Team BRAKTech

Call Light System
PROPOSAL
EE 476C

For Nelson Hochberg

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12/8/03

Mr. Nelson Hochberg
The Pain Relief Center of Northern Arizona
460 N. Switzer Canyon Drive, Suite 400
Flagstaff, AZ 86001-4899

Dear Mr. Nelson Hochberg:

We would like to thank you once again for sponsoring our project. This semester has been spent researching and developing the high-level design for the medical clinic call light system. In the spring semester of 2004, we will be implementing our design. We are dedicated as a team to complete the project according to our timeline and our budget. We have the necessary resources, abilities and time to finish this project.

The call light system will be an affordable electronic device that will help you organize your office and prioritize its patients and staff. It will safely and inexpensively improve your office's workflow.

The estimated total cost of two units is $184.34. More detailed information can be found in the budget section of this document. At our last meeting, we agreed that you would be responsible for all purchases of materials once we have a list of materials needed.

This proposal is provided to you for approval of our design concepts based on your requirements and budget. Outlined in the proposal package are the following topics:

- Executive summary
- Design
- Budget
- Updated problem overview, system block diagram, requirements and specifications, design philosophy and approach, list of deliverables, and project schedule
- Proposal presentation slides
- Acceptance document

Please look over the acceptance document that is at the very end of the proposal package. If you are pleased with the project, sign and date it and email us to pick it up. The target date for acceptance is December 19th, 2003. If you are not completely satisfied with the project proposal we will negotiate with you via e-mail during the winter break until you are satisfied.

Sincerely,

Tom Hamilton

Kevin Harkins

Alan Kinnaman

Robert Napper

Bill Okyere

cc: Abe Pralle
Dr. David Scott

Table of Contents

Executive Summary

Many medial clinics use simple mechanical systems with colored flags to display the status of each examination room. These outdated systems have several drawbacks.

Some medical clinics have installed more technologically advanced systems tailored to the specific needs of the office the system is installed in. These systems are often very expensive, due to the need to engineer each system individually.

The proposed solution is a medical clinic call light system. This system is highly autonomous, and is designed to be easily adaptable to other medical office situations. The system does not depend on the number of rooms located in the office or the relative physical location of the rooms in the building.

This system consists of a device on the outside of each examining room, called a multi-use station, as well as an accompanying device on the inside of the room, called an in-room station. Each unit will be controlled by a microprocessor interconnected with other units' microprocessors.

This proposal discusses the general high-level design of this system, including general descriptions of how the design will be implemented. Details of parts, schematics and software are presented if they are currently known.

Upcoming deliverables include the Status Reports, the Capstone Design Conference Presentation, the Final Report, and the Final Product Installed.

Design

1. Hardware

1.1. In-Wall Unit Components

1.1.1. Summary of Hardware Design

As requested by the client, the interface of the multi-use stations and in-room stations will be designed using Figures 1.1.1.1. and 1.1.1.2. as guidelines.

Multi-use stations configured as a "room station" will be paired with an "in-room station". For each pair of units, the in-room station will be an extension of, and will be controlled by the multi-use station, as shown in Figure 1.1.1.3. Each pair of units will be referred to as an "in-wall unit."

FIGURE 1.1.1.1. Multi-use station

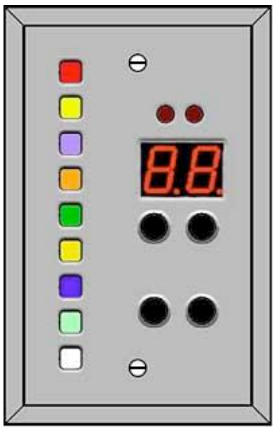
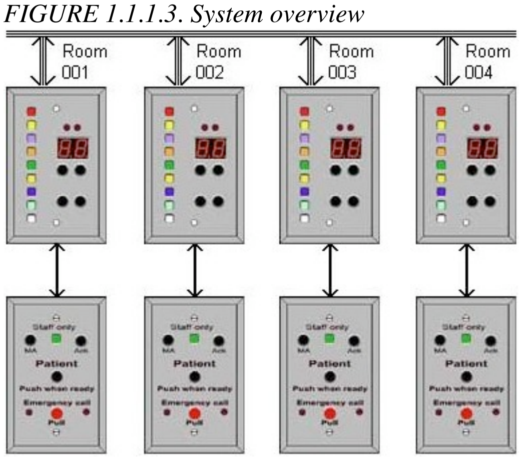


FIGURE 1.1.1.2. In-room station

FIGURE 1.1.1.3. System overview



1.1.2. Components

1.1.2.1. Microprocessor

1.1.2.1.1. Overview

Each in-wall unit will contain a microprocessor. This allows for flexibility in the installation of in-wall units. The microprocessor will control the inputs and outputs of the panel, as well as communication with other units.

1.1.2.1.2. Parts Chosen

The PIC18F458, manufactured by Microchip, has been selected as the microprocessor that will be used in the in-wall units. The PIC18F458 is a FLASH-based microprocessor that can be reprogrammed for more convenient system development.

1.1.2.1.3. Analysis

The PIC18F458 has five I/O ports. The pinouts of these ports are shown in Table 1.1.2.1.3.1.

Table 1.1.2.1.3.1. PIC18F458 digital I/O pins

	Use	Pin Number	Pin Name
PORTA (7 bits)	RS485	2	RA0
		3	RA1
		4	RA2
		5	RA3
		6	RA4
		7	RA5
		14	RA6
PORTB (8 bits)	7-Segment Display	33	RB0
		34	RB1
		35	RB2
		36	RB3
		37	RB4
		38	RB5
		39	RB6
		40	RB7
PORTC (8 bits)	Pushbuttons	15	RC0
		16	RC1
		17	RC2
		18	RC3
		23	RC4
		24	RC5
		25	RC6
		26	RC7

	Use	Pin Number	Pin Name
PORTD (8 bits)	LEDs	19	RD0
		20	RD1
		21	RD2
		22	RD3
		27	RD4
		28	RD5
		29	RD6
		30	RD7
PORTE (3 bits)		8	RE0
		9	RE1
		10	RE2

1.1.2.1.4. Schematic

Later sections will discuss how the microprocessor is to be interfaced with various components. Table 1.1.2.1.4.1. shows where these schematics can be found.

TABLE 1.1.2.1.4.1. Where to find microprocessor interfacing schematics

Component	**Section**
RS-485 Chip	1.1.2.2.4.
LEDs	1.1.2.3.4.
7-segment displays	1.1.2.4.4.
Pushbuttons	1.1.2.5.4.
Voltage Regulator	1.2.2.1.4.

1.1.2.2. Communication Chip

1.1.2.2.1. Overview

The design will utilize RS-485, a common electronic communication standard. Advantages of the RS-485 standard include:

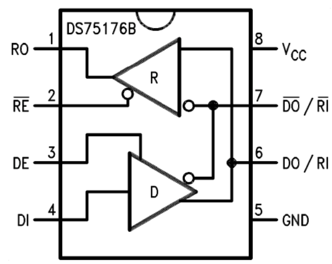
- signal transmission over long lengths of wire (as much as 4000 feet),
- high data rates (up to 100kb/sec),
- the ability to withstand bus contention problems ("data collisions"), and
- tolerance of bus fault conditions.

A transceiver chip external to the microprocessor will facilitate communication between in-wall units. To utilize the RS-485 standard, one in-wall unit must be set up as the "master," and the others are set up as "slaves."

1.1.2.2.2. Parts Chosen

RS-485 communication will take place via chip number DS75176BT. This transceiver consists of a receiving unity gain buffers and a driving unity gain buffer, as shown in Figure 1.1.2.2.2.1.

FIGURE 1.1.2.2.2.1. DS75176BT connection and logic diagram



Source: National Semiconductor

1.1.2.2.3. Analysis

The details of communication using RS-485 will take place in the software within the microprocessor (see section 2.1.2.2.). Figures 1.1.2.2.3.1 and 1.1.2.2.3.2. show function tables for transmitting and receiving data using the DS75176BT chip.

FIGURE 1.1.2.2.3.1. DS755176BT transmitting function table

Inputs			Line	Outputs	
$\overline{RE}$	DE	DI	Condition	$\overline{DO}$	DO
X	1	1	No Fault	0	1
X	1	0	No Fault	1	0
X	0	X	X	Z	Z
X	1	X	Fault	Z	Z

source: National Semiconductor

FIGURE 1.1.2.2.3.2. DS755176BT receiving function table

Inputs			Outputs
$\overline{RE}$	DE	RI-$\overline{RI}$	RO
0	0	≥ +0.2V	1
0	0	≤ −0.2V	0
0	0	Inputs Open**	1
1	0	X	Z

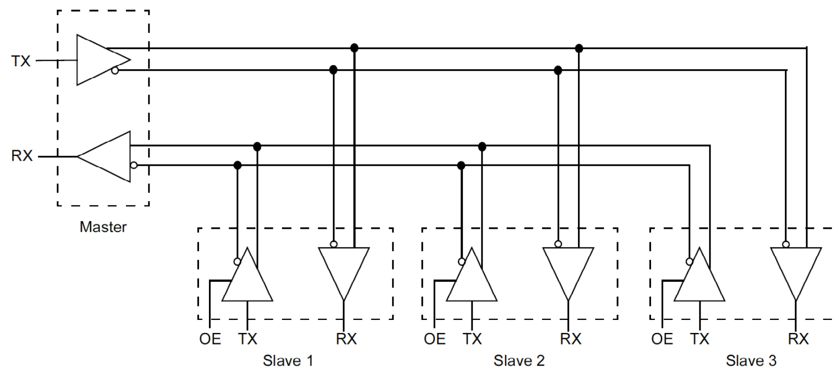
X — Don't care condition
Z — High impedance state
Fault — Improper line conditons causing excessive power dissipation in the driver, such as shorts or bus contention situations
**This is a fail safe condition

source: National Semiconductor

1.1.2.2.4. Schematic

Connections between nodes on an RS-485 network can be made using two types of configurations: two-wire and four-wire connections. To alleviate data collisions, this system will use four-wire connections. These four-wire connections will be made between DS75176BTN chips. The transceiver connection to the microprocessor requires two wires in the “master unit”, and three wires in the “slave” units, as shown in Figure 1.1.2.2.4.1. To simplify the design, three wires will connect each unit’s microprocessor to its transceiver, and each will be set up to be the “slave” by default. How the “master” unit is assigned will be discussed at a later time. In the figure, “TX,” “RX,” and “OE” denote various connections to the microprocessor.

FIGURE 1.1.2.2.4.1. Typical RS-485 four-wire connection



source: Microchip

1.1.2.3. LEDs

1.1.2.3.1. Overview

Each in-wall unit will use a total of 10 LEDs. There will be 9 colored LEDs on each multi-use station, and 1 LED on each of the in-room stations. As indicated by the client, each LED on the multi-use stations will have a unique color.

1.1.2.3.2. Parts Chosen

In the current design, the multi-use stations use 9 colored LEDs as follows:

- red
- yellow
- light blue
- orange
- green
- amber
- blue
- light green
- white

The in-room stations will have one LED, whose colors will be green. All LEDs will be installed in the faceplate using Cliplites, available at vcclite.com.

1.1.2.3.3. Analysis

The anode of each LED will be connected through a current limiting resistor to the microprocessor, and the cathode of each will be connected directly to ground. The LED will be activated when its corresponding microprocessor output is +5V.

Each pin on the PIC18F458 can supply up to 25mA, and all pins combined can supply a total of 200mA. Therefore, unless an LED's stated maximum current is less than 20mA, each LED will have a resistor that limits the current through it to 20mA. In such a design, it is feasible for the microprocessor to supply current to all 10 LEDs simultaneously. Because the typical forward voltage of each color of LED is different, each will require a different current limiting resistor. Resistor values for the LEDs will be calculated using equation 1.1.2.3.3.1. In each case, the closest available resistor value that is larger than the calculated value will be used.

EQUATION 1.1.2.3.3.1

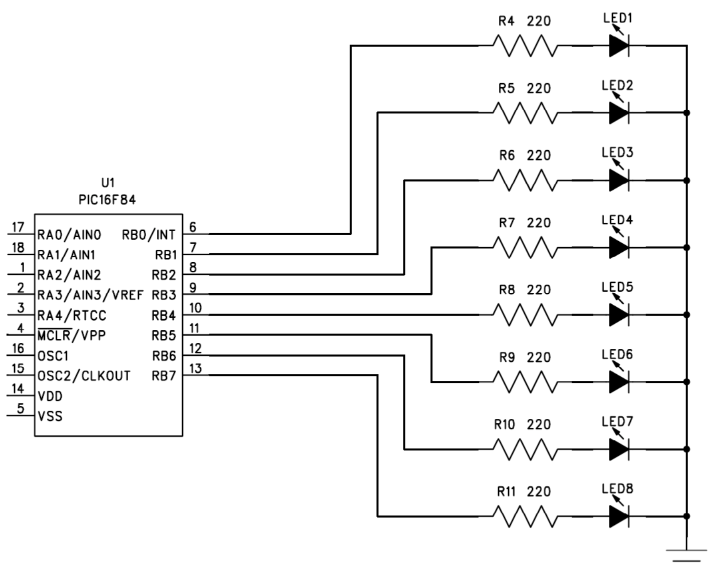
$$R = \frac{5V - V_F}{20mA}$$

NOTE: V_F is the typical forward voltage.

1.1.2.3.4. Schematic

Figure 1.1.2.3.4.1. shows a typical set of connections from a PIC microprocessor to LEDs.

FIGURE 1.1.2.3.4.1. Typical LED connections to a PIC microprocessor



source: Sirius microSystems

NOTE: While the resistors in this schematic are each 220Ω, the medical call light system will use the maximized resistor values as calculated in section 1.1.2.3.3.

1.1.2.4. 7-Segment Displays

1.1.2.4.1. Overview

Two 7-segment displays will be used to display a timer in the multi-use stations. These displays will be controlled indirectly by the microprocessor. The microprocessor will be connected to decoders, which will, in turn, control the individual segments of the displays.

1.1.2.4.2. Parts Chosen

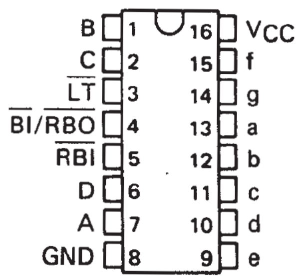
The two 7-segment displays used in this design will be common-anode displays, such as the ESA56 display available at eled.com. A 16-pin DIP decoder, such as the SN54LS49 chip available from Texas Instruments, can control this type of display.

1.1.2.4.3. Analysis

The input of the SN54LS49 decoder is a 4-bit binary number. The chip decodes this number into a single decimal digit. What number is decoded determines which of the decoder's 7 output lines are active. Each of these lines corresponds to a segment on a 7-segment display, as shown in figures 1.1.2.4.3.1. and 1.1.2.4.3.2. In order to display 2 numbers, the microprocessor will output 2 4-bit binary numbers to two 7-segment display decoders.

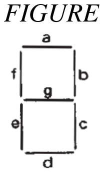
The given value for maximum current through the 7-segment display is given as 160mA. In addition to the 7 number segments, each display has a decimal point. Therefore, each LED can consume a maximum of 20mA each. The display's typical forward voltage drop is 2.5V. The value of the current limiting resistor for each segment of both displays must be at least 125Ω, as calculated in Equation 1.1.2.4.3.3.

FIGURE 1.1.2.4.3.1. Pin connection diagram for SN54LS49 decoder



source: Texas Instruments

FIGURE 1.1.2.4.3.2. Segment identification



source: Texas Instruments

EQUATION 1.1.2.4.3.3.

$$R = \frac{5V - V_F}{I_F} = \frac{5V - 2.5V}{125mA} = 125\Omega$$

NOTE: V_F is the typical forward voltage and I_F is the maximum forward current.

1.1.2.4.4. Schematic

The 8 bits controlling the decoder will be interfaced directly from a set of register output pins on the microprocessor. The common anode of the 7-segment displays will be connected through a current-limiting resistor to the 9VDC source. The cathodes will be connected to the output lines of the SN54LS49 decoder.

1.1.2.5. Pushbuttons

1.1.2.5.1. Overview

In the current design, each multi-use station uses three pushbuttons to interface with the microprocessor. These pushbuttons are to be recessed or very flat, so as to not interfere with side viewing of LEDs. The in-room station may have some type of pull-chain switch to activate an emergency call.

1.1.2.5.2. Parts Chosen

There is a good selection of pushbuttons available at nkkswitches.com. At this time, no specific switch has been has been selected. Also, the availability of a pull-chain switch will be investigated at a later time.

1.1.2.5.3. Analysis

Each pin on the PIC18F458 can supply up to 25mA, and all pins combined can supply a total of 200mA. Each pushbutton will have a current limiting resistor connected between it and the microprocessor. To limit the current to a maximum of 1mA, the resistor will be at least 5kΩ. The value of this resistor is calculated in equation 1.1.2.5.3.1.

EQUATION 1.1.2.5.3.1.

$$R = \frac{5V}{I_F} = \frac{5V}{1mA} = 5k\Omega$$

NOTE: I_F is the maximum forward current.

1.1.2.5.4. Schematic

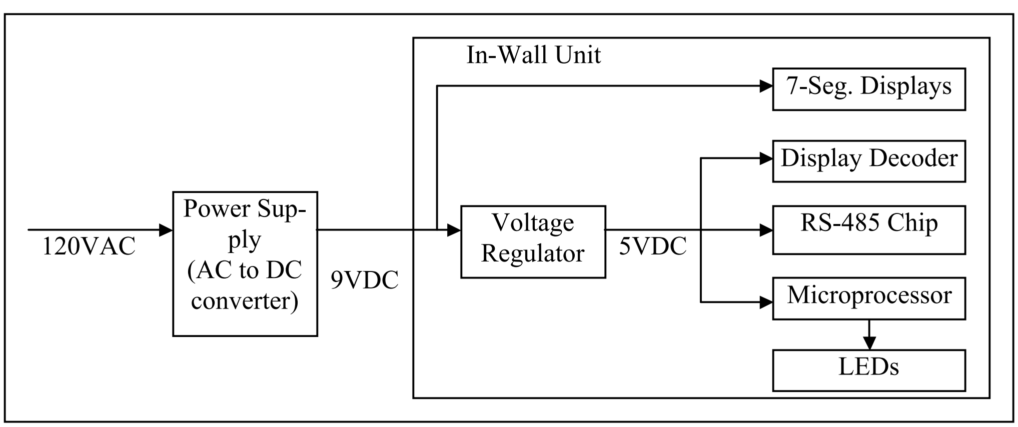
The pushbuttons will be interfaced to the microprocessor from via current limiting resistors from +5V.

1.2. Power Distribution

1.2.1. Design

Each of the components in the design can operate at 5VDC. However, a central 9VDC power supply will be used because voltage levels can drop considerably across the length of a power distribution line. Because it is not sensitive to slight fluctuations in voltage, and because it would strain the 5VDC voltage regulator, the 7-segment displays will be directly powered from the central 9VDC source. The other digital components, however, require a more steady voltage of about 5.0V, requiring the use of a voltage regulator. Figure 1.2.1.1. displays a block diagram of this configuration.

FIGURE 1.2.1.1. Power distribution block diagram



1.2.2. Components

1.2.2.1. 5VDC Voltage Regulator

1.2.2.1.1. Overview

The PIC18F458 microprocessor requires a DC source between 4.2V and 5.5V for proper operation. The DS75176BT RS-485 communication chip requires between 4.75V and 5.25V. The SN54LS49 7-segment display decoder requires between 3.0V and 18.0V. Each of these units will be supplied with 5.0VDC.

1.2.2.1.2. Parts Chosen

Each in-wall unit will use an LM7805 or similar voltage regulator to deliver 5VDC to the components. Each voltage regulator also requires two capacitors, as discussed in Section 1.2.2.1.4.

1.2.2.1.3. Analysis

According to the LM7805 data sheet, with adequate heatsinking, the LM7805 voltage regulator "can deliver in excess of 0.5A output current." Maximum current consumption for the PIC18F458 is 250mA, for the DS75176BT is 55mA, and for the SN54LS49 is 5μA. Thus, at a maximum current of approximately 0.305A, the chosen voltage regulator is adequate for supplying power to these components.

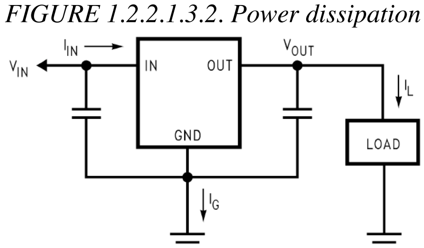
An additional consideration for the voltage regulator is the possible necessity of a heat sink. The LM7805 states, "to determine if a heatsink is needed, the power dissipation by the regulator, P_D, must be calculated." Equation 1.2.2.1.3.1. shows the formula given for calculating power dissipation. The values in the formula correspond to those shown in Figure 1.2.2.1.3.2.

EQUATION 1.2.2.1.3.1. Power dissipation formula

$$P_D = (V_{IN} - V_{OUT})I_L + V_{IN}I_G$$

source: National Semiconductor

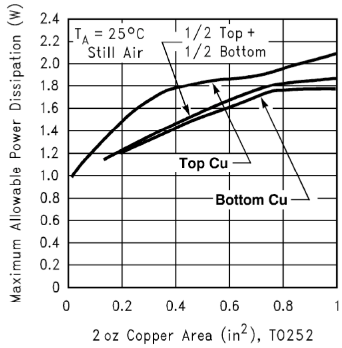
FIGURE 1.2.2.1.3.2. Power dissipation diagram



source: National Semiconductor

With a maximum I_L of 250mA, and assuming I_G to be zero, equation 1.2.2.1.3.1. gives P_D = 1.0W. According to chart 1.2.2.1.3.3., this value of P_D does not require a heat sink.

CHART 1.2.2.1.3.3. Maximum allowable power dissipation vs. 2oz. Copper area

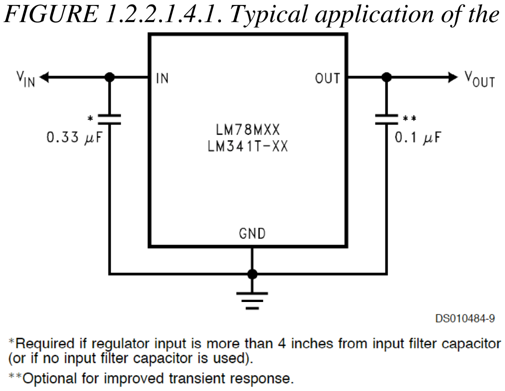


source: National Semiconductor

1.2.2.1.4. Schematic

Two capacitors will be needed in conjunction with the LM7805 in order to filter out transients. Figure 1.2.2.1.4.1. shows a typical application of the LM7805 with suggested capacitor values.

FIGURE 1.2.2.1.4.1. Typical application of the LM7805



source: National Semiconductor

1.2.2.2. 9VDC Power Supply

1.2.2.2.1. Overview

A 9VDC power supply will supply power to each of the approximately 15 in-wall units. It will be connected to the input of each of the LM7805 voltage regulators.

1.2.2.2.2. Parts Chosen

The 9VDC will use standard diodes and capacitors that can supply the desired current output. The power will be distributed to the in-wall units using an appropriate gauge wire.

1.2.2.2.3. Analysis

Table 1.2.2.2.3.1. shows the maximum current and power consumed by each in-wall unit.

TABLE 1.2.2.2.3.1. Estimate of max. power and current for each in-wall unit

Component	Maximum Current Per Device (mA)	Quantity	Max. Current (mA)
Microprocessor	250	1	250
RS-485 chip	55	1	55
LEDs	25	10	N/A
7-segment displays	160	2	320
Display decoders	0.005	2	0.01
Pushbuttons	1	3	3
Voltage regulator	10	1	10
		Total:	~638

NOTE: The LEDs are not listed in the table because their current source is the microprocessor.

As shown, each in-wall unit will consume a maximum of approximately 0.638A. This means that for an office with 15 examination rooms, the system would consume a maximum of approximately 9.5A. A power supply designed to deliver 10 amps at 9VDC would be sufficient to run these 15 units.

The maximum length of wire from the power supply to an in-wall unit is assumed to be 100 ft. According to the voltage drop calculator at electrician.com, for 100 feet of 14AWG copper wire delivering 3A, voltage will drop 1.8V. From a 9VDC supply, this would result in an output voltage of approximately 7.2 VDC. Because 3A is approximately $\frac{1}{3}$ of the total current consumption for 15 units, power must be supplied to the system through 3 “home runs”. In other words, there must be 3 sets of 5 units, where each set is powered from a different length of 14AWG wire.

1.2.2.2.4. Schematic

The 9VDC power supply will be a 4-diode rectifier in conjunction with smoothing capacitors.

2. Software

2.1. Program Execution

2.1.1. Overview of Software Design

The bulk of the processor time will be spent between three different self-contained components of focus. These three components are the user interface, the communication interface, and the timer execution. Since the micro-controller we are using is the PIC processor, we will be using PIC assembly to code the instructions.

2.1.2. Components

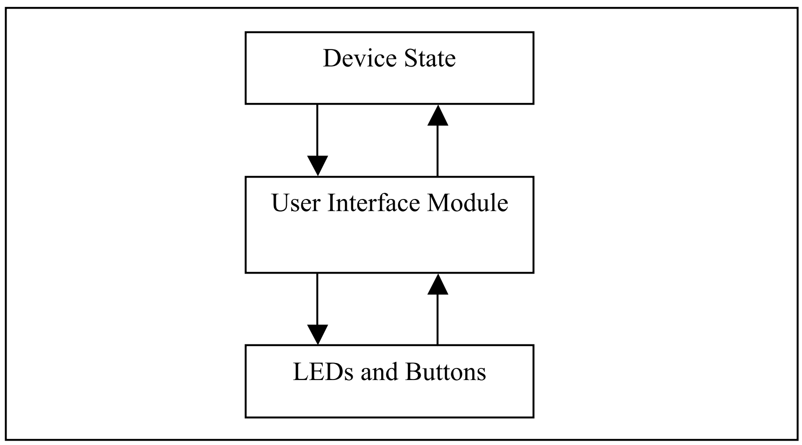
2.1.2.1. User Interface

2.1.2.1.1. Overview

The user interface component has the responsibility of handling any user interactions. This includes checking for buttons that are pushed and lighting LEDs to keep the user informed.

This module represents the state that the device is currently in to the user, and is capable of changing the state the device is currently in (see Program Flow in section 2.2.).

2.1.2.1.2. Flow Chart



2.1.2.2. Communication Interface

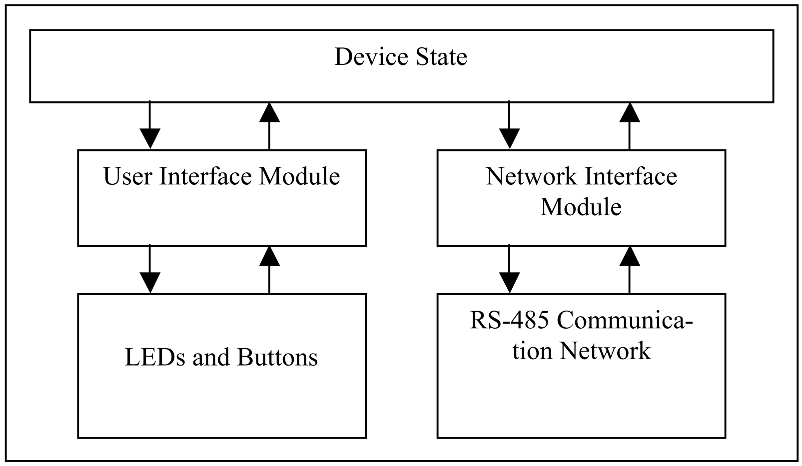
2.1.2.2.1. Overview

As mentioned above, each in-wall unit will be connected to each other using the RS-485 communication protocol. This allows a single station to obtain information about the process that each other station is in.

The communication interface is responsible for representing the present state to the other devices over the network as well as being able to change the state of the current device.

This module also can interpret the state of other devices in communication with this device. This allows these device to keep a priority of which doctor needs to be see which device/room next.

2.1.2.2.2. Flow Chart



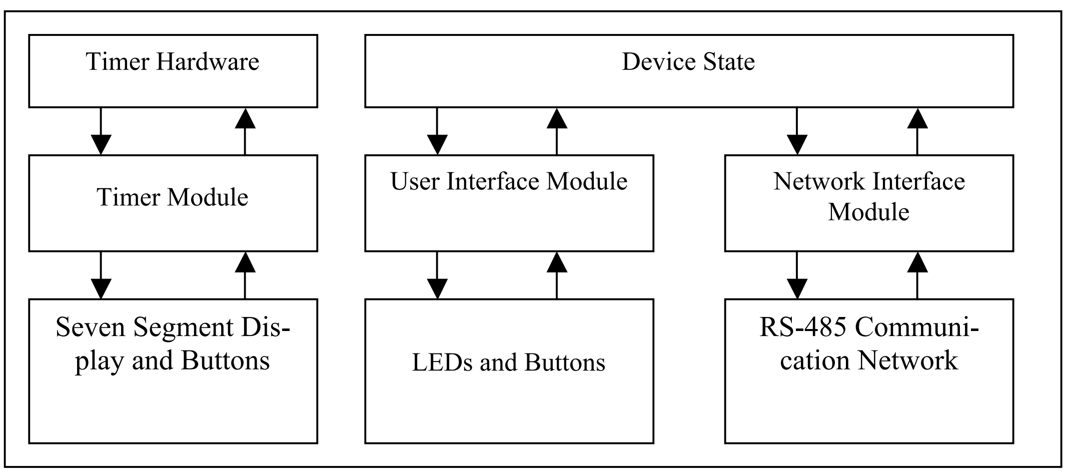
2.1.2.3. Timer Execution

2.1.2.3.1. Overview

The timer is technically a subset of the user interface, however has a unique enough function that we have separated it here under program execution.

The timer displays utilizes some of the buttons and LEDs located on the user interface. However, instead of representing or setting the state, it will serve as a timer to help doctors with timed treatments etc.

2.1.2.3.2. Flow Chart

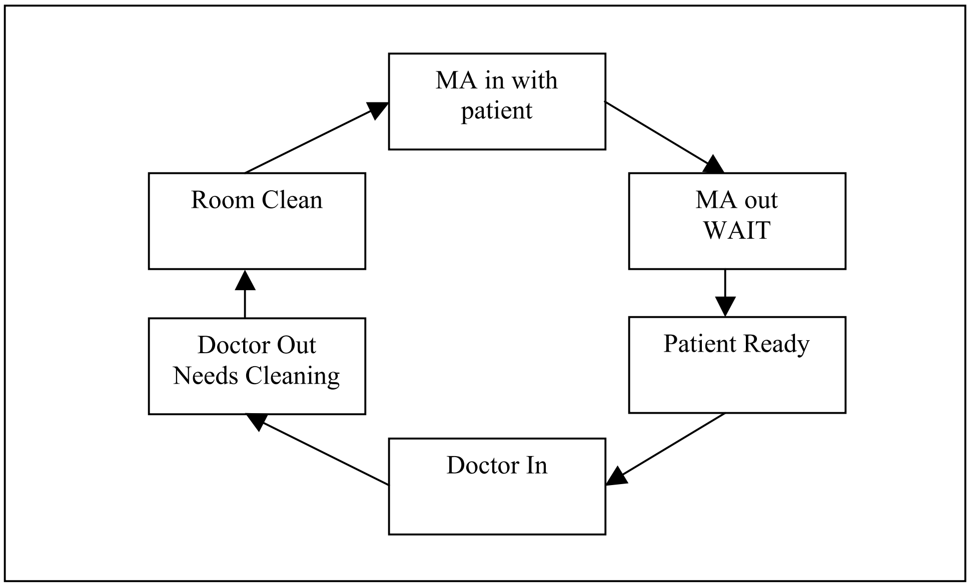


2.2. Program Flow

2.2.1. Design

The program flow section will basically describe each state the device goes through. The theory behind this section is that any process that must be completed on a computer can be accomplished through a model of a state machine.

Each state represents a different activity happening in the room. Once an activity has been completed, a button can be pushed to move the program to the next state. Once the state cycle has been completed, the process starts all over again at the top. See the flow chart diagram in 2.2.1.1 for the details.



2.2.2. Components

2.2.2.1. Room Clean

This is thought of as the first state in the cycle because when the device is reset it defaults to this state. When in the Room Clean state, the white LED is on indicating that the room is unoccupied and clean.

When the medical assistant puts a patient in the room, he/she can select which doctor will see this patient by scrolling through the doctors. Each LED on the user interface represents a different doctor. See the "Select Doctor" section 2.2.2.7.1 for more details.

With the patient in the room, the medical assistant can push the "Status" button once if the MA is going into the room with the patient to begin examination. If the medical assistant is not going into the room with the patient, the medical assistant can push the "Status" button twice or three times depending upon whether the patient needs to change.

2.2.2.2. MA in with patient

In this state the MA light is on indicating that the medical assistant is inside the room with the patient.

Once the medical assistant is done inside the room, he/she can push the "Status" button once if the patient needs to change, or twice if the patient is ready to see the doctor.

2.2.2.3. MA out – WAIT

In this state none of the LED's are on or flashing. This state indicates that the patient is in the room, however the patient is changing or is involved in some other activity where he/she is not ready to see the doctor.

Once the patient is ready to see the doctor, he/she may push the "Patient – Push When Ready" button on the in-room station. Also, the "Status" button on the outside of the room could be pushed to increment to the next state.

2.2.2.4. Patient Ready

Once the patient is ready, the doctor light is either on or flashing. If the doctor's light is on, that means the patient is in line to see the doctor, because the doctor is in another room. Once the patient is next in line to see the doctor, the doctor's light will begin to blink (50% duty cycle).

The doctor may push the "Status" button on the outside of the room in order to increment the device to the next state.

2.2.2.5. Doctor In

Once the doctor is in the room, the doctor's light will blink (10% duty cycle), indicating that the doctor is in the room examining the patient.

The doctor may push the "Status" button on the outside of the room in order to increment the device to the next state.

While in the Doctor In state, if a patient is waiting in another room to see the doctor, the green LED on the in-room station will be on.

2.2.2.6. Doctor Out – Room Needs Cleaning

Once the doctor and the patient are out of the room, the white LED will flash indicating that the room is unoccupied and needs to be cleaned.

Once the room has been cleaned, the "Status" button may be pushed to increment the device to the next state.

2.2.2.7. Other Functions

2.2.2.7.1. Select Doctor

The Doctor can be selected in the Room Clean, MA in with patient, MA Out--WAIT, or Patient Ready states. If a doctor has not been selected the top Doctor on the list of LEDs will be selected.

By holding down the "Dr. Select" button and scrolling through the list by hitting the "Status" button, a can select a doctor.

2.2.2.7.2. Emergency

Pushing the “Emergency Call” button on the in-room station will indicate an emergency. This makes the Red LED on the outside of the room blink and an alarm to sound. Also, if a doctor or MA is in another room, the Green LEDs on the inside of the room the doctor or MA is in will blink.

To stop the red light/alarm, hold the “Status” button or the “Patient – Push When Ready” button for 3 seconds.

2.2.2.7.3. Timer

The timer will count down from an amount set in the timer. To start the timer, hold the timer button and increment the time displayed on the LEDs in minutes by pushing the “Status” button and the “Dr. Select” button. The “Status” button increments the time by 1 minute, while the “Dr. Select” button increments the time by 5 minutes.

Once the timer has reached 0, the seven segment displays will blink along with a collection of LEDs. Holding the “Timer” button and the “Status” button for 3 seconds will reset the timer.

2.2.2.7.4. Reset

Holding the “Dr. Select” button and the “Status” button for a total of 8 seconds will reset the device. This brings the state back to “Room Clean” and re-initializes all network activity.

3. Constraints

3.1. Quality

The product will be used in a setting that normally consists of high-quality products and materials. The final product will meet the needs of a fast-paced and demanding workplace by providing a smart, user-friendly alternative to existing office technologies

3.2. Cost Analysis

This is a vital aspect of the project to meet the client's expectations. The goal of the analysis is to minimize and assess the costs associated with the final product to be marketed to its target segment. Our client specifically needs to know the costs of each unit for personal use as well as costs of multiple units for future plans to market the product. Providing accurate costs information will undoubtedly assist our client in assessing marketing feasibility of the product. The overall costs of this project must remain within our client's means and must follow a direction that meets the client's needs.

3.3. Design Safety

It is important to incorporate safety in our design. This is because the biggest gains in safety and the biggest reductions in cost tend to come when safety is inherent in any design. The doctors call light will be safe to the user, patients, doctors and everyone

3.4. Manufacturability

The ease of manufacturing this product is desired. This project requires multiple interconnected units in order to function properly. Therefore a design will be worthless if it is difficult to create or duplicate.

Budget

The following outlines the estimated costs of the Multi-Use Station. There is an estimated cost of one unit and an estimated cost of 10 units considering buying parts at bulk rate. It is understood that Nelson Hochberg will order (purchase) any parts and supplies that are needed when requested. At the appropriate time when parts are needed, we will research the best distributor to purchase from in attempt to lower costs. The estimated costs do not reflect tax, shipping costs, and design changes.

Bill of Materials – Multi-Use Station:

No.	Item	Distributor	Quantity	Cost	Purpose	Bulk Rate	Previously Purchased
1	1/4 watt 5% Resistors	Radio Shack	15	$3.00	Current limiters	100 @ $6	□
2	Ceramic disc capacitor	Radio Shack	2	$0.99	Surge protection	100 @ $7	□
3	LED's	Radio Shack	9	$9.00	Status lights	10 @ $0.70	-$9.50
4	Led mounting	Electronix Express	11	$1.40	Attaching LEDs to station	□	-$1.40
5	7 segment display	Radio Shack	2	$3.50	Timer indicator	10 @ $7	□
6	Volt Regulator	Radio Shack	1	$1.99	voltage control	100 @ $35	□
7	IC socket	Electronix Express	1	$1.25	Replaceable Processor	10 @ $11.90	□
8	Dip switch 8	Futurlec	1	$0.70	Module address	□	$0.70
9	Fuse Block	Electronix Express	1	$0.70	Electrical Isolation	10 @ $6	□
10	Fuse	Electronix Express	1	$0.60	Electrical Isolation	□	□
11	Terminal Block	Electronix Express	1	$1.30	Connection to wall wiring	□	□
12	Pizo Buzzer	Radio Shack	1	$2.99	audio alarm	10 @ $12.50	-$12.50
13	Push Button	Radio Shack	13	$29.77	Control buttons	10 @ 6.50	□
14	AC to DC Adaptor 1.5A	Radio Shack	1	$19.89	Power supply	10 @ $45 for 1A supply	□
15	Bread Board	Radio Shack	1	$2.99	Electronics Board	□	□
16	IR Led	Electronix Express	1	$0.50	Transmitter	10 @ $4	□
17	IR Receiver	Radio Shack	1	$3.69	Receiver	□	□
18	Pic18 processor	Microchip	1	$9.77	Microprocessor	100 @ $62.10	-$9.77
19	Blank Covers	Home Depot	1	$0.50	Control Panel	□	□
20	Plastic Riser	Home Depot	1	$6.42	Extension from Wall	□	□
21	Transistor	Radio Shack	1	$0.60	IR Receiver control	□	□
22	7 segment decoder	Futurlec	2	$1.50	Timer display decoder	□	□
23	485 Transceiver	Futurlec	1	$2.50	Communications Chip	25 @ $1.80	-$2.50
24	10 to 4 encoder	Futurlec	2	$2.00	button encoder	□	□
25	Thermostat wire or equiv.	Home Depot	250feet	$66.00	Communications Bus	7cond @ $66	-$66.00
□	**Subtotal Supplies:**	□	□	**$173.55**	□	□	**-$100.97**

Price considering manufacturing 10 units with bulk rate:

No.	Item	Quantity	Cost	Previously Purchased
1	1/4 watt 5% Resistors	150	$9.00	□
2	Ceramic disc capacitor	20	$7.00	□
3	LEDs	90	$70.00	-$70.00
4	Led mounting	110	$14.00	-$14.00
5	7 segment display	20	$14.00	□
6	Volt Regulator	10	$3.50	□
7	IC socket	10	$11.90	□
8	Dip switch	10	$7.00	-$7.00
9	Fuse Block	10	$7.00	□
10	Fuse	10	$6.00	□
11	Terminal Block	10	$13.00	□
12	Piezo Buzzer	10	$12.55	-$12.55
13	Push Button	130	$6.50	□
14	AC to DC Adaptor 1.5A	3	$13.50	□
15	Bread Board	10	$29.90	□
16	IR Led	10	$4.00	□
17	IR Receiver	10	$36.90	□
18	Pic16877 processor	10	$6.20	□
19	Blank Covers	10	$5.00	□
20	Plastic Riser	10	$64.20	□
21	Transistor	10	$6.00	□
22	7 segment decoder	20	$15.00	□
23	485 Transceiver	10	$18.00	□
24	10 to 4 encoder	20	$20.00	□
25	Thermostat wire or equiv.	250feet	$66.00	-$66.00
□	**Subtotal Supplies:**	□	**$466.15**	**-$169.55**

Bill of Materials – In-Room Station:

No.	Item	Distributor	Quantity	Cost	Purpose	Bulk	Previously Purchased
1	1/4 watt 5% Resistors	Radio Shack	3	$0.75	Current limiters	100 @ $6	□
2	LEDs multi color	Radio Shack	1	$2.99	Status lights	10 @ $0.70	□
3	Led mounting	Electronix Express	3	$0.40	Attaching LEDs to station	□	$0.40
4	Terminal Block	Electronix Express	1	$1.30	Connection to wall wiring	□	□
5	Push Button	Radio Shack	3	$6.87	Control buttons	10 @ 6.50	□
6	Pull Switch	Electronix Express	1	$2.99	Emergency pull	□	□
7	IR Led	Electronix Express	1	$0.50	Transmitter	10 @ $4	□
8	IR Receiver	Radio Shack	1	$3.69	Receiver	□	□
9	Blank Covers	Home Depot	1	$0.50	Control Panel	□	□
10	Thermostat Wire 5cond	Home Depot	250feet	$66.00	Interconnect wire	7cond @ $66	-$66.00
□	**Subtotal Supplies:**	□	□	**$85.99**	□	□	**-$66.40**

Total Estimated Costs for Nelson Hochberg:

Component	Quantity	Estimated Cost
Multi-Use Station	2	$145.16
In-Room Station	2	$39.18
Total Estimated Cost		**$184.34**

The following outlines the academic unit match. These items are provided by the College of Engineering at Northern Arizona University, and are not being billed to the client Nelson Hochberg.

Academic Unit Match:

No.	Item	Purpose
1	Pic development board and chip	prototyping and testing program
2	Software	Program development
3	Solder	assembly of circuit
4	Tools	Assembly of panel
5	Phone	calls and orders
6	Wires	Wiring of prototype
7	Computers	software development
8	multimeter & oscilloscope	Testing
9	Labor	Teem hours invested

Weekly Hours to Date:

Date project begins: 08/24/2003

Date project ends: 04/25/2004

Week	Tom Hamilton	Kevin Harkins	Alan Kinnamen	Rob Napper	Bill Okyere	Key events
08/24-08/30	0	0	1.5	6	0	□
08/31-09/06	2.5	2	1.5	2.2	2	□
09/07-09/13	5.4	2.6	1.5	2	3.5	□
09/14-09/20	2.8	2	3.0	2.6	1.5	□
09/21-09/27	2	3.1	1.5	1.8	3.5	□
09/28-10/04	2.5	4.5	6.0	3.75	2	meeting with client
10/05-10/11	4.3	3	7.5	4.3	4.5	□
10/12-10/18	1.9	2.5	6.0	4.8	2.5	□
10/19-10/25	3.1	7	6.0	4	3.5	□
10/26-11/01	5	6.2	6.0	9.8	4.3	Presentation
11/02-11/08	7.9	4	6.5	2.8	6.8	□
11/09-11/15	4.5	4	6.0	4.5	5.8	meeting with client
Total Hours	**41.9**	**40.9**	**53.0**	**48.55**	**34.1**	□

Requirements Documentation

1. Overview

Today's medical clinic can be a busy, fast-paced environment. In order to effectively attend to their patients, clinic staff must be able to maximize exam room use. This can be accomplished by using some means of indicating each room's status to other staff members.

A typical progression of events in an exam room is as follows:

(1) A medical assistant accompanies a patient to the exam room.
(2) The medical assistant takes the patient's vital statistics.
(3) The patient waits in the exam room to be seen by the doctor.
(4) The doctor sees the patient, at which time some treatment may be administered.
(5) The doctor proceeds to the next waiting patient, and the exam room is cleaned and prepared to accept a new patient.

Many medial clinics use simple mechanical systems of colored flags to display the status of each exam room. These outdated systems have the following drawbacks:

They are cumbersome. – Because the flags are mounted near the tops of doorways, it is awkward for clinic staff to change them. They are also susceptible to being incorrectly changed.
They are not automated. – Flags do not recognize when a doctor has finished attending to a patient in another room. Therefore, clinic staff must manually change the position of the flags.
They do not prioritize workflow. – Colored flags can't indicate to the doctor which patient to see next. They also cannot keep track of time for specific types of treatment.

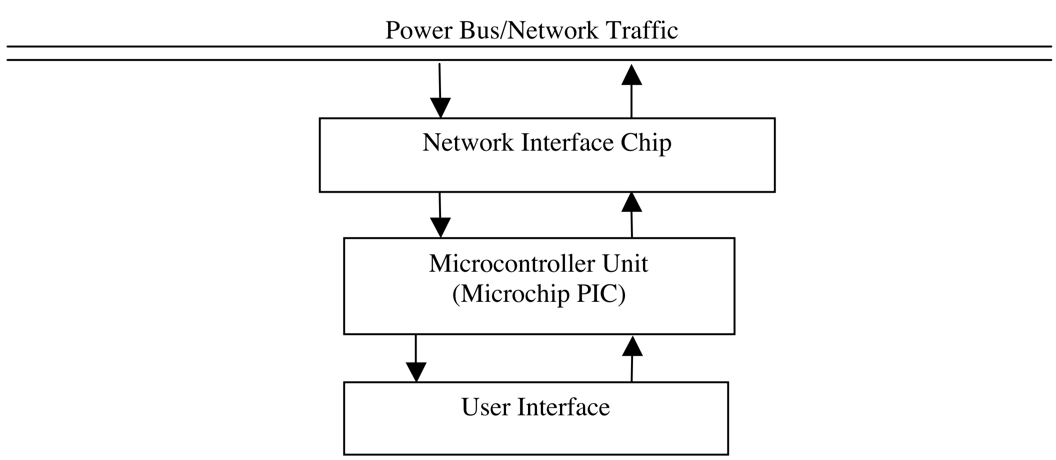
For these reasons, administrators feel the need to upgrade to a modern system.

While inexpensive electronic systems exist, they lack capabilities. They are typically switch-based systems whose units do not communicate with each other. Such systems are not much more than an electronic version of colored flags.

There are more comprehensive solutions, but they are much more expensive. These systems require significant consultation and design for each individual application. Furthermore, they can be difficult to set up, to use, and to maintain.

Our goal is to design an affordable, modular electronic system that will effectively improve a typical medical clinic's workflow. Our system will consist of multiple modular in-wall electronic indicators. These units will be easy to set up and operate. They will be interconnected, so as to display thorough information about exam room's status. Optionally, our system will include a computer interface to display and log room status.

2. Block Diagram



3. Requirements

3.1. Electrical

3.1.1. Microcontroller

This project is centered on the use of microcontrollers for each multi-use station. Therefore most of the electrical requirements pertain to the selected microcontroller's specifications.

3.1.2. Power

The multi-use stations will require one or more power supplies to deliver the proper voltages and currents for each microcontroller that is used.

3.1.3. Interfacing

The multi-use stations require a reliable communication link and protocol. Additionally, the customer has specifically requested that each unit contain its own microprocessor and interface hardware so that the stations will be modular.

Table 3.1.3.1. Electrical Specifications

Requirement	*Value*
Microprocessor Type	Microchip PIC16F877
Voltage Rating	2.0 to 5.5 Volts
Communication Link Type	13-pair cable
Communication Protocol	RS-485
Electrical Guidelines	The National Electric Code

3.2. Mechanical

3.2.1. Size

The size of the multi-use station is limited by the requirement that it must fit into a single gang electrical outlet box, and the control panel must be made from a simple outlet box blank. There are many variations on outlet box sizes, which requires the stations fit within the minimal box dimensions in order to be universally accepted for production.

3.2.2. Weight

Weight is only a factor in each station be mounted in an electrical outlet box, which is where it will be permanently installed and will not pose a constraint.

Table 3.2.2.1. Mechanical Specifications

Requirement	*Value*
Size of electronics component	Must not be greater than the following Height = 2__ Width = 2_ Depth = 2__
Size of control panel	Typical electrical outlet blank Height = 4__ Width = 2__
Weight	No pertinent constraint
Interconnection	Multiple twisted paired telephone cable or thermostat cable
Protection	Electrically isolated from ESD and if a metallic blank is used then it must be properly grounded.
Controls	Pushbuttons must be durable to withstand years of daily use.

3.3. Environment

3.3.1. Temperature

Each multi-use station will reside in a room temperature atmosphere, and the units must not build up excessive heat within the in-wall box. Also, the stations will be designed to meet specifications given by the given microcontroller's data sheets.

3.3.2. Humidity

The multi-use stations must not malfunction as a result of excessive moisture within the wall in which it installed. The stations must use fuses or circuit breakers to prevent fire hazards in the event of direct contact with moisture, such as a leaky pipe.

3.3.3. Vibration/Shock

The multi-use stations must withstand vibrations of the wall in which it is installed, such as vibration from nearby doors being closed.

3.3.4. Packaging

Since both plastic and metal blank covers will be options for the control panel, proper electrical grounding and isolation will be required to protect against electrical shocks and ESD discharges.

Table 3.3.4.1. Environmental Specifications

Requirement	*Value*
Absolute Maximum Temperature	+125°C

3.4. Documentation

3.4.1. User's Manual

A user's manual will be made available once the design has been completed and tested. This manual will include how to configure the call light system as well as how to use the call light system on a day-to-day basis.

3.4.2. Maintenance Manual

A maintenance manual to accompany the user's manual will specify any required maintenance and installation procedures. Also included will be a number of design documents relating to how the project was engineered. This document will include specifics on hardware wiring, network interfacing, and programming.

3.5. Testing

3.5.1. Procedures

Testing will be done by temporarily interfacing inputs and outputs to a test chip. No permanent connections will be made, and it will be easy to insert and remove a chip for ease of testing and debugging.

3.5.2. Equipment

Our testing environment will consist of a breadboard for interfacing inputs, outputs and power to the chip. Connected to the breadboard will be a power supply, LEDs, buttons, and other interface elements as needed. We will also use a programming board, in order to reprogram and debug chips.

3.6. General

3.6.1. Safety

This system will be installed in commercial settings where its safety and performance will be critical. This will require that the system meet all electrical codes and regulations.

3.6.2. Client Preferences

The client has purchased Microchip PIC16F877 chips for use in each multi-use station, and prefers the use of these chips in the design.

4. Design Plan

4.1. Design Philosophy

The design philosophy involves general design goals applicable to this engineering design effort.

4.1.1. Performance

System performance must not rely on a single microcontroller. The system should be comprised of autonomous, interconnected units. Failure of a single unit should not affect the performance of the rest of the system. The system must take advantage of the distributed microcontroller design, so as to be a superior alternative to simpler switch-based systems.

4.1.2. Ease of Operation

The operation of the system must be easy for new users to learn. It must improve, not hinder, the workflow of a typical medical clinic. Complicated button combinations and programming options must be kept to a minimum.

4.1.3. Installation

Installation of the units should be simple. Upon installation, each unit should not require extensive programming. When linked together with the specified connections, communication between the units should occur automatically.

4.1.4. Quality

The product will be used in a setting that normally consists of high-quality products and materials. The final product will meet the needs of a fast-paced and demanding workplace by providing a smart, user-friendly alternative to existing office technologies.

4.1.5. Design Safety

It is important to incorporate safety in our design. This is because the biggest gains in safety and the biggest reductions in cost tend to come when safety is inherent in any design. The doctors call light will be safe to the user, patients, doctors and everyone.

4.1.6. Environmental Protection

Environmental protection will also be our integral part of our design. Our final design of the doctor's call light will operate in such a way that maximum environmental protection is ensured. All team members have an ethical duty to ensure environmental protection during the course of this project.

4.1.7. Manufacturability

Manufacturing ease of the multi-use stations is desired. This project requires multiple interconnected units in order to function properly. Therefore a design will be ineffective if it is difficult to create or duplicate.

4.1.8. Maintainability

Similar to most office installations, a desire exists to have a product that does not need any substantial amount of upkeep and maintenance. All time spent maintaining an office product means less time is being spent on customers.

4.2. Design Approach

The design approach contains specific design goals and how the team will be organized to attach the problem.

4.2.1. Design Goals

4.2.1.1. Improve Medical Clinic Communication

The system should improve communication between the doctor and the patient, medical assistant(s), front desk, and cleaning assistant.

4.2.1.2. Modular Design

Most designs require a specific number of units in order to function properly. In a modular design, the number of units in a system can vary. This is an advantage because a modular system will have smooth transitions in the event of remodeling, moving, or marketing this product to another company.

4.2.2. Team Organization

Each problem should be distributed to a group or team member based up each team member's strengths.

4.2.2.1. Hardware

Alan, Bill and Rob will be directing their attention toward the hardware subsystem. This includes interfacing the microcontroller to output lights, a power supply, and a communication chip used to transmit information on the network.

4.2.2.2. Software

Kevin and Tom will be focusing on the software. The software subsystem involves completing the basic functions of the unit as well as communicating with the other units on the network.

4.2.3. Schedule

The design process consists of four stages in the following sequence: a requirement stage, a proposal stage, a design phase, and an implementation phase. The first two will take place during the fall semester of 2003. The last two will be carried out during the spring semester of 2004. This will then be followed by the capstone design conference on April 26, 2004 in which the project will be presented. This schedule is standard of the senior capstone design process, and each stage is equally important for the overall success of the project.

4.2.4. Cost Analysis

This is a vital aspect of the project to meet the client's expectations. The goal of the analysis is to minimize and assess the costs associated with the final product to be marketed to its target segment. Our client specifically needs to know the costs of each unit for personal use as well as costs of multiple units for future plans to market the product. Providing accurate costs information will undoubtedly assist our client in assessing marketing feasibility of the product. The overall costs of this project must remain within our client's means and must follow a direction that meets the client's needs.

<u>**Project Schedule and Deliverables**</u>

Team BRAKTech will produce the following deliverables on the stated dates:

1. Client Status Report – November 4, 2003
2. Client Proposal Document - December 9, 2003
3. Status Reports – Monthly, starting January 12, 2004
4. Final Product Installed – April 19, 2004
5. Capstone Design Conference Presentation – April 23, 2004
6. Final Report – April 23, 2004

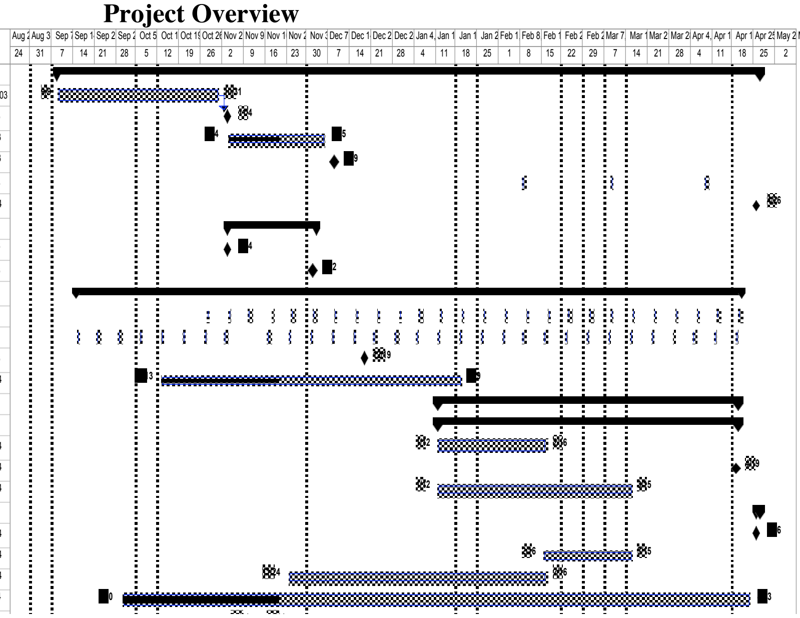
Current Project Summary

The team is currently involved in four major areas of project development. We are busy preparing the Client Proposal document that is to be submitted to the client on December 9, 2003, with the rough draft of that document due on December 5, 2003. We are also busy researching all aspects of the project. We intend to complete this activity by January 19, 2004. The web site is up and running and is constantly being revised and will continue to be until the end of the project. Financial planning is ongoing as we put together a purchasing package for our client. We expect to complete this phase by February 16, 2004.

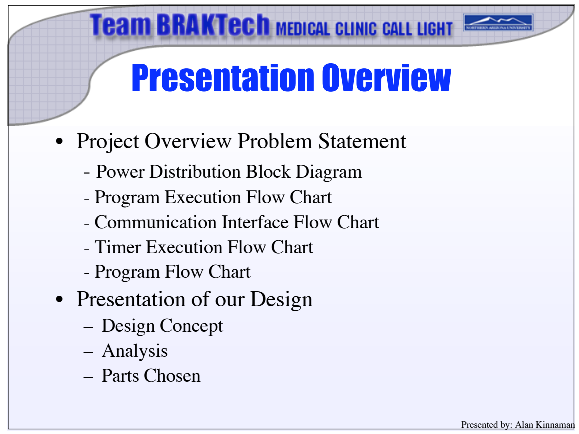
Upon returning to school in January the Status Reports to the customer will begin on a monthly basis. This will start on January 12, 2004 and continue until the end of the project. Other activities starting on January 12, 2004 will be the building of a prototyping unit to test our project and the beginning of software writing. Building the prototyping unit should be completed by February 16, 2004 and the software should be completed by around March 15, 2004. We will begin testing our project in small phases by February 16, 2004 and continuing until March 15, 2004. At this point around March 15, 2004 we expect to be installing our design for trial runs.

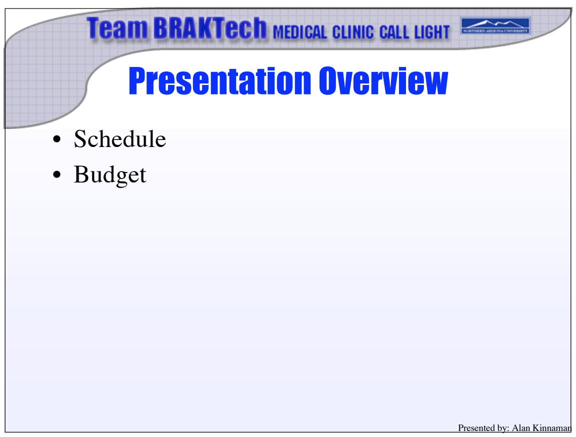
Project Overview

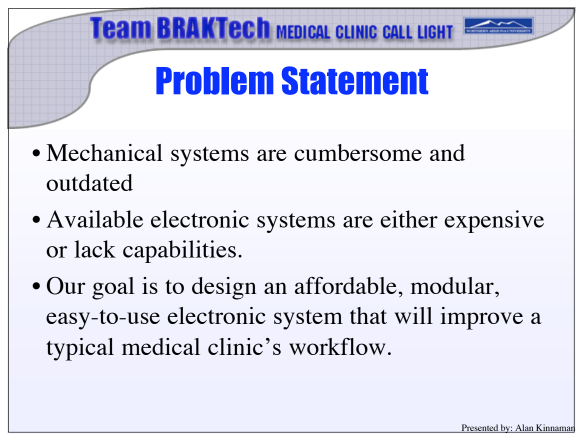
ID	Task Name	Duration	Start	Finish
1	**Documentation/Customer Reporting**	**165 days?**	**Tue 9/9/03**	**Mon 4/26/04**
2	Client Status Report (Rough Draft)	39 days?	Tue 9/9/03	Fri 10/31/03
3	Client Status Report (Final Draft)	1 day	Tue 11/4/03	Tue 11/4/03
4	Client Proposal (Rough Draft)	24 days?	Tue 11/4/03	Fri 12/5/03
5	Client Proposal (Final Draft)	5 days?	Tue 12/9/03	Mon 12/15/03
6	Status Reports	**45 days**	**Mon 2/9/04**	**Fri 4/9/04**
10	Final Report	1 day?	Mon 4/26/04	Mon 4/26/04
11	**Presentations**	**21 days?**	**Tue 11/4/03**	**Tue 12/2/03**
12	First Class Presentation	1 day	Tue 11/4/03	Tue 11/4/03
13	Client Proposal Presentation	1 day?	Tue 12/2/03	Tue 12/2/03
14	**Communication**	**157 days?**	**Mon 9/15/03**	**Tue 4/20/04**
15	Faculty Advisor Meeting	**126 days**	**Tue 10/28/03**	**Tue 4/20/04**
42	Team Meeting	**156 days**	**Mon 9/15/03**	**Mon 4/19/04**
75	Confirm Proposal Signature	1 day?	Fri 12/19/03	Fri 12/19/03
76	**Research**	71 days?	Mon 10/13/03	Mon 1/19/04
77	**Hardware**	**71 days?**	**Mon 1/12/04**	**Mon 4/19/04**
78	Hardware Implementation	**71 days?**	**Mon 1/12/04**	**Mon 4/19/04**
79	Build Prototyping Unit	26 days?	Mon 1/12/04	Mon 2/16/04
80	Product Installation	1 day?	Mon 4/19/04	Mon 4/19/04
81	**Software**	46 days	Mon 1/12/04	Mon 3/15/04
82	**Demonstration/Poster Session**	**1 day?**	**Mon 4/26/04**	**Mon 4/26/04**
83	Capstone Demonstration	1 day?	Mon 4/26/04	Mon 4/26/04
84	**Testing/Prototyping**	21 days	Mon 2/16/04	Mon 3/15/04
85	**Purchasing/Vendors**	61 days	Mon 11/24/03	Mon 2/16/04
86	**Web Site**	149 days?	Tue 9/30/03	Fri 4/23/04

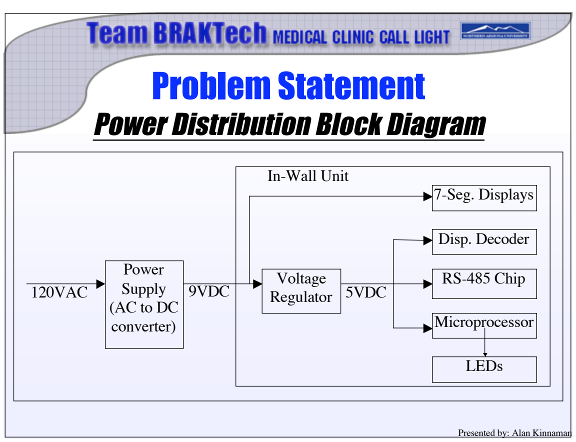


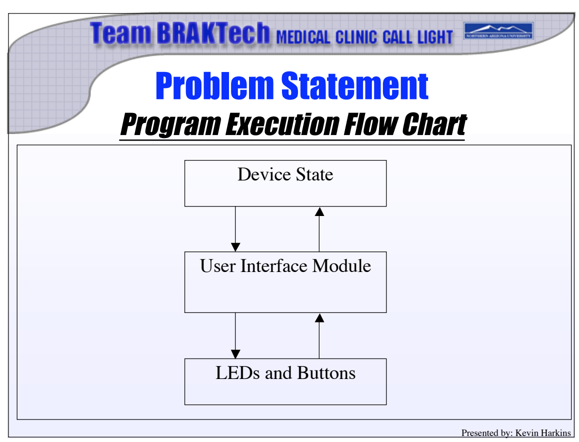

Team BRAKTech MEDICAL CLINIC CALL LIGHT
Proposal Presentation
• Team Members:
– Tom Hamilton Treasurer
– Kevin Harkins Document Coordinator
– Alan Kinnaman Team Leader
– Robert Napper Liaison
– Bill Okyere Secretary
Presented by: Alan Kinnaman


Team BRAKTech MEDICAL CLINIC CALL LIGHT
Presentation Overview
• Project Overview Problem Statement
- Power Distribution Block Diagram
- Program Execution Flow Chart
- Communication Interface Flow Chart
- Timer Execution Flow Chart
- Program Flow Chart
• Presentation of our Design
– Design Concept
– Analysis
– Parts Chosen
Presented by: Alan Kinnaman

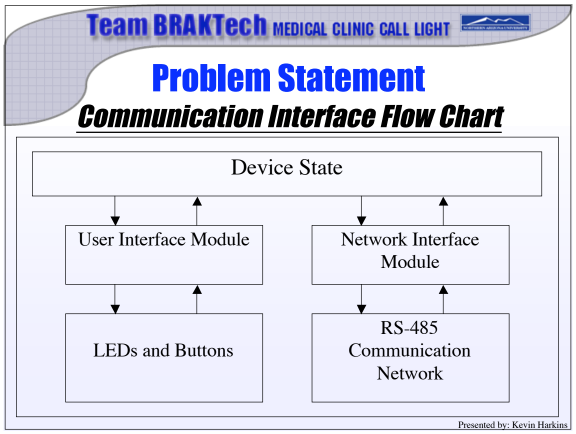

Team BRAKTech MEDICAL CLINIC CALL LIGHT
Presentation Overview
• Schedule
• Budget
Presented by: Alan Kinnaman

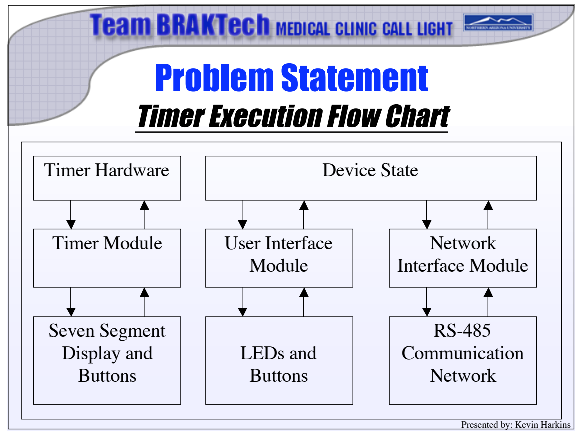

Team BRAKTech MEDICAL CLINIC CALL LIGHT
Problem Statement
• Mechanical systems are cumbersome and outdated
• Available electronic systems are either expensive or lack capabilities.
• Our goal is to design an affordable, modular, easy-to-use electronic system that will improve a typical medical clinic's workflow.
Presented by: Alan Kinnaman

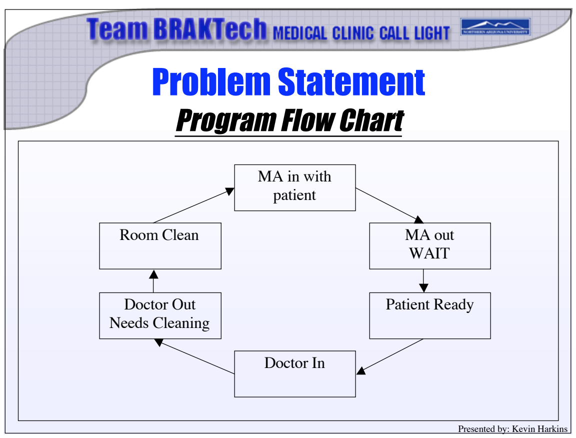

Team BRAKTech MEDICAL CLINIC CALL LIGHT
Problem Statement
Power Distribution Block Diagram
In-Wall Unit
7-Seg. Displays
Disp. Decoder
RS-485 Chip
Microprocessor
LEDs
120VAC
Power Supply (AC to DC converter)
9VDC
Voltage Regulator
5VDC
Presented by: Alan Kinnaman

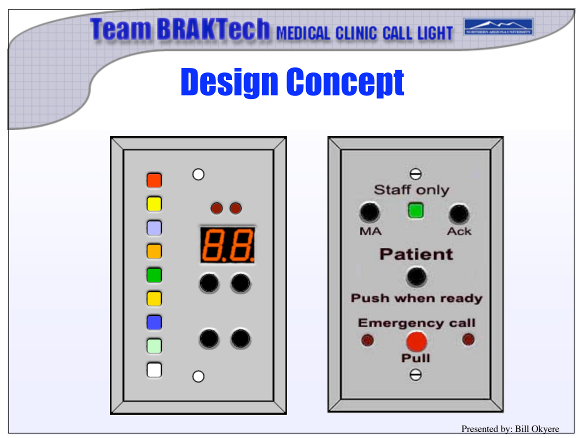

Team BRAKTech MEDICAL CLINIC CALL LIGHT
Problem Statement
Program Execution Flow Chart
Device State
User Interface Module
LEDs and Buttons
Presented by: Kevin Harkins

Proposal Presentation Slides









Analysis

Component Power Consumption

Component	Maximum Current Per Device (mA)	Quantity	Max. Current (mA)
Microprocessor	250	1	250
RS-485 chip	55	1	55
LEDs	25	10	N/A
7-segment displays	160	2	320
Display decoders	0.005	2	0.01
Pushbuttons	1	3	3
Voltage regulator	10	1	10
		Total:	~638

Presented by: Bill Okyere

Parts Chosen

Purpose	*Part*
Microprocessor	PIC18F458
Communication Chip (RS485)	DS75176BT
LEDs	Various
7-Segment Display	ESA56
Display Decoder	SN54LS49
5 Volt Power Supply	LM7805

Presented by: Bill Okyere

Team BRAKTech MEDICAL CLINIC CALL LIGHT

Project Deliverables and Schedule

Project Deliverables

Team BRAKTech will produce the following deliverables on the stated dates.

- Client Status Report - November 4, 2003
- Client Proposal Document - December 9, 2003
- Status Reports - Monthly, starting January 12, 2004
- Final Product Installed - April 19, 2004
- Capstone Design Conference Presentation - April 26, 2004
- Final Report – April 26, 2004

Presented by: Rob Napper

Team BRAKTech MEDICAL CLINIC CALL LIGHT

Project Deliverables and Schedule

Project Schedule

- Four major areas of project development
  - Client Proposal Document preparation (draft 12/5, to client by 12/9)
  - Researching all aspects of project (completed by 1/19/04)
  - Web page running and being developed (constant revision)
  - Budget/Financial concerns being resolved with client (Done by 2/16/04)
- 11/24/03 – 2/16/04 Purchasing parts for testing and finalizing design
- 12/2/03 – Presentation to class on Client Proposal
- 12/9/03 - Client Proposal submitted to client
- 12/19/03 – Client Proposal to be returned, signed by client

Presented by: Rob Napper

Team BRAKTech MEDICAL CLINIC CALL LIGHT

Project Deliverables and Schedule

Project Schedule

- Upon returning to school…
  - Status Reports begin on weekly basis starting 1/12/04 and continuing until the end of the semester.
  - 1/12/04 – Building of prototyping hardware (ending 2/16/04) and beginning of software writing (which should last until 3/15/04).
  - 2/16/04 – Begin testing project in small phases (ending 3/15/04).
  - 3/15/04 – Begin installing and making final tests

Presented by: Rob Napper

Team BRAKTech MEDICAL CLINIC CALL LIGHT

Budget

Total Estimated Costs for Nelson Hochberg:

Component	Quantity	Estimated Cost
Multi-Use Station	2	$145.16
In-Room Station	2	$39.18
Total Estimated Cost		**$184.34**

Presented by: Tom Hamilton

Team BRAKTech MEDICAL CLINIC CALL LIGHT

Questions?

Presented by: Tom Hamilton

Acceptance Document

This document lays forth a final understanding between Team BRAKTech and client Nelson Hochberg regarding the intended use of supplied products, as stated in this proposal document, and disclaiming Team BRAKTech's responsibilities once the project has been completed. Upon signing this document the proposed design, production, and implementation of this project is to be agreed on entirely. Also, by signing this document, Team BRAKTech and Nelson Hochberg agree that all service arrangements will end upon conclusion of the implantation phase, which will be no later than April 26, 2004.

Disclaimer of Liability
Team BRAKTech will not be liable for future upgrades to the supplied product. Team BRAKTech will not be responsible for maintaining the supplied products once that they have been fully installed. Therefore Team BRAKTech accepts no responsibility for damage that the supplied product might cause to itself or the structure in which it will be installed since BRAKTech cannot be aware of the existing condition of the structure.

Ownership
Team BRAKTech agrees that sole ownership of the supplied products and the unique system of hardware and software employed is that of Nelson Hochberg and may not be replicated in any way without his expressed permission.

Disclaimer of Warranty
By signing this document Nelson Hochberg agrees that the materials used for this project are of the quality needed for this application and that failure of the parts once the successful design has been implemented will be his responsibility. Team BRAKTech makes no warranties and shall not be liable for any aspect of the product or its development at any point in time beyond its initial implantation.

________________________ ________________
Tom Hamilton **Date**

________________________ ________________
Kevin Harkins **Date**

________________________ ________________
Alan Kinnaman **Date**

________________________ ________________
Robert Napper **Date**

________________________ ________________
Bill Okerye **Date**

I accept the terms that have been laid forth by the disclaimers of Team BRAKTech. Please respond by December 19th, 2003.

________________________ ________________
Nelson Hochberg **Date**