Microcontroller Based Fish Feeder

By

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

Bachelor of Science in Computer Engineering

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Approval Sheet

Mapúa Institute of Technology
School of EE-ECE-CoE

This is to certify that we have supervised the preparation of and read the design report prepared by **Patrick Henry G. Baniqued, Martin Joseph C. De Castro and Chael Triston T. Luzano** entitled **Microcontroller-Based Fish Feeder** and that the said report has been submitted for the final examination by the Oral Examinations 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 **November 24, 2008**, and hereby recommended that it be accepted as fulfilment of the design requirement for the degree in **Bachelor of Science in Computer Engineering.**

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ABSTRACT

The design is all about the microcontroller-based fish feeder. The microcontroller-based fish feeder is very useful in providing people who are always away from their home to have their fish fed regularly and on time keeping the fish healthy and safe. The main purpose of this design is the automation of the fish feeding device with accurate and precise set time of feeds to be released, the usage of LCD monitor for user interface, the implementation of alarm or signal to know if the container is almost empty, and the use of relay as electronic switch for the dc motor. This design will be installed in aquariums, operated and controlled by a PIC microcontroller. It is operated by inputting the real time and assigning a desired time the fish will be fed which will be displayed on the LCD.

Keywords: fish feeder, microcontroller, LCD monitor, Alarm or Signal, Relay

Chapter 1

DESIGN BACKGROUND AND INTRODUCTION

Design Setting

Automation is defined as self-regulating control of equipment, systems or processes without human intervention. These ideas of automation hold favor with those technologists and lazy people who do not want to do tough work particularly manual operations. The scientific wizardry of achieving automations undoubtedly makes it apparent that the day will surely come when all of the things will be automatically operated.

It is true that most fish can miss a meal without being in any danger. Some fishes can easily go a week or more without food if they are healthy. As fish owners, it will determine how they are concerned about their fish while being away for an extended period of time.

In addition, having to design and manufacture a fish feeder that can greatly assist fish farmers and the productivity of the farm can help them operate more without bearing too much of a cost on other things.

The design project is that it will be also very inconvenient on the part of the owners when on vacation and for those living a busy lifestyle because some sensitive and expensive fish normally need to be fed once or twice a day.

Thus, the purpose of the design project was to provide the fish owners a device that can actually feed their fish regularly whenever they are away or on a vacation for a while. These reasons led to the invention creation of an automatic fish feeder.

Statement of the Problem

Different fish have different diets, depending on what food they eat. Available designs of automatic fish feeder have only one container so the device is only good for one fish, or it will depend on what food is it the container. Also, if there are different kinds of fish in a certain aquarium, that feeder will be useless because the device cannot accommodate or release different kinds of feed at the same time. In addition, other fish feeders releases foods in a fixed amount causing some of the food to become just a waste in the aquarium, or if the fish have a bigger diet, there is a tendency that the food will not be enough. These problems resulted in certain inquiries:

1. How can a device feed different kinds of fish on a single container?
2. How can a user-friendly device be developed?

3. How can it release different kinds of food at the same time with different amount?

4. How can an exact and accurate amount of food for the fish be released?

5. How can the time and the amount of food to be released by the device be controlled?

Objective of the Design

The primary objective of the design was to create a device that would automatically feed the fish via a microcontroller in the aquarium. This would include having an accurate process like time setting and regulated amount of feeds to be released. In addition, since there are different kinds of fish in a certain aquarium, the device will release three different kinds of feed such as pellets, flakes and, powder either at the same time or separately. For ordinary fish owners, the device will come very simple and easy-to-use. Feeding the fish in the aquarium regularly and on time is taxing, that is why designing an automatic fish feeder can help ease up the task.

Significance of the Design

The design will aid in providing information in the development of microcontroller-based fish feeder. These can also help the students to have a background on micro-controller based devices to help them improve or develop some industrial controller based products. Furthermore, creating the device will help in promoting the school's technological advancement through the innovation of different kinds of equipment via a micro-controller. Creating the device can also identify some of the advantages and disadvantages of using this kind of process by analyzing how the fish will react and grow when given enough amount of food. These will also help some designers to know or to see if there are still ways on how to improve the device depending on how it will affect the fish or the environment.

Conceptual Framework

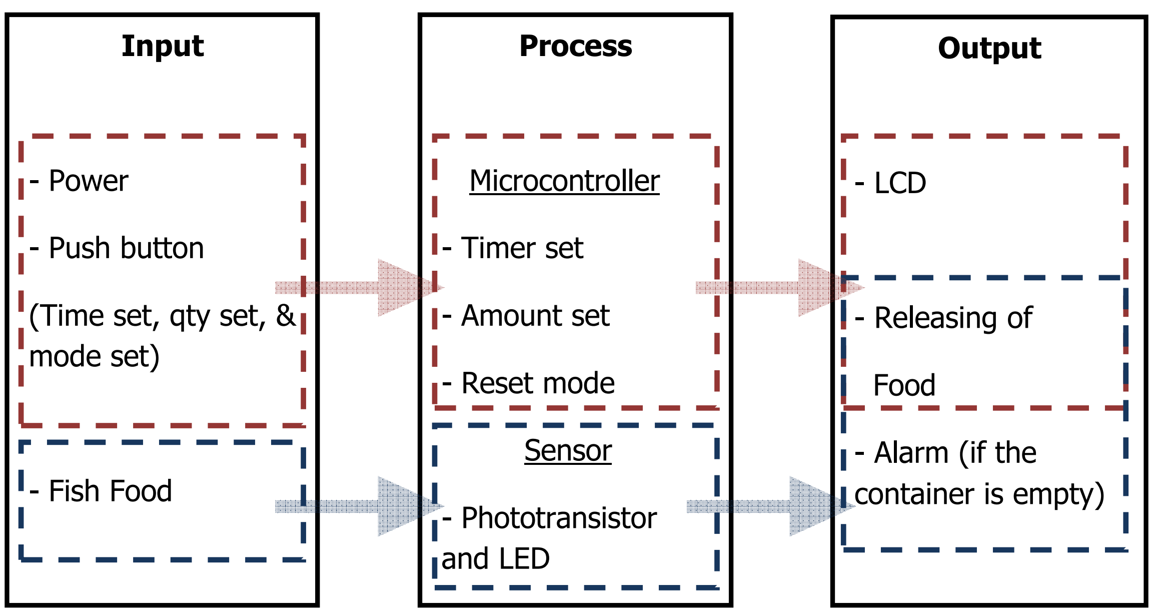


Figure 1.1 Conceptual Framework

Figure 1.1 presents the conceptual framework of the design. The input variables will be done by the client or user. First, the user will turn on the power for the device to work. Afterwards, the user will set the time on when the food will be released and the amount of food to be given. After that, the user will put the fish food on specific containers. Different kinds of food will be placed on separate containers for easy identification. These kinds of food are the pellets, flakes and powder. A push button is used to select the appropriate data. From the input variables, it will now go to its processing stage upon which the microcontroller will process the time of release as well as the amount of food. The machine will also release the food on a random or fixed place of location in the aquarium. The reset mode is an automatic process in case of a power failure. The sensor acts independently in the prototype. A signal from the phototransistor will be processed after sensing the LED. After the processing stage, the food will be released as the output stage of the machine. The LCD will act as the visual representation of the device displaying the set time and amount of food making the device user-friendly. An alarm will activate whenever the containers are almost empty.

Scope and Delimitations

The scope covers the lists of capabilities that a microcontroller-based fish feeder can perform while limitations are the operations that the device is restricted to execute because it is outside the boundaries of the project. This part of the design opens an inventor's mind for further research study.

The scope of the design includes the following:

1. Automation of fish feeding device was mainly controlled by the PIC microcontroller.
2. Pushbuttons were used for accuracy and precision to set time to release or discharge feeds.
3. LCD monitor was used as user output interface.
4. Phototransistor was used as a sensor to indicate that the container has amount to be emptied.
5. Three relays were used as electronic switch for the dc motor to aid the dispensing of feeds from the container.
6. Three containers were controlled. One, two or three containers can be set to release feeds one at a time or all at the same time.
7. The amount of feeds depends on the rotation of the plate underneath the funnel. Based on the testing 0.1 gram per rotation for pellets and powder while 0.05 gram per rotation for flakes.

For the delimitations:

1. The prototype was limited to the kind of feeds placed on the container. The feeds may vary only with pellets, flakes, and powder.
2. The design was capable of releasing feeds at the set time. Thus, it does not matter even if there are still foods on the aquarium it will still release feeds on the given time. It will depend on the user to set time in order not overfeed the fish or turn the feeds into a waste.
3. The first two limitations compensated for the third limitation. The kind of feeds and the amount of feeds that the device can release is controlled. Basically, one fish will not benefit using the microcontroller-based fish feeder. Same with any fish that does not eat the three given kinds of feeds.
4. The size of the location for the device could be used in an aquarium or in an outdoor mini-fishpond.
5. The device could not operate during black-out or brown-out and all data will be reset.

Definition of Terms

Accuracy. It is the degree of agreement between the experimental result and the true value. *(Britannica Encyclopedia)*

Alarm. It refers to a signal (as a loud noise or flashing light) that warns or alerts. *(Merriam Webster Dictionary)*

Aquarium. It is a container (as a glass tank) or an artificial pond in which living aquatic animals or plants are kept. *(Merriam Webster Dictionary)*

Aquarium fish feeders. They are electric or electronic gadgets designed to feed aquarium fish at regular intervals. They are often used to feed fish when the aquarist is on vacation or is too busy to maintain a regular feeding schedule. (Sanford, G. (1999). *Aquarium Owner's Guide.* New York: DK Publishing.)

Capacitor. It is a passive element designed to store energy in its electric field, the most common electrical components. It is consisted of two conducting plates separated by an insulator (or dielectric). It is an open circuit to dc used extensively in electronics, communications, computer, and power systems. (Alexander, C.; Matthew S. (2003). *Fundamentals of electric circuits, 2nd edition.* New York: McGraw-Hill)

Crystal Oscillator. It refers to an electronic circuit that uses the mechanical resonance of a vibrating crystal of piezoelectric material to create an electrical signal with a very precise frequency. (Floyd T.L., (2006). *Electronics fundamentals: circuits, devices and applications, 7th edition.* U.S.A.: Prentice Hall.)

DC Motors. They are extremely versatile drives capable of reversible operation over a wide range of speeds, with accurate control of speed at all times. (Robert N. B. (2001). *Introduction to control system technology, 7th edition.* U.S.A.: Prentice hall.)

Fish. They are aquatic vertebrate animals that are typically ectothermic (cold-blooded), covered with scales, and equipped with two sets of paired fins and several unpaired fins. (Nelson, S. (2006). *Fishes of the world. John Wiley & Sons, Inc.)*

Fish Food. It can be plant or animal material intended for consumption by pet fish kept in aquariums or ponds. Fish foods normally contain macro nutrients, trace elements and vitamins necessary to keep captive fish in good health. (Riehl, R. and Baensch, HA. (1996). *Aquarium Atlas.* Germany: Tetra Press.)

Flowchart. It is a graphical representation of a process, such as a manufacturing operation or computer operation, indicating the various steps that are taken as the product moves along the production line or the problem moves through the computer. (Boillot M.H., Gleason G.M., Horn L.W. (1997). *Essentials of flowcharting, 5th edition,* U.S.A.: William C. Brown Pub)

Heatsink. It is an environment or object that absorbs and dissipates heat from another object using thermal contact (either direct or radiant). Heat sinks are used in a wide range of applications wherever efficient heat dissipation is required. (Flanagan, W.M. (1993-01-01). *Handbook of transformer design and applications.* U.S.A.: McGraw-Hill Professional)

LCD (Liquid Crystal Display). It is a thin, flat display device made up of any number of colors or monochrome pixels arrayed in front of a light source or reflector. It is often utilized in battery-powered electronic devices because it uses very small amount of electric power. (Alexander C. and Sadiku M. (2003). *Fundamentals of electric circuits, 2nd edition.* U.S.A.: McGraw-Hill)

LED (Light Emitting Diode).

It is a semiconductor diode that emits incoherent narrow-spectrum light when electrically biased in the forward direction of the p-n junction, as in the common LED circuit. This effect is a form of electroluminescence. (Charles S. (2007). *Electronics principles and applications, 7th edition.* U.S.A.: McGraw-Hill Science/Engineering/Math)

Microcontroller. It is a single chip that contains the processor (the CPU), non-volatile memory for the program (ROM or flash), volatile memory for input and output (RAM), a clock and an I/O control unit. And it is called a "computer on a chip". (James L.A. (2006). *The Intel® microprocessor family: Hardware and software principles and applications.* U.S.A.: Delmar Cengage Learning)

MPLAB. MPLAB Integrated Development Environment (IDE) is a free, integrated gcc-based toolset for the development of embedded applications employing Microchip's PIC and dsPIC microcontrollers. *(MPLAB User Manual)*

OrCad. It is a proprietary software tool suite used primarily for electronic design automation. The software is used mainly to create electronic prints for manufacturing of printed circuit boards, by electronic design engineers and electronic technicians to manufacture electronic schematics and diagrams, and for their simulation. *(ORegonCAD User Manual)*

PCB (Printed Circuit Board). It is used to mechanically support and electrically connect electronic components using conductive pathways, or traces, etched from copper sheets laminated onto a non-conductive substrate. *(PCB Design by Chris Stahl)*

Phototransistors. They are packaged to allow light to enter the crystal. Light energy will create hole-electron pairs in the base region and turn the transistor on. Thus, phototransistors can be controlled by light instead of base current. (Charles S. (2007). *Electronics principles and applications, 7th edition.* U.S.A.: McGraw-Hill Science/Engineering/Math)

PIC Assembly. It is the lowest-level programming language for Microchip PIC microcontrollers. These processors are used on the LogoChip and LogoChip modules, the LogoBoard, the PIC Foundation, and every layer in the Tower system. (Covington M.A. (1999). *PIC Assembly language for the complete Beginner.* U.S.A.: University of Georgia)

Relay. It is an electromagnetic device for remote or automatic control that is actuated by variation in conditions of an electric circuit and that operates in turn other devices (as switches) in the same or a different circuit. (Bateson R.N. (2001). *Introduction to control system technology, 7th edition.* U.S.A.: Prentice hall.)

Rectifier Diode. It is an electrical device that converts alternating current (AC) to direct current (DC). (Floyd T.L., (2006). *Electronics fundamentals: circuits, devices and applications, 7th edition.* U.S.A.: Prentice Hall.)

Resistor. It is the simplest passive element. It is a device that has the ability to resist the flow of electric current that is measured in ohms. It is usually made from metallic alloys and carbon compounds. (Alexander C. and Sadiku M. (2003). *Fundamentals of electric circuits, 2nd edition.* U.S.A.: McGraw-Hill)

Schematic. It is a schematic is a diagram that represents the elements of a system using abstract, graphic symbols rather than realistic pictures. *(Britannica Encyclopedia)*

Sensor. It is a device that measures a physical quantity and converts it into a signal which can be read by an observer or by an instrument.

(Floyd T.L., (2006). *Electronics fundamentals: circuits, devices and applications, 7th edition.* U.S.A.: Prentice Hall.)

Transformer. It is a device that transfers electrical energy from one circuit to another through inductively coupled electrical conductors. (Flanagan W.M. (1993-01-01). *Handbook of transformer design and applications.* U.S.A.: McGraw-Hill Professional)

Voltage Regulator. A Diode can be used to hold a voltage constant. (Charles S. (2007). *Electronics principles and applications, 7th edition.* U.S.A.: McGraw-Hill Science/Engineering/Math)

Chapter 2

REVIEW OF RELATED LITERATURE AND RELATED STUDIES

Feeding Devices

There are a number of mechanical aids to hand feeding and many types of automatic feeders on the market. Automatic feeders are particularly appropriate to intensive systems and the feeding of nursery fry tanks which require frequent, small doses of feed.

Some feeders, particularly demand feeders, are relatively easy to construct using simple materials like oil drums or plastic containers.

- The amount of food that will be given to the fish can be measured or controlled. In that way the fish can have a good and well balanced diet and a clean aquarium that can keep them healthy.
- Feeders can feed the fish even the owner is away. This is a very convenient way for the people who are very busy at work.
- The time of feeding the fish is controlled.

These devices can be grouped into a number of categories. Some require mains or battery electrical power. Some rely on water power while, others on the weight of the feed and the action of the feeding fish. A good example of stationary device is electrically powered feeder. The automatic fish feeder falls under this category.

Electrically powered feeders are of two kinds - those which operate mechanically and those which employ compressed air. In both cases the control devices are electrical. The time and duration (thus the amount of feed) can be pre-set by the operator using an electrical timer. This may be mains or battery driven and it may operate a single feeder or a whole bank of feeders.

Basically, though there are many variants and patented examples of compressed air feeders, most are based on the same principle. A compressor supplies air to one or a number of feeders.

The operation of these types of feeders, which are also controlled by timers, depends on electro-magnets or electric motors.

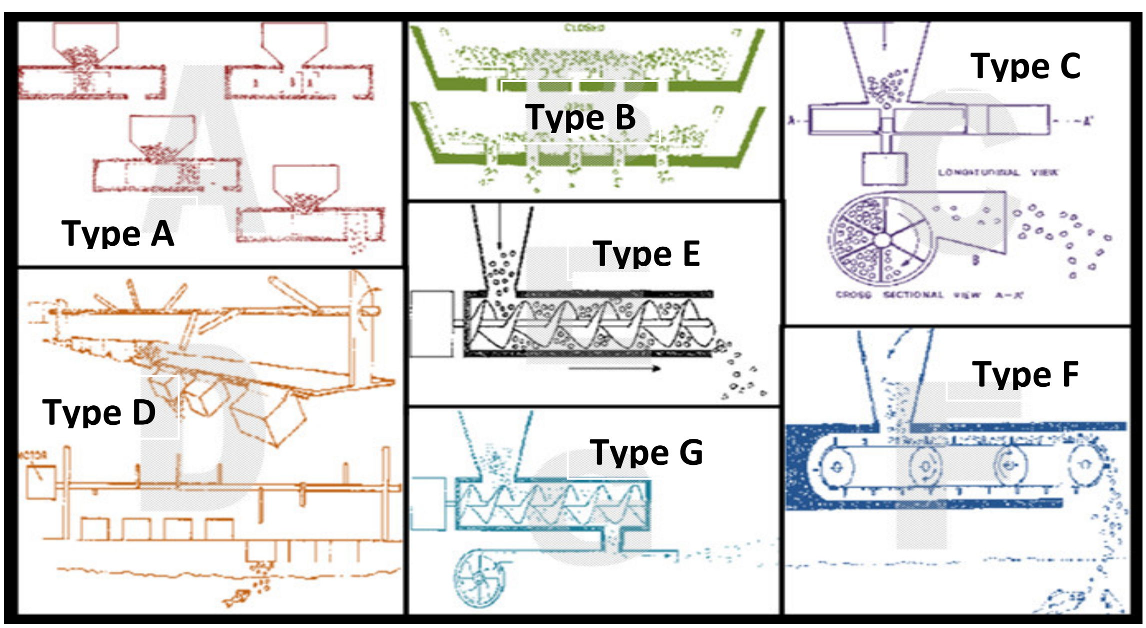


Figure 2.1 Types of Mechanical Feeders

Type A (Figure 2.1). Movement of the slug is controlled by an electro-magnet. The space governs the amount of feed released at each movement of the slug.

Type B (Figure 2.1). Here the feed through consists of two parts, one inside the other. The movement of the inner one is controlled by an electro-magnet. When the holes in the two parts of the feeder coincide, the feed falls through.

Type C (Figure 2.1). In this version the feed falls from the hopper on to a disc which is rotated by an electrical motor at intervals to eject a portion of feed. The motor also releases the feed from the hopper on to the disc by operating a valve. The feed can either be released directionally, using the guide shield or, if the latter is removed, throughout a 360 angle.

Type D (Figure 2.1). A series of spikes on a revolving spindle overturns a row of feed containers in turn. The frequency depends on the speed of revolution of the spindle.

Type E (Figure 2.1). An endless screw mechanism transfers the feed from the hopper to the outlet. The amount of feed released depends on the number of revolutions of the motor drive screw, which is controlled by a timer as is the periodicity of feeding.

Type F (Figure 2.1). Similar to type D except that a blower is added, which distributes the feed over a greater distance.

Type G (Figure 2.1). The feed is delivered on a conveyor belt driven, at selected intervals, by a motor controlled by a time switch.

The microcontroller-based Fish feeder falls under type A but instead of a slug it is replaced by a rotating disc. The hole of the disc governs the amount of feed released at each rotation of the disc. (Michael, 1987)

Types of feeds

Most commonly, fish food can be divided into 3 main categories:
1. Manufactured food. This includes floating and sinking pellet, granular and flake food.

2. Freeze-dried feeds. Worms, larvae, brine shrimp and krill etc.
3. Live foods. Maggots, fresh insect larvae, live worms, and feeder fish – all come under this category.

The microcontroller-based fish feeder uses manufactured foods. The prototype can released flakes, granules, and pellets from the container.

Flake food refers to a kind of food that is most commonly eaten by both marine as well as tropical freshwater fish. This is ideally suited for top dwellers and mid-water fish. Once the flake food has settled down, it can be eaten by the bottom dwellers, too. If one's aquarium consists of bottom dwellers mainly, it would be a good idea to pre-soak the flake food so that it will sink to the bottom as soon as it is introduced into the water.

Pellets come in various sizes and shapes, suited for fish of different sizes. Pellet fish foods come in many different types for the growth of wens, color enhancer and other things. They also come in sinking and the floating kind.

Granular feed needs to be used only if the bottom feeders are not getting enough sunken flakes or seem hungry. Bottom dwellers often need to be fed separately, so granular food is ideal for this kind of fish. (Michael, 1987)

Regardless of the type of foods to feed the fish, a variety of foods should be provided. Variety in the diet reduces the chance of any nutritional shortcomings of one or more of the selected foods becoming a health or longevity problem for the fish. Providing a variety of foods will also reduce the chances that the fish lose interest in the foods that they are offered and go on a "hunger strike." (Mark, 2004)

Types of fish

As we all know, not all fish eat the same kind of feeds. There are some fish that eat pellets, granules and/or flakes while others eat small fishes. But the types of fish that will benefit the design come from the types of feeds that are used in the microcontroller-based fish feeder container to be released and these are pellets, granules and flakes.

According to Shirlie (2001), fish are classified on their dietary or preferences of what they eat. The classifications are carnivores, herbivores, and omnivores.

Carnivores are meat-eating fish. Some prefer live prey that they can hunt down and kill before eating, such as other fish or insects.

Herbivores require a diet of all, or most likely, vegetable matter. True herbivores do not have a large stomach, and therefore must eat more frequently. Some herbivores may learn how to eat other foods like flakes and pellets.

The majority of aquarium fish are omnivores, meaning they will eat both meat and vegetables. To keep the fish healthy, they must be fed with a varied diet that includes all types of foods. Here are some popular omnivores, with notes about their preferred diet.

Angelfish - accepts all types of foods, but prefers live foods.

Goldfish - accepts all types of foods, but diet should not be too high in protein.

Gourami - accepts all types of foods, but prefers additional meat in the diet.

Guppy - accepts all types of foods, but prefers mosquito larvae.

Koi – accepts flakes, pellet and live foods.

Kribensis - accepts flakes, pellets and live foods.

Mbuna - accepts flakes, pellets and live foods.

Orandas – accepts flakes, pellets and live foods.

Rams - accepts flakes, pellets and live foods.

Severum - accepts flakes, pellets and live foods.

Zebra Danio - accepts flakes, pellets and live foods.

Automatic Fish Feeder

The present design relates to a device for automatic feeding of fish in fish cages.

Automatic feeding devices for fish cages exist in different designs adapted according to specific parameters like the nature of feed, the species of the fish, etc. Automatic feeding devices on the market today are mainly based on the use of dry feed (dry pellets) and the feeding is carried out on the water surface. This technology is not desirable for feeding of pellets based on wet feed, soft feed or gel feed which should be stored and handled together with water: fresh- or seawater. (Newton, 2001)

Another important condition is that some fish species prefer the feed "served" on a certain depth and not at the surface.

Previously automatic feeding devices have been used for wet feed, but not based on feeding of wet pellets. This technology was based on a pellet machine being placed by/above the fish cage and the pellets being produced and dropped directly into the water surface of the fish cage. This technology cannot be used just like that for the feeding of readymade pellets based on wet feed, soft feed or gel feed.

There exists a need for a controlled and automatic feeding of readymade pellets for fish feed based on wet feed, soft feed or gel feed. An automatic feeding device in this connection should comprise a complete concept which makes it possible to store the pellets submerged in sea- or freshwater as well as a controlled and automatic feeding under water. (George, 2001)

The Human Fish Feeder/House Sitter

If, instead of a mechanical feeder the fish owner chooses to arrange for someone else to stop into the house to check on things and also feed the fish, the following are words of warning and suggestions to keep the fish safe while the owners are out of town. First off, pre-measure all the food. Do not give a novice fish keeper a big can of food and expect to come home to anything but a tank full of dead fish and a mass of rotting excess food at the bottom of the aquarium. Instead, use the little containers that one can buy at the local drug store which are designed to hold daily doses of medication. They have seven small, separate compartments and are marked for each day of the week. These are perfect for holding small amounts of dry fish food. If the fish also receive frozen food, purchase the frozen food that comes in little cubes (like small ice cube trays) and tell the house sitter exactly how many cubes of food per day. Alternatively, one could purchase a second pill container and placed portions of large slab frozen foods in each compartment.

Last, hide the rest of the fish food. Do not leave cans sitting around the tank. Inevitably, the part-time novice fish feeder will feel that the fish are not getting enough to eat and will feel some sort of compulsion to give them more. Help them resist this urge by removing and hiding the food reserves and force them to stick with the rationed portions. (Evans, 1998)

CHAPTER 3

DESIGN METHODOLOGY AND PROCEDURE

Design Methodology

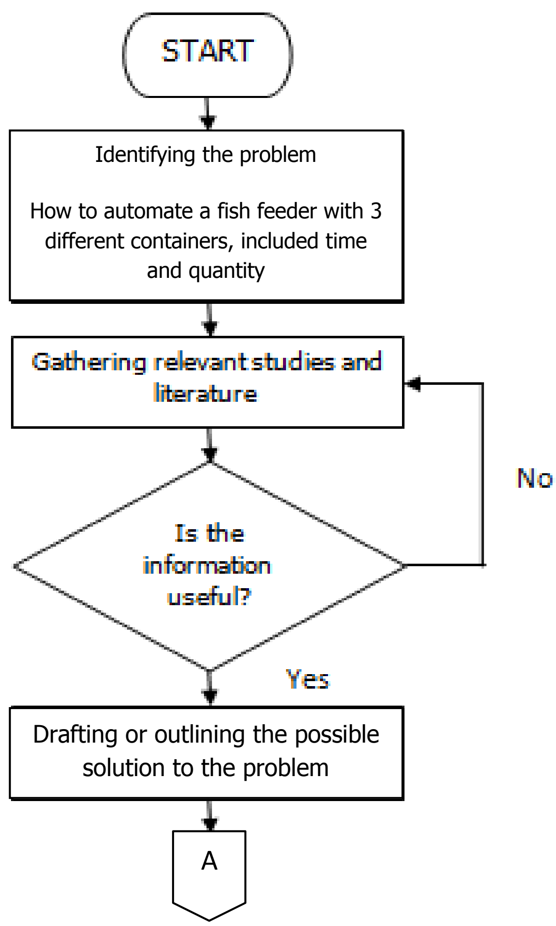
This type of design is a constructive research which means that it develops solutions to a problem that has to be solved through the development of a system. The group needs to find ways on how to automate a fish feeding device that is usually done in manual process. The automation should include accuracy of time, amount of food to be given, indication of the food in the container if it is almost empty, and the interface of the user to the machine.

Project Design Flowchart

Figure 3.1 defines the procedure in developing the design. Identifying the problem would be the first step. In this case, brainstorming is done on how to come up with the design project was done. Questions on how the group could automate a fish feeding process were asked. Is it possible to control time as well as quantity of release of food? Is it possible to control three containers at the same time?

The second step supported the first step. Gathering information related to the design would help to further develop the prototype. Previous designs were considered to know what to innovate to come up with a new design.

Developing a new design would include among others, sketching of circuits and creating possible PCB layouts. Gathering information about the needed components was necessary. Adequate research of materials to back up the design was likewise done. Choosing the right microcontroller, LCD, relay, motor, among others were accomplished. There were a few components that were bought, but were not need or used during the actual creation. This was expected in the trial and error testing of the device.



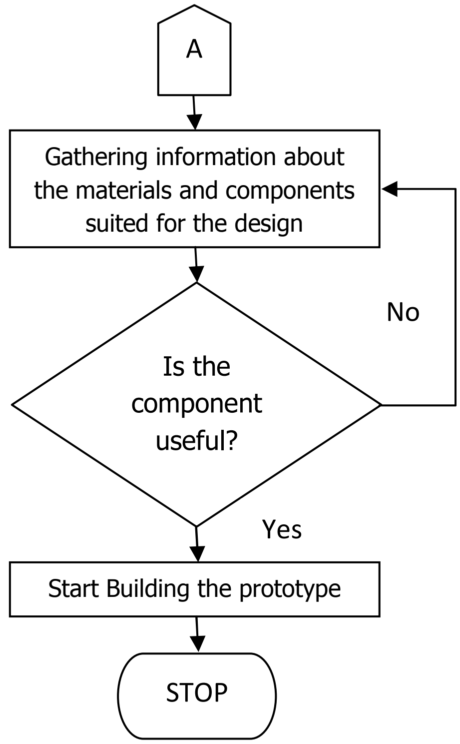


Figure 3.1 Design Methodology Flowchart

The flowchart shows the points of input and output, the logic or sequence of the various processing steps in the system, and the relationship of one element of the system to the other parts of the system or to other information systems.

Design Procedure for Actual Design

The prototype is made up of a controller box and a container box. All circuit components are in the controller box; from power supply, microcontroller, to LCD monitor are in the controller box. The controller box is the user interface of the device which contains buttons for selection in which the user will input all the data he or she wants. The container box, on the other hand, is where the feeds of the fish will be placed. It is a funnel type container in which the fish feed will go directly to the aquarium. A rotating motor is placed underneath the funnel to make the hole in the plate to reach the bottom of the funnel. The motor is controlled by the relay inside the controller box.

Procedures in creating the prototype:

1. Prepare all the things needed for starting a prototype (e.g. research, materials, etc.)
2. Use ORCAD (circuit generating software) to create a circuit design and PCB design.
3. Create a power supply with a bridge type rectifier connected to a voltage regulator. The rectifier will convert ac signal into dc signal. Connect it to a voltage regulator LM7805 that will produce another voltage 5V appropriate for some components like microcontroller and LCD monitor.
4. Prepare the microcontroller PIC16F877 for programming and burning. Burn the PIC microcontroller using MPLAB. The generated code is located at appendix B.
5. Connect all necessary components or other circuits to the microcontroller - switches for selection keys, power supply, LCD module for visual interface, and relays.
6. Prepare the container for three different kinds of feeds.

Design Procedure

A. Hardware Design

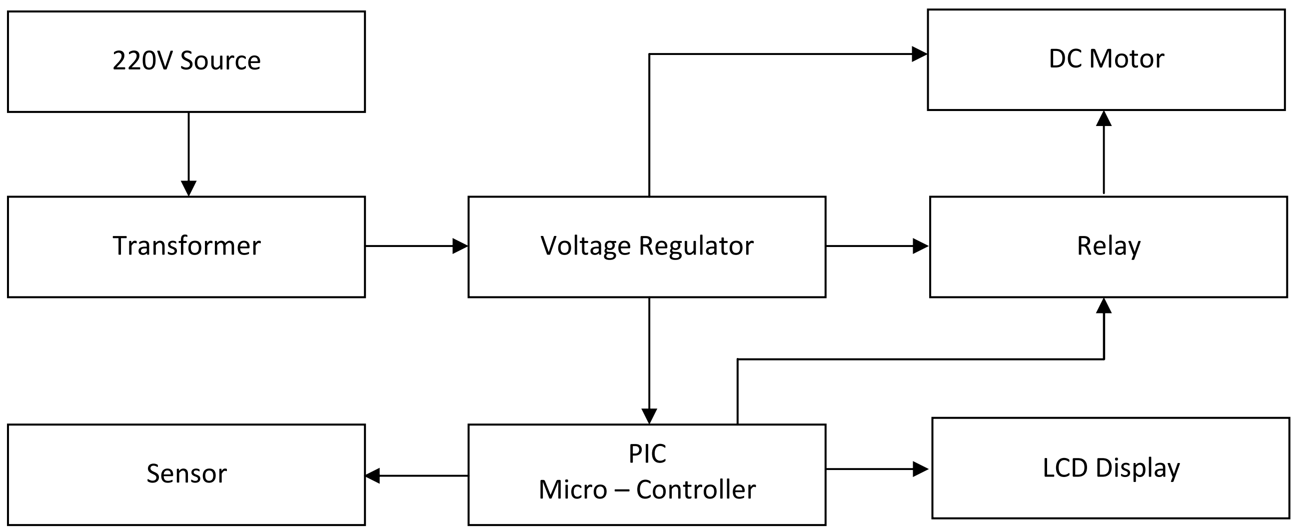


Figure 3.2 Block Diagram

The PIC Micro-controller is the one responsible for showing the settings in the LCD display for triggering the relay to the DC motor in dispensing the food, and for activating the sensor if one of the containers is empty. It is like the brain of the whole circuit for it processes all the controls inside the design. It can be powered by +5 volts of voltage.

The whole design is also being powered by a voltage regulator where it output +5 volts for the micro-controller, and +12 volts for the relay. The block diagram shows the whole hardware implementation of the design.

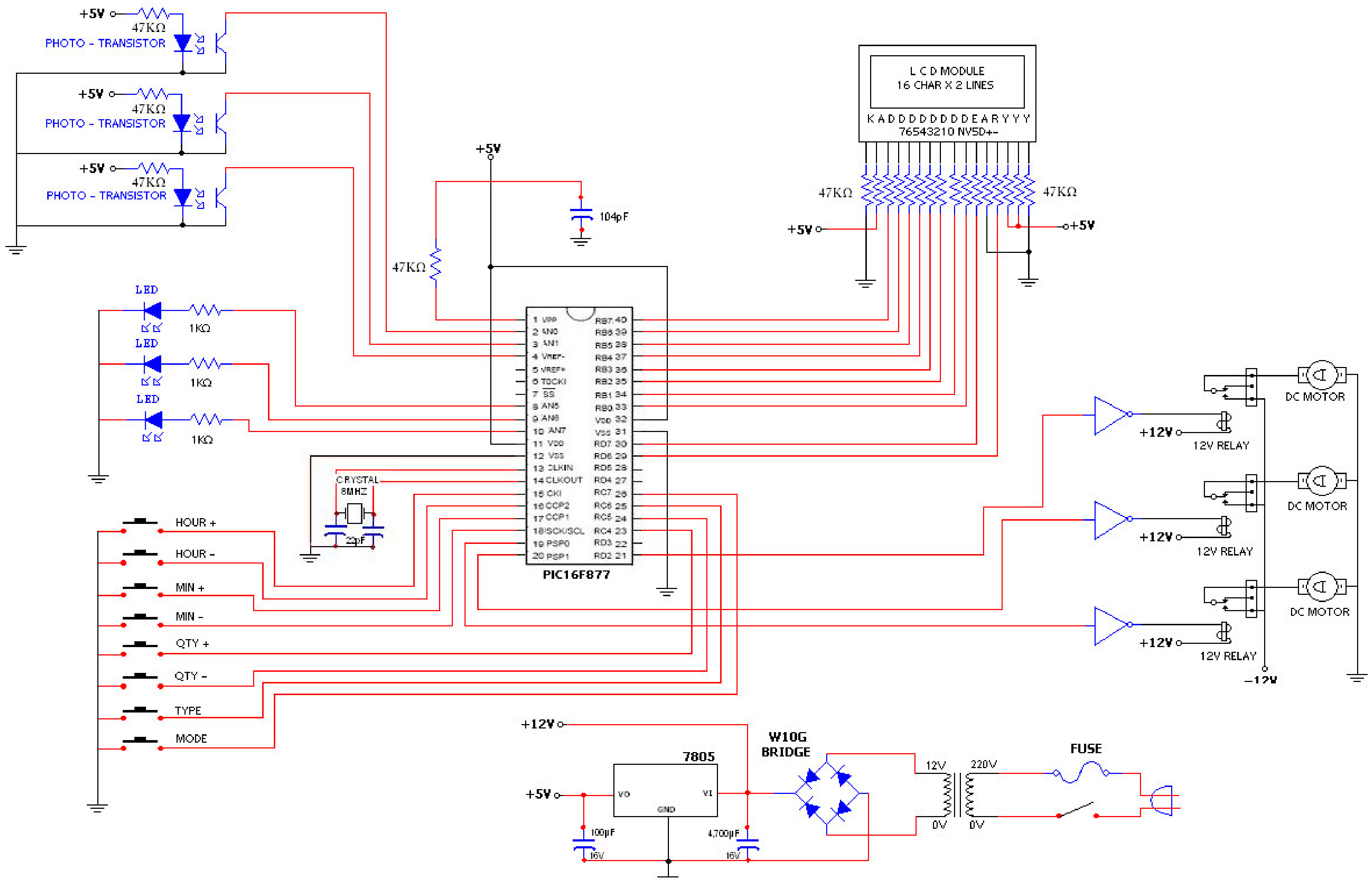


Figure 3.3 Schematic Diagram of the Controller

List of Materials

PIC16F877	1
16 X 2 LCD	1
ASSTD 1/4 W Resistor (1 Pack)	1
8 MHz Crystal	1
10K Array Resistor	2
1200μF / 16V Elect Cap	2
7805 Voltage Regulator	1
W106 Rectifier Diode	1
8 Pins Connector	2
100μF / 25V Elect Cap	1
22 PicoF Ceramic Cap	2
105 Multilayer Cap	1
Relay Module	3
UNL2003 IC	3
16 Pins IC Socket	1
12V Relay	3
3 Pins Terminal Block	3
5 Pins Connector	1
DC Motor	3
Photo Transistor	3
Limit Switch	8
4700μF / 25V Elect Cap	1
PBPC Rectifier Diode	3
Amp Transformer	1
Fuse w/ Fuse Holder	1
AC Cord	1
Box Case	1
Heat Sink	1

Table 3.1 List of Materials for Microcontroller-based Fish Feeder

All of the components listed in Table 3.1 are used in creating the microcontroller-based fish feeder. Some materials like aquarium and fiber glass (for the 3 containers) are used to support in building the design.

B. Software Design

There are two systems used for the design. One is for dispensing the food, and the other is for enabling the sensor if one of the containers is almost empty. Both act independently from each other once the device is turned-on.

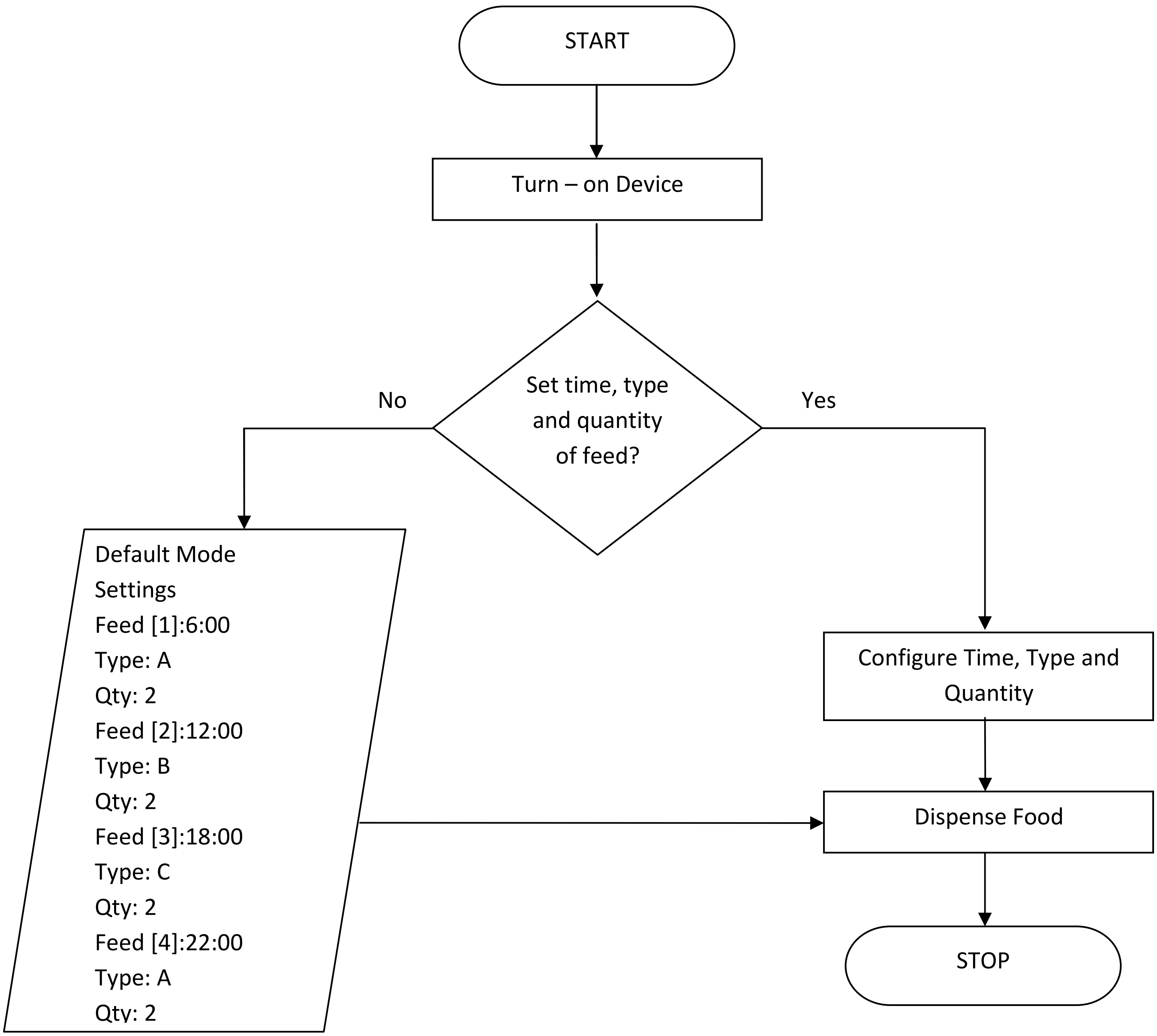


Figure 3.4 System Flowchart A

Figure 3.4 shows that whenever the device is turned-on, the user can change the default time that was set by the device. If the user chooses not to change the configuration, the default feeding time is shown on the flowchart, and dispenses the food according to the time that was set on it. On the other hand, changing the setting of the feeding time can enable the user to configure or change the time and the type and quantity of feed to be dropped by the device before it dispenses the foods.

Sensor Flowchart

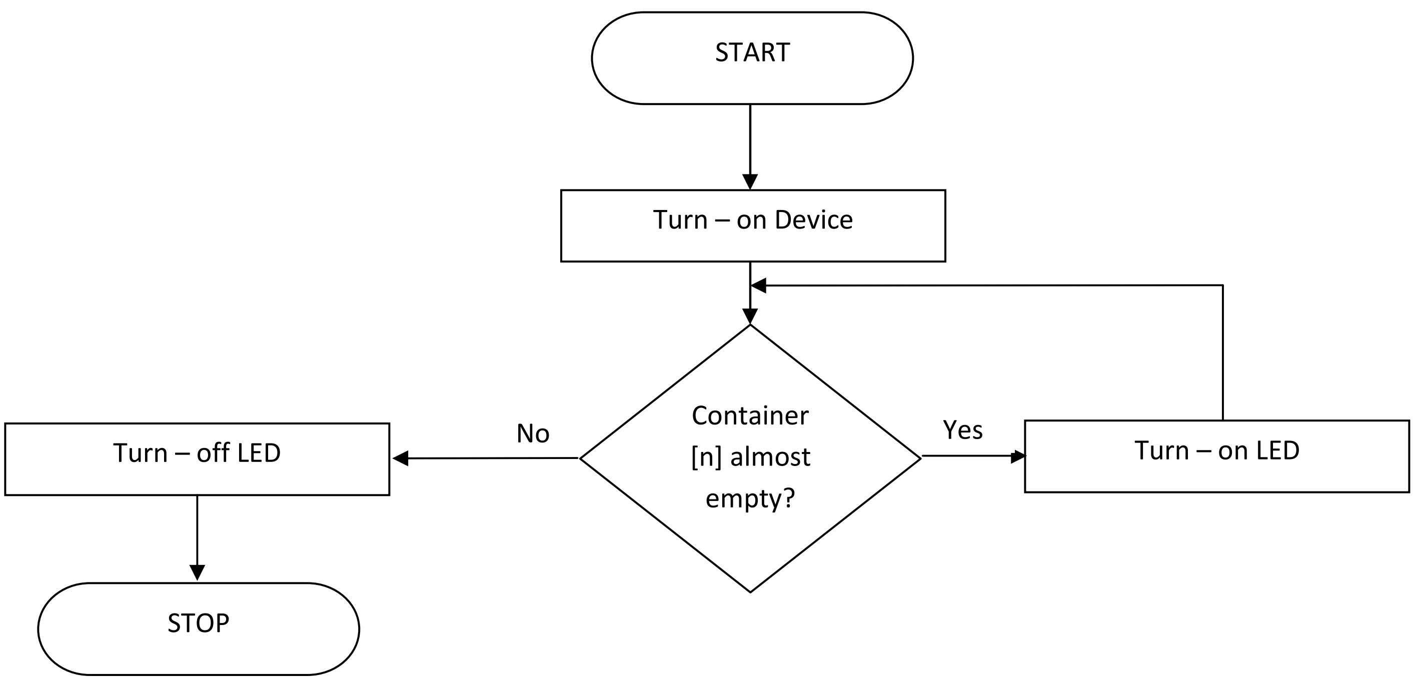


Figure 3.5 System Flowchart B

The sensor of the containers, which shows how the device reacts whenever one of it is almost empty, is being shown on system flowchart B (Figure 3.5). The LED will light-up, depending on what container is almost empty, as the sensor detects it. It is entirely a different system because it only detects the feeds inside the containers.

C. Prototype Development

The Containers

Figure 3.6 The Containers

The microcontroller-based fish feeder consists of 3 containers that are operated using a dc motor powered by a 12V source. The amount of feed given to the fish is controlled by a dc motor. While the dc motor is spinning the disk with a small hole and when the funnel hole and the hole in the disk met, the feeds will be dropped from the container. The amount of feeds will be controlled by the numbers of rotation of the disks. The sensor is placed at the funnel one inch above the tip. This will indicate that the feed is almost empty.

The Controller

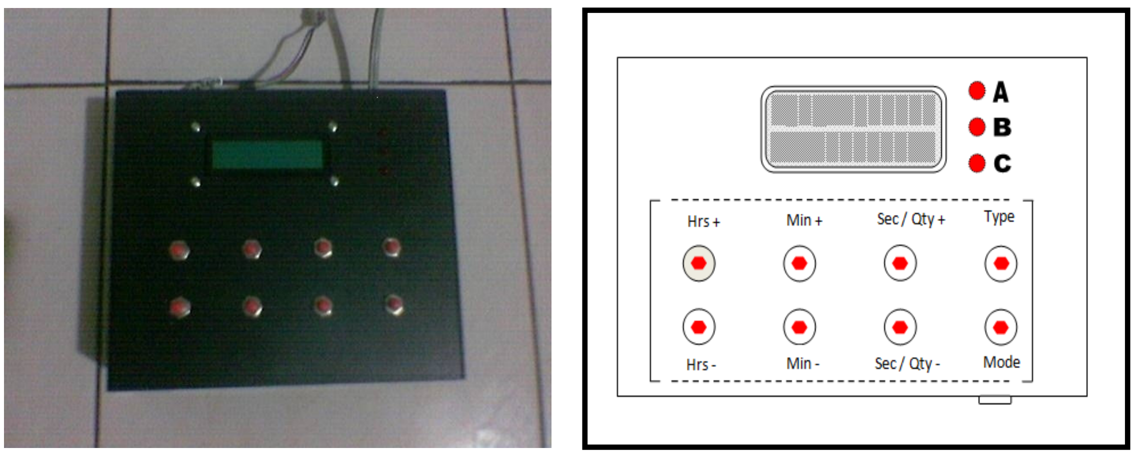


Figure 3.7 The Controller

The design consists of eight buttons that control the whole design and each button has its own function.

1. LCD Module

2. Push Buttons

3. LED Alarm Signals

4. Main Switch

1. **LCD Module -** The LCD Module is the one responsible for displaying the real-time, quantity of amount to be fed, type of feed to be dispensed, and time setting of each feeding time.

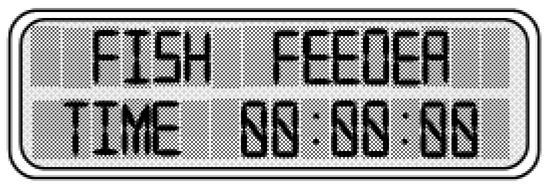


Figure 3.8 Ideal State

The LCD monitor in Idle State shows the title "Fish Feeder" together with the real time. The real time format is in military form or 24 hours: 60 minutes: and 60 seconds.

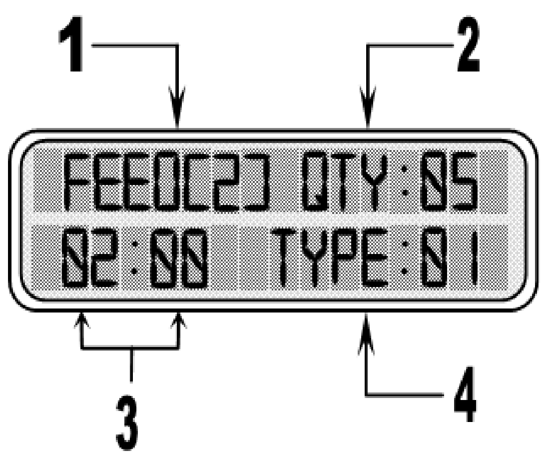


Figure 3.9 Mode State

The LCD monitor in Mode State shows the following:

1. Memory Set / Mode Set
2. Qty
3. Time Set
4. Type of feeds

2. **Push Buttons –** There are eight push buttons on the entire controller, and each has its own function.

    Mode - The mode button allows the user to change and view the settings of each feeding time, type of feed, and its quantity. It also serves as memory for any user input.

    Type - The type of feed button allows the user to choose different kinds of feed to be dispensed on the container.

    Sec / Qty (-+) – In configuring the real time, the user can use this button to change the seconds of the time. Also, in configuring the setting of each feeding time, this button can help the user change the amount or quantity of feed to be dispensed.

    Min (-+) – It is used in changing the minutes of the time, both in real time and configuration setting of the feeding time.

    Hrs (-+) – It is used in changing the hours of the time, both in real time and configuration setting of the feeding time.

3. **LED Alarm Signals –** It represents the status of each container whether it is almost empty or not. The LED will turn-on if one of the containers is almost empty, and it will turn-off if it still has a feeds in it.

4. **Main Switch –** It is used to switch the design on or off. It is at the ON setting if the switch is flipped upwards and OFF when flipped downwards.

Figure 3.9 Switch

The design is operated by following these steps:

1. Turn-on the device.
2. Put in the real time.
3. Put it the desired time when the feeds will be dropped.
4. Lastly, put in the type of feeds to use, and its quantity.

Chapter 4

TESTING, PRESENTATION, AND INTERPRETATION OF DATA

Testing

The microcontroller-based fish feeder, which can automatically feed the fish on time, has four feeding time which means that the feeder can perform up to four maximum memory slots for feeding. On each feeding time, the user can change the type of feed to be dropped, the time of dispense, and the quantity or amount of food to be release.

Accuracy of time feed

In determining the accuracy of the time set by the user, the prototype was tested on a weekly basis. It was tested on a 15-gallon aquarium with 7 gold fish. The 3 containers will feed, at any time interval.

By pressing the Hrs, Min, Sec/Qty, and Type buttons of the device, the settings of each feeding time is changed. The succeeding tables show the time and day in which the feeder will dispense. The record also shows that at any time set, the feeder will release food for the fish.

Time	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
7:00 am	Yes	Yes	Yes	Yes	Yes	Yes	Yes
10:00 am	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1:00 pm	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4:00 pm	Yes	Yes	Yes	Yes	Yes	Yes	Yes
7:00 pm	Yes	Yes	Yes	Yes	Yes	Yes	Yes
10:00 pm	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 4.1 Testing of Container 1

Table 4.1 shows the testing of container 1. The time is set from 7:00am – 10:00pm with an interval of two hours. For one whole week the prototype was observed if it would work properly or not. Based on the data, the container 1 of the prototype worked properly.

Time	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
8:30 am	Yes	Yes	Yes	Yes	Yes	Yes	Yes
11:30 am	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2:30 pm	Yes	Yes	Yes	Yes	Yes	Yes	Yes
5:30 pm	Yes	Yes	Yes	Yes	Yes	Yes	Yes
8:30 pm	Yes	Yes	Yes	Yes	Yes	Yes	Yes
11:30 pm	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 4.2 Testing of Container 2

Table 4.2 shows the testing of container 2. The time was set from 8:30am – 11:30pm with an interval of two hours. For one whole week the prototype was observed if it would work properly or not. Based on the data, the container 2 of the prototype worked properly.

Time	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
9:20 am	Yes	Yes	Yes	Yes	Yes	Yes	Yes
12:45 am	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2:50 pm	Yes	Yes	Yes	Yes	Yes	Yes	Yes
6:20 pm	Yes	Yes	Yes	Yes	Yes	Yes	Yes
9:30 pm	Yes	Yes	Yes	Yes	Yes	Yes	Yes
1:30 am	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 4.3 Testing of Container 3

Table 4.3 shows the testing of container 3. The timer was set at any time from 9:20am up to 1:30am. For one whole week the prototype was observed if it would work properly or not. Based on the data, the container 3 of the prototype worked properly.

All the 3 containers were tested in different modes as shown on the tables above. Some tests were done when all of the containers would dispense the food at the same time, or any two combinations of the containers would dispense the feed (type A and type B, type A and type C, and type B and type C).

The Default Setting

If the user accidentally shuts down the device, or the power goes out, the device will reset the setting on its default time and will not retain the previous data that the user has put in. The default setting will automatically be applied in the prototype. By turning ON the device and clicking the mode button to see each feeding time, Table 4.4 shows the default settings whenever the device is switched ON or whenever a power failure occurs.

Type A represents a pellet type of feed; Type B, a flake type of feed; and Type C, a powder type of feed. The time is in military format.

Feed No.	Type	Time	Qty
1	A	6:00	2
2	B	12:00	2
3	C	18:00	2
4	A	22:00	2

Table 4.4 Default Setting of each Feed

It shows that all feeding time have the same quantity allotted for each container with different times and types of feed to be dispensed. The first and fourth feeding time will dispense a pellet type of feed at 6:00am and 10:00pm respectively; the second feeding time will dispense a flake type of feed at 12:00nn, and the third feeding time will dispense a powder type of feed at 6:00pm.

The Amount of feeds

To know the amount of food that to be dropped by the device, and its behavior if the feeding time is the same, different kinds of test were done on each type of feed.

For Container 1, a pellet type of feed was used; Container 2, a flake type of feed; Container 3, a powder type of feed. The data on Table 4.5 was done or gathered by measuring the amount of feed which was being dropped on each rotation of the motor using a digital electronic weighing scale.

The Trial 1 test identified the amount of pellet food being dropped by the device on a specified time and the number of rotations being applied.

Feed No.	**Type**	**Trial 1**			
		Time 1	**Qty 1**	**Output 1**	**Amount (grams)**
1	A	4:00	1	**1**	0.10 g
2	A	8:00	2	**2**	0.19 g
3	A	12:00	3	**3**	0.29 g
4	A	16:00	4	**4**	0.39 g

Table 4.5 Pellets Feed

Table 4.5 shows the different times and quantities that are set on the device to dispense a pellet type of feed to the fish. In the first trial, where the pellet feed was tested, at exactly 4:00, it dispensed an amount of approximately 0.10g of pellets in 1 rotation. At exactly 8:00, it dispensed an amount of approximately 0.19g of pellets in 2 rotations. At exactly 12:00, it dispensed an amount of approximately 0.29g of pellets in 3 rotations. At exactly 16:00, it dispensed an amount of approximately 0.39g of pellets in 4 rotations. This showed that an average of 0.10 gram was being dropped on the aquarium every time it released feed.

The Trial 2 test identified the amount of flakes food being dropped by the device on a specified time and the number of rotations being applied.

Feed No.	**Type**	**Trial 2**			
		Time 2	**Qty 2**	**Output 2**	**Amount (grams)**
1	B	4:00	1	**1**	0.05 g
2	B	8:00	2	**2**	0.10 g
3	B	12:00	3	**3**	0.15 g
4	B	16:00	4	**4**	0.20 g

Table 4.6 Flakes Feed

Table 4.6 shows the same time and quantity allotted for the device to drop food, but the type of feed to be released was flakes. In the second trial, where the flake feed was tested, at exactly 4:00, it dispensed an amount of approximately 0.05g of flakes in 1 rotation. At exactly 8:00, it dispensed an amount of approximately 0.10g of flakes in 2 rotations. At exactly 12:00, it dispensed an amount of approximately 0.15g of flakes in 3 rotations. At exactly 16:00, it dispensed an amount of approximately 0.20g of flakes in 4 rotations. It was observed that an average of 0.05 gram of flakes was being dropped on the fish.

The Trial 3 test identified the amount of powder food being dropped by the device on a specified time and the number of rotations being applied.

Feed No.	**Type**	**Trial 3**			
		Time 3	**Qty 3**	**Output 3**	**Amount (grams)**
1	C	4:00	1	**1**	0.1 g
2	C	8:00	2	**2**	0.21 g
3	C	12:00	3	**3**	0.30 g
4	C	16:00	4	**4**	0.40 g

Table 4.7 Powder Feed

Table 4.7 shows the same time and quantity allotted for the device to drop a food, but the type of feed to be released was powder. In the third trial, where the powder feed was tested, at exactly 4:00 it dispensed an amount of approximately 0.1g of powder in 1 rotation. At exactly 8:00, it dispensed an amount of approximately 0.21g of powder in 2 rotations. At exactly 12:00, it dispensed an amount of approximately 0.30g of powder in 3 rotations. At exactly 16:00, it dispensed an amount of approximately 0.40g of pellets in 4 rotations. It was observed that an average of 0.1 gram of powder is being dropped by the feeder.

After knowing the amount of food that the device had dispensed, it showed that for a pellet type of feed, it dropped an average of 0.1 gram for each rotation; for flake type, an average of 0.05 gram; and for powder type of feed, and average of 0.1 gram.

Other Testing

In conducting on how the device would react if same time was set on the same type of feed, with different amounts or quantities to be dropped, different tests were performed.

On the table below, Feed No. 1 and Feed No. 2 were set with the same type and time of feeding time, but with different amounts or quantities to be dispensed. By doing this, the users could observe the behavior of the device if applied with these kinds of setting.

The Trial 4 test identified how the device would react if 2 sets of pellet feed were set to be fed on the same time with different quantities.

Feed No.	**Type**	**Trial 4**			
		Time 4	**Qty 4**	**Output 4**	**Amount (grams)**
1	A	4:00	2	**4**	**0.40 g**
2	A	4:00	4	**4**	**0.40 g**
3	B	12:00	6	**6**	0.30 g
4	C	16:00	8	**8**	0.8 g

Table 4.8 Trial 4

Table 4.8 shows that at the first feed, where the time was set to 4:00 with 2 quantities, the output was 4, or 0.40 gram. This is because the second feed overwrites the first feed, or the device reads the latest feeding time that was set on it. Before the device dispenses the food, it first scan all the feeding time that was set on it, beginning on the first feed, down to the fourth feeding time. So, when the device reads the second feeding time, it automatically overwrites the first feeding time and sets the amount of food to be dropped according to the quantity that was set on the second feed; that is why the output is 4, or 0.40 gram.

The Trial 5 test identified how the device would react if 2 sets of flake feed were set to be fed on the same time with different quantities.

Feed No.	Type	Trial 5			
		Time 5	**Qty 5**	**Output 5**	**Amount (grams)**
1	A	5:00	10	**10**	0.98 g
2	B	15:00	12	**14**	**0.70 g**
3	B	15:00	14	**14**	**0.70 g**
4	C	21:00	16	**16**	1.6 g

Table 4.9 Trial 5

Table 4.9 shows that at the second feed, where the time was set to 15:00 with 2 quantities, the output was 14, or 0.70 gram. This is because the third feed overwrites the second feed, or the device reads the latest feeding time that was set on it. Before the device dispenses the food, it first scans all the feeding time that was set on it, beginning on the first feed, down to the fourth feeding time. So, when the device reads the third feeding time, it automatically overwrites the second feeding time and sets the amount of food to be dropped according to the quantity that was set on the second feed; that is why the output is 14, or 0.70 gram.

The Trial 6 test identified how the device would react if 2 sets of powder feeds are set to be fed on the same time with different quantities.

Feed No.	Type	Trial 6			
		Time 6	**Qty 6**	**Output 6**	**Amount (grams)**
1	A	6:00	17	**17**	1.66 g
2	C	18:00	20	**18**	**1.81 g**
3	B	12:00	19	**19**	0.95 g
4	C	18:00	18	**18**	**1.81 g**

Table 4.10: Trial 6

Table 4.10 shows that at the second feed, where the time was set to 18:00 with 2 quantities, the output was 18, or 1.81 gram. This is because the fourth feed overwrites the second feed, or the device reads the latest feeding time that was set on it. Before the device dispenses the food, it first scans all the feeding time that was set on it, beginning on the first feed, down to the fourth feeding time. So, when the device reads the fourth feeding time, it automatically overwrites the second feeding time and sets the amount of food to be dropped according to the quantity that was set on the second feed; that is why the output is 18, or 1.81 gram.

Maximum Capacity

Each container has its own maximum capacity depending on what feed it is supplying. The data below was gathered by filling up the entire container with its designated type of feed and was measured using a digital electronic weighing scale.

Container	Type	Capacity (in grams)
A	Pellet	80 g
B	Flakes	80 g
C	Powder	90 g

Table 4.11 Capacity of Each Container

Table 4.11 shows that for a pellet type of feed, its maximum allowable capacity is 80 grams. It is the same for the flake feed which can also supply 80 grams. Powder on the other hand can have a maximum allowable capacity of 90 grams.

Test Settings

For Table 4.12 the data came from an actual aquarium testing. The settings are:

Fish: Gold Fish

Size of the Aquarium: 15 gallons

Number of Fish: 7

feeding time interval: 12 hours

Feeds: Pellets, Powder, Flakes

The container of the microcontroller-based fish feeder can accommodate three types of feeds. Since the release of feeds may vary, the rate on how long the container will be empty depends on the set time and set amount of the fish owner. Table 4.12 shows samples for three types of feeds on how long they can be consumed.

Types	Grams/day	Capacity (in grams)	Rate of release (Approximately)
Pellet	0.1 gram x 30 turns per day = 3 grams per day	80 grams	27 days or 1 month
Flakes	0.05 gram x 60 turns per day = 3 grams per day	80 grams	27 days or 1 month
Powder	0.1 gram x 30 turns per day = 3 grams per day	90 grams	30 days or 1 month

Table 4.12 Release of feeds

Table 4.12 presents the feeds that were tested on different amount to be released per day. Container with pellets can be empty in approximately 27 days. Since Flakes are much lighter than pellets, the container will be empty in longer days. For powder, the maximum feed that the container can hold is 90 grams; it can dispense up to 30 days or 1 month.

At the end of the testing, the feeding process of gold fish turned out to be satisfactory. The seven gold fish ate all the feeds that the microcontroller-based fish feeder dispensed at different times and in different quantities.

Chapter 5

CONCLUSION AND RECOMMENDATION

CONCLUSION

The group found that the design is capable of dispensing food automatically by using a micro-controller in the aquarium. In addition, based on the design of the prototype, it is a user-friendly or easy-to-use device. Moreover, the group was able to observe that by using an automated fish feeder, fish owners will have an easy time in their schedule because they do not have to worry about regularly feeding their fish on time. With the addition of the three containers, the automated feeder can also feed different kinds of fish because the device can control the amount of food that is being dropped on the aquarium, and can keep the fish healthy and safe from any health problems.

RECOMMENDATION

Improvements on the device can be applied to further enhance its capabilities and functionalities, like having an additional back-up power on the device so that whenever it is shutdown accidentally or the power goes out, the data that have been set on each feeding-time will not be lost or will be retained. Furthermore, other aquariums are placed on a side that is far from an electric socket so a battery-operated fish feeder device is advisable. Also, knowing the amount of food that the devices releases is a great help so that the user will know whether it is too much or less than the fish need to eat. Also, the device can only accommodate home fish food like pellets, flakes, and powder, so it is best to have an additional container that can accommodate frozen and dry fish foods like dry worms, sludge worms, water fleas, among others. In addition, since the device dispenses three different types of feeds, it is best to apply it on a medium-scale fish pond by adding some kind of a device, like a blower, so that every time it drops feeds, it will not just stay on a certain spot, but instead it will spread throughout the entire pond. It is likewise recommended that an additional device that can detect dirt, temperature, and light on the water be created. This device can help the user to know whether it is still safe to drop or dispense food on the aquarium.

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APPENDIX
APPENDIX A

Source Program

```
;*************************************************************
*****************
;           File FISHFDR8.ASM @ 4Mhz
            processor     16F877
            include       <P16F877.inc>
  __config _XT_OSC & _WDT_OFF &
_PWRTE_ON & _LVP_OFF & _BODEN_OFF &
_CP_ALL
;*************************************************************
*****************
;               Variable Declaration
PortA_New    equ   H'20'        ;
PortA_Prev   equ   H'21'        ;
PortC_New    equ   H'24'        ;
PortC_Prev   equ   H'25'        ;
Nth_Select   equ   H'28'        ;
                          ;
Cur_Hour     equ   H'30'        ;
Cur_Min      equ   H'31'        ;
Cur_Sec      equ   H'32'        ;
Clock_Pres   equ   H'34'        ;
Tmr1_Sec     equ   H'35'        ;
Tmr1_Pres    equ   H'36'        ;
Tmr2_Sec     equ   H'37'        ;
Tmr2_Pres    equ   H'38'        ;
Tmr3_Sec     equ   H'39'        ;
Tmr3_Pres    equ   H'3A'        ;
Qty1         equ   H'3B'        ;
Qty2         equ   H'3C'        ;
Qty3         equ   H'3D'        ;
                          ;
Feed1_Hour   equ   H'40'        ;
Feed2_Hour   equ   H'41'        ;
Feed3_Hour   equ   H'42'        ;
Feed4_Hour   equ   H'43'        ;
Feed1_Min    equ   H'44'        ;
Feed2_Min    equ   H'45'        ;
Feed3_Min    equ   H'46'        ;
Feed4_Min    equ   H'47'        ;
Feed1_Qty    equ   H'48'        ;
Feed2_Qty    equ   H'49'        ;
Feed3_Qty    equ   H'4A'        ;
Feed4_Qty    equ   H'4B'        ;
        Feed1_Type    equ   H'4C'        ;
Feed2_Type   equ   H'4D'        ;
Feed3_Type   equ   H'4E'        ;
Feed4_Type    equ   H'4F'        ;
;
Key_Seq      equ   H'60'        ;
                          ;
Wait1_Val    equ   H'74'        ;
Wait2_Val    equ   H'75'        ;
Msg_Num      equ   H'76'        ;
                          ;
Temp1        equ   H'79'        ; temporary variable.
Temp2        equ   H'7A'        ;
Temp3        equ   H'7B'        ;
Temp4        equ   H'7C'        ;
PCLATH_TEMP   equ   H'7D'        ;
W_TEMP       equ   H'7E'        ; temporary variable
for W.
STAT_TEMP    equ   H'7F'        ; temporary variable
for STATUS.
;------------------------------------------------------------------
-----
LCD_RAM_Buf   equ   H'20'        ; Bank 1
;*************************************************************
****************
;           Reset Vector Starts at Address 0x0000.
            org   0x0000        ; start of reset vector.
            goto  Initialize     ;
            org   0x0004        ; start of interrupt service
routine.
            goto  ISR_routine    ;
;*************************************************************
****************
Initialize:   clrf  TMR0          ; Clear TMR0
            clrf  INTCON        ; Disable Interrupts and
clear T0IF
            bcf   STATUS,RP1     ;
            bsf   STATUS,RP0     ; Select Bank 1
            movlw B'11000011'    ;
            movwf OPTION_REG     ; prescaler of 1:16
                          ;
            movlw H'06'         ;Set all Digital input
            movwf ADCON1        ;
            movlw B'11111111'    ;        0=OUT 1=IN
            movwf TRISA         ; Port A. 11xx
xxxx:TTL          movlw B'00000000'    ;
0=OUT 1=IN
            movwf TRISB         ; Port B. xxxx
xxxx:TTL
                          ;
```

```
        movlw B'11111111'   ;       0=OUT
1=IN
        movwf TRISC         ; Port C. xxxx
xxxx:schmitt
                            ;
        movlw B'00000000'   ;       0=OUT
1=IN
        movwf TRISD         ; Port D. xxxx
xxxx:schmitt
                            ;
        movlw B'00000000'   ;       0=OUT
1=IN
        movwf TRISE         ; Port E. 0000
0xxx:schmitt
                            ;
        bcf   STATUS,RP0    ; Select Bank
0
                            ;
        call  Init_Var      ;
        call  Init_LCD      ;
        call  Disp_LCD      ;
                            ;
        bsf   INTCON,T0IE   ; Enable
TMR0 Interrupt.
        bsf   INTCON,GIE    ; Enable All
Interrupts.
;*************************************************
*************************
;       Main Program Starts Here.
Main:   nop                 ;
        goto  Main          ;
;*************************************************
*************************
;       The Interrupt Service Routine.
ISR_routine:                ; Save Registers
        movwf W_TEMP        ;     W ->
W_TEMP
        movf  STATUS,W      ; STATUS ->
W
        movwf STAT_TEMP     ;     W ->
STAT_TEMP
        bcf   STATUS,RP0    ; Bank 0
                            ; Check which
interrupt has occurred.
        btfsc INTCON,T0IF   ; Timer0
Interrupt ?
        goto  TMR0int       ;
                            ; Other causes,
disregard!
RestoreReg:                 ; Restore
Registers
        movf  STAT_TEMP,W   ;
STAT_TEMP -> W
        movwf STATUS        ;       W ->
STATUS
        movf  W_TEMP,W      ;   W_TEMP
-> W
                            ;
        retfie              ; Return from
Interrupt.
;*************************************************
*************************
;       TIMER 0 (TMR0) Interrupt Service
Routine.
TMR0int:    bcf   INTCON,T0IF   ; Reset
TMR0 Overflow Flag.
        movlw D'07'         ; store value to
TMR0
        movwf TMR0          ;
                            ;
        movf  PORTC,W       ;
        movwf PortC_New     ;
                            ;
        call  Get_Time      ;
        call  Key_Seq0      ;Display Time
        call  Key_Seq1      ;Display Feed
Schedule
        call  Do_Tmr1       ;
        call  Do_Tmr2       ;
        call  Do_Tmr3       ;
                            ;
        call  Disp_Time     ;
        call  Disp_NSelect  ;
        call  Disp_LCD      ;
                            ;
        movf  PortC_New,W   ;
        movwf PortC_Prev    ;
                            ;
        comf  PORTA,W       ;
        andlw H'07'         ;
        movwf PORTE         ;
                            ;
        goto  RestoreReg    ; done!
Restore registers & exit.
;*************************************************
*************************
Init_Var:   clrf   Msg_Num      ;
        call   Ld_Msg2RAM   ;
                            ;
        clrf   Cur_Hour     ;
        clrf   Cur_Min      ;
        clrf   Cur_Sec      ;
        clrf   Clock_Pres   ;
        movlw  H'06'        ;
        movwf  Feed1_Hour   ;
        movlw  H'12'        ;
        movwf  Feed2_Hour   ;
        movlw  H'18'        ;
        movwf  Feed3_Hour   ;
        movlw  H'22'        ;
```

```
        movwf  Feed4_Hour       ;
        clrf   Feed1_Min        ;
        clrf   Feed2_Min        ;
        clrf   Feed3_Min        ;
        clrf   Feed4_Min        ;
        movlw  D'2'             ;
        movwf  Feed1_Qty        ;
        movlw  D'2'             ;
        movwf  Feed2_Qty        ;
        movlw  D'2'             ;
        movwf  Feed3_Qty        ;
        movlw  D'2'             ;
        movwf  Feed4_Qty        ;
        movlw  D'1'             ;
        movwf  Feed1_Type       ;
        movlw  D'2'             ;
        movwf  Feed2_Type       ;
        movlw  D'3'             ;
        movwf  Feed3_Type       ;
        movlw  D'1'             ;
        movwf  Feed4_Type       ;
                                ;
        clrf   Tmr1_Sec         ;
        clrf   Tmr1_Pres        ;
        clrf   Tmr2_Sec         ;
        clrf   Tmr2_Pres        ;
        clrf   Tmr3_Sec         ;
        clrf   Tmr3_Pres        ;
        clrf   Qty1             ;
        clrf   Qty2             ;
        clrf   Qty3             ;
                                ;
        clrf   PORTE            ;
        movf   PORTC,W          ;
        movwf  PortC_New        ;
        movwf  PortC_Prev       ;
        clrf   Key_Seq          ;
                                ;
        clrf   PORTD            ;
        clrf   PORTB            ;
                                ;
        return                  ;
;*************************************************
*************************
Add_Adj:    movf   Temp2,W      ;
        andlw  H'0F'            ;
        sublw  D'9'             ;
        btfsc  STATUS,C         ;
        goto   Add_Adj10        ;
        movlw  D'6'             ;
        addwf  Temp2,F          ;
Add_Adj10:  swapf  Temp2,W      ;
        andlw  H'0F'            ;
        sublw  D'9'             ;
        btfsc  STATUS,C         ;
        goto   Add_AdjX         ;
        movlw  H'60'            ;
        addwf  Temp2,F          ;
Add_AdjX:   return              ;
;*************************************************
*************************
Sub_Adj:    movf   Temp2,W      ;
        andlw  H'0F'            ;
        sublw  D'9'             ;
        btfsc  STATUS,C         ;
        goto   Sub_Adj10        ;
        movlw  D'6'             ;
        subwf  Temp2,F          ;
Sub_Adj10:  swapf  Temp2,W      ;
        andlw  H'0F'            ;
        sublw  D'9'             ;
        btfsc  STATUS,C         ;
        goto   Sub_AdjX         ;
        movlw  H'60'            ;
        subwf  Temp2,F          ;
Sub_AdjX:   return              ;
;*************************************************
*************************
Key_Seq0:   movlw  D'0'         ;Display
Time
        subwf  Key_Seq,W        ;
        btfss  STATUS,Z         ;
        goto   Key_Seq0X        ;
                                ;
Key_Seq00:  btfsc  PortC_New,0  ; Inc
Hour
        goto   Key_Seq00X       ;
        btfss  PortC_Prev,0     ;
        goto   Key_Seq00X       ;
        incf   Cur_Hour,F       ;
        movf   Cur_Hour,W       ;
        movwf  Temp2            ;
        call   Add_Adj          ;
        movf   Temp2,W          ;
        movwf  Cur_Hour         ;
        movlw  H'24'            ;
        subwf  Cur_Hour,W       ;
        btfss  STATUS,C         ;
        goto   Key_Seq00X       ;
        clrf   Cur_Hour         ;
Key_Seq00X: nop                 ;
                                ;
Key_Seq01:  btfsc  PortC_New,1  ; Dec
Hour
        goto   Key_Seq01X       ;
        btfss  PortC_Prev,1     ;
        goto   Key_Seq01X       ;
        decf   Cur_Hour,F       ;
        movf   Cur_Hour,W       ;
        movwf  Temp2            ;
```

```
        call   Sub_Adj          ;
        movf   Temp2,W          ;
        movwf  Cur_Hour         ;
        movlw  H'99'            ;
        subwf  Cur_Hour,W       ;
        btfss  STATUS,C         ;
        goto   Key_Seq01X       ;
        movlw  H'23'            ;
        movwf  Cur_Hour         ;
Key_Seq01X:  nop                ;
                                ;
Key_Seq02:   btfsc  PortC_New,2      ; Inc
Min
        goto   Key_Seq02X       ;
        btfss  PortC_Prev,2     ;
        goto   Key_Seq02X       ;
        incf   Cur_Min,F        ;
        movf   Cur_Min,W        ;
        movwf  Temp2            ;
        call   Add_Adj          ;
        movf   Temp2,W          ;
        movwf  Cur_Min          ;
        movlw  H'60'            ;
        subwf  Cur_Min,W        ;
        btfss  STATUS,C         ;
        goto   Key_Seq02X       ;
        clrf   Cur_Min          ;
Key_Seq02X:  nop                ;
                                ;
Key_Seq03:   btfsc  PortC_New,3      ; Dec
Min
        goto   Key_Seq03X       ;
        btfss  PortC_Prev,3     ;
        goto   Key_Seq03X       ;
        decf   Cur_Min,F        ;
        movf   Cur_Min,W        ;
        movwf  Temp2            ;
        call   Sub_Adj          ;
        movf   Temp2,W          ;
        movwf  Cur_Min          ;
        movlw  H'99'            ;
        subwf  Cur_Min,W        ;
        btfss  STATUS,C         ;
        goto   Key_Seq03X       ;
        movlw  H'59'            ;
        movwf  Cur_Min          ;
Key_Seq03X:  nop                ;
                                ;
Key_Seq04:   btfsc  PortC_New,4      ; Inc
Sec
        goto   Key_Seq04X       ;
        btfss  PortC_Prev,4     ;
        goto   Key_Seq04X       ;
        incf   Cur_Sec,F        ;
        movf   Cur_Sec,W        ;
        movwf  Temp2            ;
        call   Add_Adj          ;
        movf   Temp2,W          ;
        movwf  Cur_Sec          ;
        movlw  H'60'            ;
        subwf  Cur_Sec,W        ;
        btfss  STATUS,C         ;
        goto   Key_Seq04X       ;
        clrf   Cur_Sec          ;
Key_Seq04X:  nop                ;
                                ;
Key_Seq05:   btfsc  PortC_New,5      ; Dec
Sec
        goto   Key_Seq05X       ;
        btfss  PortC_Prev,5     ;
        goto   Key_Seq05X       ;
        decf   Cur_Sec,F        ;
        movf   Cur_Sec,W        ;
        movwf  Temp2            ;
        call   Sub_Adj          ;
        movf   Temp2,W          ;
        movwf  Cur_Sec          ;
        movlw  H'99'            ;
        subwf  Cur_Sec,W        ;
        btfss  STATUS,C         ;
        goto   Key_Seq05X       ;
        movlw  H'59'            ;
        movwf  Cur_Sec          ;
Key_Seq05X:  nop                ;
                                ;
Key_Seq07:   btfsc  PortC_New,7      ;
Mode
        goto   Key_Seq07X       ;
        btfss  PortC_Prev,7     ;
        goto   Key_Seq07X       ;
        movlw  D'1'             ;
        movwf  Key_Seq          ;
        movwf  Msg_Num          ;
        clrf   Nth_Select       ;
        call   Ld_Msg2RAM       ;
        movf   PortC_New,W      ;
        movwf  PortC_Prev       ;
Key_Seq07X:  nop                ;
                                ;
Key_Seq0X:   return             ;
                                ;
;*************************************************
************************
Key_Seq1:    movlw  D'1'            ;Disp
Feed Schedule
        subwf  Key_Seq,W        ;
        btfss  STATUS,Z         ;
        goto   Key_Seq1X        ;
                                ;
```

```
Key_Seq10:   btfsc  PortC_New,0      ; Inc Hour
          goto   Key_Seq10X      ;
          btfss  PortC_Prev,0    ;
          goto   Key_Seq10X      ;
          movlw  Feed1_Hour      ;
          addwf  Nth_Select,W    ;
          movwf  FSR             ;
          movf   INDF,W          ;
          addlw  D'1'            ;
          movwf  Temp2           ;
          call   Add_Adj         ;
          movf   Temp2,W         ;
          movwf  INDF            ;
          movlw  H'24'           ;
          subwf  Temp2,W         ;
          btfss  STATUS,C        ;
          goto   Key_Seq10X      ;
          clrf   INDF            ;
Key_Seq10X:  nop                 ;
                                 ;
Key_Seq11:   btfsc  PortC_New,1      ; Dec Hour
          goto   Key_Seq11X      ;
          btfss  PortC_Prev,1    ;
          goto   Key_Seq11X      ;
          movlw  Feed1_Hour      ;
          addwf  Nth_Select,W    ;
          movwf  FSR             ;
          movlw  D'1'            ;
          subwf  INDF,W          ;
          movwf  Temp2           ;
          call   Sub_Adj         ;
          movf   Temp2,W         ;
          movwf  INDF            ;
          movlw  H'99'           ;
          subwf  Temp2,W         ;
          btfss  STATUS,C        ;
          goto   Key_Seq11X      ;
          movlw  H'23'           ;
          movwf  INDF            ;
Key_Seq11X:  nop                 ;
                                 ;
Key_Seq12:   btfsc  PortC_New,2      ; Inc Min
          goto   Key_Seq12X      ;
          btfss  PortC_Prev,2    ;
          goto   Key_Seq12X      ;
          movlw  Feed1_Hour      ;
          addwf  Nth_Select,W    ;
          addlw  D'4'            ;
          movwf  FSR             ;
          movf   INDF,W          ;
          addlw  D'1'            ;
          movwf  Temp2           ;
          call   Add_Adj         ;
          movf   Temp2,W         ;
          movwf  INDF            ;
          movlw  H'60'           ;
          subwf  Temp2,W         ;
          btfss  STATUS,C        ;
          goto   Key_Seq12X      ;
          clrf   INDF            ;
Key_Seq12X:  nop                 ;
                                 ;
Key_Seq13:   btfsc  PortC_New,3      ; Dec Min
          goto   Key_Seq13X      ;
          btfss  PortC_Prev,3    ;
          goto   Key_Seq13X      ;
          movlw  Feed1_Hour      ;
          addwf  Nth_Select,W    ;
          addlw  D'4'            ;
          movwf  FSR             ;
          movlw  D'1'            ;
          subwf  INDF,W          ;
          movwf  Temp2           ;
          call   Sub_Adj         ;
          movf   Temp2,W         ;
          movwf  INDF            ;
          movlw  H'99'           ;
          subwf  Temp2,W         ;
          btfss  STATUS,C        ;
          goto   Key_Seq13X      ;
          movlw  H'59'           ;
          movwf  INDF            ;
Key_Seq13X:  nop                 ;
                                 ;
Key_Seq14:   btfsc  PortC_New,4      ; Inc Qty
          goto   Key_Seq14X      ;
          btfss  PortC_Prev,4    ;
          goto   Key_Seq14X      ;
          movlw  Feed1_Hour      ;
          addwf  Nth_Select,W    ;
          addlw  D'8'            ;
          movwf  FSR             ;
          movf   INDF,W          ;
          addlw  D'1'            ;
          movwf  Temp2           ;
          call   Add_Adj         ;
          movf   Temp2,W         ;
          movwf  INDF            ;
          movlw  H'21'           ;
          subwf  Temp2,W         ;
          btfss  STATUS,C        ;
          goto   Key_Seq14X      ;
          clrf   INDF            ;
Key_Seq14X:  nop                 ;
                                 ;
```

```
Key_Seq15:   btfsc  PortC_New,5       ; Dec
Qty
          goto   Key_Seq15X       ;
          btfss  PortC_Prev,5     ;
          goto   Key_Seq15X       ;
          movlw  Feed1_Hour       ;
          addwf  Nth_Select,W     ;
          addlw  D'8'             ;
          movwf  FSR              ;
          movlw  D'1'             ;
          subwf  INDF,W           ;
          movwf  Temp2            ;
          call   Sub_Adj          ;
          movf   Temp2,W          ;
          movwf  INDF             ;
          movlw  H'99'            ;
          subwf  Temp2,W          ;
          btfss  STATUS,C         ;
          goto   Key_Seq15X       ;
          movlw  H'20'            ;
          movwf  INDF             ;
Key_Seq15X:  nop                  ;
                                  ;
Key_Seq16:   btfsc  PortC_New,6       ; Inc
Type
          goto   Key_Seq16X       ;
          btfss  PortC_Prev,6     ;
          goto   Key_Seq16X       ;
          movlw  Feed1_Hour       ;
          addwf  Nth_Select,W     ;
          addlw  D'12'            ;
          movwf  FSR              ;
          movf   INDF,W           ;
          addlw  D'1'             ;
          movwf  Temp2            ;
          call   Add_Adj          ;
          movf   Temp2,W          ;
          movwf  INDF             ;
          movlw  H'04'            ;
          subwf  Temp2,W          ;
          btfss  STATUS,C         ;
          goto   Key_Seq16X       ;
          movlw  D'1'             ;
          movwf  INDF             ;
Key_Seq16X:  nop                  ;
                                  ;
Key_Seq17:   btfsc  PortC_New,7       ;
Mode
          goto   Key_Seq07X       ;
          btfss  PortC_Prev,7     ;
          goto   Key_Seq07X       ;
          incf   Nth_Select,F     ;
          movlw  D'4'             ;
          subwf  Nth_Select,W     ;
          btfss  STATUS,C         ;
          goto   Key_Seq17X       ;
          movlw  D'0'             ;
          movwf  Msg_Num          ;
          movwf  Key_Seq          ;
          call   Ld_Msg2RAM       ;
          movf   PortC_New,W      ;
          movwf  PortC_Prev       ;
Key_Seq17X:  nop                  ;
                                  ;
Key_Seq1X:   return               ;
;*************************************************
*************************
Chk_Time:    clrf   Temp1          ;
                                   ;
Chk_Time1:   movf   Cur_Hour,W     ;
          subwf  Feed1_Hour,W     ;
          btfss  STATUS,Z         ;
          goto   Chk_Time1X       ;
          movf   Cur_Min,W        ;
          subwf  Feed1_Min,W      ;
          btfss  STATUS,Z         ;
          goto   Chk_Time1X       ;
          movf   Feed1_Qty,W      ;
          btfsc  STATUS,Z         ;
          goto   Chk_Time1X       ;
                                  ;
Time1_Type1: movf   Feed1_Type,W   ;
          sublw  D'1'             ;
          btfss  STATUS,Z         ;
          goto   Time1_Type1X     ;
          movf   Feed1_Qty,W      ;
          movwf  Qty1             ;
Time1_Type1X: nop                 ;
                                  ;
Time1_Type2: movf   Feed1_Type,W   ;
          sublw  D'2'             ;
          btfss  STATUS,Z         ;
          goto   Time1_Type2X     ;
          movf   Feed1_Qty,W      ;
          movwf  Qty2             ;
Time1_Type2X: nop                 ;
                                  ;
Time1_Type3: movf   Feed1_Type,W   ;
          sublw  D'3'             ;
          btfss  STATUS,Z         ;
          goto   Time1_Type3X     ;
          movf   Feed1_Qty,W      ;
          movwf  Qty3             ;
Time1_Type3X: nop                 ;
                                  ;
Chk_Time1X:  nop                  ;
                                  ;
Chk_Time2:   movf   Cur_Hour,W     ;
          subwf  Feed2_Hour,W     ;
          btfss  STATUS,Z         ;
```

```
          goto   Chk_Time2X        ;
          movf   Cur_Min,W         ;
          subwf  Feed2_Min,W       ;
          btfss  STATUS,Z          ;
          goto   Chk_Time2X        ;
          movf   Feed2_Qty,W       ;
          btfsc  STATUS,Z          ;
          goto   Chk_Time2X        ;
                                   ;
Time2_Type1:  movf   Feed2_Type,W  ;
          sublw  D'1'              ;
          btfss  STATUS,Z          ;
          goto   Time2_Type1X      ;
          movf   Feed2_Qty,W       ;
          movwf  Qty1              ;
Time2_Type1X: nop                  ;
                                   ;
Time2_Type2:  movf   Feed2_Type,W  ;
          sublw  D'2'              ;
          btfss  STATUS,Z          ;
          goto   Time2_Type2X      ;
          movf   Feed2_Qty,W       ;
          movwf  Qty2              ;
Time2_Type2X: nop                  ;
                                   ;
Time2_Type3:  movf   Feed2_Type,W  ;
          sublw  D'3'              ;
          btfss  STATUS,Z          ;
          goto   Time2_Type3X      ;
          movf   Feed2_Qty,W       ;
          movwf  Qty3              ;
Time2_Type3X: nop                  ;
                                   ;
Chk_Time2X:   nop                  ;
                                   ;
Chk_Time3:    movf   Cur_Hour,W    ;
          subwf  Feed3_Hour,W      ;
          btfss  STATUS,Z          ;
          goto   Chk_Time3X        ;
          movf   Cur_Min,W         ;
          subwf  Feed3_Min,W       ;
          btfss  STATUS,Z          ;
          goto   Chk_Time3X        ;
          movf   Feed3_Qty,W       ;
          btfsc  STATUS,Z          ;
          goto   Chk_Time3X        ;
                                   ;
Time3_Type1:  movf   Feed3_Type,W  ;
          sublw  D'1'              ;
          btfss  STATUS,Z          ;
          goto   Time3_Type1X      ;
          movf   Feed3_Qty,W       ;
          movwf  Qty1              ;
Time3_Type1X: nop                  ;
                                   ;
Time3_Type2:  movf   Feed3_Type,W  ;
          sublw  D'2'              ;
          btfss  STATUS,Z          ;
          goto   Time3_Type2X      ;
          movf   Feed3_Qty,W       ;
          movwf  Qty2              ;
Time3_Type2X: nop                  ;
                                   ;
Time3_Type3:  movf   Feed3_Type,W  ;
          sublw  D'3'              ;
          btfss  STATUS,Z          ;
          goto   Time3_Type3X      ;
          movf   Feed3_Qty,W       ;
          movwf  Qty3              ;
Time3_Type3X: nop                  ;
                                   ;
Chk_Time3X:   nop                  ;
                                   ;
Chk_Time4:    movf   Cur_Hour,W    ;
          subwf  Feed4_Hour,W      ;
          btfss  STATUS,Z          ;
          goto   Chk_Time4X        ;
          movf   Cur_Min,W         ;
          subwf  Feed4_Min,W       ;
          btfss  STATUS,Z          ;
          goto   Chk_Time4X        ;
          movf   Feed4_Qty,W       ;
          btfsc  STATUS,Z          ;
          goto   Chk_Time4X        ;
                                   ;
Time4_Type1:  movf   Feed4_Type,W  ;
          sublw  D'1'              ;
          btfss  STATUS,Z          ;
          goto   Time4_Type1X      ;
          movf   Feed4_Qty,W       ;
          movwf  Qty1              ;
Time4_Type1X: nop                  ;
                                   ;
Time4_Type2:  movf   Feed4_Type,W  ;
          sublw  D'2'              ;
          btfss  STATUS,Z          ;
          goto   Time4_Type2X      ;
          movf   Feed4_Qty,W       ;
          movwf  Qty2              ;
Time4_Type2X: nop                  ;
                                   ;
Time4_Type3:  movf   Feed4_Type,W  ;
          sublw  D'3'              ;
          btfss  STATUS,Z          ;
          goto   Time4_Type3X      ;
          movf   Feed4_Qty,W       ;
          movwf  Qty3              ;
Time4_Type3X: nop                  ;
                                   ;
Chk_Time4X:   nop                  ;
```

```
                        ;
Chk_TimeX:    return                ;
;*************************************************
************************
Do_Tmr1:      movf   Tmr1_Sec,W         ;0.1
second count
              btfsc  STATUS,Z        ;
              goto   Do_Tmr1Z        ;
              incf   Tmr1_Pres,F     ;
              movlw  D'25'           ;
              subwf  Tmr1_Pres,W     ;
              btfss  STATUS,Z        ;
              goto   Do_Tmr1A        ;
              clrf   Tmr1_Pres       ;
              decf   Tmr1_Sec,F      ;
              movf   Tmr1_Sec,W      ;
              btfsc  STATUS,Z        ;
              decf   Qty1,F          ;
Do_Tmr1A:     movlw  D'34'           ;
              subwf  Tmr1_Sec,W      ;
              btfss  STATUS,C        ;
              bcf    PORTD,0         ;
              btfsc  STATUS,C        ;
              bsf    PORTD,0         ;
              goto   Do_Tmr1X        ;
Do_Tmr1Z:     bcf    PORTD,0         ;
              movf   Qty1,W          ;
              btfsc  STATUS,Z        ;
              goto   Do_Tmr1X        ;
              movlw  D'40'           ;
              movwf  Tmr1_Sec        ;
Do_Tmr1X:     return                 ;
;*************************************************
************************
Do_Tmr2:      movf   Tmr2_Sec,W         ;0.1
second count
              btfsc  STATUS,Z        ;
              goto   Do_Tmr2Z        ;
              incf   Tmr2_Pres,F     ;
              movlw  D'25'           ;
              subwf  Tmr2_Pres,W     ;
              btfss  STATUS,Z        ;
              goto   Do_Tmr2A        ;
              clrf   Tmr2_Pres       ;
              decf   Tmr2_Sec,F      ;
              movf   Tmr2_Sec,W      ;
              btfsc  STATUS,Z        ;
              decf   Qty2,F          ;
Do_Tmr2A:     movlw  D'34'           ;
              subwf  Tmr2_Sec,W      ;
              btfss  STATUS,C        ;
              bcf    PORTD,1         ;
              btfsc  STATUS,C        ;
              bsf    PORTD,1         ;
              goto   Do_Tmr2X        ;
Do_Tmr2Z:     bcf    PORTD,1         ;
              movf   Qty2,W          ;
              btfsc  STATUS,Z        ;
              goto   Do_Tmr2X        ;
              movlw  D'40'           ;
              movwf  Tmr2_Sec        ;
Do_Tmr2X:     return                 ;
;*************************************************
************************
Do_Tmr3:      movf   Tmr3_Sec,W         ;0.1
second count
              btfsc  STATUS,Z        ;
              goto   Do_Tmr3Z        ;
              incf   Tmr3_Pres,F     ;
              movlw  D'25'           ;
              subwf  Tmr3_Pres,W     ;
              btfss  STATUS,Z        ;
              goto   Do_Tmr3A        ;
              clrf   Tmr3_Pres       ;
              decf   Tmr3_Sec,F      ;
              movf   Tmr3_Sec,W      ;
              btfsc  STATUS,Z        ;
              decf   Qty3,F          ;
Do_Tmr3A:     movlw  D'34'           ;
              subwf  Tmr3_Sec,W      ;
              btfss  STATUS,C        ;
              bcf    PORTD,2         ;
              btfsc  STATUS,C        ;
              bsf    PORTD,2         ;
              goto   Do_Tmr3X        ;
Do_Tmr3Z:     bcf    PORTD,2         ;
              movf   Qty3,W          ;
              btfsc  STATUS,Z        ;
              goto   Do_Tmr3X        ;
              movlw  D'40'           ;
              movwf  Tmr3_Sec        ;
Do_Tmr3X:     return                 ;
;*************************************************
************************
Get_Time:     incf   Clock_Pres,F    ;
              movlw  D'250'          ;
              subwf  Clock_Pres,W    ;
              btfss  STATUS,C        ;
              goto   Get_TimeX       ;
              clrf   Clock_Pres      ;
                        ;
Inc_Sec:      incf   Cur_Sec,F       ;
              movf   Cur_Sec,W       ;
              andlw  H'0F'           ;
              sublw  D'9'            ;
              btfsc  STATUS,C        ;
              goto   Get_TimeX       ;
              movlw  D'6'            ;
              addwf  Cur_Sec,F       ;
              movlw  H'60'           ;
```

```
        addlw  D'8'            ;
        movwf  FSR             ;
        movf   INDF,W          ;
        andlw  H'0F'           ;
        addlw  H'30'           ;
        call   Disp_N          ;
                               ;
Disp_Type:   movlw  D'30'      ;
        movwf  Temp2           ;
        movf   Temp1,W         ;
        addlw  D'12'           ;
        movwf  FSR             ;
        movf   INDF,W          ;
        andlw  H'0F'           ;
        addlw  H'30'           ;
        call   Disp_N          ;
                               ;
Disp_NSelX:  return            ;
;**************************************************
*************************
Disp_Time:   movlw  D'0'       ;
        subwf  Key_Seq,W       ;
        btfss  STATUS,Z        ;
        goto   Disp_TimeX      ;
                               ;
        movlw  D'23'           ;
        movwf  Temp2           ;
        swapf  Cur_Hour,W      ;
        andlw  H'0F'           ;
        addlw  H'30'           ;
        call   Disp_N          ;
        incf   Temp2,F         ;
        movf   Cur_Hour,W      ;
        andlw  H'0F'           ;
        addlw  H'30'           ;
        call   Disp_N          ;
                               ;
        movlw  D'26'           ;
        movwf  Temp2           ;
        swapf  Cur_Min,W       ;
        andlw  H'0F'           ;
        addlw  H'30'           ;
        call   Disp_N          ;
        incf   Temp2,F         ;
        movf   Cur_Min,W       ;
        andlw  H'0F'           ;
        addlw  H'30'           ;
        call   Disp_N          ;
                               ;
        movlw  D'29'           ;
        movwf  Temp2           ;
        swapf  Cur_Sec,W       ;
        andlw  H'0F'           ;
        addlw  H'30'           ;
        call   Disp_N          ;
        incf   Temp2,F         ;
        movf   Cur_Sec,W       ;
        andlw  H'0F'           ;
        addlw  H'30'           ;
        call   Disp_N          ;
                               ;
Disp_TimeX:  return            ;
                               ;
Disp_N:      movwf  Temp3      ;
        movlw  LCD_RAM_Buf     ;
        addwf  Temp2,W         ;
        movwf  FSR             ;
        bsf    FSR,7           ;Ind_Addr
Select Bank 1
        movf   Temp3,W         ;
        movwf  INDF            ;
        return                 ;
;**************************************************
*************************
        include <FISH8LCD.INC>
;**************************************************
*************************
        end                    ;
;**************************************************
*************************

                               ;
```

APPENDIX B

COST OF MATERIALS

ITEM	QTY	PRICE	TOTAL
PIC16F877	1	530	530
16 X 2 LCD	1	1200	1200
ASSTD 1/4 W Resistor (1 Pack)	1	40	40
8 Mhz Crystal	1	50	50
10K Array Resistor	2	12	24
1200µF / 16V Elect Cap	2	6	12
7805 Voltage Regulator	1	15	15
W106 Rectifier Diode	1	10	10
8 Pins Connector	2	37	74
100µF / 25V Elect Cap	1	2	2
22 PicoF Ceramic Cap	2	1	2
105 Multilayer Cap	1	2	2
Relay Module	3	490	1470

UNL2003 IC	3	28	84
16 Pins IC Socket	1	4	4
12V Relay	3	30	90
3 Pins Terminal Block	3	15	45
5 Pins Connector	1	8	8
DC Motor	3	350	1050
Photo Transistor	3	39	117
Limit Switch	8	38	304
4700μF / 25V Elect Cap	1	35	35
PBPC Rectifier Diode	3	28	84
Amp Transformer	1	205	205
Fuse w/ Fuse Holder	1	15	15
AC Cord	1	45	45
Box Case	1	150	150
Heat Sink	1	20	20
		Total	5687

APPENDIX C

PIC16F87X Data Sheet

PIC16F87X

28/40-Pin 8-Bit CMOS FLASH Microcontrollers

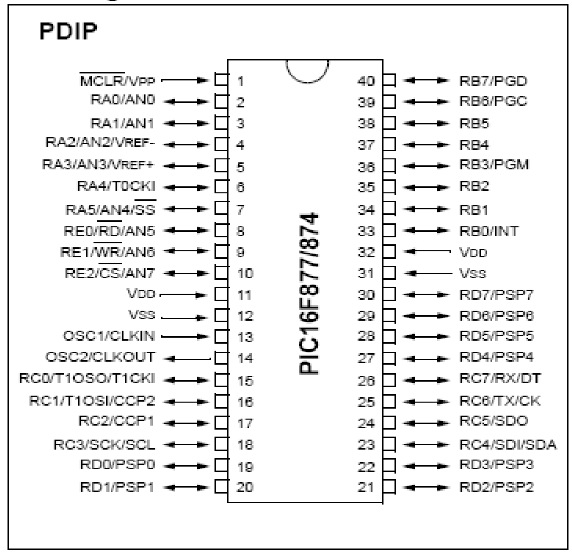
Devices Included in this Data Sheet:

- PIC16F873
- PIC16F874
- PIC16F876
- PIC16F877

Microcontroller Core Features:

- High performance RISC CPU
- Only 35 single word instructions to learn
- All single cycle instructions except for program branches which are two cycle
- Operating speed: DC - 20 MHz clock input
  DC - 200 ns instruction cycle
- Up to 8K x 14 words of FLASH Program Memory,
  Up to 368 x 8 bytes of Data Memory (RAM)
  Up to 256 x 8 bytes of EEPROM Data Memory
- Pinout compatible to the PIC16C73B/74B/76/77
- Interrupt capability (up to 14 sources)
- Eight level deep hardware stack
- Direct, indirect and relative addressing modes
- Power-on Reset (POR)
- Power-up Timer (PWRT) and
  Oscillator Start-up Timer (OST)
- Watchdog Timer (WDT) with its own on-chip RC oscillator for reliable operation
- Programmable code protection
- Power saving SLEEP mode
- Selectable oscillator options
- Low power, high speed CMOS FLASH/EEPROM technology
- Fully static design
- In-Circuit Serial Programming™ (ICSP) via two pins
- Single 5V In-Circuit Serial Programming capability
- In-Circuit Debugging via two pins
- Processor read/write access to program memory
- Wide operating voltage range: 2.0V to 5.5V
- High Sink/Source Current: 25 mA
- Commercial, Industrial and Extended temperature ranges
- Low-power consumption:
  - < 0.6 mA typical @ 3V, 4 MHz
  - 20 µA typical @ 3V, 32 kHz
  - < 1 µA typical standby current

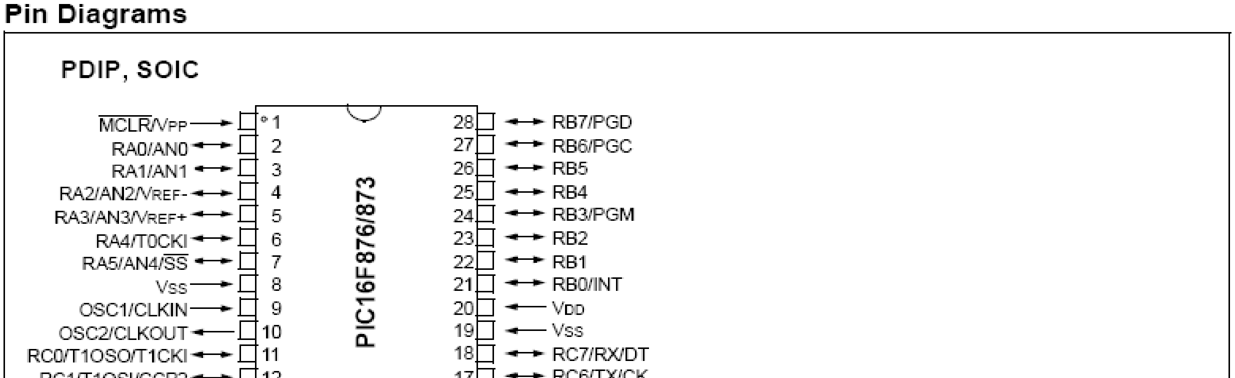
Pin Diagram



Peripheral Features:

- Timer0: 8-bit timer/counter with 8-bit prescaler
- Timer1: 16-bit timer/counter with prescaler, can be incremented during SLEEP via external crystal/clock
- Timer2: 8-bit timer/counter with 8-bit period register, prescaler and postscaler
- Two Capture, Compare, PWM modules
  - Capture is 16-bit, max. resolution is 12.5 ns
  - Compare is 16-bit, max. resolution is 200 ns
  - PWM max. resolution is 10-bit
- 10-bit multi-channel Analog-to-Digital converter
- Synchronous Serial Port (SSP) with SPI™ (Master mode) and I^{2}C™ (Master/Slave)
- Universal Synchronous Asynchronous Receiver Transmitter (USART/SCI) with 9-bit address detection
- Parallel Slave Port (PSP) 8-bits wide, with external RD, WR and CS controls (40/44-pin only)
- Brown-out detection circuitry for Brown-out Reset (BOR)

Pin Diagrams



Key Features PICmicro™ Mid-Range Reference Manual (DS33023)	PIC16F873	PIC16F874	PIC16F876	PIC16F877
Operating Frequency	DC - 20 MHz	DC - 20 MHz	DC - 20 MHz	DC - 20 MHz
RESETS (and Delays)	POR, BOR (PWRT, OST)	POR, BOR (PWRT, OST)	POR, BOR (PWRT, OST)	POR, BOR (PWRT, OST)
FLASH Program Memory (14-bit words)	4K	4K	8K	8K
Data Memory (bytes)	192	192	368	368
EEPROM Data Memory	128	128	256	256
Interrupts	13	14	13	14
I/O Ports	Ports A,B,C	Ports A,B,C,D,E	Ports A,B,C	Ports A,B,C,D,E
Timers	3	3	3	3
Capture/Compare/PWM Modules	2	2	2	2
Serial Communications	MSSP, USART	MSSP, USART	MSSP, USART	MSSP, USART
Parallel Communications	—	PSP	—	PSP
10-bit Analog-to-Digital Module	5 input channels	8 input channels	5 input channels	8 input channels
Instruction Set	35 instructions	35 instructions	35 instructions	35 instructions

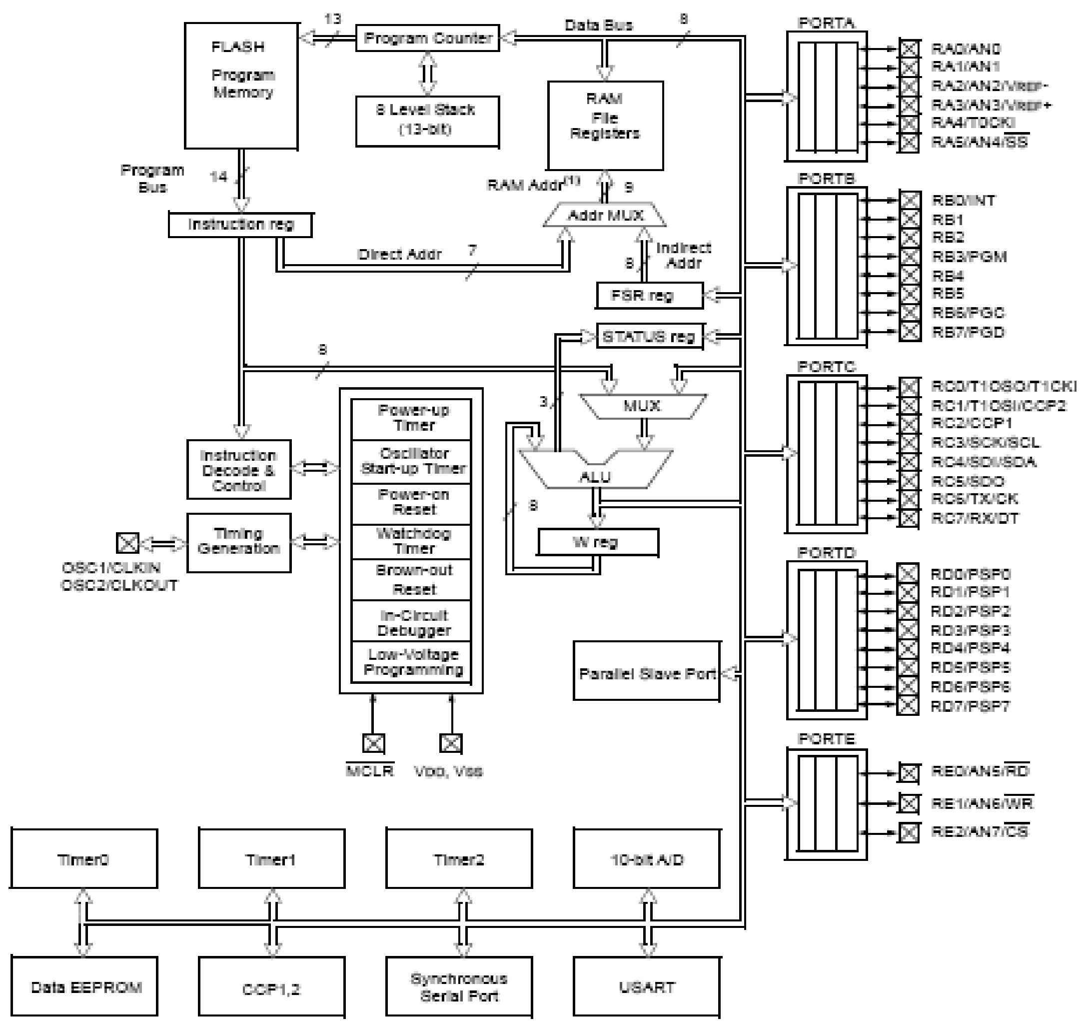
APPENDIX D

PIC16F877 Block Diagram

PIC16F87X

FIGURE 1-2: PIC16F874 AND PIC16F877 BLOCK DIAGRAM

Device	Program FLASH	Data Memory	Data EEPROM
PIC16F874	4K	192 Bytes	128 Bytes
PIC16F877	8K	368 Bytes	256 Bytes



Note 1: Higher order bits are from the STATUS register.

TABLE 1-2: PIC16F874 AND PIC16F877 PINOUT DESCRIPTION

Pin Name	DIP Pin#	PLCC Pin#	QFP Pin#	I/O/P Type	Buffer Type	Description
OSC1/CLKIN	13	14	30	I	ST/CMOS(4)	Oscillator crystal input/external clock source input.
OSC2/CLKOUT	14	15	31	O	—	Oscillator crystal output. Connects to crystal or resonator in crystal oscillator mode. In RC mode, OSC2 pin outputs CLKOUT which has 1/4 the frequency of OSC1, and denotes the instruction cycle rate.
$\overline{MCLR}$/VPP	1	2	18	I/P	ST	Master Clear (Reset) input or programming voltage input. This pin is an active low RESET to the device.
						PORTA is a bi-directional I/O port.
RA0/AN0	2	3	19	I/O	TTL	RA0 can also be analog input0.
RA1/AN1	3	4	20	I/O	TTL	RA1 can also be analog input1.
RA2/AN2/VREF-	4	5	21	I/O	TTL	RA2 can also be analog input2 or negative analog reference voltage.
RA3/AN3/VREF+	5	6	22	I/O	TTL	RA3 can also be analog input3 or positive analog reference voltage.
RA4/T0CKI	6	7	23	I/O	ST	RA4 can also be the clock input to the Timer0 timer/counter. Output is open drain type.
RA5/$\overline{SS}$/AN4	7	8	24	I/O	TTL	RA5 can also be analog input4 or the slave select for the synchronous serial port.
						PORTB is a bi-directional I/O port. PORTB can be software programmed for internal weak pull-up on all inputs.
RB0/INT	33	36	8	I/O	TTL/ST(1)	RB0 can also be the external interrupt pin.
RB1	34	37	9	I/O	TTL	
RB2	35	38	10	I/O	TTL	
RB3/PGM	36	39	11	I/O	TTL	RB3 can also be the low voltage programming input.
RB4	37	41	14	I/O	TTL	Interrupt-on-change pin.
RB5	38	42	15	I/O	TTL	Interrupt-on-change pin.
RB6/PGC	39	43	16	I/O	TTL/ST(2)	Interrupt-on-change pin or In-Circuit Debugger pin. Serial programming clock.
RB7/PGD	40	44	17	I/O	TTL/ST(2)	Interrupt-on-change pin or In-Circuit Debugger pin. Serial 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 an 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 as general purpose I/O and a TTL input when used in the Parallel Slave Port mode (for interfacing to a microprocessor bus).
4: This buffer is a Schmitt Trigger input when configured in RC oscillator mode and a CMOS input otherwise.

APPENDIX E

LM7805 Voltage Regulator Data Sheet

MC78XX/LM78XX/MC78XXA

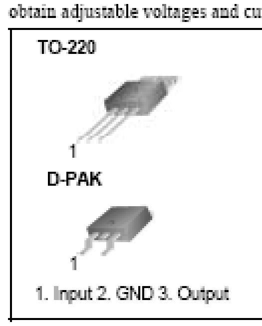
3-Terminal 1A Positive Voltage Regulator

Features

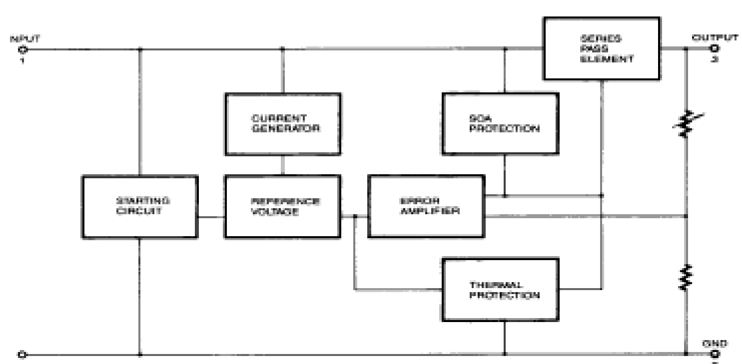
- Output Current up to 1A
- Output Voltages of 5, 6, 8, 9, 10, 12, 15, 18, 24V
- Thermal Overload Protection
- Short Circuit Protection
- Output Transistor Safe Operating Area Protection

Description

The MC78XX/LM78XX/MC78XXA series of three terminal positive regulators are available in the TO-220/D-PAK package and with several fixed output voltages, making them useful in a wide range of applications. Each type employs internal current limiting, thermal shut down and safe operating area protection, making it essentially indestructible. If adequate heat sinking is provided, they can deliver over 1A output current. Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltages and currents.



Internal Block Digram



Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
Input Voltage (for V_O = 5V to 18V) (for V_O = 24V)	V_I V_I	35 40	V V
Thermal Resistance Junction-Cases (TO-220)	$R_{\theta JC}$	5	$^oC/W$
Thermal Resistance Junction-Air (TO-220)	$R_{\theta JA}$	65	$^oC/W$
Operating Temperature Range	T_{OPR}	0 ~ +125	^oC
Storage Temperature Range	T_{STG}	-65 ~ +150	^oC

Electrical Characteristics (MC7805/LM7805)

(Refer to test circuit ,0°C < T_J < 125°C, I_O = 500mA, V_I = 10V, C_I= 0.33μF, C_O= 0.1μF, unless otherwise specified)

Parameter	Symbol	Conditions		MC7805/LM7805			Unit
				Min.	Typ.	Max.	
Output Voltage	V_O	T_J =+25 ^oC		4.8	5.0	5.2	V
		5.0mA ≤ Io ≤ 1.0A, P_O ≤ 15W V_I = 7V to 20V		4.75	5.0	5.25	
Line Regulation (Note1)	Regline	T_J=+25 ^oC	V_O = 7V to 25V	-	4.0	100	mV
			V_I = 8V to 12V	-	1.6	50	
Load Regulation (Note1)	Regload	T_J=+25 ^oC	I_O = 5.0mA to1.5A	-	9	100	mV
			I_O =250mA to 750mA	-	4	50	
Quiescent Current	I_Q	T_J =+25 ^oC		-	5.0	8.0	mA
Quiescent Current Change	ΔI_Q	I_O = 5mA to 1.0A		-	0.03	0.5	mA
		V_I= 7V to 25V		-	0.3	1.3	
Output Voltage Drift	$\Delta V_O/\Delta T$	I_O= 5mA		-	-0.8	-	mV/ ^oC
Output Noise Voltage	V_N	f = 10Hz to 100KHz, T_A=+25 ^oC		-	42	-	μV/Vo
Ripple Rejection	RR	f = 120Hz V_O = 8V to 18V		62	73	-	dB
Dropout Voltage	V_{Drop}	I_O = 1A, T_J =+25 ^oC		-	2	-	V
Output Resistance	r_O	f = 1KHz		-	15	-	mΩ
Short Circuit Current	I_{SC}	V_I = 35V, T_A =+25 ^oC		-	230	-	mA
Peak Current	I_{PK}	T_J =+25 ^oC		-	2.2	-	A

Note:

1. Load and line regulation are specified at constant junction temperature. Changes in V_0 due to heating effects must be taken into account separately. Pulse testing with low duty is used.

APPENDIX F

LCD Module

SC1602D (16 CHARACTERS X 2 LINES)

FEATURES

1. 5 X 7 DOTS WITH CURSOR
2. BUILT IN CONTROLLER (HD44780U OR EQUIVALENT)
3. 5V POWER SUPPLY
4. 1/16 DUTY CYCLE
5. 4.2V LED FORWARD VOLTAGE

MECHANICAL DATA

ITEM	DIMENSIONS	UNIT
Module Size (W x H x T)	118.0 x 43.0 x 8.8 (12.8 LED)	mm
Viewing Area (W x H)	77.0 x 26.3	mm
Character Size (W x H)	2.95 x 4.75	mm
Character Pitch (W x H)	3.55 x 5.55	mm
Dot Size (W x H)	0.55 x 0.55	mm
Dot Pitch (W x H)	0.60 x 0.60	mm

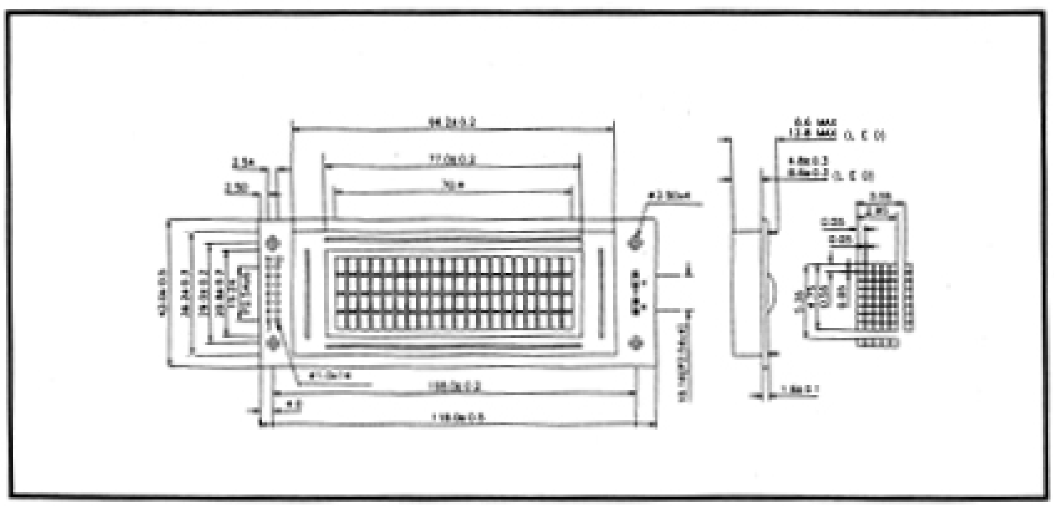
INTERFACE PIN CONNECTIONS

NO.	SYMBOL	FUNCTION	NO.	SYMBOL	FUNCTION
1	Vss	0V	9	DB2	DATA BIT 2
2	VDD	5V	10	DB3	DATA BIT3
3	Vo	Contrast Adj.	11	DB4	DATA BIT4
4	RS	Register Select	12	DB5	DATA BIT5
5	R/W	Read/Write	13	DB6	DATA BIT6
6	E	Enable Signal	14	DB7	DATA BIT7
7	DB0	Data Bit0			
8	DB1	Data Bit1			

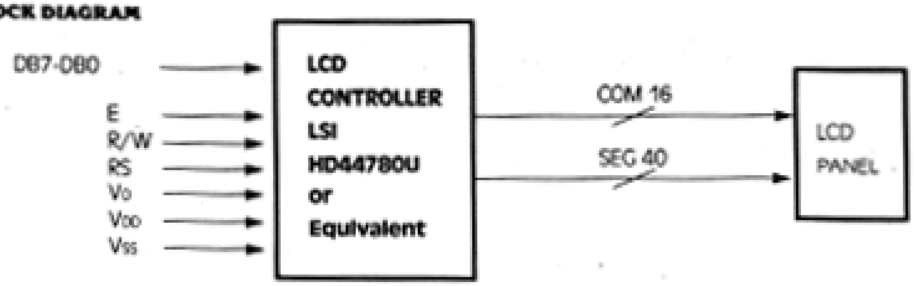
ELECTRICAL CHARACTERISTICS

ITEM		SYMBOL	CONDITION	MIN.	TYP.	TYP	UNIT
LCD Operating Voltage		VDD-Vo	Ta =0℃	—	4.8	—	V
			Ta =25℃	—	4.5	—	V
			Ta =50℃	—	4.2	—	V
Supply Voltage		VDD-Vss	—	4.7	5	5.5	V
Input Voltage	"High" Level	VIH	—	2.2	—	VDD	V
	"Low" Level	VIL	—	0	—	0.6	V
Output Voltage	"High" Level	VOH	—	2.4	—	—	V
	"Low" Level	VOL	—	—	—	0.4	V

EXTERNAL DIMENSIONS



BLOCK DIAGRAM



Display Commands

Instruction	RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	Description
1: Clear display	0	0	0	0	0	0	0	0	0	1	Clears entire display and sets DD RAM address 0 in address counter
2: Return home	0	0	0	0	0	0	0	0	1	*	Sets DD RAM address 0 in address counter. Also returns display from being shifted to original position. DD RAM contents remain unchanged
3: Entry mode set	0	0	0	0	0	0	0	1	I/D	S	I/D=1: Increment I/D=0: Decrement S=1: Accompanies display shift
4: Display on/off	0	0	0	0	0	0	1	D	C	B	D=1/0: Display on/off C=1/0: Cursor on/off B=1: Blink of Cursor
5: Cursor/display shift	0	0	0	0	0	1	S/C	R/L	*	*	S/C=1: Display shift S/C=0: Cursor move R/L=0: Shift to left R/L=1: Shift to right
6: Function set	0	0	0	0	1	DL	N	F	*	*	DL=1: 8 bits, DL=0: 4 bits N=1: 2 lines, N=0: 1 line F=1: 5×10 dots, F=0: 5×8 dots
7: Set CG RAM address	0	0	0	1	ACG						ACG: CG RAM address
8: Set DD RAM address	0	0	1	ADD							ADD: DD RAM address corresponds to cursor address
9: Read busy flag/address counter	0	1	BF	AC							BF=1: Busy, BF=0: Not busy AC: Address counter used for both of CG and DD RAM address
10: Write data	1	0	Write data								Write data to CG or DD RAM
11: Read data	1	1	Read data								Read data from CG or DD RAM

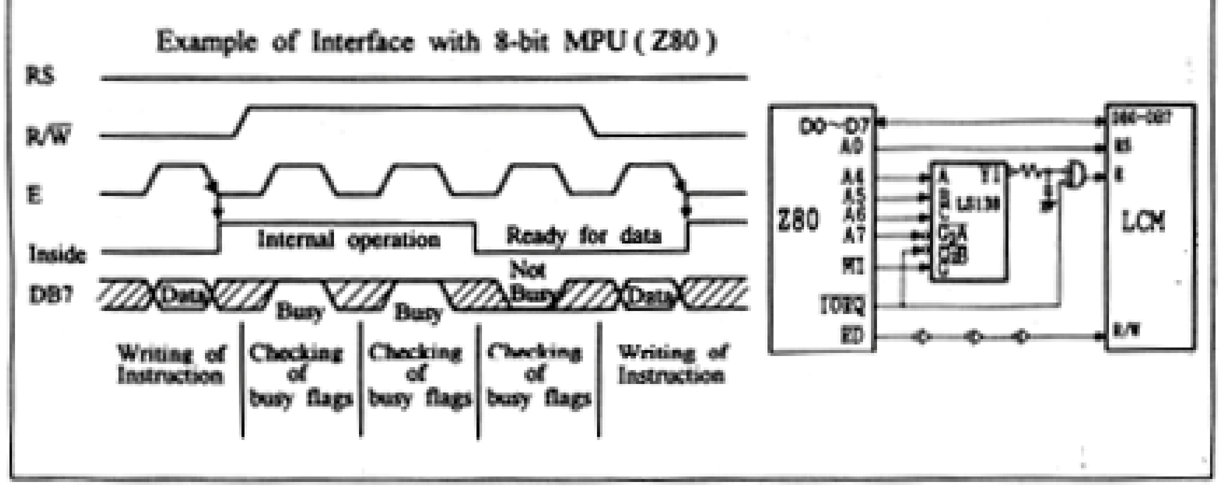
☆ Execution Time (E_t) of Instruction: (Under condition of fcp or fosc = 270 KHz)

1 & 2 : E_t = 1.52 ms

3~11 : E_t = 37 μs

☆ " * ": Either 0 or 1

Connecting Block Diagram



■ Initializing by instruction

If the power supply conditions for correctly operating the internal reset circuit are not met, initialization by instruction is required.

(1) When interface is 8 bits

Power ON

Wait more than 15ms after VDD rises to 4.5V

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	1	1	*	*	*	*

* BF can not be checked before this instruction
* Function set

Wait more than 4.1ms

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	1	1	*	*	*	*

* BF can not be checked before this instruction
* Function set

Wait more than 100 μs

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0
0	0	0	0	1	1	*	*	*	*

* BF can not be checked before this instruction
* Function set

BF can be checked after the following instruction. When BF is not checked, the waiting time between instructions is longer than the execution time.

RS	R/W	DB7	DB6	DB5	DB4	DB3	DB2	DB1	DB0	
0	0	0	0	1	1	N	F	*	*	* Function set : Specify the number of display lines and character font. * The number of display lines and character font can not be changed afterwards.
0	0	0	0	0	0	1	0	0	0	* Display OFF
0	0	0	0	0	0	0	0	0	1	* Display Clear
0	0	0	0	0	0	0	1	I/D	S	* Entry Mode Set

↓

Initialization ends

(1) When interface is 4 bits

Power ON

Wait more than 15ms after VDD rises to 4.5V

RS	R/W	DB7	DB6	DB5	DB4
0	0	0	0	1	1

* BF can not be checked before this instruction
* Function set

Wait more than 4.1ms

RS	R/W	DB7	DB6	DB5	DB4
0	0	0	0	1	1

* BF can not be checked before this instruction
* Function set

Wait more than 100 μs

RS	R/W	DB7	DB6	DB5	DB4
0	0	0	0	1	1

* BF can not be checked before this instruction
* Function set

BF can be checked after the following instruction. When BF is not checked, the waiting time between instructions is longer than the execution time.

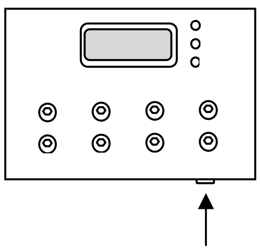
RS	R/W	DB7	DB6	DB5	DB4	
0	0	0	0	1	0	* Function set : Specify the number of display lines and character font.
0	0	0	0	1	0	* The number of display lines and character font can not be changed afterwards.
0	0	N	F	*	*	
0	0	0	0	0	0	* Display OFF
0	0	1	0	0	0	
0	0	0	0	0	0	* Display Clear
0	0	0	0	0	1	
0	0	0	0	0	0	* Entry Mode Set
0	0	0	1	I/D	S	

APPENDIX G

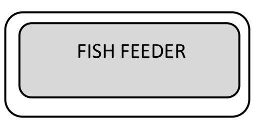
User Manual for the Design

The design is operated by the following steps:

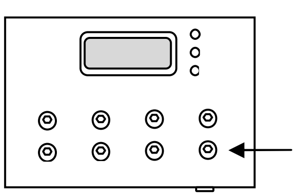
1. Turn-on the device.



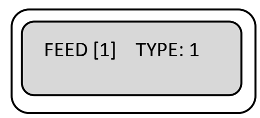
2. A text ("Fish Feeder") will appear on the LCD together with the real time.



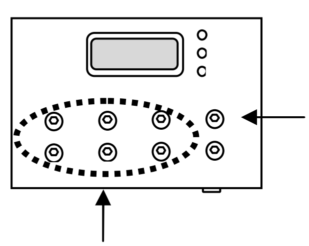
3. Press the **"Mode"** button to see and configure each feeding time of the device.



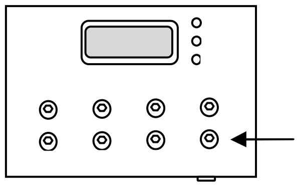
4. After pressing the **"Mode"** button, the **"First Feeding Time"** will appear together with its setting on the LCD Display.



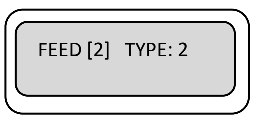
5. To configure the setting of the First Feeding Time, press the **"Hrs (-+)", "Min (-+)", "Sec / Qty (-+)",** and **"Type"** buttons to change its setting.



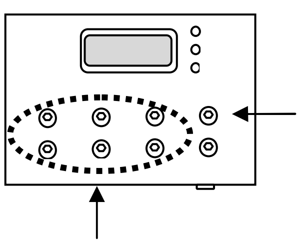
6. Press the **"Mode"** button again to see and configure the "Second Feeding Time."



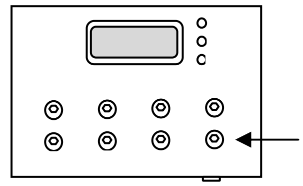
7. The LCD Module will display the setting of the **"Second Feeding Time."**



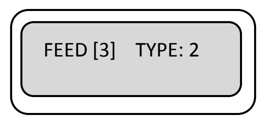
8. Configure it by pressing the **"Hrs (-+)", "Min (-+)", "Sec / Qty (-+)",** and **"Type"** buttons to change its setting.



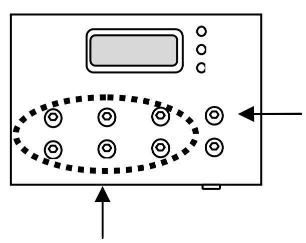
9. Press the **"Mode"** button again to see and configure the **"Third Feeding Time."**



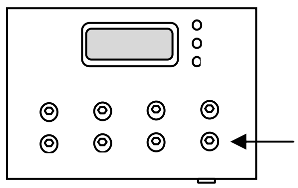
10. The LCD Module will display the setting of the **"Third Feeding Time."**



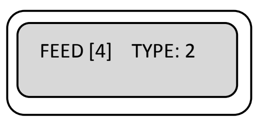
11. Configure it by pressing the **"Hrs (-+)", "Min (-+)", "Sec / Qty (-+)",** and **"Type"** buttons to change its setting.



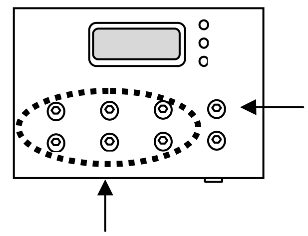
12. Press the **"Mode"** button again to see and configure the **"Fourth Feeding Time."**



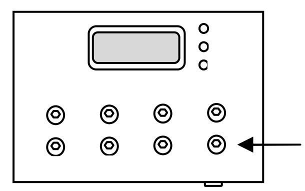
13. The LCD Module will display the setting of the **"Fourth Feeding Time."**



14. Configure it by pressing the **"Hrs (-+)", "Min (-+)", "Sec / Qty (-+)",** and **"Type"** buttons to change its setting.



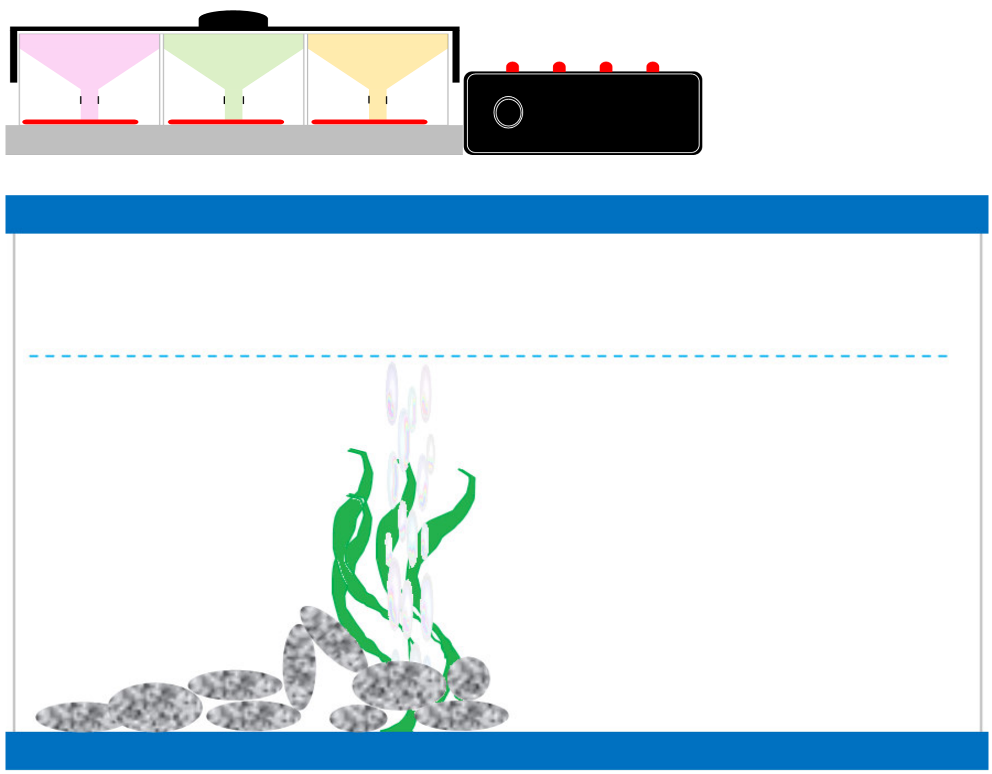
15. Press the **"Mode"** button again to finish the configuration of each feeding time.



APPENDIX H

Installation Manual

The minimum requirement of an aquarium that is capable to hold the microcontroller-based fish feeder is 10 gallon leader or 20"x10"x12"(LxWxH). The Container box is placed on top of the aquarium with proper base alignment. It is necessary to find the balance of the Container box so that it could work without from falling into the aquarium. The Controller box can be placed beside the Container box or in a different platform, away from the container and the aquarium.



Aquarium together with the microcontroller-based fish feeder