Power optimization by load monitoring and control

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September 14, 2017

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1 Introduction

In conventional power saving techniques, the user has to be vigilant in turning ON/OFF electrical loads as and when required. This ensure optimal consumption and reduce power bill for the consumer. This effort can be automated and optimized better. This project will enable the user to control loads from anywhere as long as the mobile device and the Raspberry Pi (@ home) are connected to Internet.

The intention is to retrofit this system into the existing domestic wiring scheme of the user with minimal changes as much as possible.

1.1 Purpose of this document

The purpose of this document is to list down the design specification and design details for this home automation project.

1.2 Objectives

1. The project will enable users to switch electrical loads through a mobile application
2. The load ON/OFF times shall be logged. This logged information can be used to provide the user with suggestions for power saving.
3. Power factor correction for inductive loads and switching in/out "tank circuits" shall also be done based on the load conditions
4. ....
5. .....

2 Design

3 Wiring scheme

In the conventional power switching arrangement, the following modifications should be made to implement this design. The SPST switch used conventionally to switch ON/OFF loads, should be replaced with a DPST switch (commonly known as "two-way" switch). A relay with DPST switching arrangement should be connected to the new DPST switch. This two-way switch wiring scheme established by the new two-way switch and the DPST portion of the relay allows the user to switch ON/OFF loads either from the two switch or by microcontroller. The relay shall be driven by a Arduino microcontrolller. The wire leading to the load from the relay contact shall have an ACS712 (Hall effect sensor) connected in series before the load. The pupose of the Hall effect sensor is to measure the current drawn by the load. The output of the Hall effect sensor shall be wired as input to one of the analog channels of the Arduino controller. The wiring drawing is presented below

Wiring diagram - insert here

4 High level block diagram

The following portions shall make up this design

1. Wiring scheme with modified switch, relay and Hall effect sensor
2. Arduino (Micro) micro controller
3. Raspberry Pi

4.1 Arduino micro controller

The microntroller will be able to see the ON times of all the loads if either they are switched via the controller itself or directly by the DPST switch. This information is logged at the microntroller level and passed on to Raspberry Pi.

Provided the Arduino is able to communicate directly to a server over the internet, then all data analysis and HMI functions can be passed on to application in the server machine. Data can be pulled over the network to a mobile device to control and perform HMI functions.

4.2 Raspberry Pi

4.2.1 HMI

The Pi is responsible for pulling all the data logged by the microcontroller and present it on screen for the user to review. The Pi functions like an HMI. A small 7" touch enabled screen could be wired to RPi to enable users to control loads and view reports locally

4.2.2 Data analysis

The next function of Pi is to do statistical analysis of the logged information. This analysis will come out with results that could provide suggestions to the user with load profiles. This report will tell the user how much power was consumed by respective loads. It will also present the normal ON times of the load during a day. Based on this data, the user can take an informed decision about turning OFF loads at certain time of the day.