CHAPTER TWO

2 IMPLEMENTED METHOD FOR STREET LIGHTING

This circuit consists of a battery charge controller circuit that is charged by the solar panel. The battery gives supply to the micro-controller which is programmed to work as a PWM connected to the LDR which gives high/low signal based on the light intensity. When the microcontroller gives a high signal to the MOSFET the LED is OFF. Once the MOSFET gets a low signal it turns ON and the LED glows. The circuit also consists of measurement circuit for the measurement of photovoltaic power and the variation of light for the amount of sunlight obtained. The current is sensed by the current sensor, and temperature by the temperature sensor and voltage is noted by the potential divider circuit.

2.1 THEORETICAL CONCEPTS

SOLAR POWERED LED STREET LIGHT WITH AUTO INTENSITY CONTROL

USAGE AND DESCRIPTION

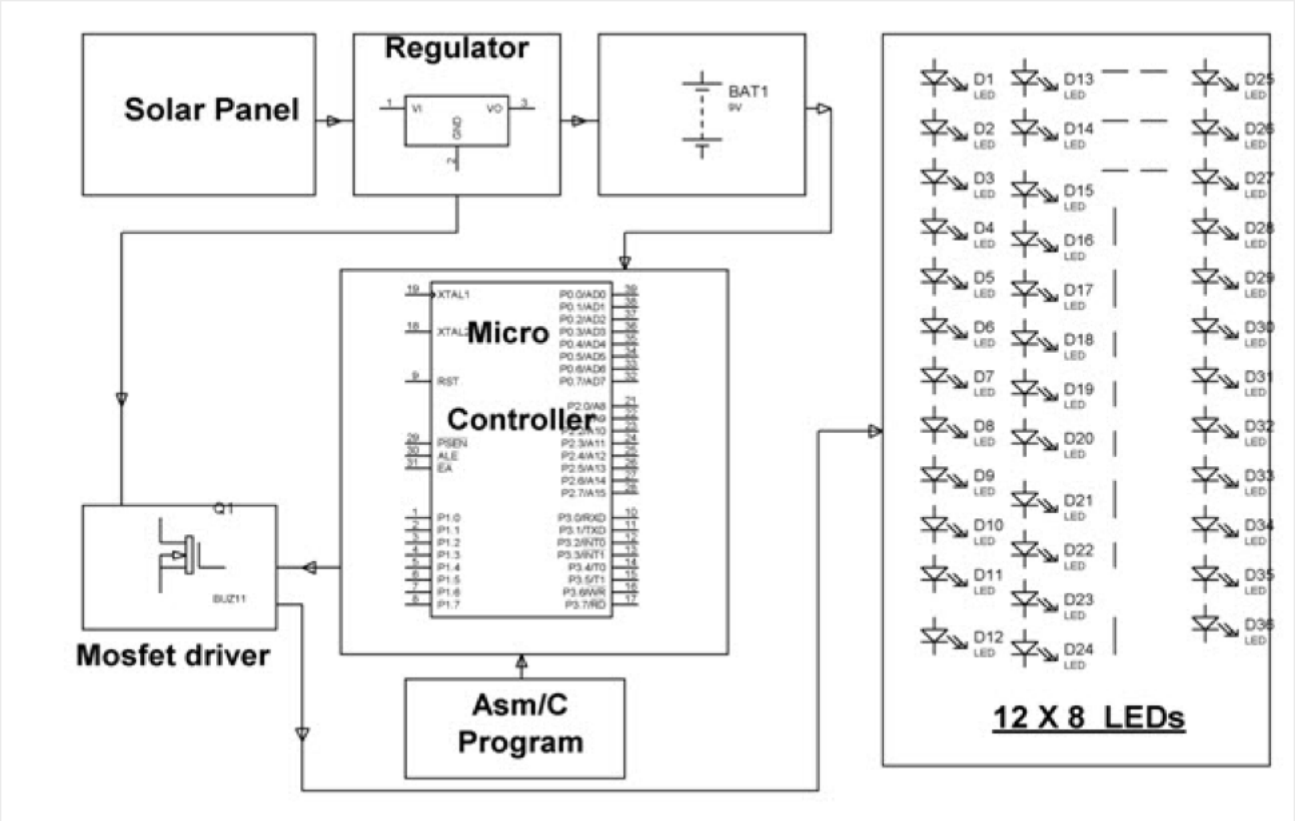

Figure (1) BLOCK DIAGRAM OF (SPLSLWAIC).

Figure (2) A TYPICAL DIAGRAM OF AUTO INTENSITY STREET LIGHT.

As we know that, nowadays energy sources are limited and energy consumption has increased, so renewable energy sources are used to meet the increase in the demand for energy. Keeping this in mind in this article, we are discussing a solar-powered LED street light with auto intensity control. This project is driven by solar energy used to control the light intensity from morning to evening based on the brightness. A case study is also done to demonstrate the advantages of this solar LED Street light compared to the traditional street light. Because this solar-powered street light can conserve a large amount of electricity compared to the other lights which are a light to their maximum intensity at all times after they are turned on Solar Powered Led Street Light with Auto Intensity Control Circuit and Its Working.

The solar-powered street light works on the principle of solar cells or PV cells to absorb solar energy in the daytime. The PV cells convert solar energy to the electrical energy. The converted energy is stored in the battery and the solar street lights use solar energy. Nowadays solar street lights are available beside the roads. At night time, the lamps start automatically and it uses the electrical energy which is stored in the battery. Every day this process continues

Light-emitting diode comprises of the chemical compound. When the direct current from the battery passes through the light, then it gives the light. Solar LEDs are available in different shapes, styles, and sizes. Generally, the life span of the light-emitting diode is very high and it requires very little current.

Working of a Solar Powered Led Street Light with Auto Intensity Control Circuit and Its Working

The solar-powered led street lights activate from dusk to dawn. The LED Street light automatically turns ON after the dusk and turns OFF after the dawn. The designing of the entire system includes: Solar panels, LED light, Rechargeable battery, Controller, Pole, and

interconnecting cables.

Solar Panels

The solar panel or PV cell in the solar street light is one of the most essential parts. These cells are available in two types: monocrystalline and polycrystalline. The monocrystalline conversion rate is higher than the polycrystalline. The light energy used by the solar panels from the sun is used to change solar energy into electricity, which can be used in various applications. Electrical connections of this project are made in series to achieve an o/p voltage and to afford current facility connections are made in parallel. The majority of the modules use silicon (Si) but most of the solar panels are fixed. . The electron and hole are then separated with electrons going to the negative terminal and holes to the positive terminal. Hence the generation of electrical power. Most of the available solar cells are made of silicon. The benefit of using silicon is its mature processing technology. The large abundance in the crust of the earth, and its non-toxicity makes it a wise and obvious choice. The silicon is used in PV cells for mono crystalline (single crystalline) and multi crystalline photovoltaic module production. In mono crystalline silicon, the crystal lattice of the entire sample is continuous with no grain boundaries. Multi crystalline are composed of a number of smaller crystals or multiple small silicon crystals. In general, mono crystalline silicon wafer is better in performance than the multi crystalline silicon wafers. The voltage of the electric current from a single or multi-crystalline silicon solar cell is 0.5 volts. This results from the voltage across the N/P barrier layer of the solar cell. The current or amperage of the solar cell is dependent on the number of electrons that are knocked into the conduction band. This current is proportional to the amount of solar radiation incident on the solar cell. The current from the solar cell can be increased by increasing the area of the solar cell or by increasing the amount of solar radiation incident on the solar cell. Solar cells can be thought of as solar batteries. If solar cells are connected in series, then the current stays the same and the voltage increases. If solar cells are connected in parallel, the voltage stays the same, but the current increases

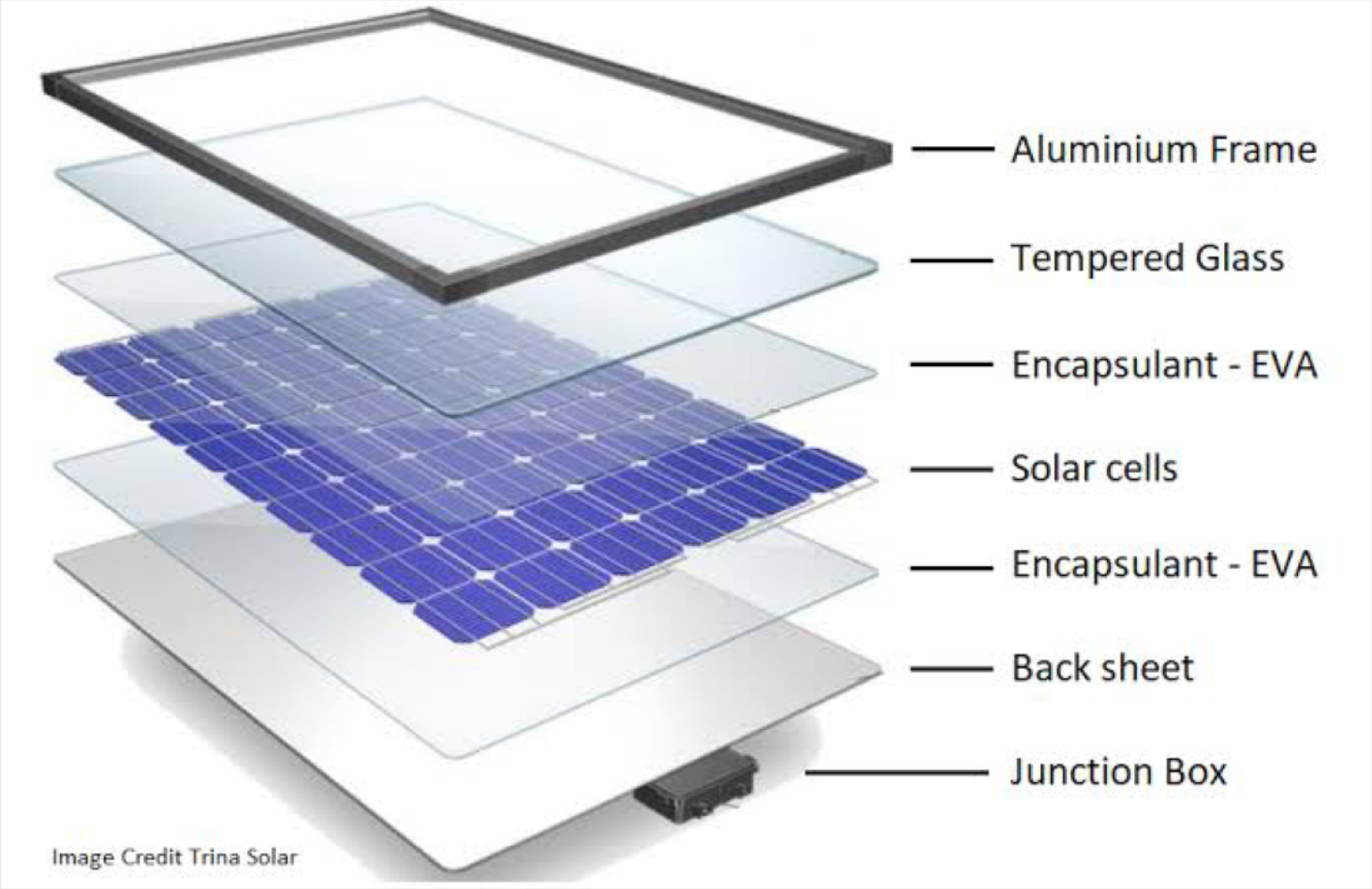

Figure (3): Solar Panel

Light Emitting Diode

LEDs are used in modern street lights to provide brighter light with low energy consumption.

The energy consumption of the LED fixture is lesser than the high-pressure sodium fixture, which is commonly used in traditional street lights. Compare to the other lamps, LED lights do not produce light in all directions. The design of lamps can be affected by the uniqueness of the LEDs. The single LED o/p is not equal to the incandescent and fluorescent lamps. But, a bunch of LEDs will give bright light than these two lamps. The advantages of LEDs mainly include Eco-friendly, durable, zero UV emissions, and long life. This will give a full view on the lighting system of solar power. There are numerous styles, shapes, sizes, and types of solar lighting. All of them were designed to be aesthetically and visually pleasing. The entire range of solar motion light is great and there are literally tons of products that can fit your style and needs. Solar lighting can be installed in different areas. From homes to parking lots, sensitive areas and remote locations where no grid infrastructure exists, it removes the costs of trenching and wiring which is why it is considered as the cheapest solution in numerous cases. Solar lightning is classified into two major categories knowns as Outdoor solar light and indoor solar light. The outdoor solar light can be very useful when it comes to lightning of gardens paths during the night, homes, backyards and terrace There are no wires required which means you can place as many solar light as many as you can solar outdoor lightning system are very effective when it comes to reduces in cost of electricity bill because energy use in providing energy at night are themed to be totally free compared to making use of other sources of energy system in which the rate of energy conserved for light environment at night is approximate to the amount of resources used to generate lightning.

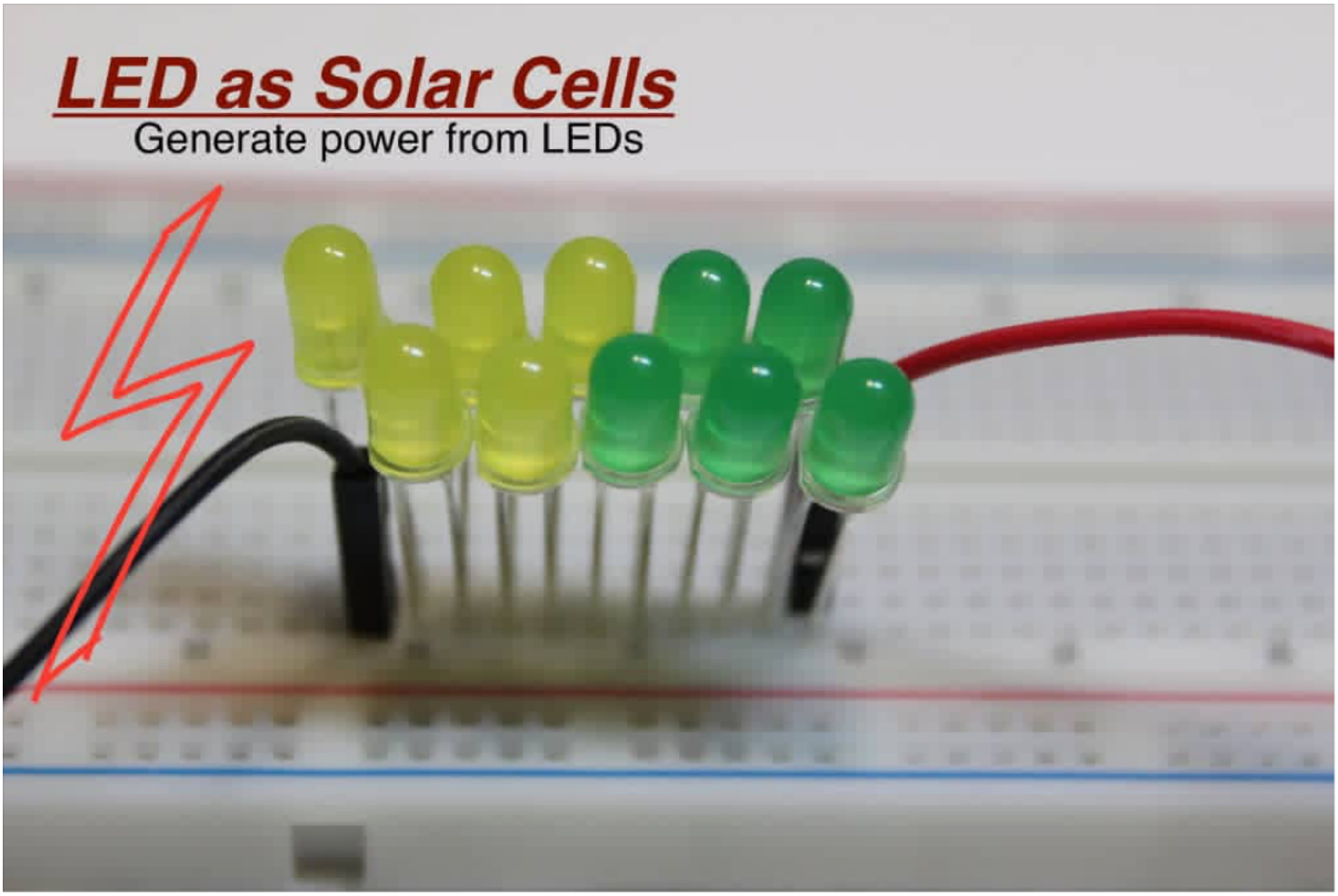

Fig 2.4

Figure 4: Light Emitting Diode (LED)

Rechargeable Battery

The rechargeable battery is one kind of electric battery and it has electro-mechanical reactions to adjust so it is also called a secondary cell. Generally, there are two kinds of batteries, namely gel cell deep cycle, and lead-acid battery. A rechargeable battery is used in solar LED street lights, this battery is used to store electricity generated from the solar panel during the sunrise to afford energy in the sunset. The lifetime and capacity of the rechargeable battery are essential as they affect the backup power days of the lights. . A battery convert's energy stored in the chemical bonds of a material into electrical energy via a set of oxidation/reduction (redox) reactions. Redox reactions are chemical reactions in which an electron is either required or produced. For primary batteries, this is a one-way process – the chemical energy is converted to electrical energy, but the process is not reversible and

electrical energy cannot be converted to chemical energy. This means that a primary battery cannot be recharged. For a secondary battery, the conversion process between electrical and chemical energy is reversible, – chemical energy is converted to electrical energy, and electrical energy can be converted to chemical energy, allowing the battery to be recharged

Figure 5: (Gel Cell Solar Battery)

Controller

A controller is a very significant device in the solar street light, used to decide the status of the charging and lighting by a switch on or switch off. Some recent controllers are pre-programmed and it consists of a battery charger, a Led lamp driver, a driver, a secondary power supply, an MCU, and a protection circuit. The battery can be controlled by the controller from the under and overcharging conditions. The battery can be charged by the power received from the solar panels in the sunrise and while in the sunset it charges the battery. Without charge control, the current from the module will flow into a battery proportional to the irradiance, whether the battery needs to be charging or not. If the battery is fully charged, unregulated charging will cause the battery voltage to reach exceedingly high levels, causing severe gassing, electrolyte loss, internal heating and accelerated grid corrosion. Actually charge controller maintains the health and extends the lifetime of the battery.

Solar Charge controller can be configured to stop the flow of current to the battery when the rated current level of the battery is reached. Charge controllers can also be referred to as Charge Regulators. A series charge controller or series regulator disables further current flow into batteries when they are full. A shunt charge controller or shunt regulator diverts excess electricity to an auxiliary or "shunt" load, such as an electric water heater, when batteries are full, Simple charge controllers stop charging a battery when they exceed a set high voltage level, and re-enable charging when battery voltage drops back below that level. Pulse width modulation (PWM) and maximum power point tracker (MPPT) technologies are more electronically sophisticated, adjusting charging rates depending on the battery's level, allow charging closer to its maximum capacity. Charge controllers may also monitor battery temperature to prevent overheating. Some charge controller systems also display data, transmit data to remote displays, and data logging to track electric flow over time

a. Pulse Width Modulation (PWM): Pulse Width Modulation (PWM) is a very effective means to ensure constant voltage battery charging by switching the solar system controller's power devices. When in PWM regulation, the current from the solar array flows according to the battery's recharging needs and condition. In the past simple on-off regulators were used to limit the rate at which batteries gas out when a solar panel produced excess energy. On-off regulators have been earlier known for battery failures and increasing load disconnections. PWM is the first significant advance in solar battery charging. PWM solar chargers use technology close to other modern battery chargers. When a battery voltage reaches the manufacturer's rated voltage, the PWM algorithm slowly decreases the charging current to avoid heating and gassing of the battery, but the charging continues to return the maximum amount of energy to the battery in the shortest time. The benefits are a higher charging efficiency, fast recharging, and a healthy battery always at full capacity.

b. Maximum Power Point Tracking (MPPT): The PV array has a highly non-linear current-voltage characteristic varying with the irradiance and temperature that substantially affects the array power output. The maximum power point tracking (MPPT) control of the PV system is therefore critical for the success of a PV system. MPPT algorithms, ranging from simple hill-climbing algorithms to fuzzy logic and neural network algorithms are used in the application of MPPT. The three main versions of the hill climbing algorithm, P&O, MP&O and EPP, are described below

c. Switching Unit: This unit is essential for the switching on and off of the luminaires. In the evening when the sun is setting, the switching unit switches the outdoor lights on. Also when the sun is rising at dawn the switching unit switches the lights off. The switching unit functions by switching the path of current. At dawn the switching unit switches current path from solar panel to luminaires to solar panel to battery. This change switches off the luminaires and charges the battery bank during the day. Likewise, at dusk the switching unit switches current path from solar panel to the battery to solar panel to luminaires. This change stops the charging of the battery and then powers the luminaires.

Figure 6: (Controller)

Pole

A strong pole is mandatory for every street light and also for a solar street light. There are various components such as panels, batteries, and fixtures fixed on the top of the pole. In this light, the input operating voltage is 12V DC which is a nominal system voltage, and the light output at the height of 12 feet is a minimum of 09 LUX (unit of luminance). The pole is of mild steel pipe with a height of 3.5 meter (approximately 12 feet) above the ground level after grounding and final installation. The pole has a moveable platform which ensures the mobility of the pole from one place to another. The pole will have the provision to hold all weather proof lamp housing. A galvanized metallic frame structure was fixed on the pole to hold the pole to the

solar panel. The frame structure has provision to adjust its angle of inclination to the horizontal between 0-90º, so

that it can be installed at the specified tilt angle.

Figure 7: (Pole)

Interconnecting Cables

The cable is used to interconnect the LED, solar panel and battery box which is fixed on the top of the pole. This cable is used to connect a Photovoltaic module to the controller, controller to the lamps, and battery. The size and length of the cable depend on the current being carried to the LED lights and the height of the pole. The assembling of the entire solar LED street light system can be connected using all the above components which use solar energy to give the power to the LED lamps fixed on street pole

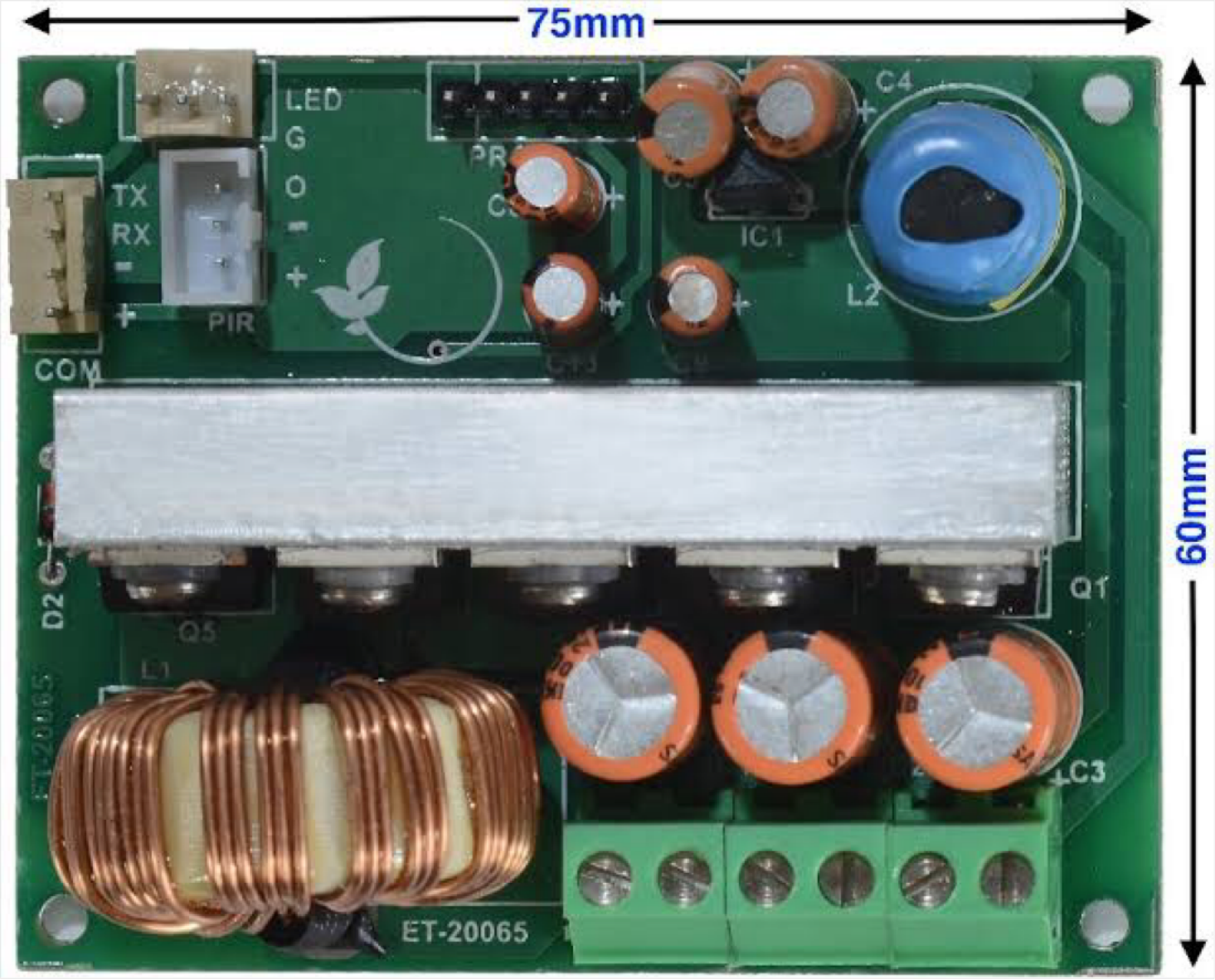

Figure 8: (Interconnecting PCB)

Figure 9: (Interconnecting Cable and Component)