

**DESIGN, IMPLEMENTATION AND SIMULATION OF
AUTOMATIC TIME-BASED STREET LIGHT CONTROL
SYSTEM**

**ABDULRAZAK TIJJANI
SPS/13/MPY/00049
B.Sc ELECTRONICS**

**A DISSERTATION SUBMITTED TO THE DEPARTMENT OF
PHYSICS BAYERO UNIVERSITY, KANO, IN PARTIAL
FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF
THE DEGREE OF MASTER OF SCIENCE IN ELECTRONICS
(M.Sc. ELECTRONICS)**

DECEMBER, 2015

DECLARATION

I hereby declare that this work is the product of my research efforts; undertaken under the supervision of *Associate Professor GarbaShehu Musa Galadanci* and has not been presented and will not be presented elsewhere for the award of degree or certificate. All sources have been duly acknowledged.

Abdulrazak Tijjani

SPS/13/MPY/00049

CERTIFICATION

This is to certify that the research work for this dissertation and its subsequent preparation of this dissertation by *Abdulrazak Tijjani* (SPS/13/MPY/00049) were carried out under my supervision.

Dr. G.S.M. Galadanci

Supervisor

Date

Dr. T.H. Darma

Head of the Department

Date

APPROVAL

This dissertation “*Design, Implementation and Simulation of Automatic Time-based Street Light Control System*” has been examined and approved for the award of Masters in Electronics (M.Sc. ELECTRONICS).

Prof. B.B.M Dewu

External Examiner

Date

Dr. Mutari Ali Hajara

Internal Examiner

Date

Dr. G.S.M. Galadanci

Supervisor

Date

Dr. T.H. Darma

Head of the Department

Date

Prof. S.Y Mudi

Representative of Post Graduate School

Date

ACKNOWLEDMENT

All praise, thanks and gratitude is to Almighty Allah for giving me the opportunity, ability and endurance to carry out this research. In Allah we seek guidance and in him we seek refuge from the evil of our soul, the mischief of our deeds. His peace and blessing be upon his last prophet (S.A.W), his household and all his companions.

My great appreciation goes to my humble supervisor and mentor Dr. G.S.M Galadanci for his contributions, assistance, patience, advice and guidance toward the successful compilation of this work despite his tight schedule, may blessing of Allah be with him and may Allah reward him abundantly.

My utmost gratitude and appreciation goes to my Internal Examiner Dr. Muktari Ali Hajara for his time to go through this dissertation, his contribution and guidance. May the blessing of Allah be with him and his family.

My profound thanks and appreciation goes to my parents and siblings for their encouragement and assistance in my studies and life in general. Also to the entire family of Engr. Bashir Ibrahim most especially Hafsat Bashir Ibrahim for endurance toward the completion of my research work. May Allah bless you all.

My special thanks and appreciation goes to my lecturers, friends and colleagues most especially; Mal. SulaimanGana, Mal. Bello, Ruhullahi Muhammad, Abdulrasheed Abu Sufyan, Usman Umar Danmama, Aisha Musa Karaye and many more for giving me support and encouragement, I really appreciate it.

My utmost gratitude and appreciation goes to Maryam Yahaya Muhammad (MYM) for her contributions, guidance and support. May the blessing of Allah be with her and herfamily.

And finally, my sincere appreciation goes the entire military, academic and non academic staffs of Air-force Comprehensive School kwa, Kano and Kano State College of Art, Science and Remedial studies for their support toward the successful completion of my research. Thanks alot, May Allah reward you all.

DEDICATION

This research work is dedicated to the memory of my beloved mother Malama Mulikat Adoke Tijjani who passed away some years ago, May her gentle soul rest in perfect peace and may Allah (S.A.W) grant her Jannatul Firdausi as final abode. I love you so much mother but almighty Allah knows the best.

TABLE OF CONTENT

Title Page.....	ii
Declaration.....	iii
Certification.....	iv
Approval.....	v
Acknowledgement.....	vii
Dedication.....	viii
Table of Content.....	xii
List of Figures.....	xii
List of Tables.....	xiii
Abstract.....	xiv

CHAPTER ONE

GENERAL INTRODUCTION

1.0 Introduction.....	1
1.1 Statement of Problem.....	2
1.2 Aim and Objectives.....	3
1.3 Scope of the Research.....	3
1.4 Flow-code5.....	3

1.4.1 Features of Flow-code5 Programmer.....	4
1.4.2 Benefits of Flow-code5 Programmer.....	5
1.5 Microcontroller.....	6

CHAPTER TWO

LITERATURE REVIEW

2.0 Lighting Control System.....	8
2.1 History of Lighting Control System.....	9
2.1.1 Lighting control techniques.....	10
2.1.2 Theatrical lighting control system.....	11
2.2 Lighting Control Functions.....	12
2.2.1 On/Off.....	12
2.2.2 Occupancy recognition.....	12
2.2.3 Scheduling.....	13
2.2.4 Tuning.....	14
2.2.5 Daylight harvesting.....	14
2.3 Categories of Light Control Systems.....	17
2.3.1 Manual control systems.....	17
2.3.2 Automatic controls.....	18
2.4 The Benefits of Lighting Control Systems.....	18
2.4.1 Energysavings.....	18

2.4.2 Utility cost savings.....	19
2.4.3 Increased worker productivity.....	20
2.4.4 Error reduction.....	21
2.4.5 Expanded space.....	21
2.4.6 Improved aesthetics and image.....	22
2.4.7 Mood setting.....	23
2.4.8 Better space marketability.....	23
2.4.9 Space Savings.....	23
2.4.10 Heightened security.....	24
2.4.11 More effective facility management.....	24
2.4.12 Improved worker morale.....	25
2.4.13 Environmental enhancement.....	25
2.5 Lighting Control System Options and Their Applications.....	26
2.5.1 Switching controls.....	27
2.5.2 Dimming controls.....	34
2.5.3 Integrated lighting control systems.....	36
2.6 Related Research Works.....	38

CHAPTER THREE

DESIGN AND IMPLEMENTATION

3.0 Design Procedures of Automatic Time-Based Street Lighting Control System.....	40
3.1 Design Architecture.....	40
3.2 Software Development.....	41
3.3 Hardware Specifications.....	43
3.4 Design Equations And Calculations.....	44
3.4.1 Regulator voltage.....	44
3.4.2 Transformer.....	45
3.4.3 LCD filament.....	45
3.5 System Working Principle.....	45
3.6 Detail Procedure for Simulation, Construction, and Testing using Flow-code5.....	47
3.6.1 Construction	49
3.6.2 Testing.....	50

CHAPTER FOUR

RESULTS AND DISCUSSION

4.0 Results and Discussion.....	51
4.1 Simulation Result of Automatic Time-Based Street Light Control System Using Flow-Code5.....	51

4.2 Comparative Results of Energy Utilization.....	53
4.3 Discussion.....	54

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.0 Summary and Conclusion.....	56
5.1 Recommendations.....	56
References.....	57

LIST OF FIGURES

Figure 1.0: PIC16F690 Microcontroller.....	7
Figure 2.0: Lighting Control Techniques.....	11
Figure 2.1: Typical Weekday Lighting Schedule.....	14
Figure 2.2: Lamp Lumen Depreciation of commonly used lamps.....	16
Figure 2.3: Results of an IERI study that frequency of errors declines when illumination levels are increased.....	20
Figure 2.4: Examples of on/off local configurations.....	29
Figure 2.5: Time switch with astronomical feature.....	32
Figure 2.6: Occupancy sensor system.....	33
Figure 2.7: System dimmer.....	35
Figure 2.8: Integrated lighting control system.....	38
Figure 3.0: Transparent block diagram of Automatic Time-base street light control system.....	41

Figure 3.1: The flow-chart operation of the proposed design.....	42
Figure 3.2: Circuit diagram of the proposed design.....	44
Figure 3.3: Simulation of Automatic Time-based Street Light control system.....	48
Figure 4.0: On Time Setting.....	51
Figure 4.1: Light On.....	52
Figure 4.2: Off Time setting.....	52
Figure 4.3: Light Off.....	52

LIST OF TABLES

Table 1: PIC116F690 Memory Storage.....	7
Table 2: Component Used	49
Table 3: Results of Energy Utilization.....	53

ABSTRACT

In this work, an Automatic Time-based Street Light Control System using microcontroller was designed, implemented and simulated. The street light control system was designed using microcontroller (PIC16F690) and the micro chip was programmed using flow-code5 programmer to automatically turn ON and OFF the light based on the time required by the user. The designed system was implemented, simulated and then tested. The result of the test shows that it works as designed, thus automatically turning ON and OFF the light as set by the user. In this system, cost of maintenance was drastically reduced and it provides an effective measure to save about half of the energy consumption with 86.4% efficiency by preventing unnecessary wastage of electricity, caused due to lighting of street-lights when it is not required.

CHAPTER ONE

INTRODUCTION

1.0. GENERAL INTRODUCTION

Street lighting is one of the vital parts of a city's infrastructure where the main purpose is to light the city's streets during dark hours of the day. Lighting can account for 10-38% of the total energy bill in typical cities worldwide (Mustafa *et al.*, 2013). Street lighting is a predominantly critical concern for public authorities in developing countries because of its strategic significance for economic and social stability. Many street light systems are being connected underground instead of wiring from one utility post to another.

Early lamps were used where light primarily served the purpose of security, both to protect the traveller from tripping on the path over something or keeping the potential robbers at bay (Roskell *et al.*, 1993). Incandescent lamps were primarily used for street lighting until the advent of high-intensity discharge lamps. They were often operated at high-voltage series circuits. Series circuits were popular since the higher voltage in these circuits produced more light per watt consumed. Furthermore, before the invention of photoelectric controls, a single switch or clock could control all the lights in an entire district.

To avoid having the entire system go dark if a single lamp burned out, each street lamp was equipped with a device that ensured that the circuit would remain intact.

Today, street lighting commonly uses high-intensity discharge lamps, often high pressure sodium lamps (HPS) (Bullough *et al.*, 2009).

Major advantages of street lighting include prevention of accidents and increase in safety (Rea *et al.*, 2009). Studies have shown that darkness results in a large number of crashes and fatalities, especially those involving pedestrian; pedestrian fatalities are 3 to 6.75 times more likely in the dark than in daylight (Sullivan and Flannigan, 1999) Towns, cities, and villages use the unique locations provided by lampposts to hang decorative or commemorative banners.

1.1. STATEMENT OF THE PROBLEM

In Nigeria, too much amount of energy is wasted on street lighting due to lack of automatic control system to turn On/Off were necessary e.g., the street light around the hostel of Bayero university kano. The current trend is the introduction of Automation to Control Street lighting. A sensor version of similar design that is commonly in use e.g., B.U.K road is accompanied

with high cost in maintenance and materials beside problem with irregular duration.

1.2. AIM AND OBJECTIVES

This research is intended to solve the aforementioned problems by employing automatic time-based light control schemes, with emphasis on programming and memory size storage.

The research objective is to meet the following aims:

- 1) Perfect usage of streetlights and other lighting control system (i.e. Home, Office, Theatre Art, etc.) in any part of country.
- 2) To employ software tool to implement the design by simulation.
- 3) To avoid the high cost in maintenance.

1.3. SCOPE OF THE RESEARCH

This research focuses on the aspect of programming a circuit using a flow-code5, which can be controlled by microcontroller PIC16F690. This circuit will be activated only when the time reaches the On-time and will remain ON until the time reaches the Off-time. Both the On-time and Off-time setting are saved in the Microcontroller memory.

1.4. FLOW-CODE5 PROGRAMMER

Flowcode5 is one of the World's most advanced graphical programming languages for microcontrollers. The great advantage

of Flow-code5 is that it allowed for those with even little experience to create complex electronic systems in minutes.

1.4.1. Features of Flow-code5 Programmer

- 1) Supported microcontrollers: Microchip PIC24, Atmel AVR, Atmel ARM.
- 2) Supported communication systems: Bluetooth, CAN, FAT, GPS, GSM, I2C, IrDA, LIN, MIDI, One wire, RC5, RF, RFID, RS232, RS485, SPI, TCP/IP, USB, Wireless LAN, Zigbee.
- 3) Supported components: ADC, LEDs, switches, keypads, LCDs, Graphical colour LCD, Graphical mono LCDs, Sensors, 7-segment displays, Internal EEPROM, communication systems, Touch screen LCD, Web server.
- 4) Supported mechatronics: Accelerometer, PWM, Servo, Stepper, and Speech.
- 5) Supported subsystems: MIAC, MIAC expansion modules, Formula Flow-code.
- 6) Panel designer: Design a panel of your choice on-screen and simulate it.
- 7) In-Circuit Debug (ICD): When used with EB006 PIC Multi programmer, EB064 dsPIC/PIC24 Multi programmer or Flow-Kit.

- 8) Tight integration with E-Blocks: Each communication system is supported by E-blocks hardware.
- 9) Virtual networks: Co-simulation of many instances of Flow-code for multi-chip systems. Co-simulation of MIAC based systems with MIAC-bus.

1.4.2. Benefits of Flow-code5 Programmer

- 1) Save time and money: Flow-code5 facilitates the design of electronic systems based on microcontrollers.
- 2) Easy to use interface: Simply drag and drop icons on-screen to create an electronic system without writing traditional code line by line.
- 3) Fast and flexible: Flow-code5 has a host of high level component subroutines system development. The flowchart programming method allows user to develop microcontroller programs.
- 4) Error free results: Flow-code5 allows you to simulate on the screen and see the result before downloading into microcontroller.
- 5) Open architecture: Flow-code allows you to view C and ASM code for all programs created and customise them. Access circuit diagram equivalents to the system you design through the datasheets and support material.

6) Fully supported: Flow-code is supported by a wide range of interface materials and books for learning about it, and developing electronic systems.

1.5. MICROCONTROLLER

Microcontroller sometimes called a single-board computer is a device which integrates numerous components onto a single chip thereby making up a complete control system suitable for electronics systems design. It is mostly used for building intelligent systems such as; military hardware, robotic systems, industrial automation, home application e.t.c.

The PIC16F690 is a microcontroller in the PIC family produced by microchip technology (Jasio *et al.*, 2008). They allow electronics designers and hobbyists add intelligence and functions that simulate big computers for almost any electronics product or project. It features (8-bits), 18 input and output pins, and the remaining pins VDD and VSS are positive supply and ground reference respectively as shown in Figure 1.0.

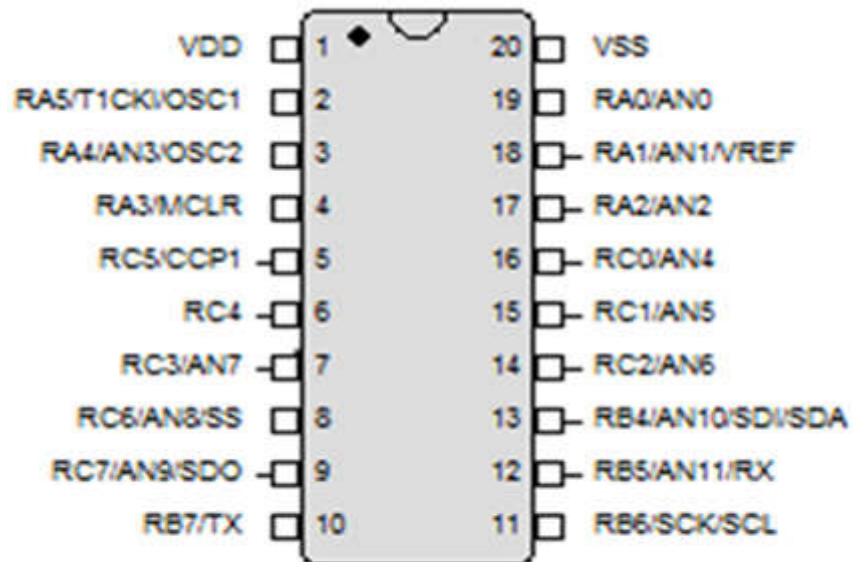


Figure 1.0 PIC 16F690 Microcontroller
(Jasio *et al.*, 2008)

PIC16F690 microcontroller has been selected as the controller in my design due to the low cost, compatibility, compact size and easy interfacing over several types of other controllers including Field Programmable Gate Array (FPGA) and Programmable Logic Controller (PLC). It has inbuilt oscillator of 4MHz and 8MHz, it uses serial programming algorithm, it's easy to erase and requires no special tools to do so, and high memory storage as shown in Table.1. The status of the system operation is displayed on the LCD and the lamps.

TABLE 1. PIC 16F690 Memory Storage

	Total	Used	Free	% Used
ROM	4096 word	2670 word	1426 word	65.2
RAM	256 bytes	140 bytes	116 bytes	54.7
Heap size	115 bytes	79 bytes	36 bytes	68.7

CHAPTER TWO

LITERATURE REVIEW

2.0. LIGHTING CONTROL SYSTEM

A lighting control system is an intelligent network based lighting control solution that incorporates communication between various system inputs and outputs related to lighting control with the use of one or more central computing devices.

Lighting control systems are widely used on both indoor and outdoor lighting of commercial, industrial and residential spaces. Lighting control systems serve to provide the right amount of light where and when it is need.

The demand for controls created by their rapidly growing popularity has encouraged manufacturers to invest millions of dollars in research and development, to bring to the market new controls that are even more versatile, more reliable, and more cost-effective than ever before (Craig, D. 2006). In fact, modern lighting controls tend to create clear and convincing evidence that a building is up to date, by relying on technology that has been expressly designed to enhance the flexibility of lighting while at the same time avoiding waste (Craig, D. 2006). It is particularly interesting to see what has

happened to the cost of lighting controls over the years. While the price of so many other products has increased, the cost of modern lighting controls has come down, due in large part to the twin impacts of mass production of electronic components and competition. At the same time, the value of the benefits associated with lighting controls-energy savings, demand reduction, increased productivity, and more retail sales, to mention a few has risen steadily.

2.1. HISTORY OF LIGHTING CONTROL SYSTEM

Modern lighting control systems methods are governed by complex computer systems that make it possible to operate hundreds of lights at one time. They also make it possible to use the many digital lights and accessories developed over the past two decades. Although each manufacturer has its own particular method of handling technical issues, the core technology that makes all of them work is basically the same.

The first type of control for electrical lighting was simply a bank of switches that turned the lights on and off (Craig, D. 2006). Not surprisingly, artists in the theatre were not entirely satisfied with the “lights up, lights down,” nature of switches in controlling lighting for sensitive scenes. Not long after the use of electric lighting

became widespread, resistance dimmers were developed so that it was possible to fade in and out of scenes. Fading indicates that the lighting change occurs over a period of time, which is an important element in lighting design. The term blackout is used to describe what happens when all of the stage lights go out instantly. (Or as fast as the cooling filaments will allow) Although blackouts are frequently used to indicate a sudden end to the action on stage, they are not appropriate for most lighting changes. Lights fading in and out, or from one look to another is a very important concept in artistic lighting.

2.1.1 Lighting Control Techniques

The main strategies for lighting control include: local switching and dimming, presence detection, daylight linked and time operated. The following diagram shows effective strategies for lighting control.

Each zone where lighting controls are to be used should be evaluated for the best strategy of control. Manual control includes the way the switches are linked to individual and groups of luminaries. Controllers can also be automated, and these can react to presence detection, daylight availability or time of day (Seai, 2014).

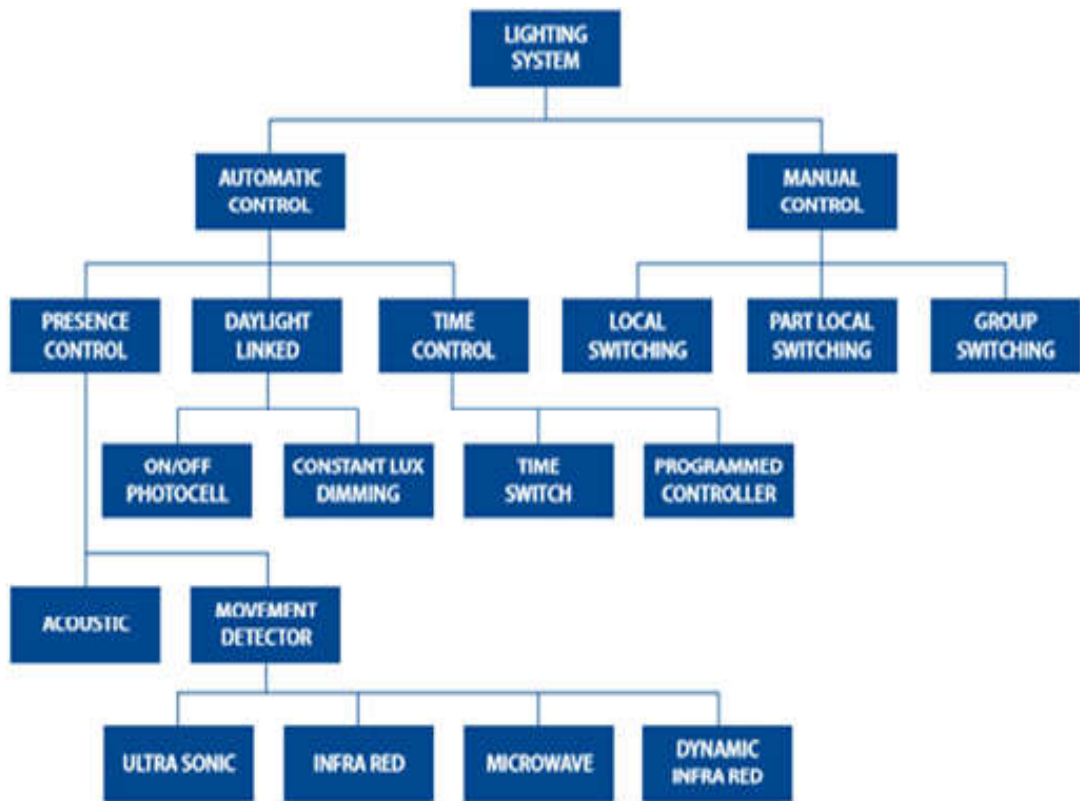


Figure 2.0 Lighting control techniques
(Seai, 2014)

2.1.2 Theatrical lighting control system

Architectural lighting control systems can integrate with a theatre on-off and dimmer controls are often used for house lights and stage lighting, and can include work lights, rehearsal lighting and lobby lighting. Control stations can be placed in several locations in the building and range in complexity from single buttons that bring up preset options-looks, to in-wall or desktop LCD touch screen consoles. Much of the technology is related to residential and commercial lighting control systems.

The benefit of architectural lighting control systems in the theater is the ability for theater staff to turn work lights and house lights on and off without having to use a lighting console.

2.2 LIGHTING CONTROL FUNCTIONS

Lighting control systems perform several discrete functions: on/off, occupancy recognition, scheduling, task tuning, daylight harvesting, lumen depreciation compensation, and demand control (Craig, D. 2006). Some lighting controls perform only one function; many perform more than one, typically on an automated basis. The following discussion provides more detail about each of these functions.

2.2.1 On/Off

The basic control function, typified by the common wall switch, is turning lighting on or off. The degree to which this function is performed depends on other variables or control functions such as occupancy recognition and scheduling, which are described below.

2.2.2 Occupancy Recognition

Occupancy recognition is commonly used in intermittently occupied areas or rooms, typically to turn lights on when people are present and off automatically after a certain amount of time when they are

no longer present. Experience indicates that occupancy detection can save significant amounts of energy and money by preventing the waste caused by keeping lights on when they are not needed. Contemporary occupancy recognition devices rely on one of two principal technologies: ultrasonic or passive infrared. Ultrasonic systems transmit an inaudible sound in the frequency of 20,000 to 40,000 Hz to a receiver. Any movement alters the transmitted sound waves and is recognized by the receiver, causing it to initiate control action. Passive infrared sensors use a pyroelectric detector and a Fresnel lens to sense the radiation emitted naturally by people. Movement of the “heat source” is transmitted through the lens to the detector, triggering a control event. Occupancy recognition is “packaged” into a variety of systems. In some, they serve only to turn lights off, in case the individual leaving the room forgets to.

2.2.3 Scheduling

When scheduling is applied, electric illumination in given areas is activated, extinguished, or adjusted according to a predetermined schedule. In some cases, the systems control may be vested in a different device. For example, the system indicated in Figure 2.1 would be under the direction of daylight harvesting controls from 9:00 am through 4:00 pm and, from 11:00 am to noon, and 2:00 pm

to 4:00 pm, demand management controls would have precedence. Scheduling is a time-based function and, as a consequence, it is most suited for facilities or spaces where certain things happen at certain times. Because “off-normal” conditions inevitably arise, local overrides usually are provided.

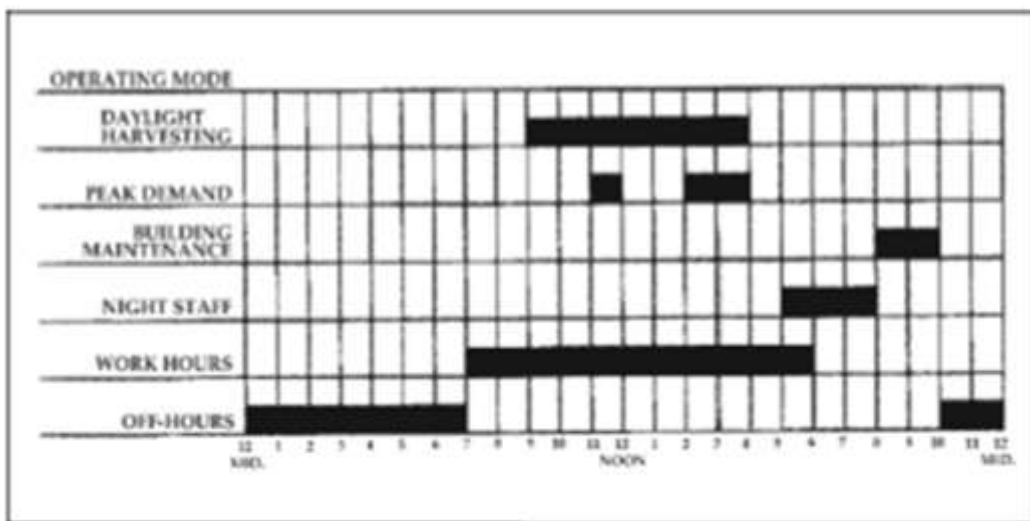


Figure 2.1 Typical weekday lighting schedule.
(Craig, D. 2006)

2.2.4 Tuning

Tuning means; adjusting the light output of a luminaries or a system of luminaries to the specific level needed for the task or other purpose, such as aesthetics. It is most commonly done through dimming. It can also be accomplished through switching, as when ballasts of a four lamp luminaries are wired in such a way that the two inboard and two outboard lamps are separately switched, permitting full light output or 50 percent light output. Tuning can

create significant monetary benefits through energy use reduction. In essence, it helps assure that only the amount of light needed is actually provided. The more flexible and easily controlled the system is, of course, the more benefits that can flow. For example, when a given worker is able to adjust electric illumination to optimal levels for that specific person, productivity will be higher. Long-term benefits are also apparent, as when tasks change or are relocated.

Tuning is also used for aesthetic purposes, when light output is adjusted to create dramatic effects of one type or another. Virtually any type of lighting system can be tuned, and particular advances have been made in the field of fluorescent and high-intensity discharge (HID) lighting. While dimmable fluorescents have been available for many years, new control modules and electronic ballasts now help assure high-quality effects and new levels of cost savings. Similarly, new HID fixtures and auxiliary equipment enable light levels to be varied, which was not possible a few years ago.

2.2.5 Daylight Harvesting

Daylight harvesting is applied when daylight entering a space can't be put to positive use. The systems involved use strategically

located photocells to determine the ambient light level. This information is fed to a control device that then rises or lowers luminaries output or turns off selected luminaries to maintain the amount of light set for the space. The adjustment occurs gradually, so occupants in a space are not aware of it. Response delays are also used to prevent frequent adjustments due to passing clouds or similar phenomena. Some buildings are designed to take advantage of daylight. Others have daylight available to them and using that daylight may or may not be worthwhile, depending on factors such as the tasks being performed and/or the orientation of workstations with respect to windows. Daylight also brings heat with it, which, in summer, might necessitate cooling unless appropriate window films are installed. In other words, if a building has not been designed to use daylight, some study is needed to help assure it can be put to positive use and to establish exactly what needs to be done in order to realize that gain.

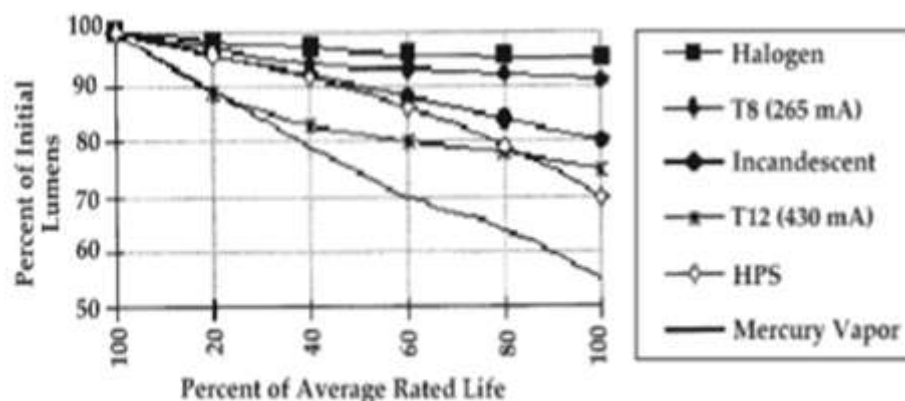


Figure 2.2 Lamp lumen depreciation of commonly used lamps.
(Craig, D. 2006)

2.3 CATEGORIES OF LIGHT CONTROL SYSTEMS

Lighting control systems generally can be categorized as manual or automatic (Seai, 2014).

2.3.1 Manual Control Systems

Manual control systems turn lighting systems on or off, or adjust light output, in direct response to manual adjustment e.g., flicking a switch or moving a dimmer slide. Manual lighting control systems include lighting panel board controls (circuit breakers) and contactors for controlling large numbers of luminaries, wall switches for flexible control for small groups of fixtures, key-activated switches for applications where lighting control security is important, and solid-state manual dimmers.

2.3.2 Automatic Controls

Automatic controls are either programmed to take a certain action at a specified time, or the action is event-initiated. Examples of automatic controls include time-based programmable controls for indoor and outdoor switching, photocell controls that respond to changes in light levels, occupancy sensor controls that operate by sensing the presence of people, and microprocessor-based programmable and network

control systems that provide flexible lighting systems control and integration.

2.4 THE BENEFITS OF LIGHTING CONTROL SYSTEMS

Modern lighting controls provide an array of benefits, ranging from energy savings and electrical demand reduction to supports of the functions for which lighting is needed (Craig, D. 2006). The bottom-line value of some of these benefits can be significant, creating paybacks that are best measured in weeks rather than years.

2.4.1 Energy Savings

Controls are the only devices that can help assure optimal use of energy and elimination of energy waste. By applying controls wisely, a building owner or manager can help assure that only the specific amount of lighting actually needed, if any, is provided. No matter how much efficiency may be designed into a system through selection of lamps, luminaries, ballasts, and shielding/diffusing media, maximum energy efficiency cannot possibly be achieved without effective controls.

2.4.2 Utility Cost Savings

For some people, utility cost savings and energy savings mean one and the same, but that seldom is the case. Almost all electric utilities

impose a demand charge on other-than-residential usage, and the cost involved can be substantial. Through effective controls, utility costs can be reduced through reduction of energy consumption (measured in kilowatt-hours or kWh) and demand (measured in kilowatts, or kW).

2.4.3 Increased Worker Productivity

The importance of lighting controls to worker productivity is underscored by the fact that maximum worker productivity cannot be attained unless workers are given optimal lighting conditions; that is, that quantity and quality of light that are best suited to the nature of the tasks involved and an individual worker's visual capability. If all tasks and all workers' eyesight were the same, lighting controls would not be needed to help maximize productivity. But the visual needs of workers vary considerably, and the tasks they perform not only differ, but can be altered during a given workday. Workers need to be able to adjust their lighting in order to create the conditions they need to perform their work as quickly and efficiently as Possible. See Figure 2.3 This study, as many others, points out those older workers, often considered among the most reliable employees, need better quality lighting to offset physiological changes that affect their eyes due to the aging process. While the reduced errors and improved

productivity that result from better lighting can justify greater lighting expense, the gains often are realized with reduced lighting expense, through proper selection of lighting management options.

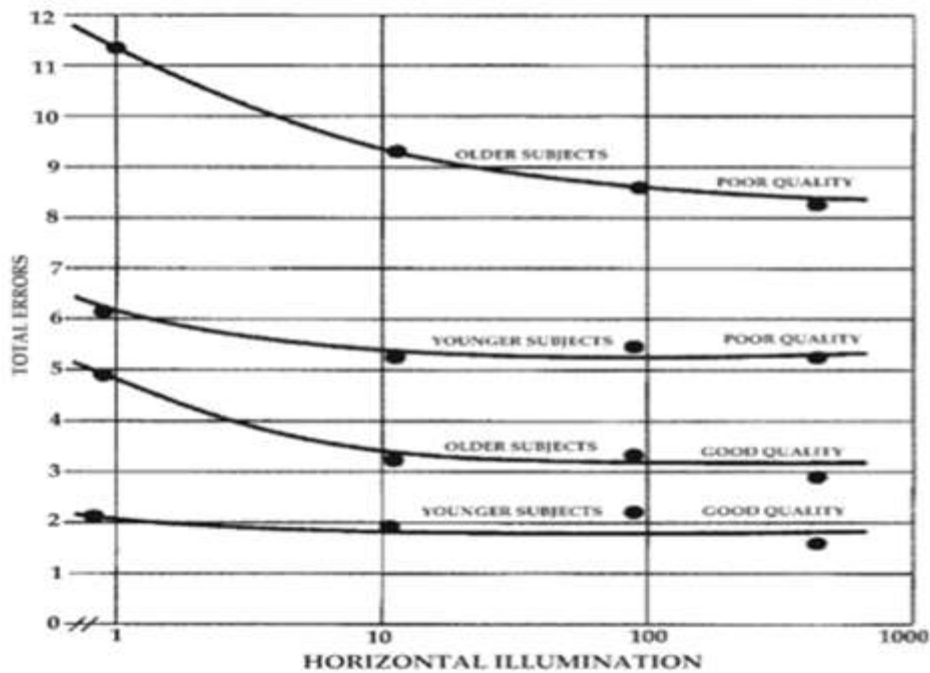


Figure 2.3 Results of an IERI study show that frequency of errors declines when illumination levels are increased.

(Craig, D. 2006)

2.4.4 Error Reduction

The same lighting control that contributes to enhanced worker productivity can also contribute to error avoidance. The cost of errors can be huge, leading to lost time and, potentially, more serious consequences. Particularly in those areas where an error can have costly consequences, obtaining the best possible lighting is a wise investment.

2.4.5 Expanded Space

Flexibility it has been reported that office layouts are modified on the average of once every three years. If the space is to be flexible, lighting must be flexible. Failing that, the lighting system would have to be overhauled every time the space is rearranged or different tasks are introduced to it. By having a lighting system whose luminaries' light output can be easily adjusted, the space itself can be easily adjusted, to accommodate new tasks and/or workstation locations. The cost savings involved can be immense, by avoiding the cost of luminaries relocation or replacement, or by avoiding the even more significant costs that can result when people are forced to perform their work in a space where lighting is a detriment rather than a support.

2.4.6 Improved Aesthetics and Image

Lighting controls can have a significant impact on lighting's ability to enhance aesthetics and affect image. Indoors, for example, lighting can be used to create highlights and contrasts, establish visual effects on walls, illuminate specific objects, and otherwise affect the appearance of a space and the objects in it. Lighting's abilities in this respect can be fine-tuned only with controls. Controls are needed in order to keep specific lighting designs

effective by compensating for lamp lumen disparities. And, when objects are moved or replaced, controls are needed to adapt the existing lighting to its new tasks. Controls are also valuable in areas affected by day lighting, to maintain visual interest and appeal as the angle and intensity of sunlight changes. Controls are the answer when it comes to creating varying lighting levels or even to alternating lighting systems created specifically for aesthetic purposes, as when the color of the illumination moves from reds, to pinks, to whites. Outdoors, much the same is true. Through lighting controls, a system can gain a level of sophistication and impact that otherwise would not be possible. And despite the many different ways in which lighting can be altered to such significant effect, the cost of the controls needed is small when compared to the value of impacts such as more effective marketing, better curbside appeal and more notice ability and attraction.

2.4.6 Mood Setting

Lighting affects mood and, through use of controls, those who control lighting in a space are in a position to affect the moods of those using the space. Restaurants or other dining areas comprise a typical case in point. To create an air of intimacy and romance,

lighting can be “turned down low.” In conference rooms, a low level of luminance can be used to encourage a relaxed approach to the topics at hand, while a far higher luminance might be used to stimulate people.

2.4.7 Better Space Marketability

Many control benefits are well-known. As such, many of today’s office managers or other responsible for locating new or additional space are looking for effective lighting as part of the package. When space is separately metered, so that individual tenants pay their own utility bills, it is important for them to have lighting controls to help keep those bills as low as possible. Controls also are essential to help adjust the lighting to meet the task and aesthetic needs involved. And, by having modern controls in place, it should not be necessary to spend much, if anything at all, to make the existing lighting fully compatible with whatever tasks a new occupant will be performing, no matter where in the space those tasks are performed. In short, effective controls contribute to the marketability of space.

2.4.8 Space Savings

In many circumstances, it may be necessary to have two or more spaces in order to support functions that have markedly different lighting needs. Through controls, it is possible to support multiple functions in one space, by being able to select exactly which luminaries will be activated, when, and to what extent. In the case of the Chesapeake & Potomac Telephone Company in Washington, DC, for example, one space was used for both a conference room and a video conferencing broadcast studio. Originally, designers thought that two spaces would be required. By using controls effectively, initial costs were reduced significantly, as were long-term costs.

2.4.9 Heightened Security

Lighting controls play a significant role in safety and security applications. For example, occupancy sensors can be used for daytime lighting control and for after-hours use, so that all lighting or a series of lights is activated instantly in the event of a detectable intrusion. Another example is a card access (entry/exit) system that can provide a command to the lighting control system to turn the lighting on for an occupant entering the building after hours. If the occupant turns on other lighting zones, the security personnel might be alerted to check the area.

2.4.10 More Effective Facility Management

Microprocessor-based lighting controls can make a facility far more responsive to the needs of building management personnel by effectively monitoring tenant lighting energy usage and costs. In some cases, a historic comparative analysis of lighting energy cost by individual load can be performed to identify operating problems. These types of controls can also contribute to better maintenance, by compiling lamp runtime and cycle data, basic factors that determine when maintenance is required. This permits less lighting equipment downtime, which increases tenant goodwill and permits performance of maintenance operations.

2.4.11 Improved Worker Morale

Better lighting often causes an improvement in employee morale, not only because the new lighting often is more comfortable, but also because it enhances the appearance of the illuminated space. Employee morale can be affected even further when employees can have individual control over their lighting, because it permits them to convert the lighting into an individualized tool. It also gives employees more control over their own space.

2.4.12 Environmental Enhancement

When individual customers reduce their energy demand and use, a utility can serve more people from the same generating facility. Over time, as customer efficiency is enhanced, less electricity has to be produced per capita, resulting in fewer pollutants being discharged into the air, especially by utilities that rely on coal. While the actions of one person or the energy performance of one building may not have much impact on the environment, using that as an excuse to put off positive action no longer is acceptable to many Americans. Problems such as acid rain are frighteningly real and pose serious concerns for the future. As such, if our future is to have a more secure environment, each person and each building must make a contribution, by not being a source of waste. Without effective control of lighting, waste is inevitable. This waste is harmful to the nation's environment and to the pocketbook of whoever must underwrite it.

2.5 LIGHTING CONTROL SYSTEM OPTIONS AND THEIR APPLICATIONS

Many types of lighting control systems are available to permit "real time" management of electric illumination (Craig, D. 2006). With few exceptions, these controls are applicable to virtually all types of buildings and most types of spaces e.g., offices, stores,

restaurants, hotels and motels, hospitals, warehouses, prisons, factories and museums. For purposes of this discussion, control options are grouped as switching controls, dimming controls, and integrated lighting control systems. Each is discussed below.

2.5.1 Switching Controls

Switching controls turn lights on and off, and many perform other functions as well. At a minimum, every space should be equipped with manual switching to permit occupants or facility management to control lighting usage. Switching off lighting when it is not needed not only reduces lighting energy consumption, it also results in less lighting system heat build-up, reducing the cooling load and air-conditioning needs. This reduces energy consumption further and provides additional savings. The following discussion addresses switching controls in ascending order of control intelligence.

Lighting contactors

Lighting contactors permit manual or automatic control of large blocks of lighting loads. Three types of lighting contactors in common use are: feeder-disconnect-type (rated up to 1200A to control large blocks of load); multi pole contactors with as many as

12 poles (rated 20A) for multi branch circuit control; and single-pole relays rated 20A with low-voltage control for individual branch circuit or luminaires control. Contactors are used with many forms of automatic controls, as through integration with solid-state lighting control modules that operate as a function of photocell or occupancy sensor input or with microprocessor-based energy monitoring and control systems.

Key-activated switches

Key-activated switches are wall switches that turn lighting on and off by a key. They are installed to prevent unauthorized or accidental use of certain lighting circuits. They are particularly useful for HID light sources that must cool down before they can be activated.

Intelligent On/Off local devices

Intelligent on/off local devices consist of at least two elements: a logic or intelligence module and a power switching device. The logic or intelligence elements vary depending on the needs of the specific applications.

Figure 2.4 illustrates two intelligent on/off local configurations that provide a simple approach to controlling a single load, using only one intelligent input.

The intelligent input in its simplest form can be a time control or an occupancy sensor. Each typically is used to control a single load and is wired directly to it.

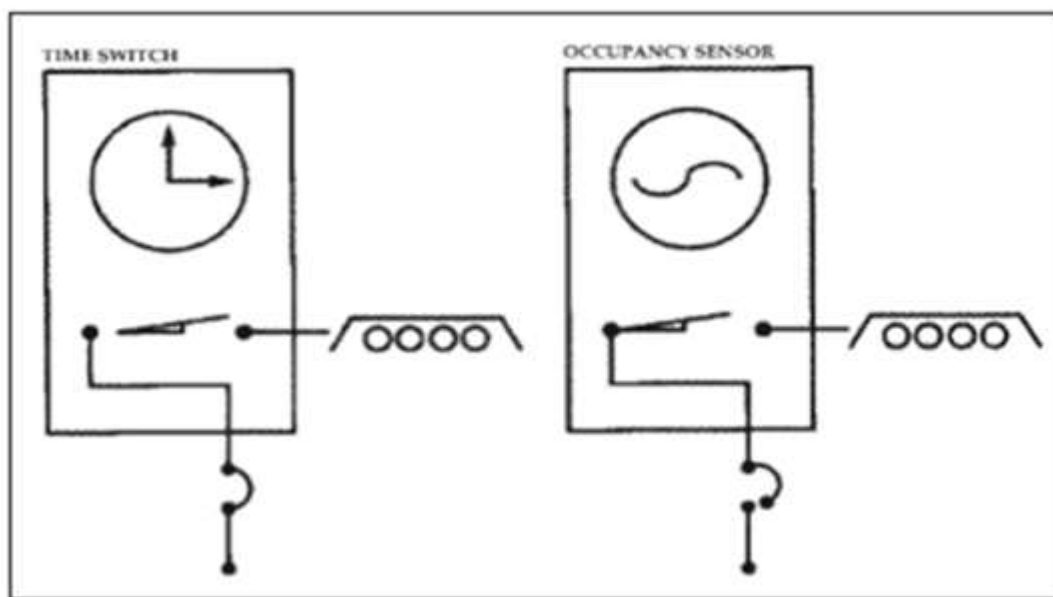


Figure 2.4 Examples of on/off local configurations.
(Craig, D. 2006)

Time Controls

These controls, also known as time clocks or time switches, activate and deactivate their loads at user-determined times. They are available as electromechanical or electronic devices. Many types of electromechanical time controls are manufactured. The 24-

hour time switch is a basic unit, usually capable of activating and reactivating a load at least several times each day. Used indoors, it could activate lighting at 8:00 am, deactivate it at noon, reactivate it at 1:00 pm, and deactivate it again at 6:00 pm. Through the use of two 24-hour time switches, selected luminaries could be turned off and on at different times or, through split ballasting, different lighting levels could be obtained at different times each day. A seven-day time switch affords the same daily selections as the 24-hour device for one week at a time. Figure 2.5 illustrates a time switch with an astronomical feature that automatically compensates for sunrise/sunset time shift during the year. This option provides an alternative to photocells for controlling exterior lighting. Most time switches are available with back-up drives to maintain accuracy despite a blackout or brownout. Some rely on spring-wound mechanisms, others use batteries. This keeps selected loads off during holidays and weekends. Microprocessor-based time controls provide a higher degree of flexibility than electromechanical devices, permitting users to program more on/off actuations each day, and to create special schedules for holidays or certain functions. Indoors, time control is ideally suited for those applications with high predictable occupancy, such as stores and factories. When used in an application with non-

predictable occupancy such as an office, the time function should be supplemented with local overrides. In such cases, the time control should be capable of multiple offs to provide “off sweeps” to catch those areas overridden and left on. Electronic time controls are needed for that purpose. Care must be taken not to put an occupied area in total darkness with a time clock off. Multiple-level switching’s to provide various lighting levels can be employed to avoid exposing occupants to a safety risk. The most advanced time controls automatically flick lights off and on to warn occupants that their area is about to go off, and then protect the individual overrides from the next timed sweep. The time control’s intelligence must be able to recognize an override by the occupant while the lights are still on and protect that override. These occupant-sensitive scheduling devices may provide a timed override with another warning when the override is about to go off. To assure proper application and occupant convenience, indoor time controls could be evaluated using the following criteria:

- Ability to provide on/off actuation matched to the needs of the space or load;
- Ability to be overridden by a local switch with automatic return to the schedule mode;

- Ability to maintain the operating schedule in the event of a power outage; and
- Ability to provide a warning in occupant areas that the lights are about to go off and then protect the occupant override.

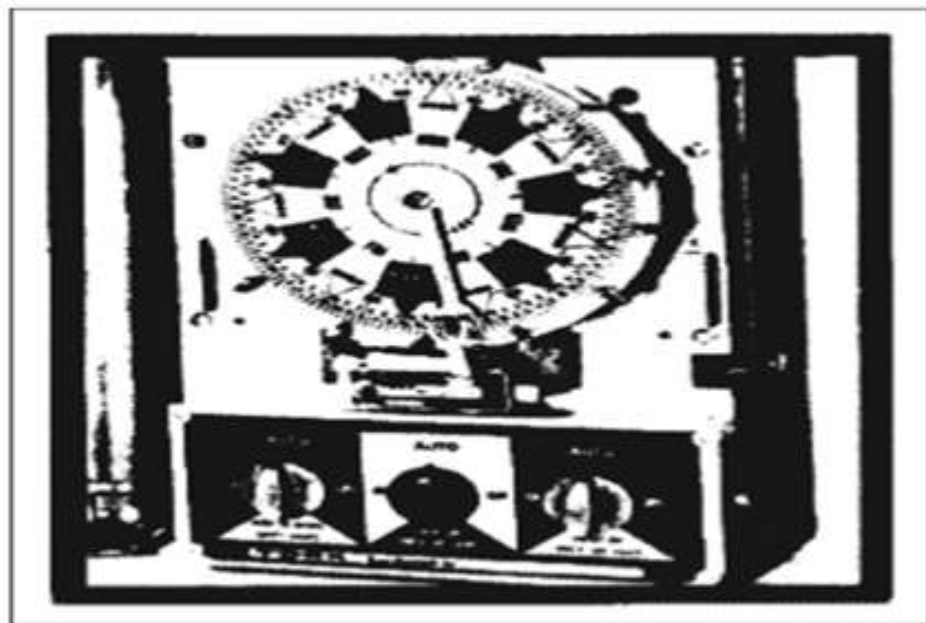


Figure 2.5 Time switch with astronomical feature.
(Craig, D. 2006)

Occupancy sensors

Occupancy sensors (see Figure 2.6) are automatic switches that control lighting based on the presence or absence of people. Their primary function is to switch electric illumination off automatically in an unoccupied space after the last person leaves that space. A

timing control provides light for a period of time after the area is vacated. Some models offer variable control while others have a fixed time delay. Issues such as reduced lamp life, because of frequent switching may enter the decision of using sensors. In most cases, the reduced hours of lamp operation and energy savings more than offset any effect the switching may have on lamp life.

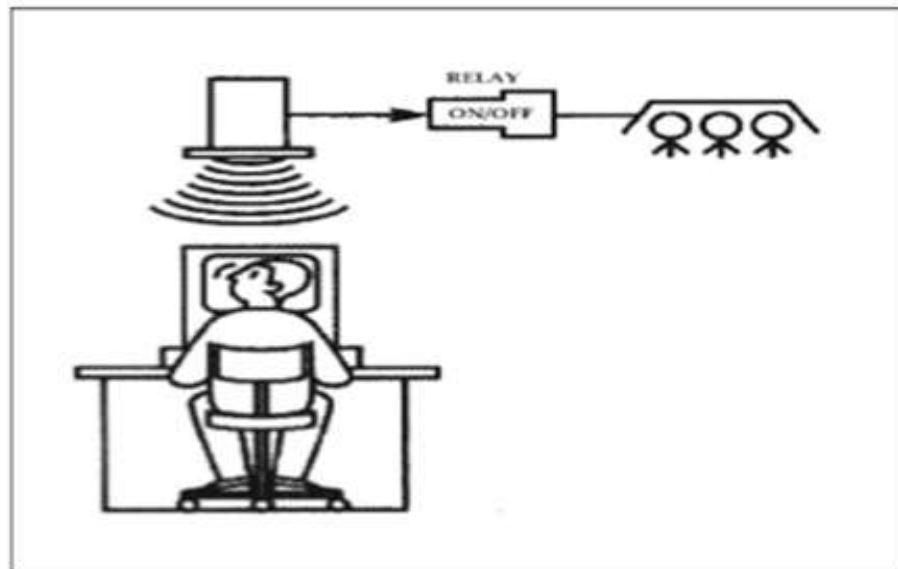


Figure 2.6 Occupancy sensor system.

(Craig, D. 2006)

Occupancy sensors can be integrated with others such as a dimmer. When no motion is detected, lighting would be kept on, but at a predetermined low level. Then, when motion is sensed, lighting would be brought to a higher level or full output. Some manufacturers of occupancy sensors suggest that their products can be used to operate both lighting and certain types of HVAC

equipment (terminal units and multi-zone system dampers) and provide interface modules for that purpose. Occupancy sensors can also be used for intrusion protection with or without an audible (local and/or remote alarm). A wide array of sensors is available. These include sensors that replace standard wall switches, using the same box and wiring, to flush mounted and surface-mounted units that are designed for wall and/or ceiling placement, to those used specifically for halls and stairways, or for outdoor security lighting systems. These vary considerably with respect to the amount of square footage covered and overall “field of view.” The ability of ultrasonic and infrared sensors to detect minor motion and to avoid false activation in unoccupied areas varies considerably among the various products presently available. To help ensure occupant convenience and economic practicality, consider the following criteria in selecting a unit:

- Detection of minor motion. In order to avoid any inadvertent deactivation of lighting in occupied areas, the sensor should be sensitive to people movements such as turning a page in a book, picking up a telephone, or shifting in a chair.
- Large area coverage. The return on investment will be affected by the number of sensors required to cover a given area.

- Installation requirements. Units that are easy to install will reduce costs and improve the return on investment.
- Appearance. When sensors are visible, they should be attractive enough to help assure acceptability by occupants of the building.

2.5.2 Dimming Controls

Dimming controls are available for most types of lighting (Floyd and Parker, 1995). They can be integrated into automatic lighting control systems and can be used manually as well. Some dimming controls require use of magnetic or electronic dimming ballasts, while others employ an electronics package installed in the panel-board or elsewhere within the system. Dimming control technologies typically rely on either voltage reduction or waveform management. Voltage reduction is used principally with incandescent lighting. Full-range dimming is obtained by lowering the line voltage to the lighting systems without significantly affecting the shape of the AC line voltage. This technique is applicable to low-voltage incandescent lighting as well, except some solid-state transformers may not be capable of full-range dimming. Although voltage reduction also can be used with gas-discharge lighting (fluorescent, mercury vapor, metal halide, high-

pressure sodium, and low-pressure sodium), its effectiveness is limited unless special dimming ballasts are used.

2.5.3 Integrated Lighting Control Systems

Integrated lighting control systems (Figure 2.8) consist of manual or automatic components designed to control compatible electronic dimming ballasts. They can be interfaced with other micro processor based centralized lighting control systems or building automation systems. These systems can perform all of the functions that are critically important to energy optimization. They can sense

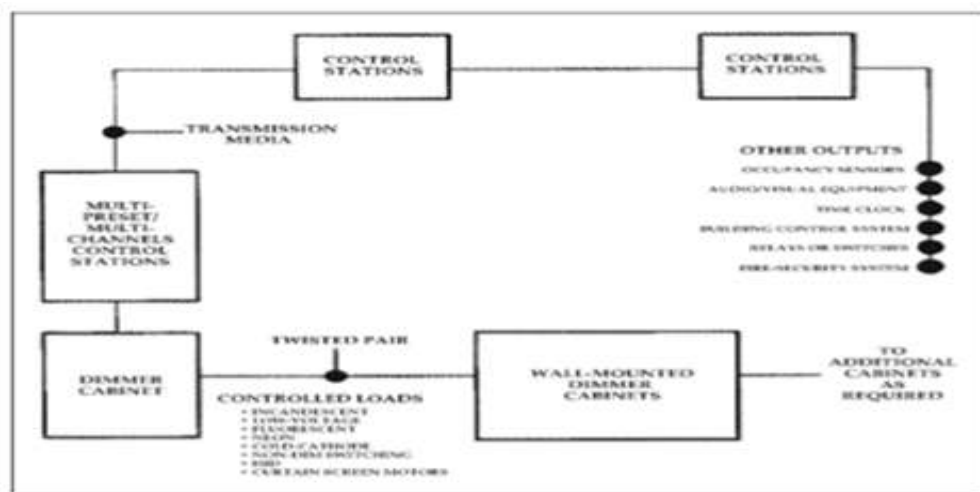


Figure 2.7 System dimmer.
(Floyd and Parker, 1995)

conditions in each area or zone and control lighting to yield maximum energy efficiency without affecting visual comfort or other conditions. Some of the newest, most advanced systems use distributed processing, resulting in “smart” components that have their own microprocessors permitting them to operate effectively without having to “ask” the central control unit for instructions. Data collected from various input sensors and commands issued to various remotely controlled points are sent through field interface devices and from the central control unit via data transmission media. Some of the more commonly used transmission media are:

- Twisted pair wiring is used to create a dedicated hardwired line between the lighting controllers sending or receiving data. Its transmitting performance is similar to that of a coaxial cable, as are its expandability and maintenance requirements.
- Coaxial cable consists of a centres conductor surrounded by a shield that protects against electromagnetic interference. Coaxial cable can operate at data transmission rates that are limited only by the data transmission equipment. Its multiplexing capability means there is no practical limit on the number of facilities that can be connected to the system, making it an excellent choice, especially when expandability is a concern.

- Triaxial cable has the same characteristics as coaxial cable. Composed of a coaxial cable plus an aluminium and drain wire, it is used where the cable will not be run in conduit.
- Fibre-optic (FO) cable uses the wideband properties of infrared light travelling through transparent fibres. It is best suited for point to point high-speed data transmission. The signal attenuation of high-quality fibre optic cable is far lower than the best coaxial cable. Repeaters are required for every 2,000 feet of coaxial cable, but are three to six miles apart in fibre optic systems.
- Microwave transmission is a practical alternative for communication between facilities separated by considerable distances. Microwave transmission affords fast scan rates, excellent reliability (assuming knowledgeable maintenance personnel are available), and compatibility with future requirements and expansion. The primary problem is high first cost: receivers and transmitters are needed in each building.
- Telephone lines are the most commonly used data medium when the lighting control computer is remote from the buildings served. The local telephone company charges a small initial connection fee and ongoing fees for monthly equipment lease. Maintenance is included in the monthly lease fee, with a certain level of service guaranteed.

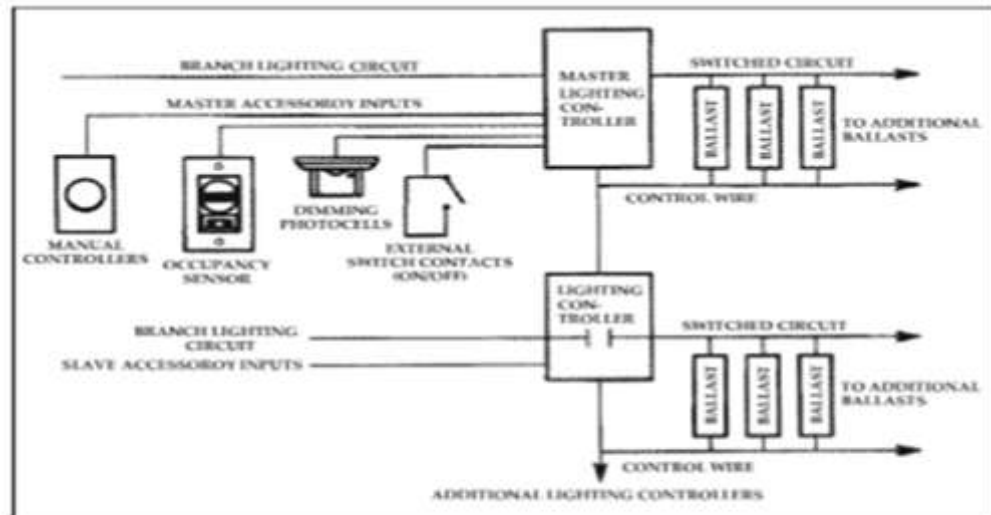


Figure 2.8 Integrated lighting control system.
(Craig, D. 2006)

2.6. RELATED RESEACH WORKS

There are many numbers of control approach and the ways in which its been controlled such as Design and Implementation of CPLD based Solar Power Saving System for Street Lights (Devi and Kumar, 2012), Design and Fabrication of Automatic Street Light Control System (Wazed *et al.*, 2010), Automatic Street Light Control System (Sudhakar *et al.*, 2013), Intelligent Street Lighting System Using G.S.M (Rajput *et al.*, 2013), Automatic Street Lighting using PLC (Madhuri *et al.*, 2013), Automatic Street Lighting System for Energy Efficiency based on Low Cost Microcontroller (Rohaid *et al.*, 2012), A Novel Design of an Automatic Lighting Control System for a Wireless Sensor Network with Increased Sensor Lifetime and Reduced Sensor Numbers

(Mohamaddoust *et al.*,2012), Power Consumption Reduction in a Remote Controlled Street Lighting System (Caponetto *et al.*, 2008), and A high Efficiency Autonomous Street Lighting System Based on Solar Energy and LEDs (Costa *et al.*, 2009).

CHAPTER THREE

METHODOLOGY

3.0. DESIGN PROCEDURES OF AUTOMATIC TIME-BASED STREET LIGHTING CONTROL SYSTEM

Three stages have been incorporated in to this design for the achievement of the system. Design architecture which is the main block function for the proposed design. While, the software

development based on the proposed design will be discussed in software part. The hardware specification will point out the components involved in this design from the time setting components pending the controller selection.

3.1. Design Architecture

The system developments start with the design architecture of the proposed system. Transparent block diagram has been used to produce the proposed design as shown in Figure 3.0. Two main components have been identified as the input to the system; Time setting and Power, while two components are been declared as the output which are; display and lamps.

The On time setting, off time setting and main time setting are the three processes managed and controlled by the PIC16F690 microcontroller.

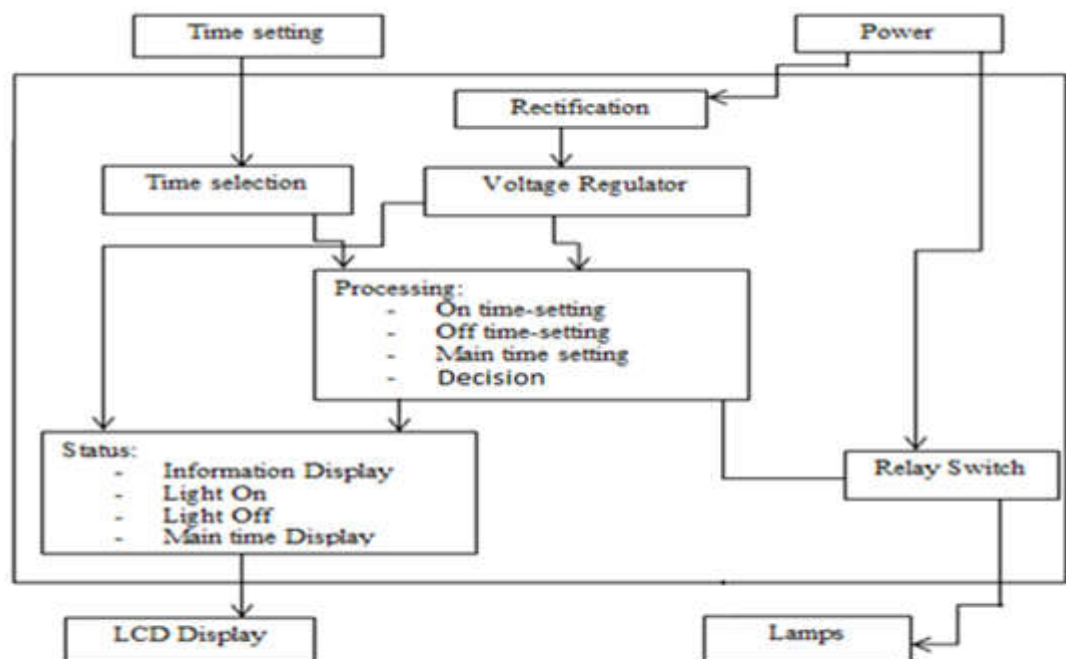


Fig 3.0 Transparent block diagram of Automatic Time-based Street Lighting Control System

3.2. Software Development

The microcontroller required a program to design and carry out the processes related to the proposed design. Flow-code5 programming tool has been used to construct the program for the proposed design. In this software development, several stages have been added as the stage of response for the program. It starts with initializing the LCD; the LCD has been used to indicate the current operation in the system based on the programmes. The decision for the time-on and time-off will be taken care of by the processes or operation of the system.

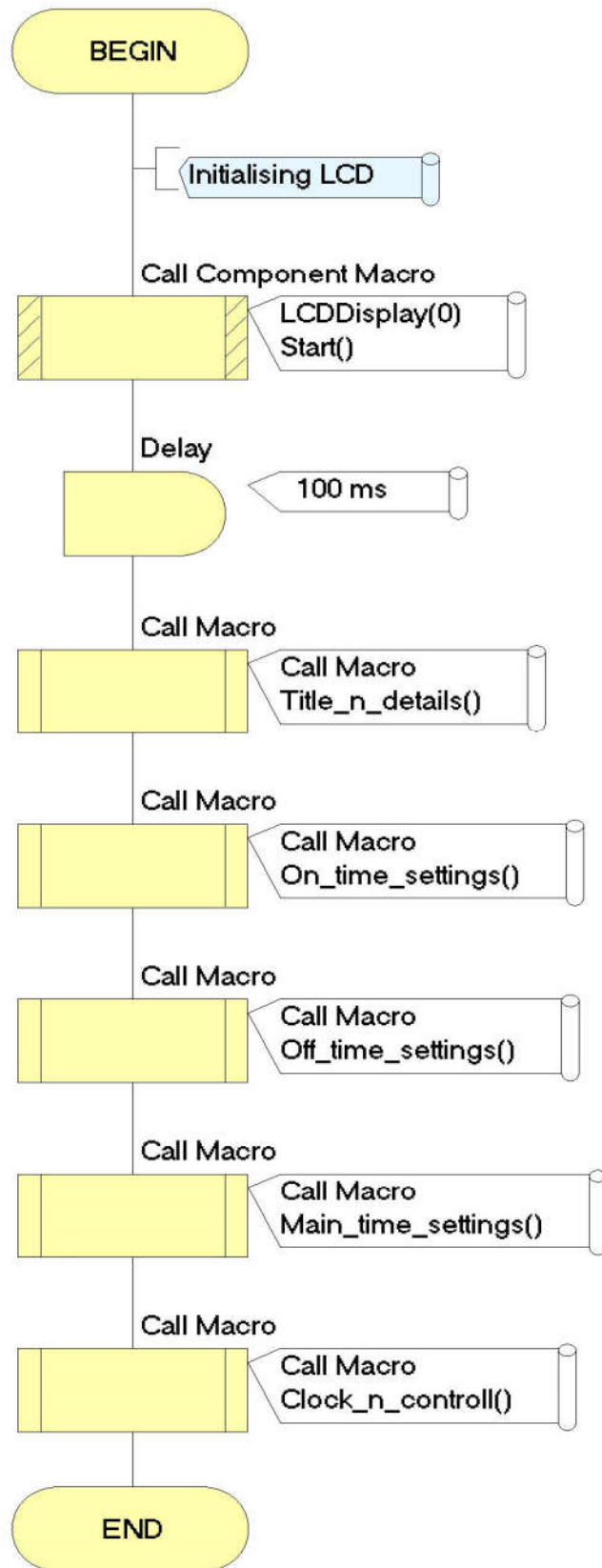


Figure3.1.The flow-chat operation of the proposed design

The system is initialised by determining three set of time inputted by the user or operator. The first category is the On-time setting, the second category is the Off-time setting and the last category is the main time setting. The control unit will then make decision based on the description below.

The lamps will be activated only when the main time is equivalent to the On-time and remain ON until the main time is equivalent to the Off-time.

3.3. HARDWARE SPECIFICATION

In hardware specification, the components for the proposed system have been classified based on the components group; input, control and output; two type of the input have been used in this system; the time setting and power supply.

The time setting is carried out by four buttons, this buttons are incremental or plus, decremental or minus, SHIFT and OK.

The shift buttons is used to select either hour, minute or second while incremental and decremental buttons are used to set the corresponding hour, minute and second and OK is used for saving the time into the microcontroller memory while the power supply is used to power on the overall system.

LCD and lamp are the two outputs used in the proposed system and connected to the microcontroller. The function of LCD is to

display the status of the system which include the main time, activate and deactivate, while the lamps are used as Prototype Street light. The complete circuit diagram for the system designed and the components involved is shown in Figure 3.2.

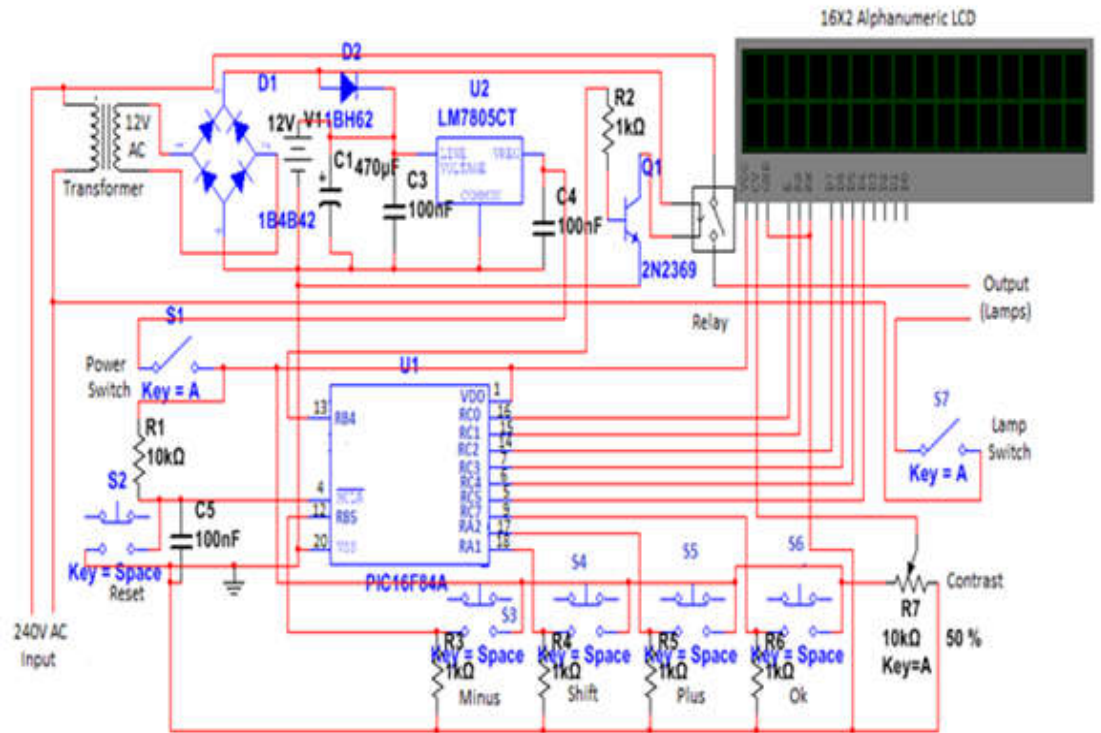


Figure 3.2 Circuit Diagram of the proposed design

3.4. DESIGN EQUATIONS AND CALCULATIONS

The values of Regulator Voltage, Transformer Ratio and LCD Filament were obtained using the equations;

$$V_{d.c} = 16.97V$$

3.4.1 Regulator Voltage

$$V_{in} = V_{d.c} + V_{drop}(diode) \quad (\text{Theraja, 2000}) \quad (1)$$

$$V_{in} = 16.97 + 0.7 = 16.27V$$

The output voltage from the regulator (7805) is $V_{out} = 5V$.

3.4.2 Transformer Ratio

$$\text{Transformer Ratio } (T_r) = \frac{\text{Primary voltage}}{\text{Secondary voltage}} \quad (2)$$

$$(T_r) = \frac{240}{12} = 20:1$$

3.4.3 LCD Filament

$$R_{\text{filament}} = 800\Omega$$

$$R_{\text{Limiting}} = 270\Omega$$

$$V_{dc} = 5V$$

Using voltage divider; (Theraja, 2000)

$$V_{\text{filament}} = \frac{R_{\text{filament}}}{R_{\text{filament}} + R_{\text{Limiting}}} \times V_{dc}$$

(3)

$$V_{\text{filament}} = \frac{800}{800+270} \times 5 = 3.74V$$

3.5. SYSTEM WORKING PRINCIPLE

System working principle has been used to summarize the principle of operation of the proposed design. When one terminal of 220-240V is applied to a transformer of 12V alternating current (AC) which is converted to 12V direct current by the means of rectification and then the output is inputted in to voltage regulator (LM7805CT) to produce an output D.C voltage of 5V which is connected to power switch

(S1) down to pin14 of the microcontroller and VCC of the LCD display, the same terminal is also connected to a relay to allow a small current flow circuit to control a higher current circuit.

When On-time, Off-time and the main time are saved on the microcontroller, as soon as the microcontroller senses the On-time or Off-time, the signal will be sent to the relay to be activated or deactivated which will set the lamps On or Off.

This system also have an inbuilt battery of about 11.3V, the purpose of this battery is to ensure that the time saved on the microcontroller memory should not be interrupted even if there is light failure for a short period of time. The battery can last for about 3 hours even if the LCD display goes off, the memory is still in active mode. This battery will regain its energy from the main sources either the power system is ON or OFF, in as much as the system is connected to the main source and there is flow of current, then the battery will continue charging.

The details of this circuit can be summarized as follow:

- 1) Pin 1 (VDD) of the PIC is connected to one of the terminals of the following components VCC of the LCD display, power switch (S1), R1, R3, R4, R5, R6 each with 1k Ω and R7 of 10k Ω .

- 2) Pin 18 (RA1) is connected to R2 is connected to reset bottom for resetting the circuit.
- 3) Pin 12 (Osc1 CLKIN) is connected to the other ends of R1, R3, R4, R5, R6, R7, RW and GND of the LCD.
- 4) Pin 20 (VSS) is connected to the ground.
- 5) Pins 16 (RC0), 15 (RC1), 14 (RC2), 7 (RC3), 6 (RC4), 5 (RC5), 9 (RC7), are connected to E, RS, D7, D6, D5, and D4 of the LCD respectively.

3.6. DETAIL PROCEDURE FOR SIMULATION, CONSTRUCTION, AND TESTING USING FLOW-CODE5.

Flow-code5 allows the creation of simple microcontroller applications by dragging and dropping icons on to a flowchart as shown below in Figure 3.3 to create simple programs. These programs can control external devices attached to the microcontroller such as LED's, LCD displays, switches, etc.

Once the flowchart has been designed, its behaviour can be simulated in Flow-code before the flowchart is compiled, assembled and transferred to a chip. Testing the system's functionality can be achieved by clicking on simulate icon and the effects displayed on-screen.

To achieve this, using Flow-code5, the following steps are performed:

- 1) Create a new flowchart, specifying the microcontroller that is to be used, e.g. PIC16F690.
- 2) Drag and drop icons from the toolbar onto the flowchart to program the application.
- 3) Add external (input and output) devices by clicking on the appropriate icon, edit their properties, how they are connected to the microcontroller and call macros within the device.
- 4) Run the simulation to check that the application behaves as expected.
- 5) Transfer the programme to the microcontroller by compiling the flowchart to Hex Code.

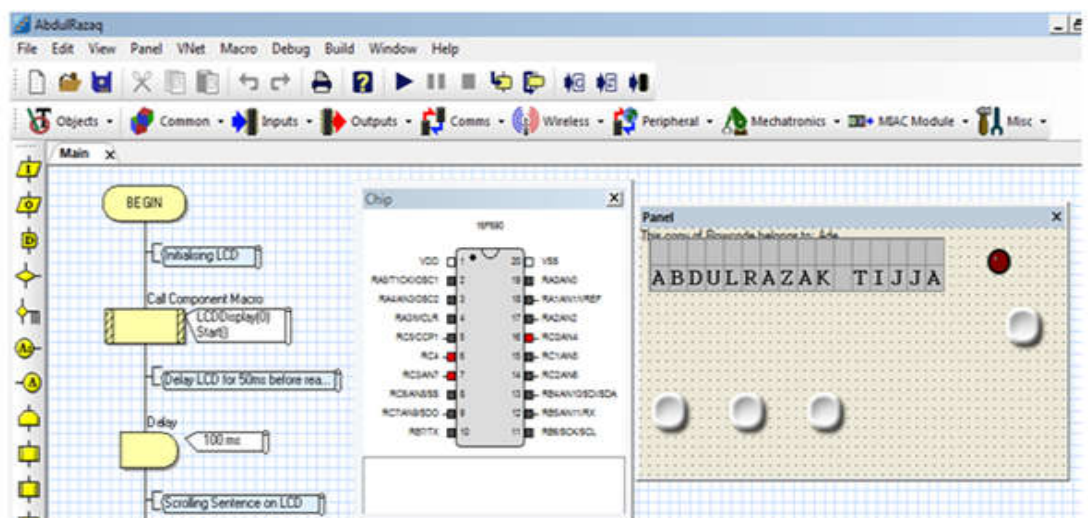


Figure 3.3 Simulation of Automatic Time-based Street Light Control System

3.6.1. Construction

The system was constructed as described and then mounted in a plastic casing of dimension 11cm x 11cm x 4.5cm. The components used are shown in Table 2.

TABLE: 2. Component used

S/N	COMPONENT	QUANTITY
1	4-Surface Connector	1
2	240V-to-12V Step Down Transformer	1
3	Full-wave Rectifying Diode	1
4	220uF Electrolytic Capacitors	2
5	7805 Voltage Regulator	1
6	100pF Mica Capacitors	3
7	PIC16F690 Microcontroller	1
8	On/Off Switches	2
9	Active-High Momentary Switches	5
10	10 K Ω Resistors	6
11	BD 137 NPN Transistor	1
12	SPST Relay Switch	1
13	3.7V Dry Secondary Cells	3

The Connector, Transformer, Rectifying Diode Electrolytic Capacitors, Voltage Regulator, Mica Capacitors, On/Off Switches and the Cells were used to make up the Power Unit of the Hardware; Microcontroller, Momentary Switches, Resistors and Transistor for the Control Unit of the Hardware; While the Relay Switch serves as the Actuating Unit of the Hardware.

The following are the steps taken while constructing the Circuit:

- 1) The components, along with Vero Board and Connecting Wires, were bought.
- 2) The components were then arranged in accordance with the Circuit Diagram after which all terminals were soldered correctly.
- 3) General cross-checking was performed on each component arranged and corrections were made where necessary.

3.6.2. Testing

The Automatic Time-based Street Light Control System was tested using different power sources; the seconds, minutes and hours of its ON-time, OFF-time and Main-time were adjusted several times; and the system was finally left to continue running on Battery, to

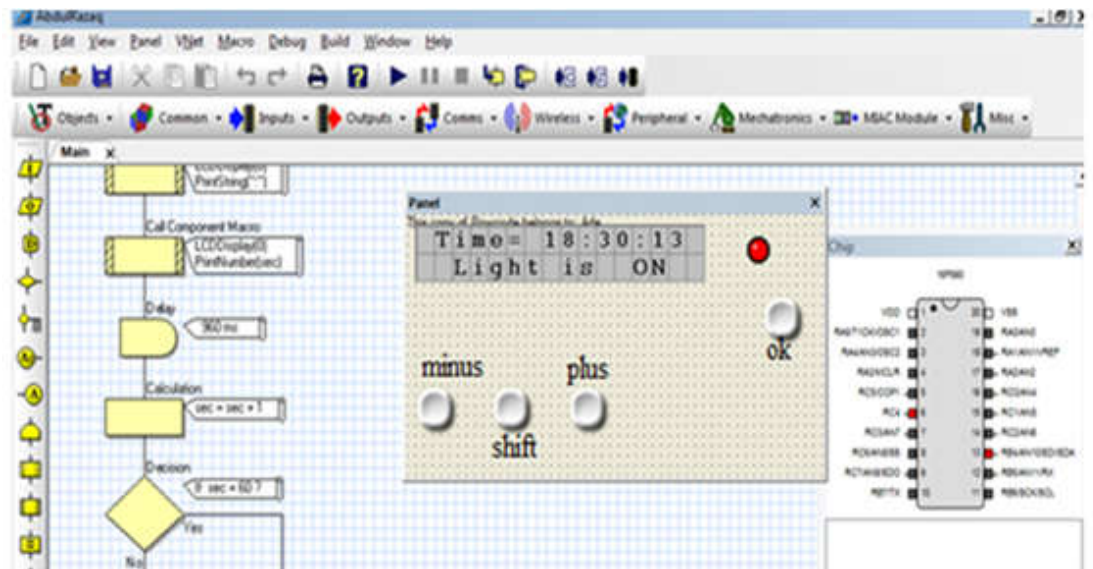


Figure:4.2 Light ON

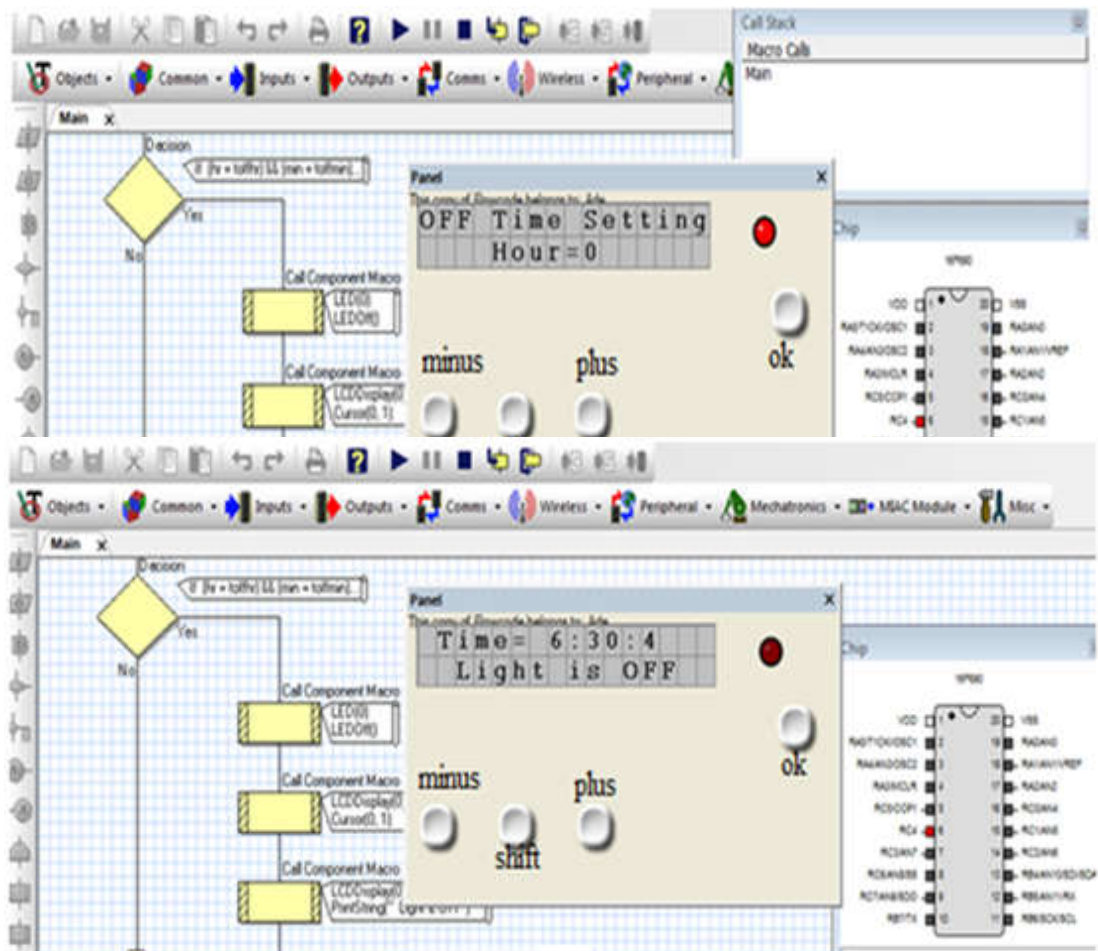


Figure:4.4 Light Off

4.2. Comparative Results of Energy utilization for different types of lamps are shown on Table 3.

TABLE 3 Results of energy utilization

Lamps	Power in W	Energy for 12 hours in W-hour	Energy for 24 hours in W-hour
Neon	60	720	1440
	100	1200	2400
	200	2400	4800
Fluorescent	8	96	192
	15	180	360
	30	450	720
Halogen	1000	12000	24000

Based on research, majority of street light are ON from 18:30 to 6:30, in other words street lights are functioning completely for 12 hours a day (Mohelnikova, 2008). Assuming 3 nodes are to be operated using fluorescent bulb of 8W each, then the energy consumed for number of working hours per day is calculated below;

Numbers of hours = 12 hours

Number of nodes = 3

Bulb in Watt = 8W

$$\text{Energy consumed} = \text{No. of nodes} \times \text{Power} \times \text{hour} \quad (4)$$

$$\text{Energy consumed} = 3 \times 8 \times 12 = 288 \text{ W hour}$$

If the system were to operate under the same condition but for 24 hours, then the energy consumed will be 576W hour (Popa and Cepisca, 2011). This shows that about half of the energy is utilized.

$$\text{Efficiency} = \left(\frac{\text{Power output}}{\text{Power input}} \right) \times 100\% \quad (5)$$

$$\text{Efficiency} = \left(\frac{\text{Power output}}{V_i I_i} \right) \times 100\% \quad (6)$$

$$\text{Efficiency} = \frac{8}{220.4 \times 0.042} \times 100\% = \frac{8}{9.26} \times 100\% = 86.4\%$$

Where V_i and I_i are the input voltage and current respectively measured from the metre.

4.3. Discussion

Automatic time-base street light control system is designed, simulated and tested. This method is to build up the device with a PIC16F690 microcontroller which was programmed using flow-code5 programming languages for microcontrollers, through the process of the research, it was found that cost of maintenance will be drastically reduced compare to manual control that will be assigned by an individual or offices and also provides an effective measure to save about half of energy by preventing unnecessary

wastage of electricity, caused due to manual switching or lighting of street-lights when it is not required.

The time setting is carried out by four buttons, these buttons are incremental or plus, decremental or minus, SHIFT and OK.

The shift buttons are used to select either hour, minute or second while increment and decrement are used to set the corresponding hour, minute and second and OK is used for saving the time into the microcontroller memory while the power supply is used to power on the overall system.

LCD and lamp are the two outputs used in the proposed system and connected to the microcontroller. The function of LCD is to display the status of the system which includes the main time, activate and deactivate while the lamps are used as Prototype Street light.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.0. CONCLUSION

In this work, microcontroller time-base intelligent light control system was designed, simulated, implemented, and tested. The result of the test shows that it works as designed, thus automatically turn ON and OFF the light as set by the user. In this system, cost of maintenance was drastically reduced and it provides an effective measure to save about half of the energy consumption with 86.4% efficiency by preventing unnecessary wastage of electricity, caused due to lighting of street-lights when it is not required.

5.1. RECOMMENDATIONS

The following are my recommendations for further research to improve this dissertation work:

- 1) Manual dimming during midnight is impracticable using Flow-code5 programmer.
- 2) Dynamically tracking the light level is impracticable using flow-code5 programmer.

3) Contactor should be used for a long distance Street Light Control.

REFERENCES

- Bullough, J., Rea, M.S., Akashi, Y. (2009). “Several views of metal halide and high pressure sodium lighting for outdoor applications”, *Lighting Research, and Technology*, PP. 297-320
- Caponetto, R., Dongola, G., Fortuna, L., Riscica, N., and Zufacchi, D. (2008). Power consumption reduction in a remote controlled street lighting System, *International Symposium on Power Electronics, Electrical Drives, Automation and Motion, Ischia, June*, PP. 428-433.
- Costa, M.A.D., Costa, G.H., Dos Santos, A.S., Schuch, L., and Pinheiro, J.R. (2009). A high efficiency autonomous Street Lighting System Based on Solar Energy and LEDs, *Brazilian Power Electronics Conference, Bonito*, PP. 265-273.
- Craig, D. (2006). *Advanced Lighting Controls*. India Trail: Fairmont Press, pp. 3-39.
- Devi, D.A., and Kumar, A. (2012). Design and Implementation of CPLD Based Solar Power Saving System for Street Lights and Automatic Traffic Controller, *International Journal of Scientific and Research Publications*, Vol. 2, Issue11, PP. 70-78.

- Floyd, D.B, and Parker, D. (1995). Field Commissioning of a Daylight dimming lighting system, In Proceedings of Right Light Three, 3rd European Conference on Energy Efficient Lighting, Newcastle, UK, PP. 83–88.
- Jasio, L., Wilmshurst, T., Ibrahim, D., Morton, J., Bates, M., Smith, D.J. and Hellebuyck, C. (2008). *PIC Microcontrollers: know it all*, Publishing Elsevier Science.
- Madhuri, V.V.S., Mallikarjuna, S.P., and Sandhya, R.M.N. (2013). Automatic Street lighting Using PLC, *International Journal of latest trends in Engineering and Technology (IJLTET)*, Vol.2, PP. 353-357.
- Mohamaddoust, R., Haghghat, A.T., Sharif, M.J.M., and Capanni, N. (2012). A Novel Design of an Automatic Lighting Control System for a Wireless Sensor Network with Increased Sensor Lifetime and Reduced Sensor Numbers, *Sensors*, Vol. 11, PP. 8933-8952
- Mohelnikova, J. (2008). Electric Energy Savings and Light Guides, *Energy & Environment, 3rd IASME/WSEAS International Conference on, Cambridge, UK*, pp.470-474.
- Mustafa, S., Abdulhalim, F., Ahmed, S., and Abdulroof, A. (2013). Automatic Street Light Control System Using Microcontroller, *Mathematical Methods and Optimization Techniques in Engineering*, ISBN: 978-960-474-339-1. PP. 92-96

- Popa, M., and Cepișcă, C. (2011). Energy Consumption Saving Solutions Based on Intelligent Street Lighting Control System. *U.P.B. Sci. Bull.*, Vol. 73, April, PP. 297-308.
- Rajput, K.Y., Khatav, G., Pujari, M., and Yadav, P. (2013). Intelligent Street Lighting System Using Gsm, *International Journal of Engineering Science Invention*, Vol2, Issue 3, PP. 60-69.
- Rea, M.S., Bullough, J.D., Fay, C.R., Brons, J.A., and Donnell, E.T. (2009). Report to the national cooperative High way Research Program. Washington, D.C.
- Rohaid, H., Syed, A., and Zulkifli, A.M. (2012). Automatic Street Light System for Energy Efficient Based on Low Cost Microcontroller, ISSN: 1473-804X online, 1473-8031 print, PP.43-48.
- Roskell, J.S., Clark, L., and Ravcliffe, C. (1993). The History of Parliament, PP. 1386-1421. ISBN 9780862999438.
- Seai, (2013). Lighting controls Guide to energy efficient and cost effective lighting. Retrieved from <http://www.seai.ie/aca>.
- Sudhakar, K.S., Anil, A.A., Ashok, K.C, and Bhaskar, S.S. (2013). Automatic Street Light Control System, *International Journal of Emerging Technology and Advanced Engineering*, Vol. 3, PP. 188-189.
- Sullivan, J.M., and Flannigan, M.J. (1999). Assessing the Potential Benefit of Adaptive Head lighting Using crash Databases, Report

No.UMTRI-99-21.University of Michigan Transportation Research
Institute.

Thereja, B.L., and Theraja, A.K. (2000). Electrical Technology
23rdEdition, S. chand and company, New delhi india. PP. 175-188

Wazed, M.A., Nafis, N., Islam, M.T., and Sayem, A.S.M. (2010).
Design and Fabrication of Automatic Street Light Control System,
Engineering e-Transaction, Vol. 5, No. 1, PP. 27-34.