Port E	
Test program	keypad.hex

2. Test Procedure

1) Wire power to all boards.
2) Configure system and board options as above.
3) Download the test program to the Multiprogrammer
4) Press each button on the Keypad Board and check that the binary value of that Keypad number illuminates on the LED Board
5) For example pressing keypad button 5 will illuminate "(MSB) 0 0 0 0 0 1 0 1 (LSB)"
    1. The * button on the keypad represents the number 10
    2. The # button on the keypad represents the number 11

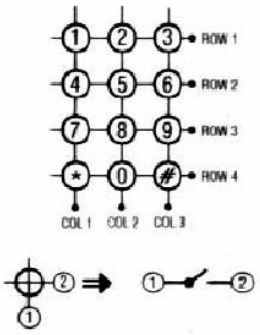
5. Circuit description

1. Description

The circuit board consists of 7 digital I/O lines on a 'downstream' 9-way D-type plug. This routes each bit to a particular line of the keypad. Columns 1, 2 and 3 and routed to bits 0, 1, and 2 respectively. Rows 1, 2, 3 and 4 and routed to bits 5, 6, 7 and 8 respectively. These values were chosen to enable the use of interrupts when connecting the keypad to Port B.

The diagram below shows the internal characteristics of the Keypad.

Circuit Diagram



OUTPUT ARRANGEMENT	
Output pin no.	Symbols
1	
2	Col. 2
3	Row 1
4	Col. 1
5	Row 4
6	Col. 3
7	Row 3
8	Row 2
9	
10	

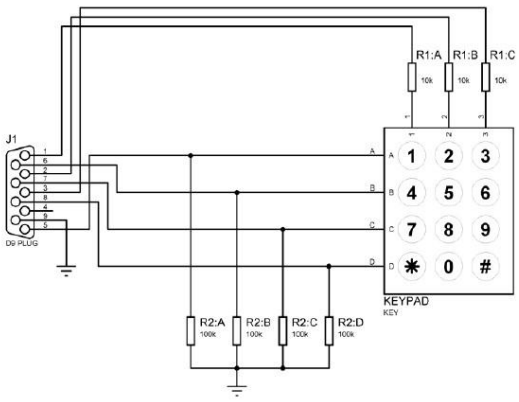
2. 3.3V operation

This board is compatible with upstream boards operating off 3.3V.

Appendix 1 – Circuit diagram

THIS SYSTEM INCLUDES:-

→ FEET



Keypad Ref. No.	Keypad Pinout	Column / Row
1	4	Col 1
2	2	Col 2
3	6	Col 3
A	3	Row 1
B	8	Row 2
C	7	Row 3
D	5	Row 4

MATRIX MULTIMEDIA LTD.
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TITLE:	DATE:
Keypad Board EB-014-00-1	04/05/04
BY: Conor Cair REV 1.0	PAGE: 1/1

Basic School Supplies Dispensing Machine with Single Transaction Payment (December 2011)

Zyner M. Detablan, Mari Alexis Kaye F. Marquez, and Gerome Cristopher P. Refre

***Abstract*— The design's concept is a vending machine that dispenses various school materials. It is intended to provide students faster access buying school supplies rather than purchasing supplies on the bookstore that usually results on too much time wasted and normally, a hassle. When buying a specific school material, the student can itemize the quantity they want and it will be dispense after inserting the necessary amount of coins needed. The whole transaction will only be once—depends on how many items the student bought—since the design is incorporating a single payment. The total number of item obtained with each type of school supply available will also be tallied automatically by the machine. Student inserts an amount of money necessary then specifies the type of school supply and its desired quantity. The vending machine will check the amount of money inserted and process the dispensing of the school material. The vending machine dispenses the desired school material and its quantity.**

***Index Terms*— dispensing, school supplies, vending machine, single payment**

I. Design Background and Introduction

Background

Convenience nowadays, plays an essential role in the development of social environment. Purchasing distinct items at ease is one primary technique in selling products. In providing solution to this, different types of vending machines were introduced to provide customers the opportunity to buy items almost any time when necessary. Basically, a vending machine is an apparatus that dispenses merchandise after the customer selects and deposits money. The mechanism of this device is that after paying, a product will be dispensed by either the machine releases it, so that it falls in an open section at the bottom or the turning of a knob to release an item. Vending machines have a money detector which determines if the amount inserted is sufficient to purchase the desired product.

The design is intended to help both students and the bookstore. This vending machine can distribute basic school supply needs especially if the class hours of the students do not fit within the bookstore hours. Convenience as well is brought by this school supply dispenser provided that the students need not any more to go to the bookstore just to buy certain products which can cause hassle and consumption of time. With the aid of this device, the bookstore can effectively distribute school supplies.

The main feature of the vending machine is the single transaction payment. The vending machine that can be seen in airports, streets, and other places can only dispense a single item per transaction or at least one kind of item per transaction. Unlike this new and improved vending machine, different items can be transacted at the same time. This basic school supply vending machine dispenses items such as large yellow booklet with and without lines, small yellow booklet, black ball pen, and a pencil. First, the user selects the type of school supply followed by the number of quantity of each item. After selecting specific items with corresponding quantity, student can now insert appropriate amount of coins into the machine. The cost for each kind of item, the total cost for the whole sale to be purchase, and the total credit will be displayed.

The dispenser will exhibit a keypad for selecting school supplies as well as for entering desired quantity and a 4-liner LCD display for showing the selection of items to be purchased. There will be a 3 coin slot intended for 1-peso, 5-peso, and 10-peso coin. Once the items are chosen and the coins are inserted, the asterisk button should be pressed for the whole transaction to start. The pressing of the said button will send a signal to the relay coming from the microprocessor for the DC motor to dispense the chosen products. In case of a power interruption, a backup battery is installed ensuring that any transaction will be completed and the total sale is saved. Lastly, the outside coating used for the design is acrylic glass.

Statement of the Problem

Nowadays, many facilities around the world uses vending machine, such as airport, canteens, and condominiums, but one of the places that are also essential in having this equipment are universities and institutes. The common problem in different institutes and universities is how to distribute students' school supplies proficiently because accommodating too much students at the same time is formidable. The start of a semester can be considered as an example because many students buy books, index card, fillers, and other miscellaneous items at the same time for their subjects. This incident causes frustration to some students especially if the only product they intend to buy for example is a single ball pen but the queue is extensive forcing them to be late in class. Students whose school hours do not fit within the operating hours of the bookstore will appreciate the machine most considering that the bookstore will close earlier than the class hours of some students. The main problem to solve is how to have effective distribution of basic supplies in universities and institutions.

Objectives of the Design

The main objective of the design is to assist the bookstore in distributing basic school supplies to the students. Furthermore, this project aims to obtain the following objectives:

1. To develop a multi-item dispensing vending machine;

2. To define a new method of transaction in a regular vending machine;
3. To build a dispenser that will help the admin to compute the total sales; and
4. To create a vending machine that will dispense basic school supplies such as quiz booklet, pencil and ball pen.

Significance and Impact of the Design

Basic school supplies dispenser helps school bookstores and students in everyday lives. Nowadays, most of the school bookstores are closed after 5 to 6pm, using the vending machine the bookstores can still distribute basic school supplies after office hours. This also aids the students to have basic school supplies when needed. The common vending machine available in the market dispenses items only one at a time. The dispenser contribution to the advancement of technology is speed and the capacity to dispense multiple items in a single transaction.

The vending machine has a positive impact in terms of manufacturability because the goods will be traded with relative as ease at minimum cost and maximum reliability.

Design Constraints

Many relevant constraints are considered while making this project. First is coin stability, it is an aspect to examine since many coins will eventually became crude due to the fact that it will pass on to various market place, shopping malls, and public transportations. With regard to the first constraints, another issue to consider is the type of material used in the coin; for the 1-peso coin there are two types of materials used, first is the metal and the non-metal. Since there are two types of material used, either one of the two can only be used for the machine depending on the type of coin used in the coin slot sensor. Due to those different reasons, the coin sensor will have a hard time detecting it and sometimes completely not detecting the coin.

Economically, every legal transaction made in the business industry requires a receipt but the vending machine is unable to produce one. Receipt serves as a proof for the product or service that is purchased. An example is a case of product exchange; it serves as a checker of the price of something that is bought and tells you what you bought. If kept, it also maintains warranties and guarantees, as well as refunds on products if broken or refundable for other reasons.

Slightly slow dispensing of the large examination booklet is another issue to consider; this examination booklet is composed of paper material and friction take into account between two papers in contact are most likely to slide against each other.

Measurement of the coefficient of friction has applications in packaging where a high coefficient will indicate that containers such as sacks, bags and paperboard containers will resist sliding in unit loads or on packaging lines.

Definition of Terms

1. **Vending Machine** – a machine that automatically dispenses consumer goods such as cigarettes, food, or petrol, when money is inserted. (*Collins English Dictionary)*
2. **Keypad** – a small keyboard with push buttons, as on a pocket calculator, remote control unit for a television, etc. *(Collins English Dictionary)*
3. **LCD (Liquid Crystal Display)** – an electronic display (as of the time in a digital watch) that consists of segments of a liquid crystal whose reflectivity varies according to the voltage applied to them. *(Merriam-Webster Dictionary)*
4. **PCB (Printed Circuit Board)** – a circuit in which the interconnecting conductors and some of the circuit components have been printed, etched, etc., onto a sheet or board of dielectric material. *(Random House Dictionary)*
5. **Coin Slot** – a small narrow opening, especially one to receive coins. (*Kenerman English Multilingual Dictionary)*
6. **Microprocessor** – a single integrated circuit performing the basic functions of the central processing unit in a small computer. (*Collins English Dictionary)*
7. **Relay** – an electrical device in which a small change in current or voltage controls the switching on or off of circuits or other devices. *(Collins English Dictionary)*
8. **DC Motor** – An electric rotating machine energized by direct current and used to convert electric energy to mechanical energy. *(McGraw-Hill Science & Technology Dictionary)*
9. **Acrylic** – of, derived from, or concerned with acrylic acid, a paint or colour containing acrylic resin. *(Collins English Dictionary)*
10. **Coefficient of Friction** – The ratio of the force that maintains contact between an object and a surface and the frictional force that resists the motion of the object. *(The American Heritage® Dictionary of the English Language)*

II. Review Of Related Design Literature And Studies

This chapter comprises researches and studies that are correlated to the design. The compilations in this chapter were used as reference for the advancement of the design. The group used these diverse articles and research works in sorting out the conceivable components to be used in the design by considering the benefits and drawbacks discussed respectively in the reviewed studies. This chapter provides an outline of details congregated during the course of development of the design.

Vending Machine

An article entitled "Today and tomorrow of vending machine and its services in Japan" by Yokouchi (2010) talks about how the vending machines expands over the time and how it is successful in their country because of the public security enforced in Japan that they didn't need to worry for any misdemeanor. In Japan,

vending machines are not limited to dispensing soft drinks in tin can or coffee; they have this "unique vending machine culture" that is changing its phase from the regular vending machine to a place providing several services such as; a) various kinds of information; b) food supply to disaster area; c) support to emergency patients; d) security service for outskirts; etc. The article is a foreword of these unique services to public and local society provided with vending machines and can still be further improved in the distant future for more advancement of the vending machine culture.

The article "Vending Machine" by Williamson, Henry C. (1934), talks about the vending machine that dispenses school supplies. This vending machine was suggested by the parent-teacher association—commonly known as PTA—that a stock of school supplies should be kept in school to be sold to the students, thus eliminating the need to go the stores outside the school especially if the campus doesn't have a bookstore. Using this vending machine in their school, they could eliminate the excuses of the students to go out and buy school supplies outside the campus, since it sometimes lead to traffic accidents and to the vices of the students. This invention was created in 1934; the materials used in this vending machine were not microprocessor and other electronic materials since the said materials were not yet invented. The design of this vending machine was mostly created using levers and rods. The article also specified the problem regarding the vending of the design.

In a case study entitled, "Automatic Chocolate Vending Machine using MUCOS RTOS" by Yadav, S.G. Shiva Prasad (2003), tackles about a vending machine that dispenses assorted chocolates. The design uses a 3-liner LCD display, microcontroller based hardware, mechanical coin sorter, and coin inlet. This Automatic Chocolate Vending machine uses microcontroller based dispensing unit, at the start of the transaction the LCD display will show welcome messages for the customer and after inserting the necessary amount of coins into the inlet, it will display a string of messages saying "Wait for a moment" and "Collecting a nice chocolate soon". It is also possible for the customer to retrieve or refund his money if he inserts too much coin. This machine also uses RTOS—Real-time Operating System, it schedules the processes or the tasks for buying from start to finish. The device can be reprogrammed and relocate the codes in the system ROM of flash or EPROM whenever the price of the chocolate increases, the message lines need to be changed or if the machine features needs to be change.

"Reverse Vending Machine Simplifies Recycling" by Smith, Thomas (2009), discussed about vending machines that have become a staple in society as a convenient way to overpay for a soda or snack. These contraptions look similar to average vending machines, but they are designed to accept, clean and crush recyclable materials. Individuals who recycle, say a plastic bottle, will receive coupons, cash credit or vouchers from the machine to be used at neighboring shops. The machines hold up to 3,000 containers and accept PET, HDPE, PVC, plastic, brown, clear and green glass and aluminum cans. In addition, they're said to reduce carbon emissions by preparing the recycled materials for direct shipment to a recycling depot, bypassing waste processing facilities. These devices are being deployed throughout Australia. If those work out, expect to see recycling machines on street corners everywhere in the very near future.

The project entitled "Vending Machine" by Singh, Virdi Sabegh (2003), discussed about the design, simulation, realization and demonstration of a vending machine system using a Field Programmable Gate Array. This project is somewhat similar to the other vending machines; the difference is that it is more flexible in terms of changes in the product demands as it is also very powerful, and relatively low-cost.

On "A Wireless Vending Machine System Based on GSM" by Hong Gu, Shuang Qiao, and Jiang Tian (2006), it was said that several methods by which we may realize wireless data communication of GSM network are analyzed and compared, the overall structure of vending machine system based on USSD is given an in-depth introduction. Furthermore, control modules which realize data transmission and control function of terminal device, middleware which connects application and BOSS (business operation support system), and transaction software embedded in USSD platform, are also developed respectively. Finally, the operating support system of wireless vending machine system is formed, which can not only integrate vending machines, USSD platform and payment system together, but also manage sale information, logistic information and consumer information on-line.

The paper "Automatic mobile payment on a non-connected vending machine" by Azami, S.B.Z, Tanabian, M. (2004), addresses a mobile payment solution where there is no connection required for the vending machine, and while the local means of communication is through infrared (IR). It is assumed that the cellular phone has the IR feature. All the user has to do is to select the item, and point the infrared enabled cellular phone to the vending machine. The vending machine will detect the presence of the cellular phone through IR, and the communication will take place by sending a message to the back-end server. Detailed inventory and telemetric information can be added to the transaction data. Data compression, segmentation and reassembly schemes are implemented. The message gets decoded in the back-end server where the transaction is processed, billing is done, and inventory information is sent to the vending machine operators. Another program in the vending machine operator side optimizes the route management of the truck fleet, responsible for replenishing the vending machines. An intelligent route management saves on the operational costs, by reducing the number of times each vending machine needs to be visited. The proposal is a hybrid of three payment methods: currency (coin), manual mobile and infrared mobile.

Currently in Dublin the system of public transport ticketing is under review and there are plans to introduce a multi-modal, multi-operator ticketing system. It is planned that this system, "Passenger requirements of a public transport ticketing system" by Caulfield and O'Mahony (2005), would be operated via smart card technology, whereby passengers can pass between mode and operator with ease of use. The purpose of this paper is to examine what passengers require from their ticketing system with regard to the means and method of payment and the kind of information they require from an at-stop ticketing vending machine. Between January and February 2004 a detailed survey of a representative sample of 1,005 adults aged 15 and over in Dublin was completed using face-to-face at home interviews. With the format of the ticketing system decided upon (contact-less smart cards) the research focused upon the payment options and the design of the at-stop/station ticket vending machines. The first section of the paper looks at international examples of ticketing systems and how intelligent transport systems (ITS) applications have been used to aid passengers' comprehension of the ticketing system and ease of use of the system. The second section describes the methodology used in the data collection. The third section details the passenger requirements from a ticketing system based upon the data collected from the Dublin survey. The final section of the paper details the

conclusions that can be drawn from the data gathered in the Dublin study.

A new approach to prepayment schemes could make it easier for UK consumers to shop around for the best value gas and electricity. The "Paying for energy the smart way" article of Cowburn, J., proposed approach to smart prepayment uses the same building blocks as a traditional budget scheme. For each day of the week, the meter records the energy used in each half hour period and calculates average usage over a specified period which can be monthly, quarterly etc. The majority of consumers will fall into a small number of profiles, so matching the consumption pattern to one of a number of preprogrammed profiles downloaded from the vending system via the smart card or communications channel would take up less storage space. When the customer wants to top up their gas or electricity credit they visit a vending machine which uses the consumption data stored on their card to allocate a tariff and calculates how much energy to offer the consumer for their money. A multi-supplier machine could even compare the different tariffs available to a customer with a particular profile and offer the cheapest. Once the transaction is complete, the card is credited with the amount of energy purchased for downloading to the meter. The meter would be capable of interrupting the supply when credit has been used, although there would probably have to be an emergency credit facility-paid back at the next transaction-to provide a period of grace.

These articles can serve as an inspiration for us that the vending machines are becoming more and more unique as time passes by.

Microcontrollers

The article "Workhorses of the electronic era [microcontrollers]" by Khan, AR., discussed about microcontrollers and how it is always around us embedded in the machines and different appliances. Controllers are embedded in cordless and portable telephones, point-of-sale retail electronic cash registers, scanners of all kinds, security systems, automobiles and gas pumps, automated tellers, computers, and compact disks and disk drives, not to mention phone-answering, fax, vending, and washing machines. Here, the author describes how today's microcontrollers are performing better than ever through their use of high-level languages and multitasking techniques.

In an article entitled "Network model based automation of thermal processes using an embedded digital controller", by Ganesh, A.B. Sangeetha, A.L. Ravi, V.R. issued last Dec. 2009 from IEEE, a microcontroller is used. The article describes the network architectures of both WAN and LAN based real time control and monitoring of thermal process station using an embedded digital controller. The function of the microcontroller in this design is a temperature controller that communicates directly with the temperature transmitter. The design uses the PIC16F877A microcontroller.

Coin

In this paper, "Efficient coin recognition using a statistical approach" by Al-Zoubi, H.R., the author proposed a coin recognition system using a statistical approach and apply it to the recognition of Jordanian coins. The proposed method depends on two features in the recognition process: the color of the coin, and its area. Although the proposed recognition approach is applied to Jordanian coins, it can be applied to the recognition of any coins.

Through this article, we could use it as a guide in implementing the coin slot in the group's design project.

III. Design Procedures

This chapter discusses the step-by-step procedures that were followed in making and developing the design. This section includes both the hardware and software development. The hardware development is composed of the block conceptual diagram, block diagram, and schematic diagram. Conversely, the software development consists of system flowchart.

Hardware Development

Conceptual Diagram

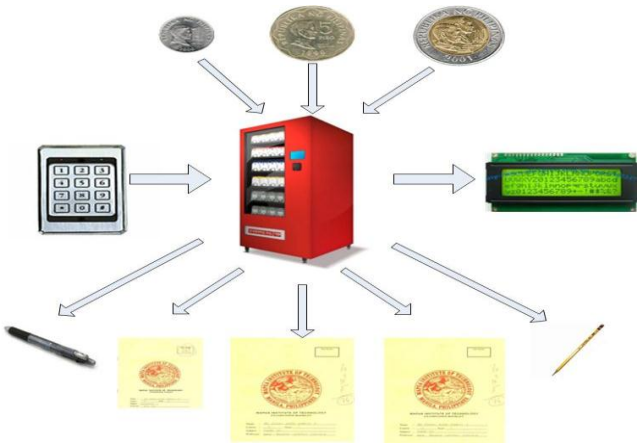

Figure 3.1 Conceptual Diagram

Figure 3.1 shows the conceptual diagram and the whole flow of the design. As shown, the school supplies dispenser accepts three different kinds of coins, and once inserted the credits will be automatically stored and displayed. The keypad then will determine the type and quantity of item that will be dispensed off. A 4-liner LCD display will show the current transaction; shown in the display are the unit price of each item, quantity to be purchase, current credit, and total cost.

Block Diagram

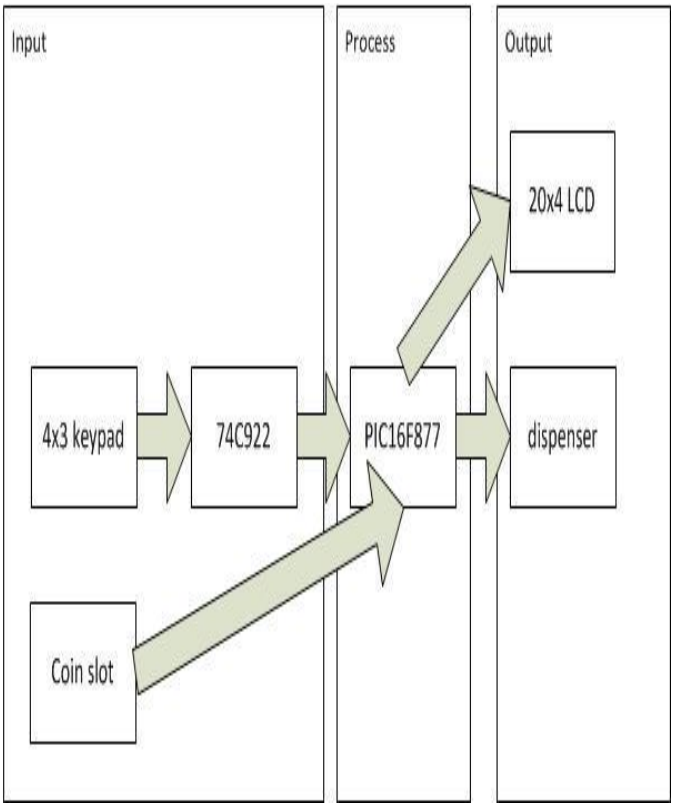

Figure 3.2 Block Diagram

Figure 3.2 illustrates the basic diagram and interconnection of the main parts of the design. The design is divided between the input, process and output. The input of the system will be coming primarily from the 4x3 keypad that will go directly to the 74C922(16-key encoder) to provide the necessary logic to encode the array of the SPST (single pole, single throw) switches, this is mainly for sending the appropriate instructions to the PIC16F877. The coin as well is provided in the input to count the number of credits entering the machine.

The primary output of the system is composed of the 20x4 LCD display and the dispensers. The LCD display provides the complete information about the whole transaction while the dispenser is for the output delivery of the purchase materials.

SCHEMATIC DIAGRAM (see page 150)

SOFTWARE DEVELOPMENT

System Flowchart

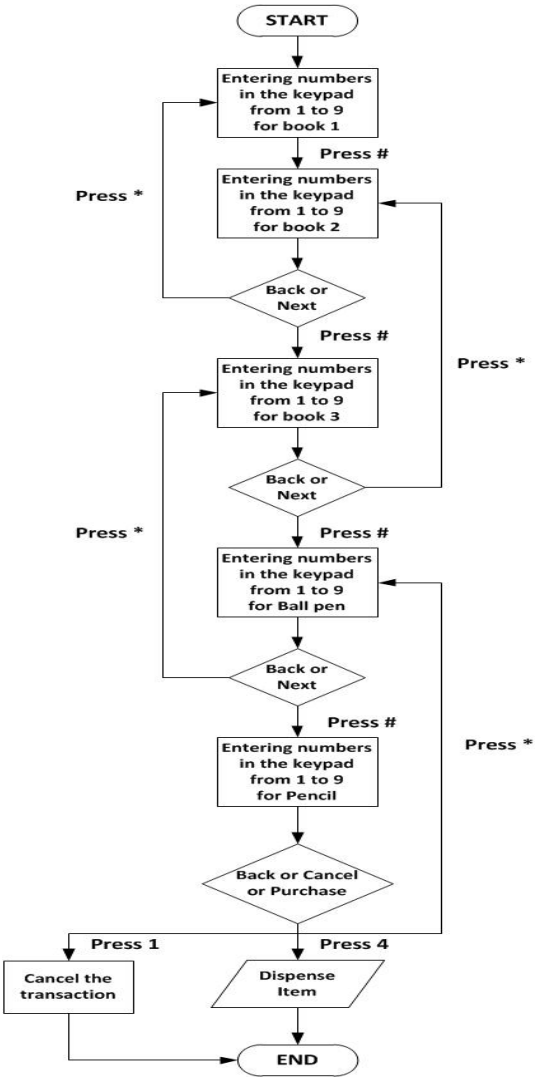

Figure 3.4 System Flowchart

Figure 3.4 shows the system flowchart of the Basic School supplies dispenser with single transaction payment. The micro controller checks what keys you pressed in the keypads. This also shows that when you pressed asterisk (*) the program will back to the previous items except for the Book 1 that will do nothing if you press *. Number sign (#) will go to the next item except for the final part that will do nothing because instead of pressing # the dispenser require you to press 4. The last part, when you cancel the transaction the machine will automatically give the coins that you insert.

Program Flowchart

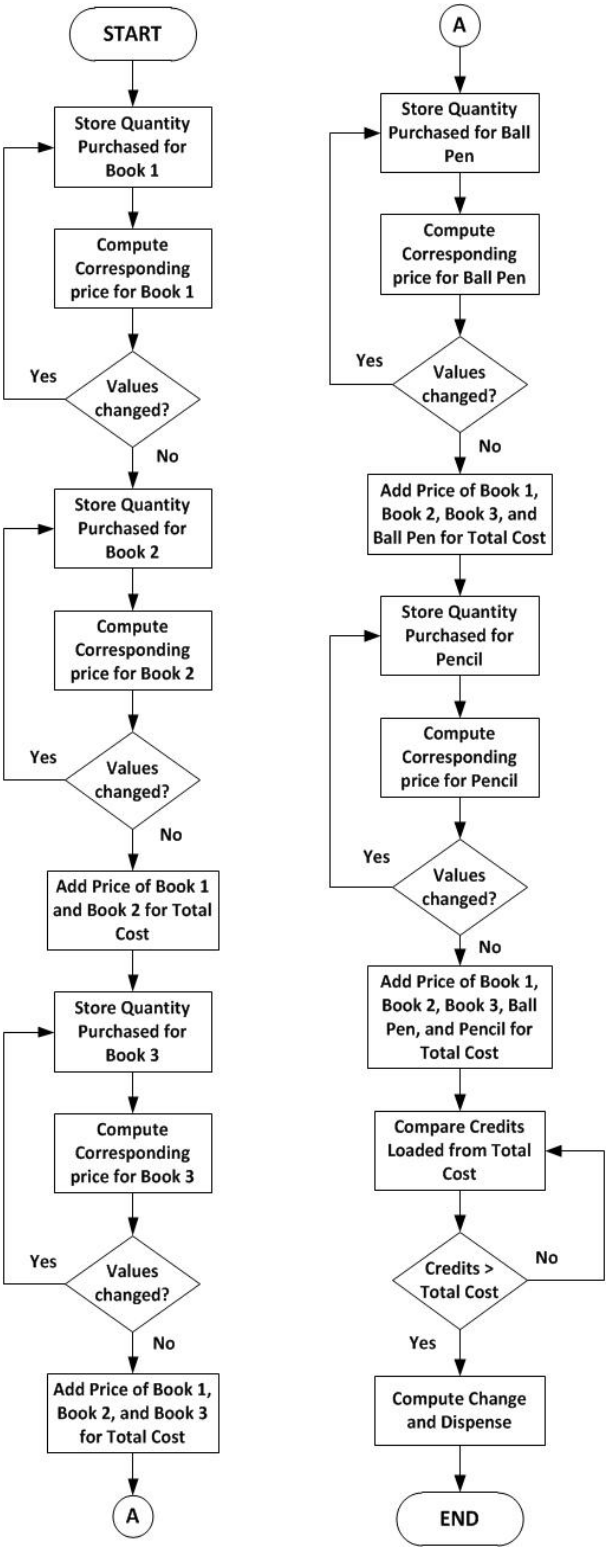

Figure 3.5 Program Flowchart

Figure 3.5 illustrates the program flowchart of the design. As shown from the figure, the program stores the quantity and price of each of item that will be purchased. As the user proceed to the next transaction page, the price of the previous item will be carried over and be added to the price of the current transaction page. This flow will be continuous and the same for all the items until the program reaches the finalize transaction page wherein the total cost for all the items to be purchased will be computed. As the credits are loaded in the machine, the change are computed and dispensed.

Prototype Development

The design procedure shows the step-by-step procedure on how the design was built by the researcher. Detailed information will be described about the conceptualization of the design project.

1. Conceptualization

After knowing the design will work as a whole, the conceptualization of the input and output devices part must be equated to simplify the design hardware and software.

2. Simplified Design Requirement

It is also important to create initial drafting of materials required as the development of the project proceeds. This gives the researchers the overview of the project.

3. Illustrate the Block Diagram

Defines the major composition of the block and shows how each block is related with each other. The block diagram for the input which consist of the keypad, 74C922 16-key encoder and coin slot. The output which consists of the 20x4 LCD and dispensers.

4. Draw schematic diagram

Schematic diagram of this design shows how each device was interconnected, it contains components such as Microcontroller (PIC), DC motors, 20 x 4 Line LCD, Keypad, Coin slot, power supply, sensors, and battery. In developing the design, the following materials are used:

PIC16F877A

This type of microcontroller is used in the design primarily because of its many inputs. PIC16F877A has a maximum of 40 I/O pins which is very much suitable for the design. It has a maximum of 256 bytes for its register which is also much appropriate for the design to be possible.

74C922

The 74C922 key encoders provide all the necessary logic to fully encode an array of SPST switches. The keyboard scan can be implemented by either an external clock or external capacitor. We used this to encode the keypads.

20x4 Line LCD

The 20x4 LCD Module makes it easy to add an alphanumeric display module to your design. It requires only a 5V power supply and two data connections for either mode, freeing up pins on your processor. Many useful texts formatting functions are provided, including the ability to create custom characters.

ULN2003

The ULN2003 is a monolithic high voltage and high current Darlington transistor arrays. It consists of seven NPN Darlington pairs that feature high-voltage outputs with common-cathode clamp diode for switching inductive loads. The collector-current rating of a single Darlington pair is 500mA. The Darlington pairs may be paralleled for higher current capability. Applications

include relay drivers, hammer drivers, lamp drivers, display drivers (LED gas discharge), line drivers, and logic buffers.

LIST OF MATERIALS

Name of Material	Unit Price
4x20 LCD w/ ribbon wire	1,900
Coin slot	1,200
Numerical keypad w/ 74C922 IC	650
PIC16F877	530
10k array resistor	12
7805 voltage regulator	15
Heat sink	20
1000 uF/16v electrolytic capacitor	8
100uF / 25v electrolytic capacitor	3
2 pins terminal block	12
¼ W resistor	0.25
105 mylar capacitor	2
22pF ceramic capacitor	0.5
4 MHz crystal	35
W10G rectifier diode	12
12v relay	30
3 pins terminal block	15
Power supply module	150
4x4 relay module	490
Coins dispenser	950
Limit switch	38
DC motor	315
Paper dispenser	1350
Rocker switch	25
Fuse w/ holder	10
Transformer	290
Backup battery	800
Tubular aluminum	388
Acrylic	2,300
AC cord	30
ULN2003	28
Quiz booklet large	8
Quiz booklet small	7
Pencil	7
Ball pen	7

Table 3.1 List of Materials

IV. TESTING, PRESENTATION AND INTERPRETATION OF DATA

This chapter presents various tests performed by designers to determine the effectiveness of the design. These tests were done considering the objectives given in the first chapter of this documentation.

Dispenser Accuracy Test

The researchers conducted an accuracy test to determine if the design can dispense an accurate number of items such as booklets, ball pen and pencil. The following table sum up the results gathered based on the test that the designers performed.

Trials	1pc	2pcs	3pcs	4pcs	5pcs	6pcs	7pcs	8pcs	9pcs
Book1	OK	OK	OK	OK	OK	OK	OK	OK	OK
Book2	OK	OK	OK	OK	OK	OK	OK	OK	OK
Book3	OK	OK	OK	OK	OK	OK	OK	OK	OK
Ball Pen	OK	OK	OK	OK	OK	OK	OK	OK	OK
Pencil	OK	OK	OK	OK	OK	OK	OK	OK	OK

Table 4.1 Product Dispensing Test Result

Table 4.1 shows the dispenser can dispense the item. The test confirms that the correct quantity of items will be distributed depending on the number specified by the customer. The word "OK" means that the vending machine can dispense the items accurately.

Coin Slot Test

The researchers conducted a test on the design's coin slots. There are three kinds of coin slots in this design; the ten-peso coin slot, five-peso coin slot, and one-peso coin slot. The researcher tests if the one peso coin slot will accept the five peso coin or ten peso coin and so as for the other two. The first attempt on this test, the 10-peso coin slot accepts the 5-peso coin because it checks the material of the coin and there are some minor similarities between the composition of the 5 peso and 10 peso coin. In the second attempt, the 10-peso coin slot already did not accept the five peso coin because the knob inside the 10 peso coin slot was adjusted. The following table shows the results of the tests.

Trials	Coin Slot	COIN INSERTED		
		P1	P5	P10
1	P1	Accept	Reject	Reject
2	P1	Accept	Reject	Reject
3	P1	Reject	Reject	Reject
4	P1	Accept	Reject	Reject
5	P1	Reject	Reject	Reject
6	P1	Accept	Reject	Reject
7	P1	Accept	Reject	Reject
8	P1	Accept	Reject	Reject
9	P1	Accept	Reject	Reject
10	P1	Accept	Reject	Reject
11	P5	Reject	Accept	Reject

12	**P5**	Reject	Accept	Reject
13	**P5**	Reject	Accept	Reject
14	**P5**	Reject	Accept	Reject
15	**P5**	Reject	Accept	Reject
16	**P5**	Reject	Reject	Reject
17	**P5**	Reject	Accept	Reject
18	**P5**	Reject	Accept	Reject
19	**P5**	Reject	Accept	Reject
20	**P5**	Reject	Accept	Reject
21	**P10**	Reject	Reject	Accept
22	**P10**	Reject	Reject	Accept
23	**P10**	Reject	Accept	Accept
24	**P10**	Reject	Accept	Accept
25	**P10**	Reject	Reject	Accept
26	**P10**	Reject	Reject	Accept
27	**P10**	Reject	Reject	Accept
28	**P10**	Reject	Reject	Accept
29	**P10**	Reject	Reject	Accept
30	**P10**	Reject	Reject	Accept

Table 4.2 Coin Slot Test Result

Table 4.2 shows the result on what will happen if a certain coin is inserted to a specific coin slot. This test confirms that only the appropriate coin will be accepted in their respective coin slots and those inserted in the wrong coin slot will be rejected.

Change for Purchased items test

The researchers conducted a test to determine if the dispenser accurately gives change to the customers upon purchasing school supplies. The following table sum up the results gathered based on the test that the designers performed.

Trials	Amount Inserted (Php)	Total Amount Purchased (Php)	Change (Php)
1	**10**	7	3
2	**10**	14	Invalid
3	**20**	14	6
4	**20**	21	Invalid
5	**16**	14	2
6	**16**	23	Invalid
7	**19**	25	Invalid
8	**50**	42	8
9	**50**	75	Invalid
10	**36**	35	1
11	**36**	42	invalid
12	**8**	7	1
13	**8**	8	0
14	**14**	14	0
15	**21**	21	0
16	**30**	28	2
17	**30**	21	9
18	**30**	14	16
19	**24**	14	10
20	**17**	18	Invalid
21	**17**	14	3
22	**25**	14	11
23	**25**	18	7
24	**35**	29	6
25	**28**	24	4
26	**28**	35	Invalid
27	**28**	28	0
28	**25**	23	2
29	**25**	24	1
30	**1**	20	Invalid

Table 4.3 Change Test Result

Table 4.3 shows the results on what will happen if a certain amount of coins is inserted to the machine satisfying the condition that this amount is not equal to the total amount purchased. The

results showed that correct amount of change will be dispense automatically after the confirming the transaction. In the 4th column there are results which are invalid, these indicates that the amount inserted by the user is less than the amount he wants to purchase. As a result, the machine will not dispense the items.

LCD Display and Keypad and Administrator Button

The researchers conducted a test to the four liner LCD display and keypad to verify if the buttons pressed will correctly display the output and perform its desired instruction. The following table sums up the results gathered based on the test that the designers performed.

Key Pressed	Output
1 (item quantity selection)	1
2 (item quantity selection)	2
3 (item quantity selection)	3
4 (item quantity selection)	4
5 (item quantity selection)	5
6 (item quantity selection)	6
7 (item quantity selection)	7
8 (item quantity selection)	8
9 (item quantity selection)	9
0 (item quantity selection)	0
*****	Previous
#	Next
0 (finalize transaction page)	Cancel all transaction
4 (finalize transaction page)	Dispense ordered items
Admin button + #	Display total sales

Table 4.4 Keypad input and LCD output test result

Table 4.4 shows the result if a corresponding key on the keypad is pressed and what are its effects on the display and how does it affects the operation of the system. As shown, this test confirms that each of the buttons in the keypad is correctly performing its intended operation. These table shows that when the user press the button 1 the dispenser displays number 1. Button 2, 3, 4, 5, 6, 7, 8, 9, and 0 displays on the LCD 2, 3, 4, 5, 6, 7, 8, 9, and 0 respectively. When the user press the * the machine will go to the previous item except if the user is currently on the Book 1 page, because it will not do a thing since there are no previous items before book 1. When the user press the # the machine will go to the next item except if the user is currently on the transaction page, because it will not do a thing since there are no items beyond the transaction page. In the transaction page when the user presses 1, it will cancel the transaction and give back the coins inserted by the user. In the transaction page when the user presses 4, it will begin the transaction. The vending machine also helps the administrator in calculating the total sales of each item and the total sales of all the items included by holding the admin button simultaneously with the # button. This automatically displays the total sales.

Empty Sensor Test

The researchers conducted a test to check if the sensors installed on the design can detect if the dispenser of each item is already empty. The following table sum up the results gathered based on the test that the designers performed.

Trials	Items	No. of items in the Dispenser	Output of the LED indicator (ON or OFF)
1	**Book 1**	5	OFF
2	**Book 1**	4	OFF
3	**Book 1**	3	OFF
4	**Book 1**	2	OFF
5	**Book 1**	1	OFF
6	**Book 1**	0	ON
7	**Book 2**	5	OFF
8	**Book 2**	4	OFF
9	**Book 2**	3	OFF
10	**Book 2**	2	OFF
11	**Book 2**	1	OFF
12	**Book 2**	0	ON
13	**Book 3**	5	OFF
14	**Book 3**	4	OFF
15	**Book 3**	3	OFF
16	**Book 3**	2	OFF
17	**Book 3**	1	OFF
18	**Book 3**	0	ON
19	**Ball pen**	5	OFF
20	**Ball pen**	4	OFF
21	**Ball pen**	3	OFF
22	**Ball pen**	2	OFF
23	**Ball pen**	1	OFF
24	**Ball pen**	0	ON
25	**Pencil**	5	OFF

26	**Pencil**	4	OFF
27	**Pencil**	3	OFF
28	**Pencil**	2	OFF
29	**Pencil**	1	OFF
30	**Pencil**	0	ON

Table 4.5 Empty dispenser detection test

Table 4.5 shows the results when a certain items had run out of supplies. As the result implies, the red light indicator turns ON when the sensor detects that no items is currently on the top of the dispenser, but if there are at least one piece of each item above it the LED indicator will turn OFF.

V. Conclusion And Recommendation

This chapter gives the overall conclusion of the development of the design in relation to its objectives. The results of the various tests performed are also clearly defined in this chapter. Recommendations for the improvement of the design are also specified to indicate the need for further studies, with reference to the design constraints.

Conclusion

In the Basic School Supplies Dispenser with Single Transaction Payment, the designers were able to develop a device that would dispense basic school supplies such as quiz booklet, pencil and ball pen. This device also helps the administrator to compute the total sales. One of the additional advancement of this device with the others is that it can detect the dispenser if it is empty by having a red light indicator.

The design is incorporated with a new way of purchasing items, which is by multiple items at a single transaction. Multiple items in the sense that not only a single kind of item can be purchase with different quantity but also with the ability to purchase multiple kind of items with multiple quantity. Due to this innovation, the school materials can now be distributed faster and effectively.

Recommendation

Certain enhancements and modifications can be made to the design in order to develop it into a more sustainable mechanism from latent users. The following are the recommendations to consider:

1. Improvement on the tube capacity for the 1 peso and 5 peso coins for the change;
2. Implementation on the design to accept bills as credits for purchasing items;
3. Additional kinds of school supplies to dispense;
4. Implementation of the receipt for the customers to check their transaction records; and
5. Enhancements on the outer covering of the design; either use fiber glass to add more security to the inventory.

Appendix

Appendixes, if needed, appear before the acknowledgment.

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Schematic Diagram