# Design, Modeling, and Applicationof Microcontroller on Navigational Light Indicator/Control Panel

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**ABSTRACT**

Safe navigation is very essential for smooth operation of ship. To aid in safe navigation and communicating with other ships there are verity of equipment used such as RADAR, ECDIS, AIS, Navigation Lights etc. All navigating equipment need to be in perfect condition at all time as faulty or failure in any equipment can cause miscommunication or improper navigation signal from ships which can lead to an accident or incident. Most of the equipment are present inside the Bridge but the lightings which are overlooked to be checked because a crew has to go personally to all places to check its condition. This proposed project is to explain a simple circuit using microcontroller PIC16F877A to remotely check the condition and raise alarm to the crew if any lighting faulty.Thus, this project will help to save the time of each personnel onboard ship and will maintain the vessel seaworthiness at all times.

**KEYWORD** : *PIC microcontroller, Navigational Lights Indicator/Control Panel, LDR, MCU*

**NOMENCLATURE**

*A/D – Analog-to-Digital*

*CPU – Central Processing Unit*

*EEPROM – Electrically Erasable Programmable Read-Only Memory*

*LED – Light Emitting Diode*

*LDR – Light Dependent Resistor*

*MCU – Microcontroller*

*ON/GOOD – the light's supply power is "ON" and light intensity is "GOOD"*

*ON-BAD – the light's supply power is "ON" and light intensity is "BAD"*

*PIC – Peripheral Interface Controller*

*PWR OFF – the supply power to the light is "OFF"*

*SPDT – Single Pole Double Throw*

*SPST – Single Pole Single Throw*

## 1.0 INTRODUCTION

There are many forms of signaling devices now a day. It may be in form of radio signal, digital signal, audible signal, and visual signal which include the use of lights as a signal. Thus, in marine navigation, light signals are very important tools in safe navigation. "All boats whether big or small are required to have night lights as

a part of the navigation system[1]. " Whether a vessel using ECDIS, RADAR, AIS and other signaling devices, navigational lights are important as with the others. "In Annex I(12) it is specified that the manoeuvring light shall be carried, where practicable[2]" . As of now, to be enabling to know the condition of the navigational lights in each different location human intervention is needed. A personnel need to check locally the condition of its light.

### 1.1 Project Conceptualization

Do you ever wonder how can we save some of our electricity for the daily use? Especially on street lights, there are plenty of street lights where unnecessary "ON" during daylight. Can we do it automatically turn "ON" during night and turn "OFF" during daylight. The answer is definitely "YES". Now a day, it was very simple to create automation in our world. There are a lot of ways to create simple thing that can ease our lifestyle.

When we say lamppost or street light, in this modern time usually turn "ON" or "OFF" automatically depend on daytime or availability of sunlight. "It automatically switches OFF lights when the sunlight fall on it (i.e on LDR), e.g. in morning, by using sensor called LDR (Light Dependent Resistor) which senses the light just like our eyes[3] "

With the same concept as the automatic street lights, the authors decided to incorporate this idea to the project proposal.

### 1.2 Project Proposal

From the concept of automatic on/off street lights, we integrated this to our project "Navigational Light Indicator/Control Panel". This project will work dependent on the light source in each specified location of the lights. Once there is fall on light intensity user will be notified immediately and do some necessary action. It is a modest, inexpensive, configurable; easy to be operated electronic control system is anticipated to deliver a favorable assistance for the watchkeepers on the ship's navigational bridge.

## 2.0 METHODOLOGY

As an aide to constantly monitoring the navigational lights system onboard, this proposed system will lessen the human intervention of constantly checking the lights condition outside the wheelhouse. In this system, a microcontroller is embodied to constantly monitor the navigational lights condition. An LDR or photoresistor are attached in every light (Masthead, Port Side, Stbd Side, Stern, etc.) that will be measuring the light intensity. In the event, a drop of intensity in any light happen an alarm will be triggered in the control panel inside the wheelhouse. This control panel is consisting of LED for "ON/OFF" and "WARNING" indication, buzzer for alarm, and LCD for display messages.

### 2.1 Component

The component of the Navigational Light Indicator/Control Panel is divided into subcategories such as (a) Control Processing Unit, (b) Input Unit, and (c) Output Unit. (See Fig. 2.1 : Simplified Schematic Diagram)

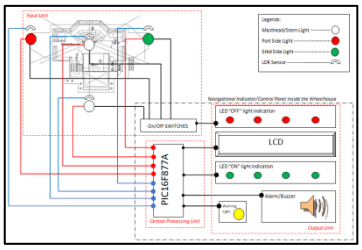


*Fig. 2.1 : Simplified Schematic Diagram*

First, in Control Processing Unit the researches intended to use the PIC16F877A. This type of microcontroller is Plastic Dual in Line Package (PDLP) and consist of 40-pins and five I/O ports. It will serve as the main brain of the whole system.

Next, the Input Unit are consisting of switches and LDR sensors. Switch is used to power on the navigational light on respective location such as Masthead, Port Side, Starboard Side, Stern., etc. Each navigational light will have LDR sensor and will measure the light intensity.

Lastly, the Output Unit are composed of light emitting diodes (LED), liquid crystal display (LCD) and buzzer. LED serve as the visual indication of the system. LCD use to print the required messages. Buzzer is put as to give audible sound for any warning/alarm in the system.

All detailed components will be discussed in the 3.0 CIRCUIT DESIGN AND SIMULATION

**2.2 Microcontrollers**

In this proposed system, the authors used PIC16F877A microcontroller. This is the main brain of the system, wherein has the ability to function without other sophisticated modules to be attached. "The PIC16F877A features 256 bytes of EEPROM data memory, self programming, an ICD, 2 compactors, 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)[4]". With this type of MCU it is ideal to more advance level of A/D applications such as automotive, industrial, appliances and consumer application.

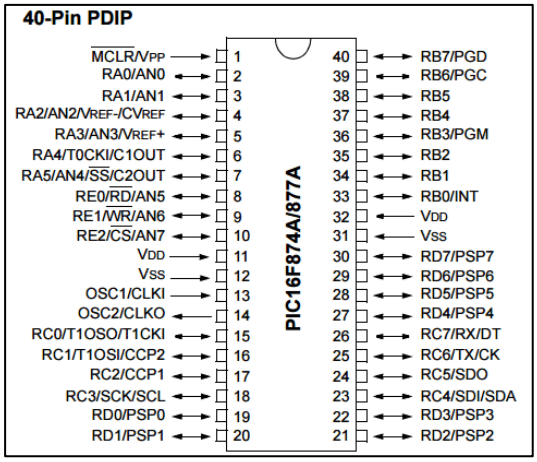


*Fig. 2.1 : PIC16F887A pin assigment*

**2.3 Software**

To write or compose, editing, compiling and programming a code for microcontroller software are needed. Thus, in this proposed project all this process will be utilized by the "C compiler for the PIC MCU". With these compiler and PicKit2 programmer, it empowers the microcontroller to be customized in high level programming languages. With the written algorithm of the codes, the microcontroller will think and decide by the actions of the input ports. Then eventually will enacting by the output ports.

**2.4 Programming Description**

Most of the MCU uses C language as an algorithm code. This code will be embedded to the PIC16F877A. All codes have been compiled and tested using the CCS compilers.

**2.5 Operation**

This system will be operated as the concept described in the following below:

- When the switch in respective navigational light is "OFF" position. The LED for "OFF" indication will lit on. And the rest of LEDs are off. While in LCD a printed message "PWR OFF" will appear.
- As the switch for any of the navigational light is change to "ON" position. The LED for "OFF" turn off. Then the LED for "ON" indication will lit on. The LDR now will sense the light intensity in respect to the switch been turn on. Once the light intensity is high or enough the LDR will be send signal to microcontroller. Finally a message of "ON/GOOD" will appear in LCD indicates that the light is still in good condition.
- However, when the LDR sense the light intensity is low or nothing, no signal will be send to microcontroller. Thus a message of "ON-BAD" will appear in LCD. It means the power is "ON" but the light never lit on. Additionally, visual and audible alarm is incorporated by means of LED and buzzer. Therefore, necessary action must be done to rectify the problem.

Here is the truth table as showing the logic of the operations.

| Location | Inputs | | Outputs | | | | |
|---|---|---|---|---|---|---|---|
| | Switch | LDR | "OFF" LED | "ON" LED | Alarm LED | Buzzer | LCD |
| Masthead Light | 0 | 0 | 1 | 0 | 0 | 0 | PWR OFF |
| | 0 | 1 | 1 | 0 | 0 | 0 | PWR OFF |
| | 1 | 0 | 0 | 1 | 1 | 1 | ON-BAD |
| | 1 | 1 | 0 | 1 | 0 | 0 | ON/GOOD |
| STBD Side Light | 0 | 0 | 1 | 0 | 0 | 0 | PWR OFF |
| | 0 | 1 | 1 | 0 | 0 | 0 | PWR OFF |
| | 1 | 0 | 0 | 1 | 1 | 1 | ON-BAD |
| | 1 | 1 | 0 | 1 | 0 | 0 | ON/GOOD |
| Port Side Light | 0 | 0 | 1 | 0 | 0 | 0 | PWR OFF |
| | 0 | 1 | 1 | 0 | 0 | 0 | PWR OFF |
| | 1 | 0 | 0 | 1 | 1 | 1 | ON-BAD |
| | 1 | 1 | 0 | 1 | 0 | 0 | ON/GOOD |
| Stern Light | 0 | 0 | 1 | 0 | 0 | 0 | PWR OFF |
| | 0 | 1 | 1 | 0 | 0 | 0 | PWR OFF |
| | 1 | 0 | 0 | 1 | 1 | 1 | ON-BAD |
| | 1 | 1 | 0 | 1 | 0 | 0 | ON/GOOD |

*Fig. 2.2 : Truth Table*

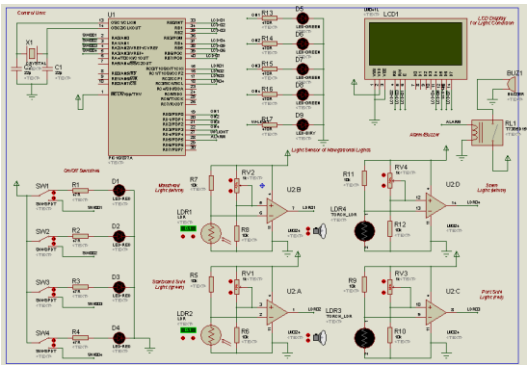

*Fig. 2.4 : Navigational Light Indicator/Control Panel Circuit Design*

### 2.6 System Flow

In this system, it works when the switch with respect of navigational lights locations (Masthead, Port Side, Stbd Side, Stern, etc.) is turn on. Then the sensor in each navigational light will sense the light intensity. The signal from this will be send to the microprocessor. This MCU will logically decided on the action to be done depend to the signal it receive. Lastly output will be displayed at the LEDs, LCD, and buzzer. Below is the flow chart for better understanding of the system.

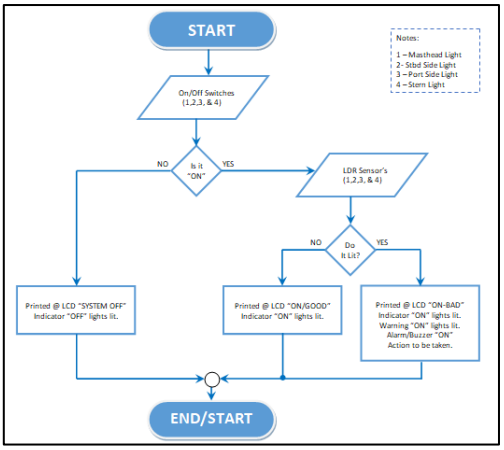


*Fig. 2.3 : Flow Chart*

## 3.0 CIRCUIT DESIGN AND SIMULATION

### 3.1 Circuit Design

The proposed Navigational Light Indication/Control Panel system is consisting of three main components such as (1) Central Processing Unit, (2) Input Unit, and (3) Output Unit.

#### 3.1.1 Central Processing Unit

This is the main brain of the system as well as the power for the system. It is composed of the microcontroller (1) PIC16F877A, (2) crystal, (3) capacitor, and (4) power source.

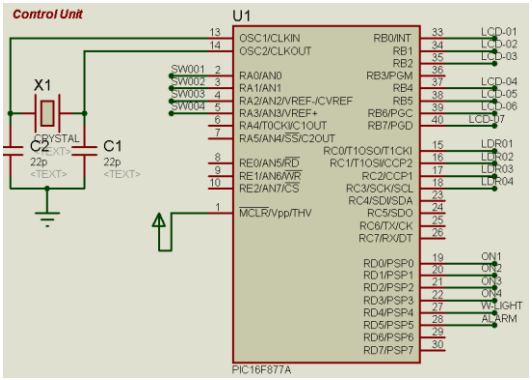


*Fig. 2.5 : Central Processing Unit Circuit*

#### 3.1.2 Input Unit

In this part is the senses of the system, where in any deviation from the system is due of this component. This is consisting of (1) switches such as SPST (Single Pole Single Throw) or SPDT (single pole double throw) connected to the Port A and (2) LDR sensor connected to the Port C.

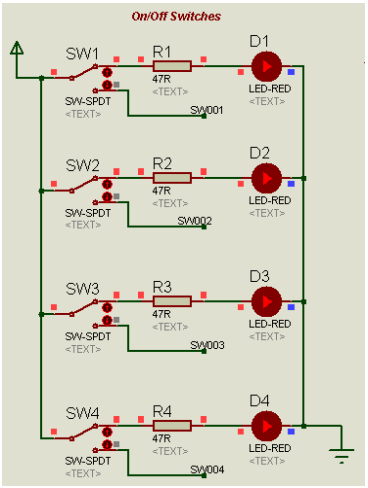


*Fig. 2.6 : Input Switches Circuit*

The signal from the LDR is boasted by means of amplier circuit show in the figure below.

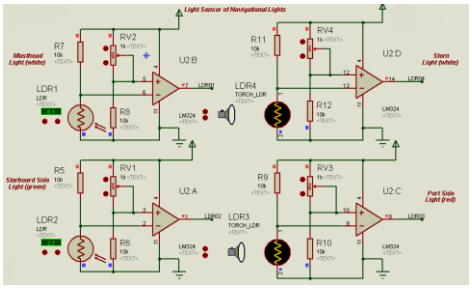

*Fig. 2.7 : Input LDR Sensor Circuit*

### 3.1.3 Output Unit

This part is where the action to take or the responses of system. It is mainly consisting of (1) LED, and (2) buzzer is both connected to the Port D, (3) LCD which connected to Port B, (4) resistor, and (5) relay. The LED serves as the visual signal of the system. In which the LED lit on when a current passes through and regulate by the resistor. Additionally the LCD is used to display the information process by the microprocessor, a signal send to the LCD through the PORT B. These messages include the location of the light and condition. Example if light is "OFF" position LCD will have this message "MASTHEAD : PWR OFF", wherein "MASTHEAD" is the location and "PWR OFF" is the condition of the light. Furthermore, when the light is turn "ON" message will appear at LCD as "MASTHEAD : ON/GOOD" which means in the "MASTHEAD" light the power is "ON" and light intensity is "GOOD". However, if light intensity fall, the information at the LCD will be "MASTHEAD : ON-BAD" it indicates the "MASTHEAD" light the power is "ON" but the intensity of light is "BAD". These will do as well with the other navigational lights such as Starboard Side, Port Side, and Stern. While audible sound will be given by the buzzer which is connected to the Port D through the relay.

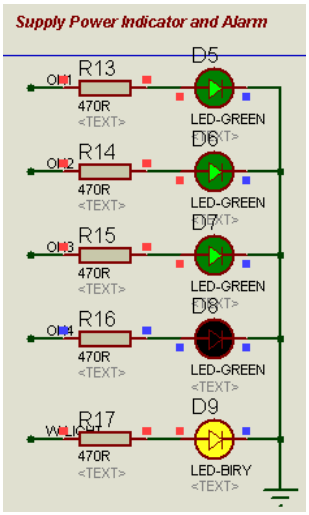


*Fig. 2.8 : LED Output Circuit*

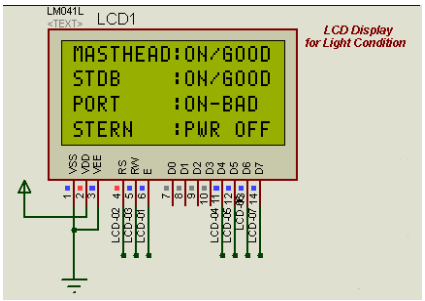


*Fig. 2.9: LCD Output Circuit*

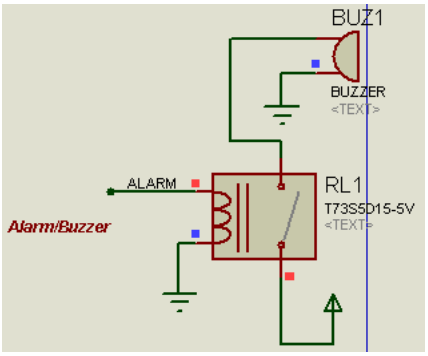


*Fig. 2.10 : Alarm/Buzzer Output Circuit*

### 3.2 Simulation

Using the software Proteus v7.6 simulation of the proposal project will be possible. Proteus contains everything need to develop, test, and virtually prototype system deigns based around the Microchip Technologies ™ PIC16 series of controllers. In this software, the entire components of the circuit were selected from the software library and wiring connection was done by drawing the lines. Then the program for the microcontroller was created and complied using the CCS C compiler. The output file or hex file of the program is loaded into microcontroller with the help of PicKit 2. The PicKit 2 is a device to encode the program into microcontroller. It has a programmer-to-go (PTG) feature, which can download the hex file and programming instructions into on-board memory.

Ultimately, the system can be simulate and tested. The circuit to be used for the simulation is in Fig. 3.0 : Navigational Light Indicator/Control Panel Circuit. The microcontroller is connected to the four (4) I/O ports, two (2) ports for input and the other two (2) ports for output. The two (2) input ports are mainly for switches and LDR sensors which in Port RA and Port RC respectively. While the remaining two (2) output ports are primarily for LCD and LED & Buzzer which in Port RC and Port RD respectively.

## 4.0 RECOMMENDATIONS

In this paper the author has explained a simple circuit which is cost efficient using microcontroller PIC16F877A to find and intimate faults in navigation lighting system to the users, but a similar system can be used throughout the ship's lighting system for the user to find the faulty lighting which can save time and avoid missing some of the lighting fixture during watch keeping. It is a frequent observation of port state control and vetting inspector to point out these faults as observations and hence with this arrangement it can be rectified at the earlier stage. A modified arrangement of similar circuit can be even used to turn off and on the lights automatically using limit switches at doors. This could save electricity and environment.

## 5.0 CONCLUSION

Through this paper presentation we can create a low cost microcontroller circuit to find the faults which occur in navigation lighting system and alert the crew, since the fault in Lightings anytime and needed to be rectified immediately for smooth and safe navigation of ships.

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