# Domestic Lighting Control System (Security / Energy Saving)

The project was one of the bespoke embedded control solutions offered to customers for domestic and industrial environments in Malawi. This particular system provided an energy saving and security lighting control system for home use.

## Background / Challenge

It is common practice in Malawi (Africa) for residents to turn their security lights on in the evenings and switch them off early in the mornings. Besides illumination, it is necessary (as it is believed) to put off burglars and thieves as it gives the impression of the residents being at home. This is somewhat effective towards the intruders but not so cost effective on the electric bill. Therefore, it becomes a problem when there is no one home, which lives many people left with two options: Either asking a neighbour or relative to house sit for them or more commonly leaving their security lights on throughout the day when they are out short term or even long term (Holidays).

## Requirements

Eliminate the need to manually switch the lights on and off (wake up early to switch them off). Use a cheaper solution compared to dedicated 240 Volt PIR Sensors devices. Save on the electric bill.

## Design

The system consisted of DC powered components set to control AC powered lighting. The solution applied was designed to:

1. Control the lights switching on / off autonomously through a Microcontroller (MCU) and Relays. This was done using information from a Real-Time Clock Module (with the option of Photoresistors for accurate information on sunrise and sunset).
2. Extend the switching functionality of the security lights using inexpensive DC Passive Infrared Sensors (PIR Sensors) motion detectors. This was to allow the lights to go off at a set point during the evening and come back on after detecting motion (around the perimeter of the house).
3. Implement a similar motion detection lighting process for common areas inside the house to maximize on energy saving such as corridors, bathrooms, toilets, kitchens, front door (external) etc.
4. Have the customer switch to Low Consumption LED Light Bulbs to lessen consumption as well as the load requirement for the Relays.

The house security lights would come on at sunset and then go off around a set time during the evening (e.g. 10 pm). From this point onwards, the PIR Sensors would determine when the lights turned on after motion detection until sunrise (The lights would come on for a user specified amount of seconds / minutes). Further motion signal detections would prolong the period the lights stayed on.

The internal lights integrated with motion sensing could also work similar to the security lights, where they start to work at sunset and stop at sunrise. Internal PIR lighting was set to turn on for varied time intervals depending on the area used and customer’s request (normally 30 seconds for corridors and 3 – 7 minutes for kitchens, bathrooms etc.).

## Implementation

### Hardware

This section lists the hardware used and some decisions that were made in installation.

* Microcontroller
* 10A Relay Modules (5v to 240v / 10A)
* Photoresistors (if necessary)
* Real-Time Clock Module (DS32231)
* Passive Infrared Sensors (HC SR501 PIR Sensors)
* Low Consumption LED Light Bulbs

**PIR Sensors** – were placed strategically around the external ceiling structure of the house to pick up motion (especially near windows and doors). Overlapping the detection arcs between the PIR Sensors was necessary to eliminate blind spots and utilise the least amount of sensors. Internally, PIR sensors were installed on the ceiling of the areas where motion detection lighting was required. The sensors were then interfaced to the Microcontroller (MCU).

**Photoresistors** – were grouped and positioned in an area were the light intensity from outside would be properly detected. These were used when accurate detection of sunrise and sunset was required due to variations that occur throughout the year. These resistors were interfaced to the Microcontroller (MCU).

**Relay Modules –** were used to interface the 240 volt light switches to the DC powered Microcontroller (MCU), bypassing the manual light switches. The eliminated manual light switches were replaced with blanking plates for safety and clean aesthetics.

**Real-Time Clock Module** – was used to provide real-time clock information to the Microcontroller (MCU). This module was set and used to provide the time information needed to tell the system when to alter its behaviour depending on the time of the day.

**Microcontroller (MCU)** – was responsible for interpreting sensor information and giving commands to the Relay Modules connected to the light switches.

Software

This section shows snippets of the code that written to run the hardware.

## Future Upgrades

* Alarm system was an option that could be added with the controller.
* Closed Circuit Television (CCTV) Surveillance system could be integrated with the system
* Mobile phone GSM notifications could be integrated to alert the residents of Sensor detections.