Geek Binary Alarm Clock
Senior Design Dec06-04

Design Report

Client

Senior Design

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List of Definitions:

AC/DC rectifier – an electronic device that converts alternating current to direct current.

Binary – a number system using a base of 2 consisting of on/off, high/low, or ones and zeros used by almost all computer systems.

C programming language – a powerful, efficient, low-level language developed in the 1970s for Unix OS now used for systems software and general applications.

C++ programming language – an extension of C, a more object-oriented, high-level programming language.

Daylight saving time (DST) – the time is which clocks are set exactly one hour ahead of standard time in order to provide more daylight during late spring, summer, and fall.

Fourteen possible calendar years – There are only fourteen possible calendar years supported that include all of the leap years and DST.

Geek - *slang* – a term to describe a person with good computer skills, an interest in technology, and firm knowledge of the sciences…usually accompanied with an almost complete social ineptitude.

Industrial Review Panel (IRP) – an audience group comprised of industry members that judge senior design projects.

Java programming language – a high-level language developed by Sun-Microsystems for use in consumer electronics, now popular for web applets.

Light-emitting diodes (LED) – a type of diode that emits light when it is subjected to a flow of current. LEDs may have different colors depending on the material used.

Liquid-crystal displays (LCD) - two thin sheets of plastic filled with individual cells of ionic liquid crystal capable of being manipulated by a current.

Microsoft Project (or MSP) – a Microsoft Windows application that offers various project tracking and management tools.

PCB (printed circuit board) – a thin plastic board onto which electronic components such as resistors and capacitors are soldered.

Twelve-hour format – the standard hourly display of analog and digital clocks which a separate indication for AM or PM. e.g. 12:34 pm

Twenty-four hour format – (a.k.a. military time, universal time) – the hourly display of clocks without a separate indication for AM or PM that increments hours upon reaching noon based on 24 hours. e.g. 23:45 equals 11:45 pm.

Visual Basic (VB) – an object-oriented, event-driven programming language developed by Microsoft for graphical user interface design.

1 Introductory Material

The introductory material will give a brief overview of the product that will be discussed in more detail in the later parts of the document. This part of the paper will cover the problem statement, the intended user/uses, the design assumptions and limitations, and finally the expected end product.

1.1 Executive Summary

This design report is part of the Dec06-04 senior design project for CprE 491 at Iowa State University. The goal of this project is to design and construct a digital binary alarm clock. The CprE 491 Senior Design course requires students to implement a tangible end product in order to demonstrate a year long approach to proposing, designing, and constructing a major project. Primarily a hardware project, the Dec06-04 group consists of three electrical engineers and one computer engineer. The final end product is expected to be completed in December of 2006.

A general solution approach and technical approach is described in further sections of this design report. The proposed approach to this project consists as follows: individual research on constituent components of the digital clock divided into these categories: LEDs, LCD display, power unit, microcontroller, buttons/switches, casing, PCB, resistors/capacitors, and other components.

After research, individual parts were chosen from a list of potential components. For example, research on microcontrollers led to a family of PICMicro P16 microcontrollers. From that group, a specific PICMicro microcontroller was chosen. This method was used with all other components of the project. A final parts list was then compiled and placed into this design report. The parts list will be finalized upon inspection by faculty advisors. A parts request form will then be completed in order to acquire the necessary components. Upon receipt of these parts the integration, implementation, and testing stages of the project will begin. This latter part of the Dec06-04 project will begin in the fall semester of 2006.

The following is a description from the senior design course notes of the expected end product:

The purpose of this project is to develop a digital alarm clock to display the current time in binary format. The clock is to be capable of displaying its results in either twelve-hour format (XX:XX:XX with an AM/PM indicator) or twenty-four hour format (XX:XX:XX). Other features (stopwatch, elapsed time, dual time zone) may also be implements if possible. It is also to include a settable alarm function, be self-correcting for daylight saving time changes, and be able to ride through power outages of at least two hours in duration. The resultant end product is to be implemented to the level of a completed consumer product, including PCB layout, supporting power supply, and attractive case. Additional requirements for commercial production should be evaluated if possible.

Some of the prior features will be omitted, included, or extended. Also, some new features will be implemented.

The design process for this project is a top-down engineering approach. Several abstractions of the digital binary clock exist in this design report. An overall design of the digital binary clock in the form of a block diagram has been created. The block diagram will then be followed with a fairly detailed circuit diagram. These diagrams can be created in design software such as PSpice or Microsoft Visio. Using these diagrams as a blueprint, the individual components will be integrated together. Software design for the PICMicro microcontroller will be written in the C programming language using the MPLAB integrated development environment provided by the senior design lab. MPLAB is also freeware obtainable from reputable sources on the internet such as microchip.com or mouser.com.

The digital binary clock described in this design report will display time in both digital and binary formats. The clock will also have features that include an alarm, automatic adjustment for daylight savings time, and a battery backup. Physical switches will be embedded in the casing in order to allow users to toggle features. The clock will have the ability to display time in both twelve and twenty-four hour formats. Month, day, and time information will also be displayed.

Some of the major issues to be resolved are software, circuit design, and power. Because the microcontroller has not yet been obtained, no software has been written or tested. Upon receipt of a microcontroller, software will be written, simulated and tested before being placed into the chip. Overall circuit design is also an issue that requires approval from faculty advisors. Approval is needed for security reasons. The project team would lose valuable time and resource if parts were ordered and integration began using a flawed circuit diagram. And finally, advice and finalization of an AC/DC rectifying circuit will be required. Power issues will be address once a consensus is reached up power requirement for the digital binary clock.

1.2 Acknowledgements

The team would like to extend its thanks to both Prof. Lamont and Prof. Patterson for their guidance throughout the project planning phase as well as continual support through its completions. Their knowledge and assistance will no doubt prove instrumental.

1.3 Problem Statement

The problem statement of the project plan will describe the general problem for the Senior Design06-04 group. It will also describe the proposed solution to the problem developed by the group.

1.3.1 General Problem Statement

A multifunctional clock is needed to display the current time. The clock should be able to display the time in either twelve-hour format, thus also needing an AM/PM indicator, or in twenty-four hour format.

It should also have the possibility to be used as an alarm clock. This clock should be able to self-correct for daylight saving time changes. Power outages should not affect the clock's ability to keep the time and it should be able still have backup power for at least two hours duration.

The clock should reflect a certain geek personality for the target consumer. This is the person that is characterized as wanting or interested in all the newest technology and gadgets.

The main display of the clock should show the time in the normal digital format. To do this the clock should display the time of day in binary code. Although this is the main display, the digital readout of the binary time should also be displayed so that anyone could learn binary from this clock. Table 1.3-1 below shows an example of how to calculate a value from binary code. Note that only positions that have a value of "1" are calculated into the numerical value.

Table 1-1 - Binary Code Example

Binary Number	Position Placement	Position Calculation	Numerical Value
000000	2^5 2^4 2^3 2^2 2^1 2^0	0+0+0+0+0+0	0+0+0+0+0+0 = 0
111111	2^5 2^4 2^3 2^2 2^1 2^0	$2^5+2^4+2^3+2^2+2^1+2^0$	32+16+8+4+2+1= 63
101010	2^5 2^4 2^3 2^2 2^1 2^0	$2^5+0+2^3+0+2^1+0$	32+0+8+0+2+0 = 42
010101	2^5 2^4 2^3 2^2 2^1 2^0	$0+2^4+0+2^2+0+2^0$	0+16+0+4+0+1 = 21

Displaying the day, month, and year should be an option for this clock. This can be done in both digital and analog format. It should be displayed in the standard, month/day/year format. The day of the week should also be indicated.

This clock must have a variety of location options, meaning sitting on a desk, hanging on a wall, or attaching onto a magnetic surface. With this requirement the size of this clock should be no bigger than 8" by 11", a standard sheet of paper.

The physical appearance should also be attractive to the target consumer. It should have a "cutting edge" technology look that keeps with the "geek theme" for this clock. It should offer a variety of geek themes, and a personalized geek touch.

1.3.2 General Solution Approach

The clock will be made of two main displays. A primary display will show the binary times, and the secondary will be the digital displays like other clocks. See Figure 1.3-1 below for pictorial of the design for solution.

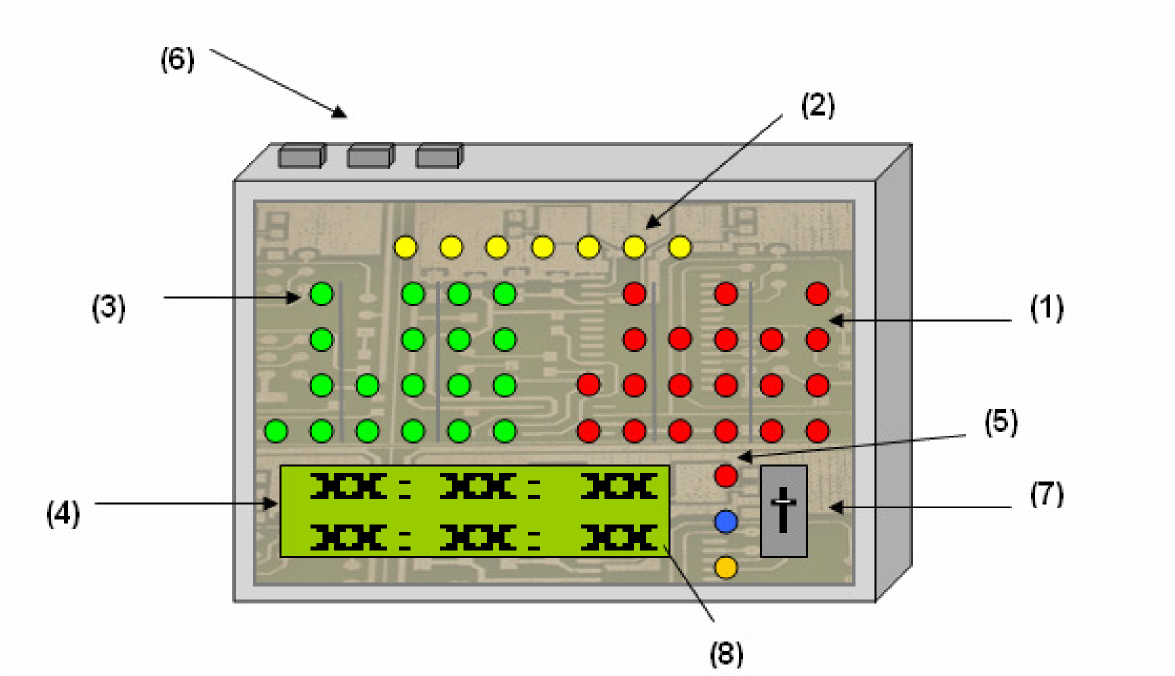


Figure 1-1 - Design of geek binary clock

The primary display of the time will be done in the binary format. It will show the time, day of the week, and date. These can be seen in Figure 1-1 as parts labeled (1), (2), and (3) respectively. To accomplish this, an array of light emitting diodes (LED) should be used. These will light up in a pattern according to what the current time is. There should be seven LED's for the day of the week, lighting up one for the respective day of the week.

The secondary display, showing the time and the date (month/day/year) will be in digital format. This will be shown on a multi-line/multi-character display. The date will be figured into the program which should be built with C using the fourteen possible calendar years. Figure 1-1item (4), shows the secondary display.

Since the clock has the capability of displaying the time in either twelve-hour or twenty-four hour format, a toggle switch will be used to switch between formats. For the twelve-hour format an AM/PM indicator such as an LED will be used to notify the user of the format being used. Figure 1-1, item (5) shows this.

For this clock to be used as an alarm, a function programmed in C will be built in for this capability. It will send out a noise at the set alarm time. Figure 1-1, item (6) shows the alarm control buttons, which will perform standard alarm functions such as: sounding at a designated time. Other possibilities if time, material, and funds permit is a snooze function, a generated voice stating the time, and specific time increment alarms, such as every fifteen or thirty minutes.

The program will also compensate for daylight saving times (DST). It will automatically correct itself at the designated time of the years. This will be built in the program with the fourteen possible calendar years. The DST function will have a toggle switch that when on will auto correct itself, or when off, the user will correct it. This is an included feature for areas of the country that do not observe daylight savings. Figure 1-1, item (7) depicts the DST toggle switch.

It will also auto correct itself for leap years using the standard fourteen possible calendar years. This should be done in the software of the clock. The clock will not correct itself for century leap years.

The main power supply will be an AC source of 120V that can be plugged into any standard United States wall outlet. The clock will have a transformer and an AC/DC rectifier to provide the correct DC voltage.

To ensure that a power outage will not affect the clock's time keeping a standard 9-Volt battery will be used for backup. This will allow for at least two hours of running time. During a power outage the primary and secondary displays will turn off, but the internal clock will keep running to conserve energy. When power is restored to the clock, both displays will return on with the correct time.

An alert will appear on the secondary display signaling when the battery is low and needs to be replaced. Figure 1-1, item (8) shows this alert.

The appearance of the clock should appeal to the target audience, geeks. The shell/case of the clock should be made of a hard yet light material that is semi-transparent such as plexiglass. This will allow the user to see the wiring and "electrical make-up" of the clock. An option to have the shell a standard black plastic should also be available.

For the different location options, the clock will have a metal folding stand for support (like a picture frame) so that it can be placed on a desk. It will have a wall hook to allow it to hang on the wall. It will also have magnetic strips that can be attached to the back to hang it on a magnetic surface.

A personalized option should also be available. This could include engraving the person's last name or nickname on the front top of the clock.

The colors of the LED's used for each function can also vary according to user preference and the available options.

1.4 Operating Environment

The operating environment is limited to indoor places. The environment should be able to supply the appropriate power needed through a regular wall outlet. It should not be used in areas that contain a lot of moisture such as the bathroom or pool room. It should not be in an area that it could potentially be dropped in a sink such as a kitchen or laundry room. It should be limited to places such as bedrooms, home offices, and in the work office.

1.5 Intended User(s)

The intended user(s) are those who know binary code and fit the geek persona. It can also be used by those who would like to learn binary through a practical application. This should not be used by children due to certain dangers such as small parts and electrical components.

1.6 Intended Use(s)

This object is a clock meant to display time primarily in binary with LED's. It provides other functionalities that are closely associated with a geek personality. It is also intended to help individuals learn binary by using the secondary display of the digital readout of the binary.

This clock can also be used as a standard alarm clock as well. It will sound at a designated time by the intended user.

1.7 Assumptions and Limitations

The following part of the document will provide the assumptions and limitations that the group has made/encountered thus far into the project.

1.7.1 Assumptions

This section describes the assumptions of the project.

- LCD display

  The size and physical capabilities of the LCD display will have the ability to meet the project's requirements.

- DST and leap year

  The clock will be receiving a low frequency transmission to update itself for daylight saving time or leap year. It will also be self-correcting for time discrepancies. This function will have the ability to be disabled.

- "Geeky" appearance

  The outer shell of the clock will be made of a hard, semitransparent material such as plexiglass.

- LED's

  There will be several sets of lights on the clock's exterior. The first set of lights will be a horizontal set of seven lights indicating the day of the week. The two other sets of LED's will display the time in binary format and the date in month, day, and year format.

- Location and operating environment

  The clock will only operate on a typical 120VAC, 60Hz outlet. The clock is meant to be used indoors.

1.7.2 Limitations

This section describes the limitations of the project.

- Features

  The clock must have an alarm function, be self-correcting for daylight saving time, have a battery backup, and be able to display time in twelve and twenty-four hour formats. The twelve hour format must have an AM/PM indicator.

- Costs/Budget

  The clock cannot cost over $150 in parts. Labor will not be counted in the budget costs.

- Testing

  Another limitation will be testing. Testing of the prototype model will occur during the fall. This means that the construction of the model assumes a lot of information. The size in length and shape of many parts has not been determined, and the design size and shape of the clock is dependent upon these parts.

- Size and Weight

  The size and weight will be a limitation in the project. It is intended to be small enough to be put on a small table, and it also has to be light enough to be wall mountable.

1.8 Expected End Product and Deliverables

The following part of the document will discuss the expected end product and other deliverables that will be included with the prototype at the end of the project.

1.8.1 Expected End Product

The geek clock will be a hybrid model based off existing binary clock structures. Its exterior shall reflect that of the intended audience. Its overall appearance will be a blend of technology and elegance. The idea behind the project is to build a device that incorporates “geeky” features, but at the same time, have an end product that is useful and practical to everyone.

The clock will display time in both twelve and twenty-four hour formats. These times will be displayed digitally and in binary respectively. The clock will incorporate daylight saving time automatically into the calendar year. It will display the day of the week as well as date, month, and year information. In addition, it will also have an alarm feature.

1.8.2 Deliverables

Along with the clock, there will also be a user’s manual. This manual is to assist the user in operating the clock’s many features. It will include information on all of the features discussed previously as well as a detailed description of their operations. The manual will also include a troubleshooting section designed to help the user as much as possible if he/she incurs a problem.

2 Proposed Approach

The second section of the document provides the proposed approach by the group. This will include the functional requirements, and several consideration sections including: constraints, technology, testing requirements, security, safety, and commercialization. This section will also cover the areas of project evaluation with milestones and other criteria, as well as project tracking procedures and possible risks and risk management.

2.1 Design Objectives

This section of the paper describes the design objectives for the project. These were developed from the problem statement from the group's project plan. A detailed description of each objective is also described below the list.

- Display the current correct time
- Option for twenty-four or twelve-hour format
- Need an AM/PM indicator for twelve-hour format
- Perform basic alarm clock functions (set a time to alarm, snooze, alarm sound)
- Self-correcting for daylight saving time (DST)
- Able to run during power outages for at least two hours
- Styled for the "geeky personality"
- Display time in binary code
- Option of having a digital display of time as well

A multifunctional clock is needed to display the current time. The clock should be able to display the time in either twelve-hour format, thus also needing an AM/PM indicator, or in twenty-four hour format.

It should also have the possibility to be used as an alarm clock. This clock should be able to self-correct for daylight saving time changes. Power outages should not affect the clock's ability to keep the time and it should be able still have backup power for at least two hours duration.

The clock should reflect a certain geek personality for the target consumer. This is the person that is characterized as wanting or interested in all the newest technology and gadgets.

The main display of the clock should not show the time in the normal digital format. To do this the clock should display the time of day in binary code. Although this is the main display, the digital readout of the binary time should also be displayed so that anyone could learn binary from this clock.

2.2 Functional Requirements

This section will describe in detail what the clock's features will and will not be. Below is a list of its functions as well as a brief description of each one.

- **Power**

  The clock will be powered by a standard 120VAC outlet. It will also have a battery backup which will maintain accurate date and time information in the instance of a power outage.

- **Alarm function**

  The clock will have an alarm function integrated with its time function. This alarm will sound through a small speaker. The clock will not be equipped with an AM/FM radio function. The alarm feature will have the ability to be turned on and off based upon user preference.

- **Displays**

  The clock will display date and time information in both digital and binary formats. The digital display will also have the ability to be enabled or disabled upon user preference.

- **Date/Time format**

  The clock will display time in both twelve and twenty-four hour formats. The twelve hour format will have an AM/PM indicator in the form of an LED. Also included with the actual time information will be month, day, and year information. This will also be represented digitally and in binary format.

- **DST and leap year**

  The clock will use a very low frequency receiver (VLF) to gather date and time information. The clock will automatically update itself through this transmission. It will be self-correcting for both DST and leap year. It will also be self-correcting for any time discrepancies that may occur. This feature will have the ability to be disabled based upon user preference.

2.3 Design Constraints

This project has a few key constraints that need to be addressed. There are a few design and software constraints as well as physical and operating limitations.

2.3.1 Design Constraints

- **Weight**

  The clock's weight must be such that it can be wall mountable. Its size, therefore, must also be accommodating to such a circumstance. Its final weigh shall be no more than two pounds.

- **Maximum Size**

  The clock itself cannot be incredibly large or bulky. It shall be not larger than 8.5" x 11". The idea behind the project is to make final product that is both multi-featured yet visually appealing.

- **Cost**

  The cost of building the clock must not exceed $150. It is important to choose parts carefully keeping in mind that there is a limited budget.

2.3.2 Software Constraints

- **Twenty-four/twelve hour time formats**

  The clock needs to be able to display time in both twenty-four and twelve time formats. The twelve hour time format needs to have an AM/PM indicator as well.

- **Daylight Saving Time / Alarm Functions**

  These two features described in previous sections must have the option to be disabled upon user request. Though these features maybe helpful for some people, they are not applicable to everyone.

2.3.3 Physical/Hardware Constraints

- **Power**

  The device is intended to operate on a typical 120VAC residential outlet. It is not designed to operate on a 220V source. There will also need to be an onboard power supply in case of power failure. This backup power source will provide power to the clock for at least two hours.

- **Operating Atmosphere**

  This device is not intended to be used outdoors. The device will not be waterproof, and it will not be designed to withstand adverse weather conditions.

3 Technology and Technical Approach Considerations and Results

In the design and implementation of a Geek Binary Alarm Clock, there are many different types of technology to be considered. The design of an alarm clock from scratch elicits many preliminary questions. Some of these questions include:

- How will the time be displayed?
- How will the overall layout of the clock look?
- What type of software will be needed to write the logic?

The following section pertains to the multitude of options available to engineers for designing and implementing a small project such as a binary alarm clock. There are always multiple ways of approaching an engineering problem. Several aspects of the project can be broken up into problem solving sections such as layout, software, hardware, and power consumption. Each of these aspects has several approaches which is the topic of this section.

3.1 Date/Time Display Technical Approach Considerations and Results

The most pertinent question that arises when considering technology for designing and implementing a clock is: how will the time be displayed? The Geek Binary Alarm Clock requires time to be displayed in binary format. The initial technological consideration is LED's. LED's are the natural choice because of their relatively low power consumption and ease of integration onto a breadboard. The requirement to represent binary digits (on/off states) finalizes the decision to use LED's. They also offer a wide variety of selection for the consumer.

Other technologies considered for display binary time were physical switches, small light bulbs, LCD (liquid crystal display), and numerous other light producing sources. Physical switches were immediately excluded because the necessity to automate changes in states. Small light bulbs can be thought of as bigger versions of LED's. The size limitations and aesthetic requirements of the binary clock exclude the use of small light bulbs. LCD screens are also considered for representation of binary digits. Most digital electronic clocks utilize this technology which is why it is better suited for standard display rather than binary display.

In order to display the day of the week electronically another method is needed. It's been chosen that an array of letters, S M T W Th F S, will be placed at the top of the clock with respective single LED's associated with them. In order to display the time in standard format a large, electronic array of changeable letters is required. The first technology considered for this job is an LCD display. Alternate methods and technologies to display standard time are mechanical flip displays such as those is older clocks, small computer screen display, analog displays, and audible features. LCD screens provide an enormous amount of malleability with respect to displaying alphanumeric information.

LCD's also allows both twelve and twenty-four hour times to be displayed without difficulty. LCD's are easily manipulated in programming, offer almost unlimited versatility in alphanumeric display, and are relatively inexpensive.

Another technology considered for displaying standard time is the mechanical flip displays of older clocks. These displays consist of multi-sided plastic chips in loops that flip mechanically to show the correct time. The first problem is the fact that the clock would be incapable of displaying twenty-four hour time. Switching between twelve hour and twenty-four hour would also be difficult. Another technology considered for displaying standard time is a small computer screen. This idea is an entire project within itself but is a viable option given enough time and money.

An alternate technology considered for displaying standard time is an analog display. This would be a very simple technology to implement but would not be very flexible. Like the mechanical flip display, the analog display would be incapable of displaying twenty-four hour time. The standard hour label of an analog clock could be pulled out and replaced like the following image in Figure 3-1. This clock looks somewhat convoluted and unprofessional. The project proposal requirements does not require the standard display of time to be in digital format but, in order to preserve the "geek" concept of the project a digital display such as an LCD screen is preferred.

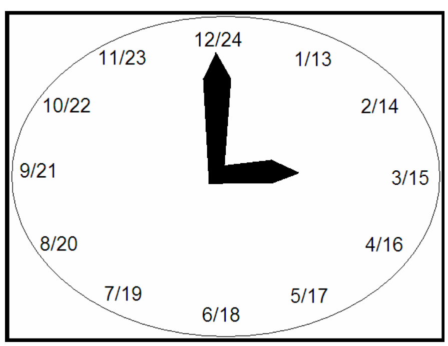


Figure 3-1 - Analog 12/24 Display Option

The last technology considered is an audible announcement of time. This concept will be considered as an optional extra feature because it presents many problems. These problems include the frequency of announcement, alternation of twelve and twenty-four hours, and implementation requirements such as loudness, voice, and speakers.

3.1.1 LED Size and Color Scheme Technical Approach Considerations and Results

LED's come in a wide variety of sizes, colors, and material. The approach that the project required for the display was to be seen at a glance (like any clock), thus larger and brighter LED's are preferred. This statement contradicts the size of unit the whole clock needs to be. The LED's must be a decent size for one to see the time at a quick glance at the clock, but not large enough to inhibit the size mentioned in the functional requirements. The LED's must also be spaced far enough away from each other for one to distinguish each LED from the other, thus the design should use a smaller LED size. The group chose to use two different sizes of LED's larger LED's (5mm) for the date and time functions that would need to be looked at a glance. Smaller LED's (3mm) were chosen for the lesser used functions such as week notification LED's and ON/OFF LED's that only need to be looked at occasionally.

Originally the color of the LED's were just all going to be either green or red because these were assumed to be the most accessible and easiest to read. The group decided against limiting the LED colors to just those two because they do not offer a sense of personalization to the project. The group also felt that those colors are used quite frequently in the technology/electronic field and would like some variety. The color of the LED's has been preferred to be customer specific, meaning that each customer can pick the color for their LED's from the color availability list below.

The group also decided to use ultra bright and superflux type LED's for the date, time, and day of week LED's. These will increase the brightness of each LED and will make it easier for the user to read. The tables below shows a schematic of an ultra bright LED compared to a regular LED. Notice that the ultra bright LED uses less voltage and has an higher wavelength intensity.

Table 3-1 - Regular LED

Operating Characteristics (T_A=25°C)		UR (GaAsP/GaP)	Unit
Forward voltage (typ.) (I_F=10mA)	V_F	1.9	V
Forward voltage (max.) (I_F=10mA)	V_F	2.5	V
Reverse current (V_R=5V)	I_R	10	uA
Wavelength at peak emission (I_F=10mA)	λ peak	627	nm
Wavelength of dominant emission (I_F=10mA)	λ D	625	nm
Spectral Line half-width (I_F=10mA)	Δλ	45	nm
Capacitance (V_F=0V, f=1MHz)	C	15	pF

Table 3-2 - Ultra Bright LED

Operating Characteristics (T_A=25°C)		ZR (GaAlAs)	Unit
Forward Voltage (typ.) (IF=20mA)	VF	1.85	V
Forward Voltage (max.) (IF=20mA)	VF	2.5	V
Reverse Current (VR=5V)	IR	10	uA
Wavelength of Peak Emission (IF=20mA)	λ P	660	nm
Wavelength of Dominant Emission (IF=20mA)	λ D	640	nm
Spectral Line Full Width At Half-Maximum (IF=20mA)	Δλ	20	nm
Capacitance (VF=0V, f=1MHz)	C	95	pF

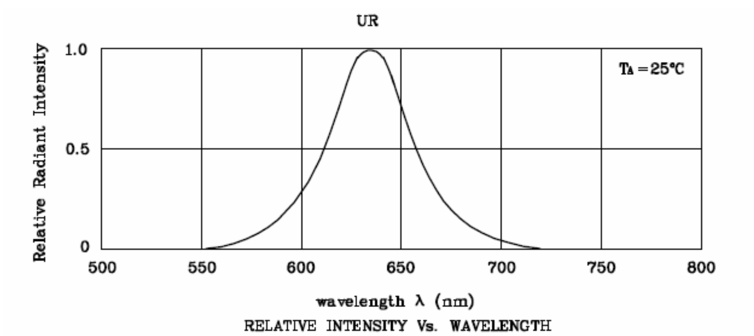


Figure 3-2 - Regular LED

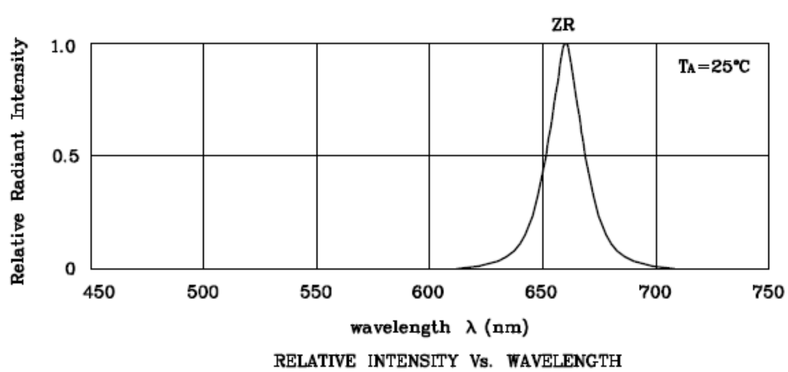


Figure 3-3 - Ultra Bright LED

There are some limitations for this. One is that the date, time, and week notification LED's must be different colors so that the sections can be placed closer together to keep the size of the clock down. It would also provide an ease for the user to look at the clock and be able to see a distinct difference between each LED field. The ON/OFF LED's would also have a similar limitation based on their available colors.

The ON/OFF notification LED's were designed originally to be single color LED's that would light up when ON and not light up when the function it represents is OFF. The group felt that this had many flaws in it because during testing faulty LED's would be harder to detect. Or if the user has the switch constantly in the OFF position, they would never know if the LED worked or was broken unless they turned it to the ON state. The group decided a bi-color LED would be preferred. These LED's would show one color for an ON position and different color for the OFF position. It is varied by voltages. The following shows the specifics of the bi-color LED's for the red/green option.

Table 3-3 - Operating characteristics for Red (MDK) and Green (VG) bicolor LED's

Operating Characteristics (T_A=25°C)		**MDK (InGaAIP)**	**VG (InGaAlP)**	**Unit**
Forward Voltage (Typ.) (I_F=20mA)	V_F	1.95	2.1	V
Forward Voltage (Max.) (I_F=20mA)	V_F	2.5	2.5	V
Reverse Current (V_R=5V)	I_R	10	10	uA
Wavelength of Peak Emission (I_F=20mA)	λ P	650	574	nm
Wavelength of Dominant Emission (I_F=20mA)	λ D	635	570	nm
Spectral Line Full Width At Half-Maximum (I_F=20mA)	Δλ	28	20	nm
Capacitance (V_F=0V, f=1MHz)	C	35	15	pF

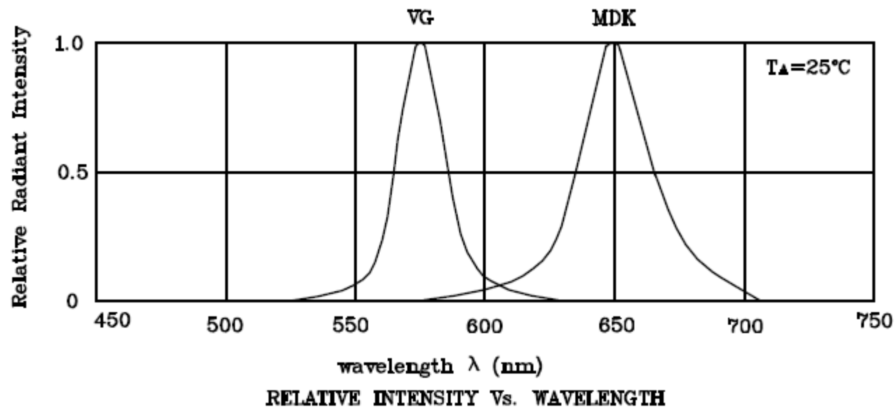


Figure 3-4 - Differences in Intensity graph

Finally the group has come up with the list of available options for the LED's in the display. It has been put all together in the following table.

Day of Week:					
Type:	Ultra Bright Round LED XLMxx11x Series				
Size:	3mm				
Color:	blue	green	red	orange	yellow
Date:					
Type:	Ultra Bright Round LED XLMxx12W Series				
Size:	5mm				
Color:	blue	green	red	orange	yellow
Time:					
Type:	Ultra Bright Round LED XLMxx12W Series				
Size:	5mm				
Color:	blue	green	red	orange	yellow
ON/OFF Notification:					
Type:	Bicolor LED XLxxxx29M Series				
Size:	3mm				
Color:	red/ green	green/ yellow	red/ yellow		

Figure 3-5 - Available color options for each clock display section

3.1.2 Layout Technical Approach Considerations and Results Approach Considerations

For designing the layout of binary clock two major approaches can be considered. One approach is that the layout of the clock is to favor aesthetic value rather than purely functional value. The other is the reverse of the first: to use a minimalist approach and disregard aesthetics and any "bells and whistles". The following is a simple diagram of the proposed layout of the front of the binary clock:

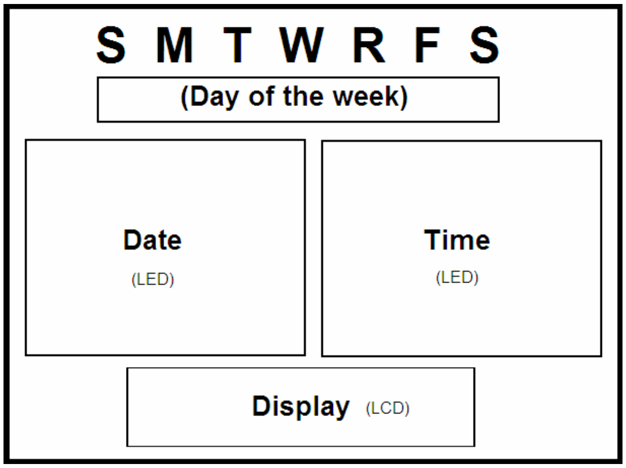


Figure 3-6 - Basic proposed layout

In order to implement the logic behind a digital clock, electrical components will have to be merged together in a centralized location. This location will then have to be placed inside a physical structure. There are multiple technology considerations for this aspect of the project.

3.1.3 LCD Display Technical Approach Considerations and Results Approach Considerations

Formalizing the layout to use with the LCD display took the following approach. Determining what binary information that needs to be display in decimal format was performed first in order to gather how many characters are required. The following figure displays possible character utilization spots in a series.

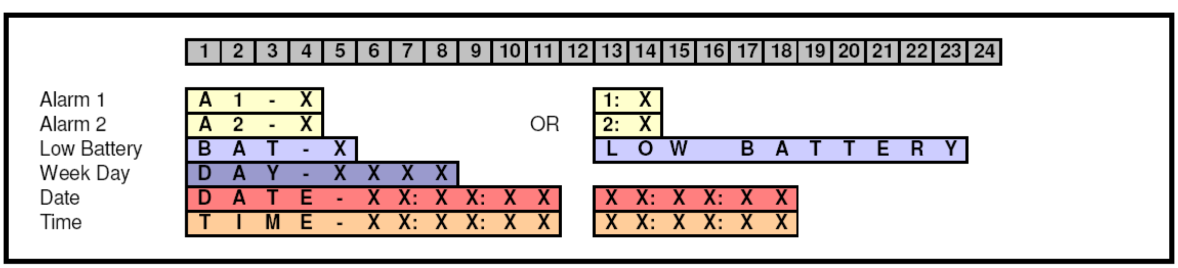


Figure 3-7 - Segment Possible Sizes

Then, arranging how are these character segments are to be placed within the LCD display was executed to determine the number of rows needed. Thus, Figure 3-8 displays 20 possible character utilization spots, with common end sizes being highlighted with the dashed lines (i.e. 8, 12, 16, & 20). Different layout combinations of these segments are also displayed within this figure. However, only some of these combinations utilize the day display data where others overwrite the displays when a low battery is present.

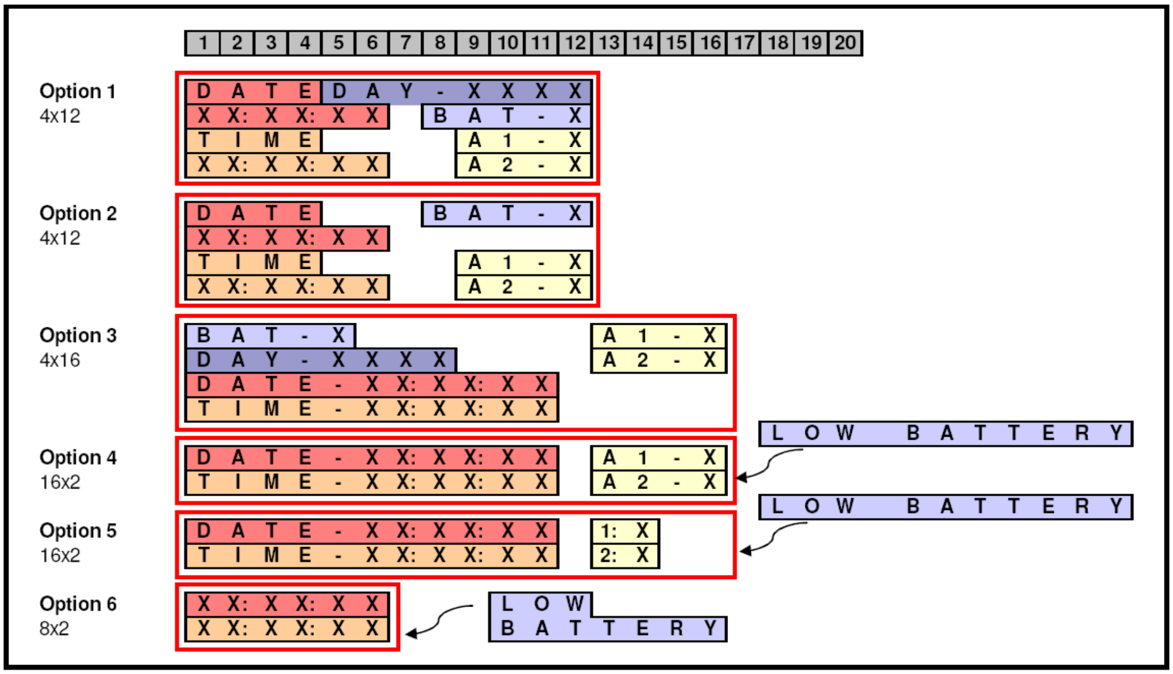


Figure 3-8 - Possible LCD Layouts

While an effort will be made to make the clock look presentable no extra time or money will be spent on a specialized physical appearance. Therefore an 8x2 sized LCD screen will be utilized as it displays only pertinent information when needed as well as being cost efficient.

3.1.4 Accurate Time Technical Approach Considerations and Results Considerations

Large consideration and research was performed to determine a way to acquire and maintain accurate time functionality. A large focus on precise accuracy was placed to extend the "geek" feel of the clock. Thus a few possible implementations were gathered, such as utilizing counters (software or hardware), crystal oscillators, and AC 60Hz frequency conversions. However, the previous possible implementations were deficient in the preferred accuracy. With further research the ultimate components for accuracy were found. These were the RTC—real time clock—and the RF receiver and controller.

The RF antenna and receiver will work together to automatically gather precise month, date, and time information from a low frequency radio transmission called WWVB. This method of gathering data is often referred to as RCC or radio-controlled clock. This radio transmission is also coded with flags for leap year and daylight savings time. Given this radio transmission, the clock will be able to automatically update itself in case of a discrepancy in time keeping.

Although precise time information is gathered from the RF receiver, maintaining this accuracy between updates is surmounted with the use of the RTC. First of all, it does have a 32kHz crystal oscillator as well as a adjustment function to correct the oscillator from slight variances in accordance to the surrounding environmental temperature. Furthermore, this component contains numerous other favorable characteristics. End of the month calculations (28, 29 [leap year], 30, 31) for calendar updates, a low power supple detection, and alarm interrupters functionalities are all provided which will help reduce software coding. All information outputted from the RTC will be sent to the microcontroller to decode and send to the subsequent display and alarm components.

3.2 Microcontroller Technical Approach Considerations and Results

The “brain” behind the digital binary clock will be the microcontroller which will control and direct all internal functions. The choice of microcontroller is an important one which required much research. There are literally thousands of microcontrollers resulting in many considerations. A digital clock requires a basic microcontroller that has a minimum execution time, high amount of I/O pins, is easily programmable, and is cheap. The large list of potential microcontrollers suggested by faculty advisors and others found during research were narrowed down to three selections: Intel 8051, Motorola 68HC11, and Microchip PICMicro microcontrollers. Further research was performed on these three microcontrollers as well as inquiries from fellow students. The final result, concurred by faculty advisors, was the choice of the PICMicro family. Readily available from a faculty advisor was a PICMicro PIC16F877A microcontroller. The following is a picture of several PICMicro microcontrollers in the PIC16 family.

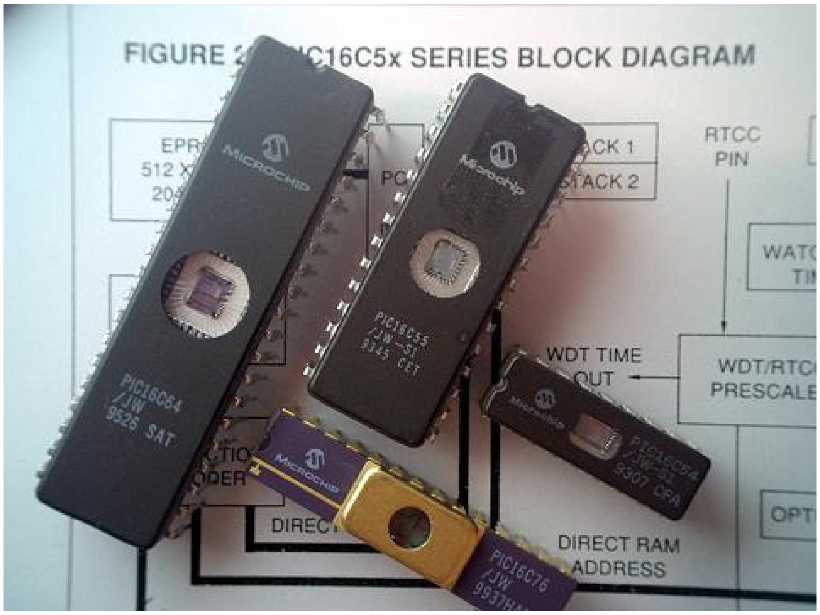


Figure 3-9 - Microchip PICMicro microcontrollers – PIC16Cxxx

This chip was readily available, easily programmable, cheap, and had enough I/O pins to complete the project. Senior design labs also have testing boards, software, and other equipment specifically made for PICMicro microcontrollers. The following is a grid of information concerning the chosen microcontroller for this project, the PICMicro PIC16F877A. The grid is then followed by a data sheet of this particular microcontroller. More specific information on this family of microcontrollers is available at this link:

http://ww1.microchip.com/downloads/en/DeviceDoc/39582b.pdf.

Architecture	Memory Type	Kbytes	KWords	EEPROM	RAM	I/O	Max speed	Pin count
8-bit	Enhanced Flash	14	8	256	368	33	20 MHz	44

Figure 3-10 - PIC16F877A Information Grid

PIC16F877A

Parameter Name	Value
Program Memory Type	Enhanced Flash
Program Memory Size (Kbytes)	14
RAM (bytes)	368
Data EEPROM (bytes)	256
I/O	33
Packages	
Pb Free Available	Yes

Summary

This powerful (200 nanosecond instruction execution) yet easy-to-program (only 35 single word instructions) CMOS FLASH-based 8-bit microcontroller packs Microchip's powerful PIC® architecture into an 40- or 44-pin package and is upwards compatible with the PIC16C5X, PIC12CXXX and PIC16C7X devices. The PIC16F877A features 256 bytes of EEPROM data memory, self programming, an ICD, 2 Comparators, 8 channels of 10-bit Analog-to-Digital (A/D) converter, 2 capture/compare/PWM functions, the synchronous serial port can be configured as either 3-wire Serial Peripheral Interface (SPI™) or the 2-wire Inter-Integrated Circuit (I²C™) bus and a Universal Asynchronous Receiver Transmitter (USART). All of these features make it ideal for more advanced level A/D applications in automotive, industrial, appliances and consumer applications.

Features

2 PWM 10-bit
256 Bytes EEPROM data memory
ICD
25mA sink/source per I/O
Self Programming
Parallel Slave Port

Figure 3-11 - PIC16F877A Information Datasheet

3.3 Power Consumption Technical Approach Considerations and Results

Power consumption is another topic for technical approach considerations. A binary clock can consume energy is several ways. It can use solely a DC power source, a local battery source, a mechanical device, or a chemical reaction. It can also use a combination of these energy sources as implied by the requirements and suggested in the project assumptions. Different approaches to energy consumption are also limited by project assumptions and constraints. The clock needs to be a small size, use little energy, and look presentable.

One assumption has been established: the clock will require two different power sources in order to ride through a power outage and one of these sources will be from a DC electrical source. One approach to solving the energy problem, the chemical reaction, is immediately seen as impractical. A chemical reaction may refer to a gasoline engine or any combustible reaction which creates energy. The energy consumption of a binary clock is not great enough to warrant the use of such a source of energy. Therefore, the approach of deriving and using energy produced from a chemical reaction is ruled out. Another approach to the energy problem is a mechanical device. A device which turns mechanical energy into electrical energy is called a dynamo or, in general terms, a generator. Turning mechanical gears physically is impractical because this project is not about the binary clocks source of energy.

Simplicity tells us to use the easiest form of energy available to us which is standard DC electricity. The simplest and most readily available source of energy is the electricity coming from the AC electrical outlets in a building. Of course, this electrical energy may be regulated by equipment such as small voltage generators available to electrical engineering students. The second source of energy will have to be a battery. The type of battery to be chosen was discussed in the previous section.

3.3.1 Backup Power Technical Approach Considerations and Results

The power requirement in the project proposal is that the Greek Binary Alarm Clock be capable of riding through a power outage for at least two hours. The assumptions indicated that an independent battery source would be required to power the clock through a power outage. The assumption is that the clock will use a DC source from an electrical socket as the main source of power and a local battery as the second.

The type of local battery is another technology consideration of the project. There are several types of batteries available for implementation including rechargeable cell batteries, PP3 (9V batteries), AAA batteries, AA batteries, watch batteries, coin cell batteries, and other voltages. Below Figure 3-12 shows the many different types of batteries.

Figure 3-12 - Different types of batteries

Rechargeable cell batteries were rejected as an idea because of their relative complexity. In order to implement them specialized circuitry would be required to handle their regenerative properties. The two way nature of rechargeable batteries makes them more complex.

Keeping it simple and emulating consumer clocks with “power ride-through” features has shown that a 9V battery will be the easiest to implement. Many consumer clocks on the market today possess internal battery compartments for nine-volt batteries. The choice of battery to be used depends on several factors. The power generated from the different classes of non-rechargeable batteries and relative size will determine the selection. Also dependent is the amount of power consumption from the binary alarm clock. The following is a small grid of alkaline battery options, sizes, and voltages, amp hours, and weights.

Table 3-4 - Battery Statistics

Battery	Size	Voltage	Amp Hours	Weight
AAA	Length=44.5mm Diameter=10.5mm	1.5V	1.15 Ah	0.42 oz
AA	Length=50mm Diameter=14.2mm	1.5V	2.85 Ah	0.85 oz
C	Length=46mm Diameter=26mm	1.5V	3.80 Ah	2.3 oz
D	Length=58mm Diameter=33mm	1.5V	8.0 Ah	4.8
Energizer 337B	Width: 7.62mm Depth: 7.62mm Height: 2.54mm	1.55V	8-25 Ah	0.16 oz
CR2354	Width=23mm Depth=5.4mm Height=2.54mm	3.0V	25-80 Ah	0.2 oz
PP3	Width=25mm Depth=15mm Height=48mm	9V	595 mAh	17.6 oz

As it can be seen in the grid, a PP3 or 9V battery as it’s commonly known has the most voltage in the least amount of space. This is perhaps why so many smaller consumer products use 9V batteries.

Watch batteries and coin cell batteries are extremely small batteries with high voltages that power small electronics such as watches, calculators, memory chips, PDAs, mp3 players, and many more. These batteries have the advantage of being small and powerful. Many of them can produce voltages greater than household batteries. The following picture is an example of some of the coin cells available today.

Figure 3-13 - Coin Cell Batteries

The flat nature of these batteries allows them to be easily integrated onto a printed circuit board. As visible on some of the batteries above, coin cells can produce 3V which is more than enough to power the internal electrical components of the digital binary clock. A method is needed to bridge the battery and PCB. This method is a coin cell holder which can be easily placed onto a PCB. Figure 3-14 shows some examples of this necessary component.

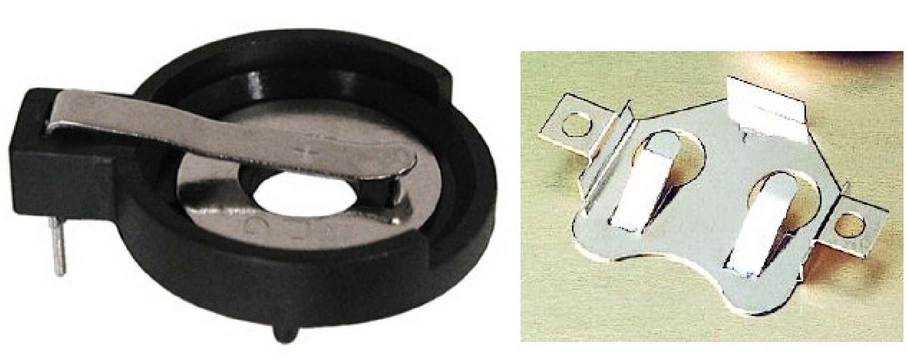


Figure 3-14 - Coin Cell Battery Holders

The final battery to be used in the digital binary alarm clock will be a coin cell battery because of the size, voltage, and ease of integration.

3.4 PCB Technical Approach Considerations and Results

The immediate consideration is a PCB. A PCB is the industry standard for coupling electrical components such as resisters, capacitors, inductors, microchips, memory, and bus lines. Another consideration is a breadboard. A breadboard is a thicker, plastic version of a PCB with a single sheet of connecting metal underneath. This sheet of metal conducts electricity through components and does not require soldering. Because the bulky, unattractive, and unprofessional (breadboards are usually used by beginners) look of breadboards a PCB will undoubtedly be used. The following figure depicts different types of breadboards and PCBs.

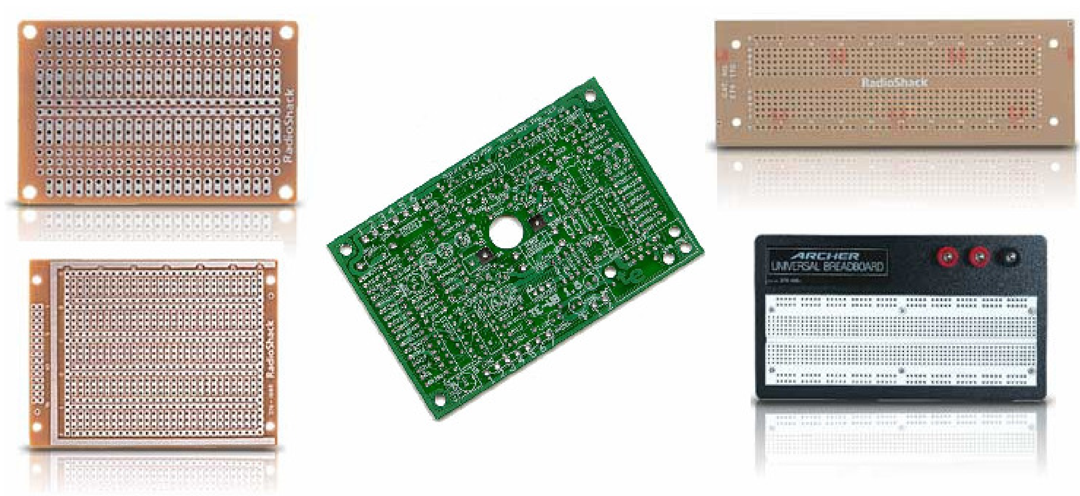


Figure 2.2.2: Different PCBs and breadboards

Multiple types of PCBs exist such as single sided, double sided, through-hole, grid layout, and others. This simplest type of PCB that fulfills requirements will be used for this project. A single sided, through-hole PCB measuring close the size of a standard photograph will be used. The through-hole technology will allow for easy integration of electrical components. A PCB of this type can be purchased for less that $5 at any electronics store such as Radio Shack.

3.5 Casing Technical Approach Considerations and Results

One of the requirements in the project proposal is that the Geek Binary Alarm Clock end product be placed in an attractive case. There have been multiple ideas for material and casing. Different technologies have been considered including using the casing of an old clock, plastic casing, plexiglass, and metal. The idea of encasing the end product in a metal casing was immediately eliminated because of the clocks electrical properties. A non-conducting material would be preferable. A metal casing would also significantly add to the weight of the clock is thus undesirable. The use of metal such as aluminum or steel is also impractical because of cost. Metal, in general, is more expensive to produce, manipulate, configure, and maintain than plastics. This is the reason why many electrical components in the technology industry are made with light-weight plastic polymers. Designing the layout of a binary clock may also require a specific shape and construction of a shell. In example, LED's may be placed vertically or horizontally based on preference. Manipulating a metal casing would undoubtedly be more expensive than plastics.

Another, somewhat primitive technology considered for implementing the casing of the binary clock is removing the casing of an old clock. The advantage of this method is the cost. An old clock can be found for little or no cost. The disadvantage would be the inflexibility of the casing. In order to implement a clock to specific desired specifications a custom casing would be most suitable.

The final two technologies considered for the casing of the binary alarm clock are plastic and plexiglass. Local hardware stores such as Lowe's or Home Depot have many varieties of plexiglass available to customers. These hardware stores even offer to cut plexiglass to meet customer's needs. Lowe's stocks a transparent blue plexiglass measuring approximately 24" x 36" at varying thickness which may be cut into six pieces to form the sides of a clock. Plastics are the last and most probable choice in technology considerations for the casing of a binary clock. Plastic is cheap, easily manipulated, easy to maintain, and fairly shatter resistant. Seeking the help of materials engineers and onsite production labs may prove useful to finding the most adequate casing.

Plexiglass casing would also allow the clock to have a more "geeky structure". The user would be able to view all the inner workings and circuitry of the clock that they find interesting. They would be able to see exactly how the clock worked.

3.6 Hardware Technical Approach Considerations and Results

The design of overall hardware integration can take multiple approaches. The most popular approach for engineering is the top-down approach. In the top-down model a general overview of the project is formulated without describing any specific details. Each part of the project is then refined by designing it in more and more detail. The opposite of this engineering process is the bottom-up approach. The bottom-up method involves designing individual parts of the project in specific details. These parts are then linked together to form larger components. The process is repeated until the whole project is completely formed. The hardware approach for the Geek Binary Alarm Clock will be the top-down approach. The overall layout of the clock will first be designed. The individual components will then be divided among group members who will then individually design the specific details. After these individual pieces are completed the binary clock will be assembled from its constituent components to form the final end product. The preferred approach to designing and implementing a binary clock will be top-down and from scratch. Senior design requirements would also prefer that the project be approached from a unique-to-a-group approach.

3.7 Software Technical Approach Considerations and Results

The last section on technology consideration will discuss is software. Software can be written in many languages, some appropriate for certain high-level tasks while some are appropriate for lower-level tasks. The aspect of technology consideration in this section is concerned with choosing the correct language, development environment, and coding implementation for writing the software to a binary clock.

The options for languages include C, C++, Java, Visual Basic, and many, many more. The indented use of a programming language will help to sway the considerations for which language to choose. Questions may be asked like: is this a high-level or low-level project? Will highly specialized functions and reference libraries be required? Should a fairly flexible language be chosen for maintenance and updating purposes? In order to answer these questions the project needs to be looked at from a computer engineer's perspective. The pertinent question a computer engineer would ask is: how is the software supposed to function with respect to the hardware? The answer is that procedural coding will communicate with hardware such as LED's and LCD's to produce on/off states.

An object-oriented procedural coding approach should be used. This essentially describes the language to be chosen. Visual Basic is immediately eliminated because there is no GUI involved with the clock and VB is incapable of low-level communication. Java is another high-level language specifically made for consumer electronics. It is a viable option but may present difficulty when attempting low-level operations. C++ is much like Java in its high-level attributes. The best foreseeable option for a programming language is C. C is a language in between low-level and high-level. It will give a programmer low-level access while being able to utilize high-level functions to implement logic needed for a binary clock with many extra features.

The final result for programming language is the C programming language. C has a reputation for handling pointers and memory well. This will aid in the communication of hardware components. The integrated development environment to be used is MPLAB. MPLAB is freeware available to students in the senior design lab and is specifically designed to work with PICMicro microcontrollers.

3.7.1 MPLAB Software Technical Approach Considerations

Approaches in software are far less in-depth than most aspects of the project because of its relative simplicity. Implementing a 12/24 hour clock with corresponding on/off states and a list of extra features will require very little designing and planning. The difficult part of the project dealing with software is its integration with hardware. Technical approaches in software include procedural, object-oriented, and modular programming. Procedural and object-oriented programming techniques will undoubtedly be used in the Geek Binary Alarm Clock project. Procedural programming will be used to break apart different functions of the clock. For example the following code will return a string value representing the day of the week:

```
/*Return the day of the week in string format*/
String dayOfWeek(clock input)
{
     String ans="";
     ans = input.dayofweek();
     return ans; }
```

Procedural programming is a technical approach that almost goes with the need for saying. It is a basic requirement of programming and greatly will help organize values used in the software written for the binary clock. Object-oriented programming is another basic technical approach where data in encapsulated in virtual "objects" manipulated by specific procedures. Because a binary clock will have many values that need to be monitored such as on/off state variables for LED's, object-oriented programming is a must.

An approach to software will require a medium in which to write code whether it be Visual Studio, Metroworks CodeWarrior, or notepad for that matter. The IDE to be used in this project will be MPLAB because of its close relation to PICMicro microcontrollers. Here is an example snapshot of the MPLAB IDE:

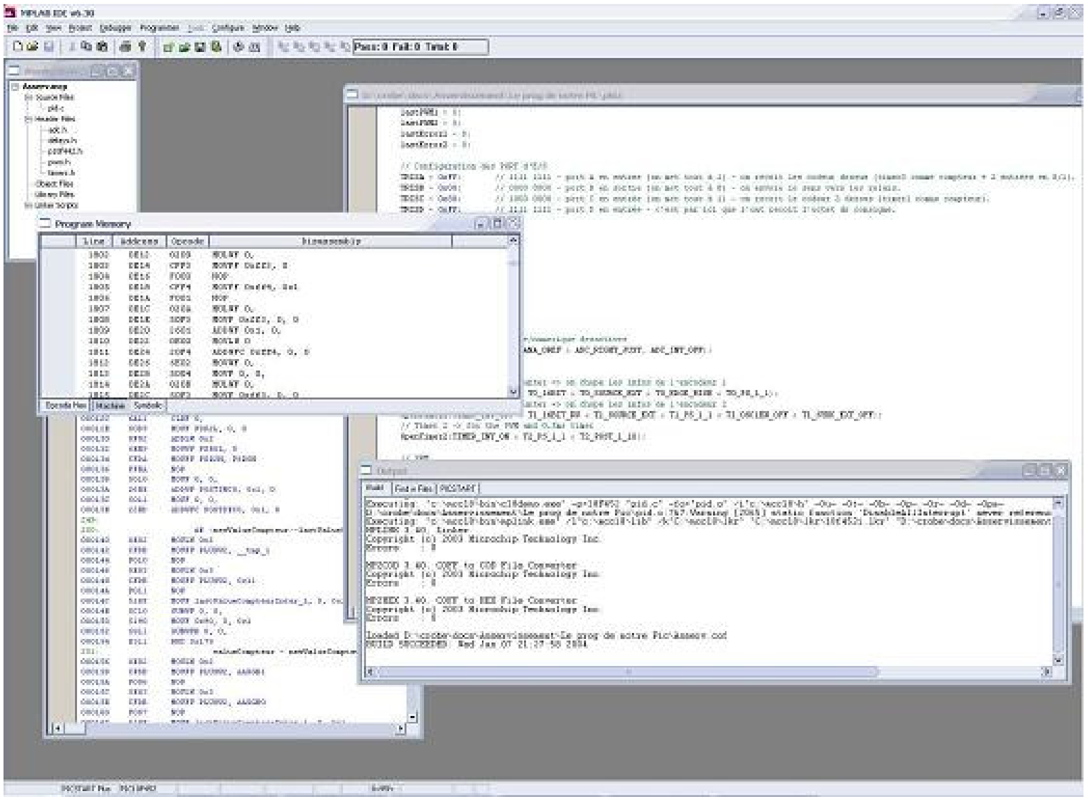


Figure 3-15 - Example screenshot from MPLAB

This IDE will provide the necessary environment to write and test software before loading into the microcontroller. The overall process is described in the following steps: (1) Obtain a blank PIC, (2) write a program in the MPLAB IDE, (3) Compile and simulate the program in MPLAB, (4) load the final program onto the PICMicro microcontroller, and (5) test the microcontroller in a real circuit. The testing of the microcontroller will mainly be performed with help from the IDE and the test board available in the senior design lab.

The following is some pseudo-code that generally reflects the operation of the software for the Geek Binary Alarm Clock.

```
#include<files>

//prototypes
void checkUI();
void init();
void aquireOSC();
void sendOSC();
void aquireReceiverIC(int ctr);
void sendReceiverIC();
void buzzer();
```

```
//declare a time counter
int counterForReceiverIC;
int main()
{
     init();

     //enter superloop
     while(1)
     {
          //check for user input
          CheckUI();
          //perform necessary changes
          aquireOSC();
          //process OSC

          //acknowledge receipt
          sendOSC();

          //piezo alarm buzzer code
          if( //trigger alarm )
               buzzer();

          //get time update form ReceiverIC
          aquireReceiverIC(counterReiverIC);
          sendReceiverIC();

          counterReceiverIC++;}
}
```

4 Testing Approach Considerations

Details on how the team plans on performing tests to ensure end product functionalities is described in this section. To minimize the time/cost factor associated with the project, periodic test intervals throughout implementation will occur as the project progresses. A brief description of each of these testing phase along with a visual flow represented in Figure 3.1-1 is explained in the follow, which covers how, where, and what will be tested.

All phase testing will be preformed in the senior design laboratory or in Coover Hall laboratories. Software or hardware will be modified if results do not meet design requirements. All types of testing mentioned below will be performed by team members, as they have a thorough knowledge of how the system works. However, during debugging situations, certain group members knowledge will be utilized more compared to others due to their expertise in that particular area.

4.1 Phase 1

The following three tests describe the procedure for Phase 1 for the device.

Test #1- LED LCD Display Functionality Test

To verify hardware functionality amongst LEDs, they will first be connection to a power supply will test their ON/OFF functionality. Visually verifying the light illumination from the LEDs will then be noted.

Specifically with the bicolor LED's, these will further be tested to make sure that the ON state is a specified color and the OFF state is the second color by using the mechanical switches for each function. This will vary the voltages going to those LED's from the power supplied.

LEDs that do not meet the illumination functionality will be discarded. A successful criterion is all of the remaining LEDs illuminates when connected to a power supply.

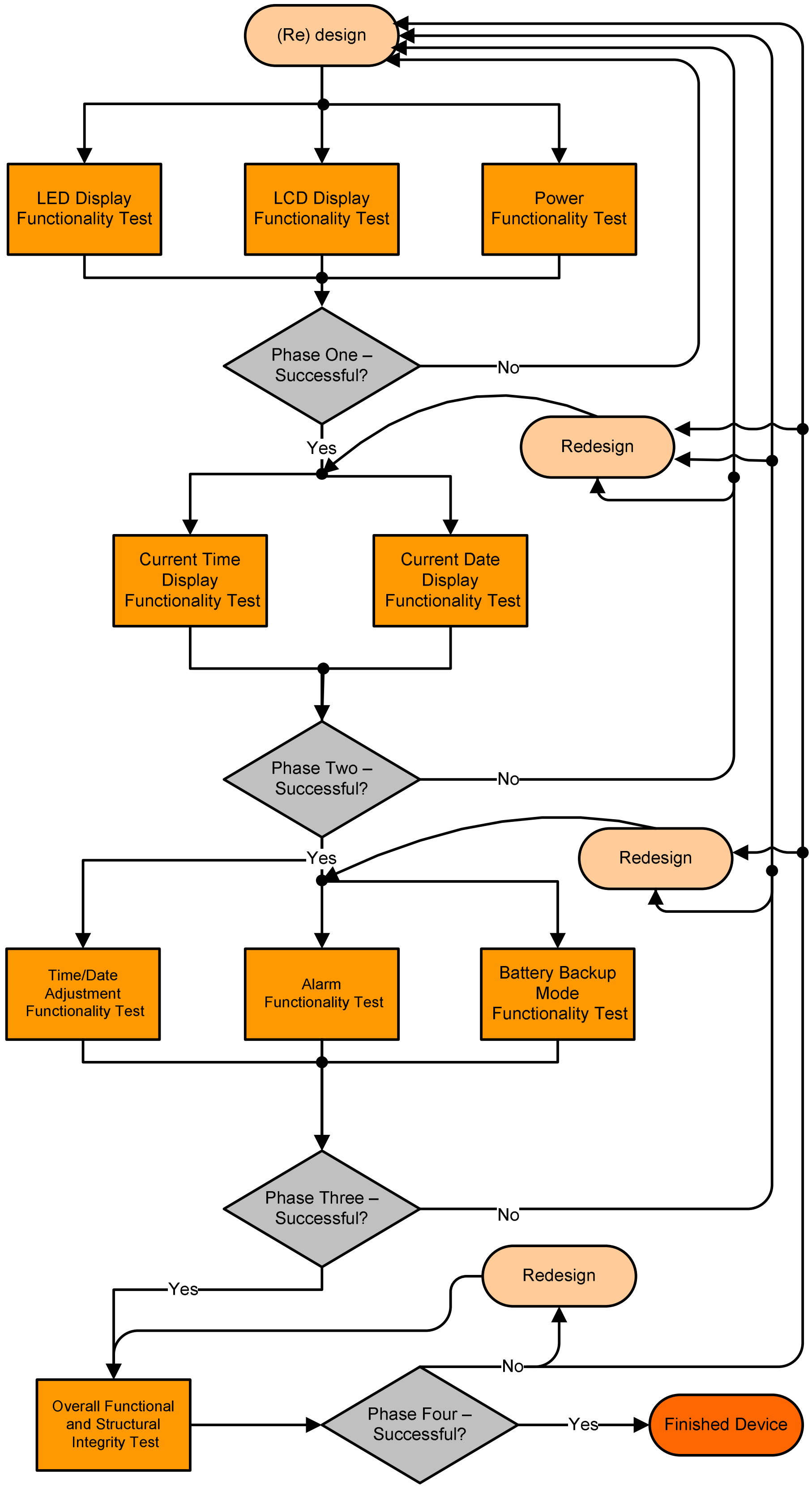


Figure 4-1 - Basic testing flow

Test #2- LCD Display Functionality Test

To verify hardware functionality amongst LCDs, its connection to a power supply and the PIC microcontroller will visually verify the alphanumerical functionality. A simple string from the PIC microcontroller will send all characters for each segment to the LCD screen. The display/illumination from the LCDs will be measured.

LCD screens that do not meet the illumination functionality will be discarded. A successful criterion is the LCD screens that can illuminate any character when connected to a power supply and PIC microcontroller.

Test #3- Power Functionality Test

Due to the multiple components associated with the device in which all require power to operate, except for the antenna. Thus verifying that all power ranges are being provided will be preformed during this test.

Table 4-1 – Power functionality testing table

Component	Required Voltage	Success
Microcontroller		
Receiver		
Buzzer		
RTC		
LED		
LCD		

These voltages will be verified visually with a DMM—Digital Mulitmeter—in the laboratory.

Figure 4-2 – Digital Multimeter

A successful criterion is the AC power supply provides all necessary power voltages to all components.

4.2 Phase 2

The following two tests describe the procedure for Phase 2 for the device.

Test #4- Current Time Display Functionality Test

To test the drift of the RTC oscillatory and the functionality between the PIC microcontroller and the LED/LCD displays, these displays will be periodically verified. This verification will take place over a range of times, varying from seconds to weeks. With in these intervals, photos will be taken of the component compared the atomic clock to increase the accuracy of testing. As switching time is less than a second, human real time verification contains a large percentage of error. Therefore, the photos are utilized to help reduce this. To acquire the atomic clock time, *The Official U.S. Time* website will be used. Therefore, the photos will have both the displays and the computer screen within the shots in order to compare the data. According to their website, they state their time format of Coordinated Universal Time should never differ more than 0.000 000 1 seconds, thus establishing a highly accurate comparison for the clock device.

Below is a figure that represents the template to gather and review the results of the photos. As can be seen, four pictures will be collected. These pictures can be taken at the tester preference as long as group stay within the time period.

Table 4-2 - Current time display functionality table

	Picture 1	Picture 2	Picture 3	Picture 4	Success
Seconds					
Minute 1					
Minute 2					
Minute 3					
Minute 4					
Hour 1					
Hour 2					
Hour 3					
Hour 4					
Day 1					
Day 2					
Day 3					
Day 4					
Week 1					
Week 2					

The success criterion is the device maintains the current binary time and digital time (when applicable) on the displays, updating every second.

Test #5- Current Date Display Functionality Test

To test the drift of the RTC oscillatory and the functionality between the PIC microcontroller and the LED/LCD displays, these displays will be periodically verified. This verification will take place over a range of a few weeks.

With in these intervals, photos will be taken of the component compared the atomic clock to increase the accuracy of testing. As switching time is less than a second, human real time verification contains a large percentage of error. Therefore, the photos are utilized to help reduce this. To acquire the atomic clock time, *The Official U.S. Time* website will be used. Therefore, the photos will have both the displays and the computer screen within the shots in order to compare the data. According to their website, they state their time format of Coordinated Universal Time should never differ more than 0.000 000 1 seconds, thus establishing a highly accurate comparison for the clock device.

The figure below represents the template to gather and review the results of the photos. As can be seen, four pictures will be collected at set times to verify the precise switching date. Both midnight and noon is collected to double check if errors occur.

Table 4-3 - Current date display functionality table

	23:59:59	00:00:00	11:59:59	12:00:00	Success
Day 01					
Day 02					
Day 03					
Day 04					
Day 05					
Day 06					
Day 07					
Day 08					
Day 09					
Day 10					
Day 11					
Day 12					
Day 13					
Day 14					

The success criterion is the device maintains the current binary time and digital time (when applicable) on the displays, updating every second.

4.3 Phase 3

The following three tests describe the procedure for phase 3 for the device.

Test #6- Day Light Saving Adjustment Functionality Test

Due to the limited time constraints and the nature of the test, this test will only be preformed once on October 29 around the 2:00:00 crossover. Thus, two functioning prototypes need to test the user ON/OFF preferences. Human visual verification will only be needed to view whether or not the updates occur. However, this will occur at 2:01:00 as the WWVB frequency requires one minute of data to be send to collect all time/date information.

Table 4-4 - Day light saving adjustment functionality table

	Protype 1	Protype 2
DST	OFF	ON
Time		

The acceptance criterion is the device adjusts the time and date on the designated daylight saving dates when applicable.

Test #7- Alarm Functionality Test

To test the functionality between the PIC microcontroller, the LED/LCD displays, buttons, and buzzer these components will be periodically verified. This verification will take place over a range of a few options as can be seen in the figures below. The first figure declares some of the set values (to test the edges) for the alarms as well as allowing the tester with some personal preference to set the random1-5 values (to mimic typical user usage).

Table 4-5 - Alarm table

Alarm 1	Alarm 2
00:00:00	12:00:00
random1	random2
random3	random4
random5	random5
00:00:00	00:00:00

Furthermore, these values will then be tested according to the grid below to determine whether multiple alarms will cause unforeseen problems. Here, human visual verification will test the displays update accordingly to the tester/user alarm input. Also, the buzzer will be tested to hear if the sound starts accordingly and if the volume is within reason. The tester will use his/her own hearing capability without the use of any blockers or amplifiers.

Table 4-6 - Alarm sound functionality table

Alarm 1	Alarm 2	Display Update	Sound		Success
			ON/OFF	Volume	
OFF	OFF				
OFF	ON				
ON	OFF				
ON	ON				

The success criterion is the device correctly triggers the alarm display and sound at the determined times.

Test #8- Battery Backup Mode Functionality Test

The battery backup mode functionality test will occur once all hardware and software components are integrated into the system. Different time and alarm combinations will be tested to ensure minimum battery life when the device is unplugged from the AC power supply. In the figure below, the voltage output will be measured with the DMM at the defined time interval. Testing will occur longer than the minimum time interval to determine the final time of backup power functionality.

Table 4-7 - Battery backup functionality table

Disconnect Time	Voltage	Success
00:30:00		
01:00:00		
01:30:00		
01:45:00		
01:50:00		
01:55:00		
01:56:00		
01:57:00		
01:58:00		
01:59:00		
02:00:00		
02:01:00		
02:02:00		
02:03:00		
02:04:00		
02:05:00		
02:15:00		
02:30:00		
02:45:00		
03:00:00		
03:30:00		
04:00:00		

The success criterion is the device maintains current time information, alarm settings, and battery life display when operating on battery backup for at least two hours.

4.4 Phase 4

The final test describes the procedure for Phase 4 of the device.

Test #9- Overall Functional and Structural Integrity Test

This test will occur once the end-product hardware and software component integration is near completion. This will be tested amongst eight to ten individuals to aid in usability verification. These individuals shall comprise a “geek” personality; therefore, engineers will be the primary target. The following figure displays a draft of possible questions to test the device’s functionality.

The success criterion is the device maintains product functionality while withstanding common everyday usage during these surveys. If major concerns arise from these results, and time permits, some redesign may be performed.

To organize the results from all these four phases, the following two forms shall be utilized. The *Component Testing Form* on page 44 gathers all pertinent information collected for each individual test. The *Testing Track Form*, like the name implies, on page 45 keeps track of what tests were done and were successes in an easily viewable and concise document.

4.5 Recommendations Regarding Project Continuation or Modification

At this point in time a decision must be made by individuals invested in this project as to the proper course of action. There are three options available: (1) continue the project as originally envisioned, (2) alter the direction of the project, or (3) abandon the project. At this time, the geek binary alarm clock Dec06-04 project is to be continued as scheduled. The final decision will be made by faculty advisors. The reason for the continuation of the Dec06-04 project is the good progress shown by the team. All deadlines have been met, adequate research has been performed, and a vast amount of knowledge concerning digital clocks has been acquired. The team is on schedule, knowledgeable, and competent enough to complete the project as envisioned.

Survey Testing Form

for Dec06-04 Geek Binary Alarm Clock

Sex (M/F): ________ **Date & Time:** ________ **Location:** ________

	Excellet	Good	Netural	Fair	Poor
Power					
Connecting to outlet	5	4	3	2	1
Connecting battery	5	4	3	2	1
Identifing low power	5	4	3	2	1
Time/Date					
Setting the time/date	5	4	3	2	1
Setting daylight saving	5	4	3	2	1
Displays					
LED read/reconizable	5	4	3	2	1
LCD read/reconizable	5	4	3	2	1
Overall appearance	5	4	3	2	1
Alarm					
Volume	5	4	3	2	1
Appeasing sound	5	4	3	2	1
Setting the alarm	5	4	3	2	1
Identification if set	5	4	3	2	1
Overall appearance	5	4	3	2	1
Casing					
Buttons	5	4	3	2	1
Overall appearance	5	4	3	2	1
Information					
User manual	5	4	3	2	1
Website	5	4	3	2	1

Improvements/feature you would like to see:

Other comments:

Figure 4-3 - Example survey form

Component Testing Form

for Dec06-04 Geek Binary Alarm Clock

Name(s): ____________ **Location:** ____________ **Phase #:** ____________

Date & Time: ____________ **Runtime:** ____________ **Test #:** ____________

Components being tested: ____

Test description:

Measurements:

Description of results:

Comments:

Overall results: (circle)

Success Failure

Figure 4-4 – Example component testing form

Test Tracking Form

for Dec06-04 Geek Binary Alarm Clock

Phase #	Test #	Components tested	Name(s)	Date	Time	Location	Runtime	Success/Failure

Figure 4-5 – Example testing track form

5 Detailed Design

The third section of this paper is the group's detailed design for the project. This section describes the projects parts including a master table. It also includes a detailed description table located on page 48 of how each part is used for the project's completion as well.

5.1 Summary of Material part usage

The following sections describe the main component for this project. Furthermore, Table 4.1 provides an image of the component as well as other specific details, such as manufacture/vender, part number, cost.

5.1.1 Microcontroller

The microcontroller is the "brains" of this device. It has an 8-bit architecture with 14 Kbytes of Enhanced Flash memory. The amount of Data EPPROM is 256 bytes and the amount of RAM is 368 bytes.

5.1.2 Real Time Clock

This IC is used for multiple functionalities, primarily accurate time keeping capability for the clock. It utilizes information from the radio frequency receiver to initialize the time. An internal 32 kHz crystal oscillator is provided to maintain this time, as well as clock adjustment function to correct the oscillator slight variance in accordance to environmental temperature. Additional features provided are calendar updates for leap year calculations up to the year 2099, low power supply detected, and alarm interrupter. All data will be sent to the microprocessor to separate the output data.

5.1.3 Receiver IC

The receiver IC will accept the incoming coded WWVB broadcast and send the information to the microcontroller for decoding. The information present in this coded signal will provide the clock the ability to self-update day and time information.

5.1.4 Antenna

This antenna is specially tuned to receive a 60 kHz, low frequency transmission called WWVB. This antenna will deliver the coded signal to the receiver IC.

5.1.5 LCD Screen

This is a LCD panel for displaying the time, date, alarms, and low battery information. The display is of two lines by eight characters which can display numerals, letters, and symbols.

5.1.6 Ultra bright LED's

This is a light emitting diode (LED) that will be used for the displaying the date, time, and day of the week in binary format. As shown in the approach the date and time will be in 5mm size and the day of the week will be in 3mm size. The LED's will be powered by the power supply from the 120V standard wall outlet. During a power shut off, when the battery is running everything the LED's will not have power supplied to them to conserve energy for the rest of the clock.

5.1.7 Bicolor LED's

The bicolor LED's are LED's that will be able to switch between two different colors for an "ON" and "OFF" state. The two different colors are dependent upon applied voltage. These will be 3mm in size. They will be used for the functions of the clock that notify the user of an ON/OFF state for such functions as DST, AM/PM, ect. Like the other display LED's these will not be powered during a main power failure and the clock's primary power is battery backup. This will conserve energy for a longer running time under the battery back up condition.

5.1.8 Piezo Buzzer

This is a sound device which will emit a buzzing sound at a user defined alarm time setting.

5.1.9 Transformer

An AC power cord connected to a DC transformer will provide power to the clock.

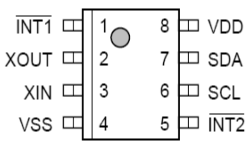
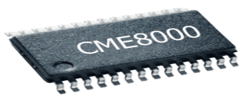
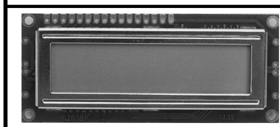
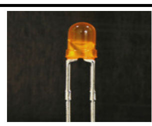
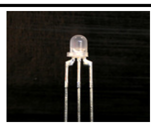
5.1.10 Coin Cell Battery and Clip

This provides backup power functionality for the device.

5.1.11 Mechanical Switches

These provide user interface with the device.

Table 5-1- Component information

Image	Part Name	lanufacturer/Vendc	Part Number	Cost
	Microcontroller	Microchip	PIC16F877A	$3.71
	Real Time Clock	Seiko Instruments Inc (SII)	S-35390A-T8T1	$0.89
	Receiver IC	C-Max	CME8000	$3.60
	Antenna	C-Max	CMA-MF-60	$1.50
	LCD Screen	Microtips Technology	MTC-S0802X FYHSAY-10	$8.93
	Ultra Bright LED (5mm)	SunLed Corp	XLMxx12W Series	$0.20
	Bicolor LED (3mm)	SunLed Corp	XLxxxx29M Series	$1.02
	Piezo Buzzer	CUI Inc.	CEP-1123	$1.60
	Power Transformer	Pulse Specially Company	E41-1410	$3.69
	Coin Cell Battery (3V)	Energizer	1620BP	$2.50
	Buttons	ITT Industries	D6 C 40	$0.90

5.2 Block Diagrams of Design

Figure 4.2.a presents a high level block diagram of the binary/digital geek clock where as Figure 4.2.b presents the circuit schematics of this device.

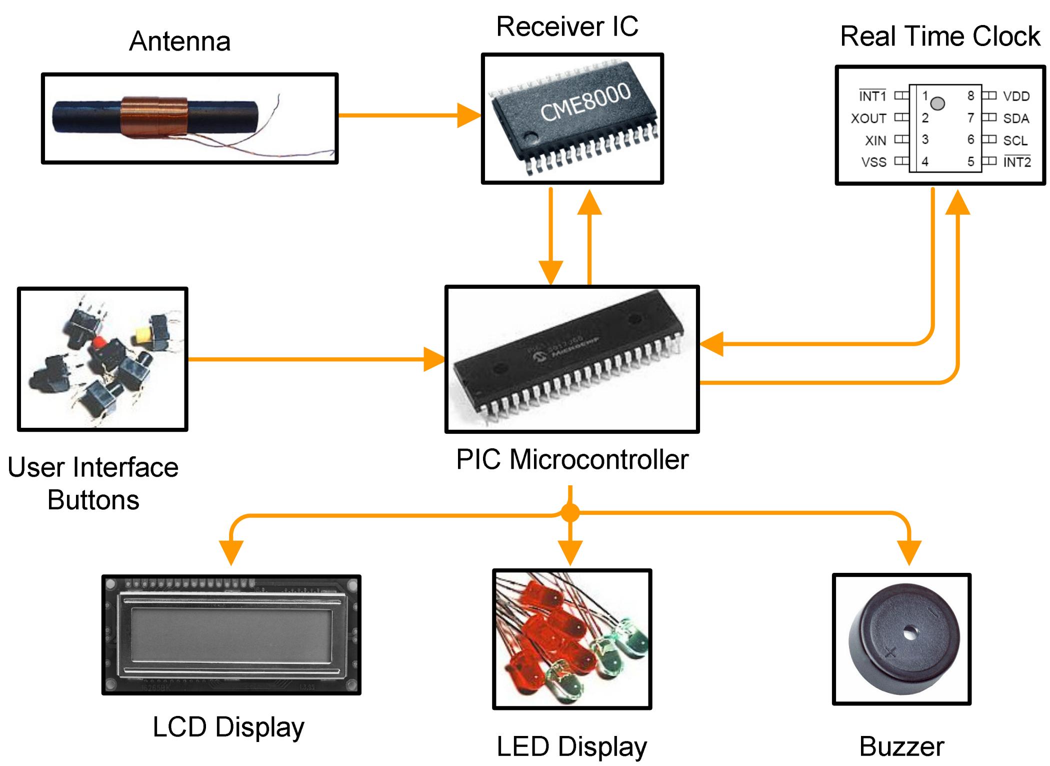


Figure 5-1 - Geek clock block diagram

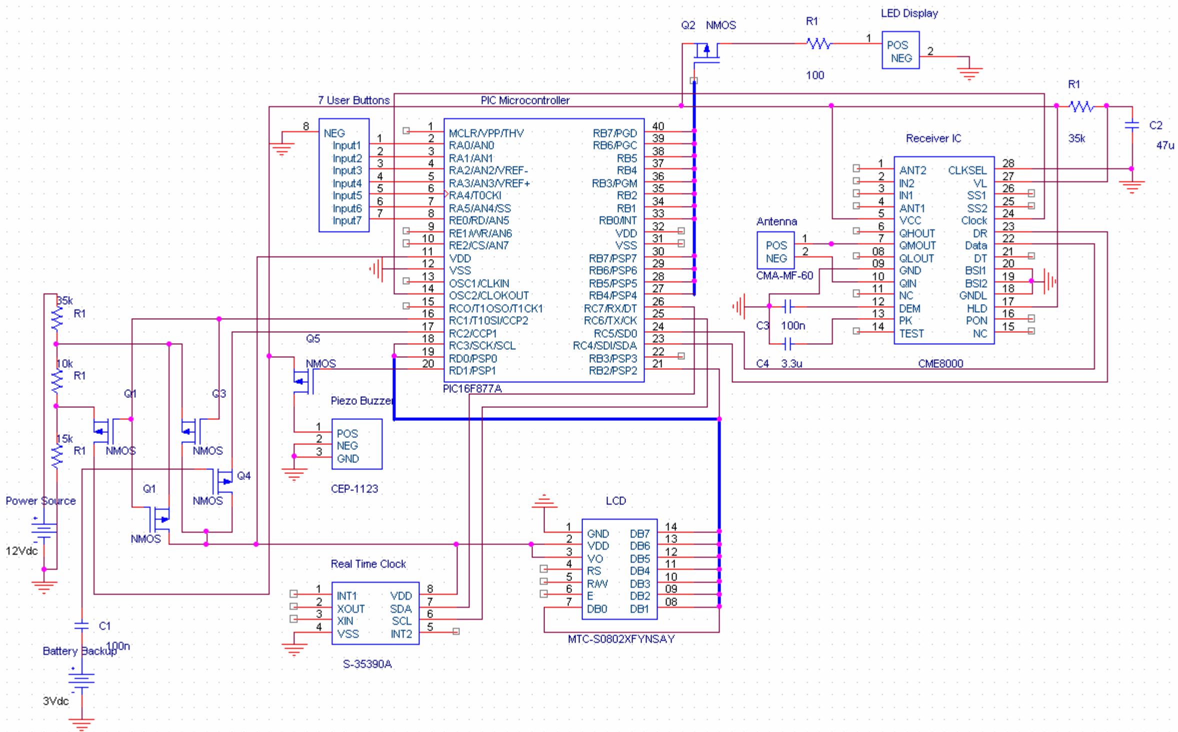


Figure 5-2 - Geek clock circuit schematic

5.2.1 PIC Microcontroller

One of the hardware components to be used in the Geek Binary Alarm Clock project is the Microchip PICMicro microcontroller model PIC16F877A. The following figure is a PIC16F877A from the 40-pin Plastic Dual In-line Package.

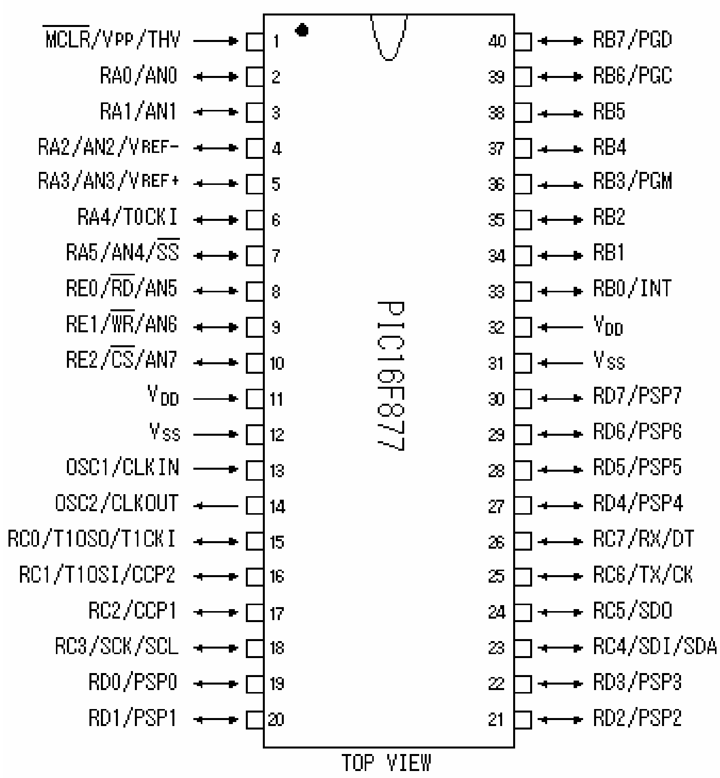


Figure 5-3 - Top-down pin layout view of PIC16F877A

The microcontroller has an 8-bit architecture with 14 Kbytes of enhanced flash memory. The amount of Data EPPROM is 256 bytes and the amount of RAM is 368 bytes. The most important aspect of the microcontroller is it's input and output. The PIC16F877A has 33 I/O pins: RA0-RA5, RB0-RB7, RC0-RC7, RD0-RD7, and RE0-RE2. This section will attempt to address the physical connections to and from the microcontroller. References to the hardware block diagram will be made.

The first and foremost need of the microcontroller is electrical energy. The PIC16F877A operates on a voltage between 2 Vdd and 5.5 Vdd. Input pin 32 will be used to deliver the voltage and pin 31 (Vss) will be grounded.

Input/output pins 2 through 7 corresponding to RA0-RA5 will be used to connect the user interface module. The UI module will contain four binary buttons for time, alarm, hours, and minutes and two on/off switches for LCD display toggle and daylight saving time toggle. A total of six, unidirectional signals will be connected to the microcontroller.

The real time clock (RTC) and receiver IC will also be connected to the microcontroller. The RTC's oscillator output will be connected to pin 13 (OSC1/CLKIN) on the PIC16F877A. The connection will be a constant, bidirectional in order for the RTC oscillator to know the current time. The clock signal will be sent to the RTC from pin 14 the OSC2/CLCKOUT port. No direct connection to the antennae will be necessary.

In order to utilize the periodic updates from radio frequencies the receiver IC will have to be connected to pin 26 of the microcontroller. Pin 26 (RC7) is an USART asynchronous receive port. The microcontroller will send read to receive and polling signals to the receiver IC through pin 25 (RC6). Pin 25 is an USART asynchronous transmitter. A DR register containing data will be read by one of the RC I/O ports. Asynchronous signals will be used because clock updates do not need to occur synchronously.

A 52-bit connection will be required in order to communicate with the LED display. Because of the limitation of I/O pins on the microcontroller, four 4:6 decoders will be required. These decoders can be connected to pins RB and RD.

The microcontroller will be connected to the LCD display with requires 112 signals. More digital logic circuits will be required to communicate between these two components. The logic circuits wires will be connected to pins RC and any leftover pins available.

The final component connected to the microcontroller is the Piezo buzzer which only requires a single on/off signal. The connection will be made at any available I/O pin.

5.2.2 Real Time Clock

The figure below displays the internal components within the RTC in addition to highlighting some the dominate features in blue.

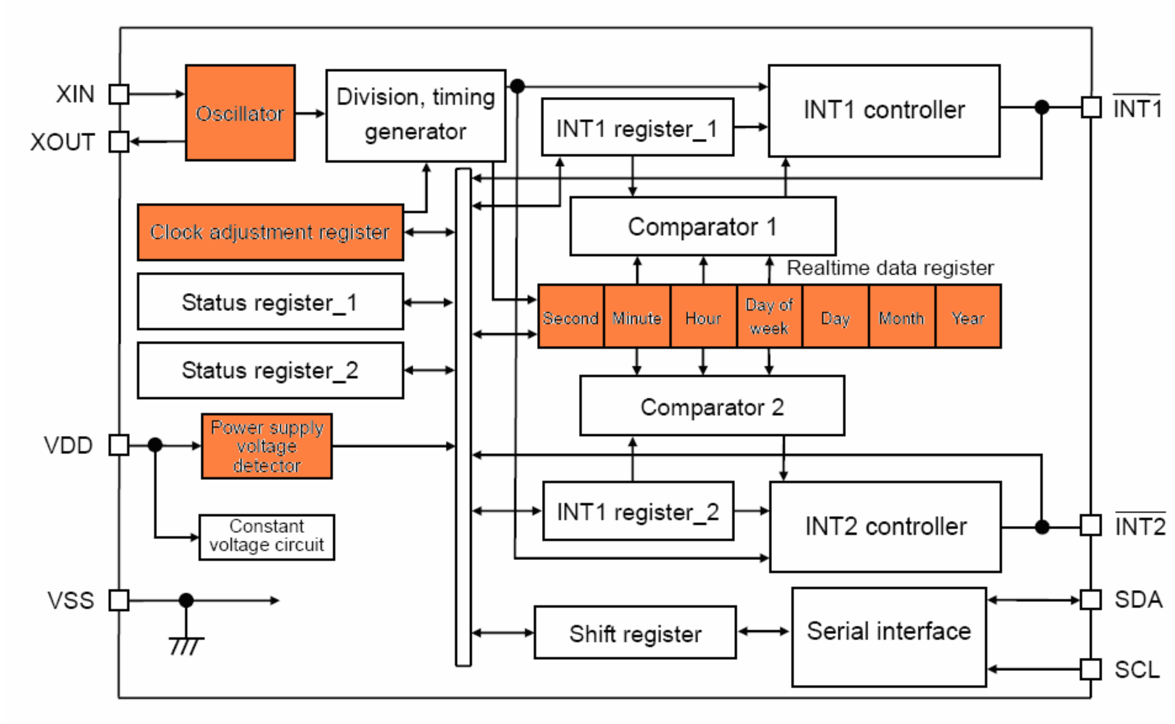


Figure 5-4 - RTC Internal Block Diagram

5.2.3 Receiver IC and Antenna

The antenna will be connected to the receiver through pins 7 and 10. This information will be processed and then sent to the microcontroller via pins 22 and 23.

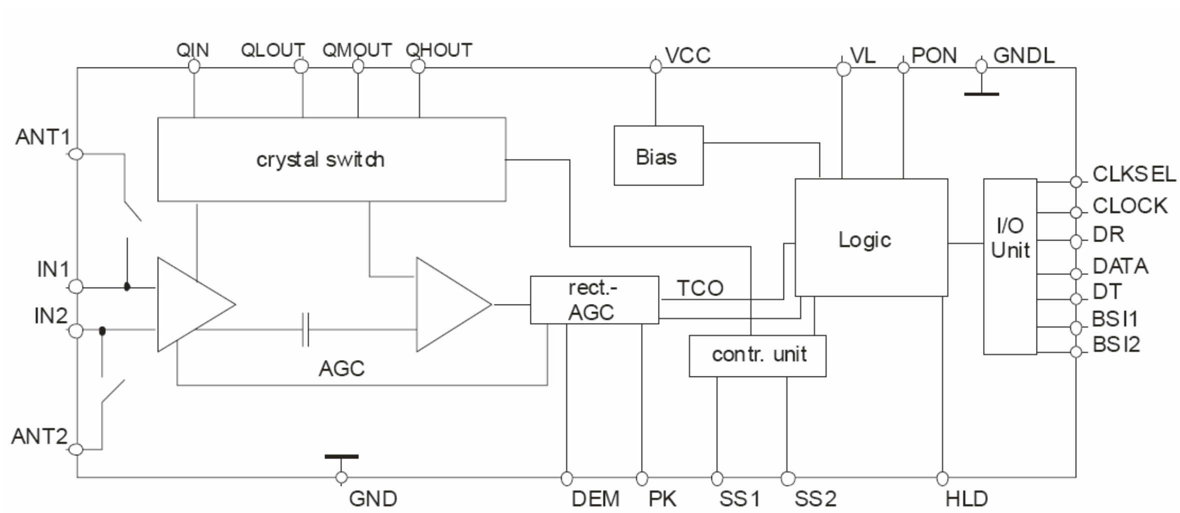


Figure 5-5 – Receiver IC internal block diagram

5.2.4 Power

Below is a demonstration of the distribution of power to the different clock components.

Regulated Power Supply Source

The primary power supply will utilize the 120 volt AC source from the wall. This source will be fed into the primary (input) winding of a small transformer to step down the voltage to 12V on the secondary (output) side. Once the voltage is reduced to a more workable level for the device, a bridge rectifier shall be employed. Thus these four diodes constructed in a diamond configuration will produce a full-wave varying DC voltage. Smoothing this output will be done by the electrolytic capacitor in which the output will lastly pass a voltage regulator to keep the final output at a constant voltage. The reduced voltage due to the step-down power consumption, voltage drops in the diodes, etc., are not large concern at all following components contain a large range for working functionalities between 2-6 volts. The actual large current supply is more of a concern to operate all the LEDs and LCD displays. The figure below depicts the final circuit diagram of the AC to DC converter power source.

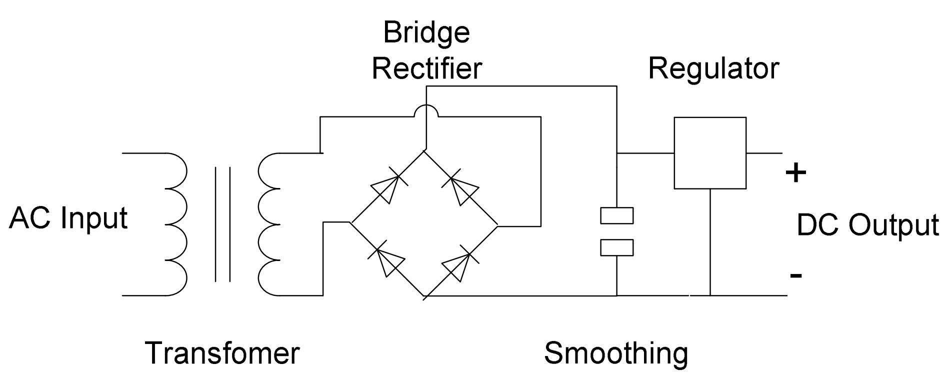


Figure 5-6- AC to DC Circuit Diagram

The secondary back-up power supply will utilize a battery source in case of a power outage, thus following the same setup as the primary power supply source. The large current supply here is now not a concern as in this mode the LEDs will be turned off.

Switching Circuit

To create a simple switching circuit, NMOS transistors were utilized. Connecting the output from the PIC microprocessor to the gate of these transistors will control the final signal going trough the transistor. Below, this figure represents a simple case of this concept. When a 1V input is placed both gate of the NMOS, then the input signal will pass through to the output. This therefore simulates a short circuit. Furthermore, to obtain the switching effect, when a 0V input is placed on the gate a degraded 0 will be produce. Thus, this 0V gate input simulates an open circuit. Figure 5-7 graphically displays this switching capability.

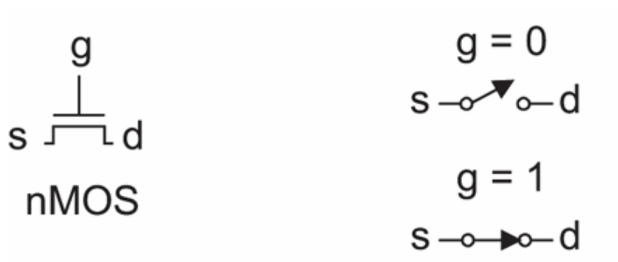


Figure 5-7 - NMOS signal functionality

Thus, this concept was used to control the different voltages supplies of the regular power mode of 3V and 5V to be switched over to the 3V battery backup mode. Furthermore, this was also utilized for the peizo buzzer and the LED displays.

6 Estimated Resources

This following describes the estimated financial and personnel expenses that will be utilized in order to complete the project. The end-product has an upper limit budget of $150 for parts and materials in addition to reference materials. Table 6.1 below details the updated estimated implementation cost with and without the labor included in the calculations. Table 6.2 displays the same information, just the information at the beginning of the project. Furthermore, since two clocks were required in the final deliverables, clock components cost were separated from the reference materials and the multiplier into sub sectioned to easily display the cost of the single clock device. Again, updated and previous detailed estimations of individual projected time spent on items can be viewed in Table 6.3 and Table 6.4, respectively, on the following few pages.

Table 6-1- Adjusted Estimated Project Cost

Parts and Materials	With Out Labor	With labor
LEDs	$13.60	$13.60
LCDs	$7.14	$7.14
Coin Cell Battery	$2.50	$2.50
Microcontroller	$3.71	$3.71
Receiver IC	$3.60	$3.60
Antenna	$1.50	$1.50
Real Time Clock	$0.89	$0.89
Power Transformer	$3.69	$3.69
Plexiglass Casing	$15.00	$15.00
Miscellaneous parts for final assembly	$10.00	$10.00
Single Geek Binary Alarm Clock	$61.63	$61.63
Multiplier (for required amount of clocks)	2	2
Subtotal	$123.26	$123.26
Labor @ 10.50 per hour		
Diana Calhoun	$0.00	$2,635.50
Matthew Koch	$0.00	$2,331.00
Kelly Melohn	$0.00	$2,677.50
Yesuratnam Thommandru	$0.00	$2,751.00
Subtotal	$0.00	$10,395.00
Total	$123.26	$10,518.26

Table 6-2 - Previous Estimated Project Cost

Parts and Materials	With Out Labor	With labor
LEDs	$10.00	$10.00
LCDs	$15.00	$15.00
9V Battery	$2.50	$2.50
Microcontroller	$9.00	$9.00
Casing	$25.00	$25.00
Miscellaneous parts for final assembly	$10.00	$10.00
Single Geek Binary Alarm Clock	$71.50	$71.50
Multiplier (for required amount of clocks)	2	2
Subtotal	$143.00	$143.00
Labor @ 10.50 per hour		
Diana Calhoun	$0.00	$2,709.00
Matthew Koch	$0.00	$1,879.50
Kelly Melohn	$0.00	$2,499.00
Yesuratnam Thommandru	$0.00	$2,110.50
Subtotal	$0.00	$9,198.00
Total	$143.00	$9,341.00

Table 6-3 - Adjusted Personal Estimated Project Hours

	Diana Calhoun	Matthew Koch	Kelly Melohn	Yesuratnam Thommandru	Total
Task 1 - Problem Definition					
Project plan	19	12	17	10	58
Subtotal	19	12	17	10	58
Task 2 - Technology Implementation & Considerations					
Component part/design research	10	15	17	20	62
Subtotal	10	15	17	20	62
Task 3 - End-Product Design					
Hardware/software layout design	5	10	9	12	36
Design report	17	18	29	22	
Subtotal	22	28	38	34	36
Task 4 - End-Product Implementation					
Subtask 4a- Hardware implementation					
Acquire parts	6	5	6	5	22
LED/LCD displays	10	1	5	4	20
Power supply components	2	5	4	2	13
Alarm sound	3	5	5	6	19
User control switches	2	2	3	2	9
Product casing	10	5	10	8	33
Subtask 4a- Software implementation					
Acquire parts	3	2	2	4	11
Power supply components	2	1	2	3	8
Time function	4	5	3	7	19
Date function	4	5	3	7	19
Alarm functionality	3	5	2	4	14
Daylight saving function	3	5	3	5	16
User control switches	3	5	2	4	14
Subtotal	55	51	50	61	217
Task 5 - End-Product Testing					
Subtask 5a- Phase 1					
LED/LCD displays functionality test	7	5	5	5	22
Power functionality test	4	5	5	4	18
Subtask 5b- Phase 2					
Current time display functionality test	7	6	6	7	26
Current date display functionality test	6	6	5	7	24
Subtask 5c- Phase 3					
Daylight saving adjustment functionality test	3	4	4	5	16
Alarm functionality test	3	2	5	5	15
Battery backup mode functionality test	7	10	10	9	36
Subtask 5d- Phase 4					
Overall functionality and structure integrity test	10	8	12	12	42
Subtotal	47	46	52	54	199
Task 6 - End-Product Documentation					
Final report	20	15	20	20	75
User manual	20	15	20	20	75
Subtotal	40	30	40	40	150
Task 7 - End-Product Demonstration					
Subtask 7a- Faculty advisor/ peer presentation	12	10	10	10	42
Subtask 7b- Industrial review panel presentation	10	10	8	10	38
Subtotal	22	20	18	20	80
Task 8 - Project Reporting					
Weekly emails	20	5	3	2	30
Webpage	1	5	5	6	17
Project poster	15	10	15	15	55
Subtotal	36	20	23	23	102
Total	251	222	255	262	904

Table 6-4- Previous Personal Estimated Project Hours

	Diana Calhoun	Matthew Koch	Kelly Melohn	Yesuratnam Thommandru	Total
Task 1 - Problem Definition					
Project plan	19	12	17	10	58
Subtotal	19	12	17	10	58
Task 2 - Technology Implementation & Considerations					
Component part/design research	15	5	16	12	48
Subtotal	15	5	16	12	48
Task 3 - End-Product Design					
Hardware/software layout design	12	10	15	10	47
Design report	21	10	17	16	
Subtotal	33	20	32	26	47
Task 4 - End-Product Implementation					
Subtask 4a- Hardware implementation					
Acquire parts	6	5	8	5	24
LED/LCD displays	5	1	5	4	15
Power supply components	2	1	4	2	9
Alarm sound	3	5	4	4	16
User control switches	2	2	3	2	9
Product casing	10	5	10	6	31
Subtask 4a- Software implementation					
Acquire parts	3	2	2	2	9
Power supply components	2	1	2	2	7
Time function	4	5	3	6	18
Date function	4	5	3	6	18
Alarm functionality	3	5	2	2	12
Daylight saving function	3	5	3	4	15
User control switches	2	5	2	2	11
Subtotal	49	47	51	47	194
Task 5 - End-Product Testing					
Subtask 5a- Phase 1					
LED/LCD displays functionality test	4	5	4	3	16
Power functionality test	4	5	3	3	15
Subtask 5b- Phase 2					
Current time display functionality test	7	5	6	5	23
Current date display functionality test	6	5	5	5	21
Subtask 5c- Phase 3					
Daylight saving adjustment functionality test	3	2	4	5	14
Alarm functionality test	3	1	5	4	13
Battery backup mode functionality test	7	4	10	3	24
Subtask 5d- Phase 4					
Overall functionality and structure integrity test	10	2	12	8	32
Subtotal	44	29	49	36	158
Task 6 - End-Product Documentation					
Final report	20	15	15	15	65
User manual	20	15	17	15	67
Subtotal	40	30	32	30	132
Task 7 - End-Product Demonstration					
Subtask 7a- Faculty advisor/ peer presentation	12	10	10	10	42
Subtask 7b- Industrial review panel presentation	10	10	8	10	38
Subtotal	22	20	18	20	80
Task 8 - Project Reporting					
Weekly emails	20	1	3	2	26
Webpage	1	5	5	6	17
Project poster	15	10	15	12	52
Subtotal	36	16	23	20	95
Total	258	179	238	201	812

7 Schedule

To visually illustrate the team's proposed schedule for completing the project, Figure 7.3, as well as the team's deliverables, Figure 7.1, are given below. This Gantt chart provides a detailed plan of what and when items shall be preformed throughout this and the next semester. Some of the deliverables due dates are not set for the second semester in which approximations were made based on previous senior design class schedules.

The only deliverable change updated was when the unbound version of the design report was due. This changed from Friday, March 31 to Monday, April 3.

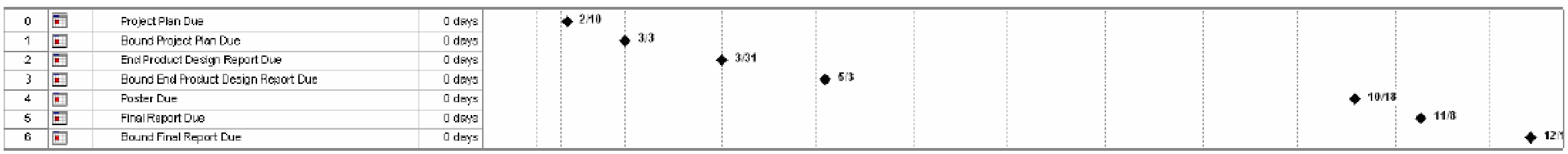


Figure 7-1 - Adjusted Project deliverables

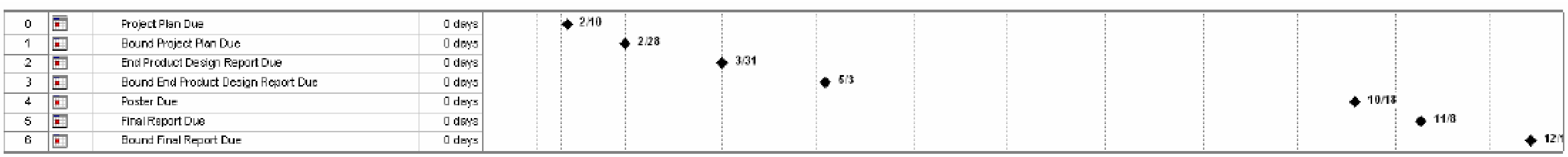


Figure 7-2 - Prevous Project deliverables

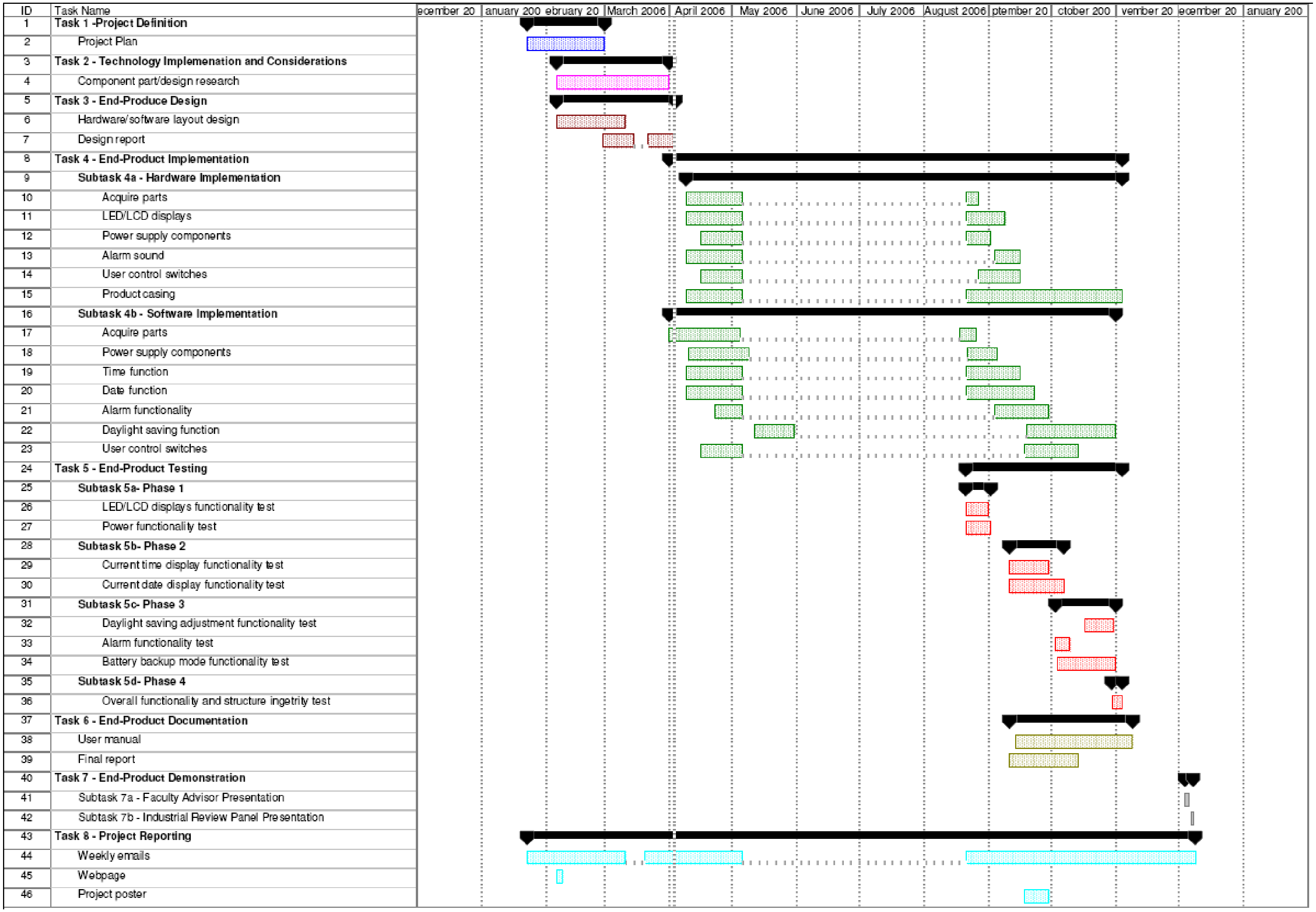


Figure 7-3 - Adjusted Gantt chart of project schedule

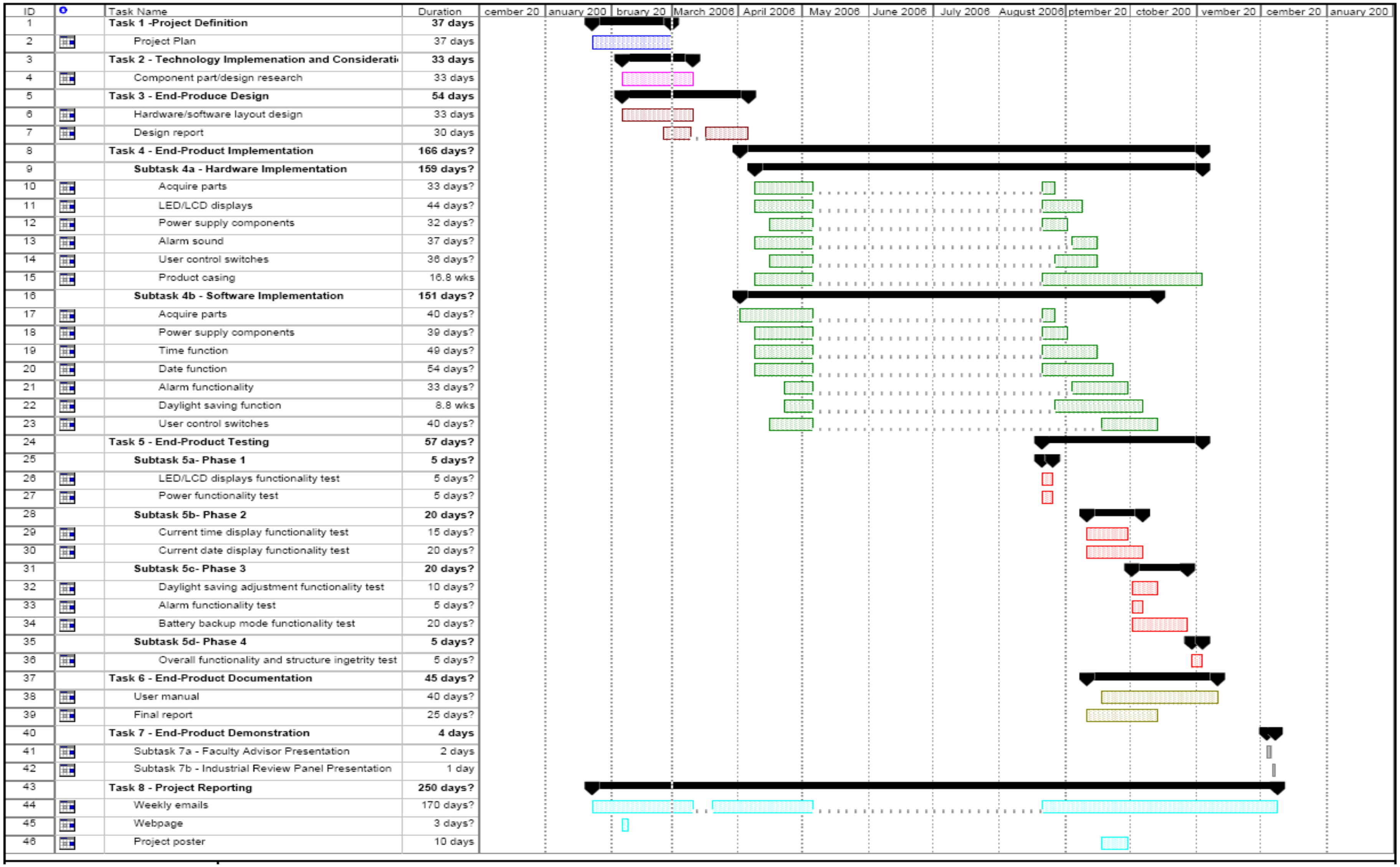


Figure 7-4 - Previous Gantt chart of project schedule

8 Closure Material

This section contains information about the Geek Binary Alarm Clock team.

8.1.1 Client Information

The following is the client of the team.

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9 Summary

This purpose of this project is to create a binary alarm clock that will incorporate several fun and interesting features into it. The intent of this item is to blend in with today's technology. It is important that the design be sleek and compact, ultimately appearing physically attractive.

Its outer shell will be made of a hard semitransparent material such as plexiglass. It will contain colored LED lights (most likely orange, red, green, and yellow), and a digital readout display. On the front of the clock, there will be a couple different sets of LED's. The first set will be a horizontal set of seven LED's. This will indicate the day of the week. Its color will most likely be yellow or orange in color. The next set of lights will display the month, date, and year in binary format. These lights will be either green or red in color. The final set of lights will contain the actual time, again, in binary form. These lights will be the color green or red. However, they will be the opposite color of the month, date, and year information. Finally, there will be a digital readout in addition to its binary time information. This will be an LCD display. This feature will have the ability to be disabled based upon user preference.

The clock will incorporate many special, "geeky" features. The first special feature will include an alarm clock. This feature will involve a small onboard speaker to sound at the specified alarm time. The alarm function will be able to be turned on or off as necessary. The next special feature that will be included is daylight saving time (DST). This feature will automatically self-adjust the clock for daylight saving time. Just like the alarm, this feature will have the option to be disabled. Lastly, there is to be a reliable battery backup in case of a power loss. This feature will provide power to the clock for a minimum of two hours after the outage has occurred. The battery backup method will give the clock the ability to keep current time/day information during the power loss. The clock will also contain a digital readout in addition to its binary format. Most features will have the ability to be enabled/disabled based upon user preferences.

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