iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 8 **Issue:** IX **Month of publication:** September 2020

DOI: https://doi.org/10.22214/ijraset.2020.31544

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue IX Sep 2020- Available at www.ijraset.com

Wireless Client Monitored Inverter with Integrated Automation System

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Abstract: This Project deals with an intelligent inverter that operate using a client-server base system which monitors power wastage in the building, house, office or any place and accordingly control the systems which are running unnecessarily and wasting the power. This Inverter can also automate the place and control the electrical appliances from any part of the world by using the internet and can also be integrated with Alexa or Google Assistant. This Inverter outputs both single phase and 3 phase power output. It works with the existing appliances. Therefore any room using power without any use can be shut down automatically and again turned on when someone enters the room.
Keywords: Power efficiency, Automation, single-phase.

I. INTRODUCTION

At this present scenario power inefficiency has been a great problem and people take it very lightly so it was my aim to make an inverter and the electrical systems as efficient as possible. With this problem being solved people nowadays need modern ways of controlling the appliances with the rise of technology so with this inverter you can also control your appliances from any part of the world through your cellphone using internet and can also be integrated with Alexa and Google Assistant. Inverters are also very costly when we come to control heavy 3-phase appliances, therefore this inverter is really very cheap compared to those in the market. This Inverter can also be driven using Solar Power.

II. FUNCTIONAL UNITS

A. Inverter (Main Local Server)

This inverter working outputs both single phase and 3 phase power and work as main local server which receives the signals from the clients wirelessly that senses power wastage and control the appliances accordingly. This Inverter is also the main automation unit that can control the appliances remotely from any part of the world using internet and can be used with Alexa or Google Assistant. This unit consists of all the circuitry required. It also consists the battery level indication circuit.

B. Sensors (Clients)

These clients are small wireless rechargeable systems that senses the power wastage in the locations they are placed and send the data wirelessly to the main server (the inverter) so that it can control the devices. These devices also sense Infrared rays to detect human presence very accurately and turn on the basic appliances automatically.

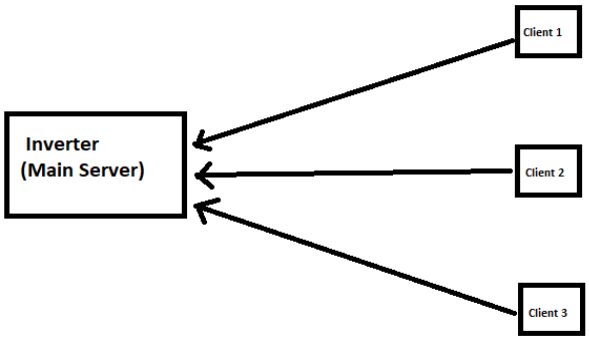


Fig 1: Server Connection Diagram

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C. The Specifications

The Inverter consists of Two MOSFETS which is triggered using a microcontroller every 10 milliseconds alternatively with creates phase differenced pulses. The signals from the microcontroller are amplified and then sent to the MOSFETS because they need more than 10V to be active. The Inverter contains relays rated 30A each. There is also a automatic charging circuit to charge the battery. There is also Wi-Fi microcontrollers(esp-8266) Node MCU to create a local server for the clients and another Wi-Fi microcontroller for the automation from the internet. This uses a Fauxmo Library to emulate itself as a switch for Amazon Alexa or Google Assistant. The Clients consist of Infrared Sensors and Wi-Fi microcontrollers to send the motion sensed or human presence sensed an send the data wirelessly to the inverter to turn ON or OFF the appliances automatically.

D. Functional Units Working Methodology

1) *The Inverter Logic Board:* This logic controller consists of a Microcontroller (Arduino Nano) it is programmed in such a manner (Fig:2) that it output positive pulses through pin 2 and 3 every 10 Milliseconds alternatively. The logic board consists of a buzzer to alert the closing of load circuit after the booting time of Arduino is completed. The pin 2 and 3 are connected to 10 kilo-Ohm resistors to limit the current then the other terminals of the resistors are connected to the base of transistors BC548 after the regular MOSFET Inverter circuit is made using two IRF 540N MOSFETS .Then the drains of MOSFETS are connected to the 12-0-12 step up transformer with the center tapped terminal connected to the positive of the 12V DC Source. This inverter gives a single-phase Square Wave output but according to the requirement it can also be scaled up to output pure sine wave or 3 phase output very easily. This logic board also consists of a battery indication system also controlled with an Arduino Nano that senses full charge and cuts-off the circuit. Again, when the Battery level goes down to a certain point the Relay closes the circuit and it charges it again. The program works with certain level and led branch to display the battery level (As per the circuit). The logic uses an algorithm of calling functions defining the led on and off status LEDs

```
const int output_1 = 2;
const int output_2 = 3;
const int buzzer = 4;
void setup()
{
  pinMode(output_1, OUTPUT);  pinMode(output_2, OUTPUT); pinMode(buzzer, OUTPUT);
  digitalWrite(buzzer, HIGH);
  delay(250); digitalWrite(buzzer, LOW);
  delay(250);
  digitalWrite(buzzer, HIGH);
  delay(250); digitalWrite(buzzer, LOW);
  delay(250);
  digitalWrite(buzzer, HIGH);
  delay(250); digitalWrite(buzzer, LOW);
  delay(250);
  digitalWrite(buzzer, HIGH);
  delay(250); digitalWrite(buzzer, LOW);
  delay(250);
  digitalWrite(buzzer, HIGH);
  delay(1000); digitalWrite(buzzer, LOW);
  delay(1000);
}
void loop()
{
  digitalWrite(output_2, LOW);
  digitalWrite(output_1, HIGH);
  delay(10);
  digitalWrite(output_1, LOW);
  digitalWrite(output_2, HIGH);
  delay(10);
}
```

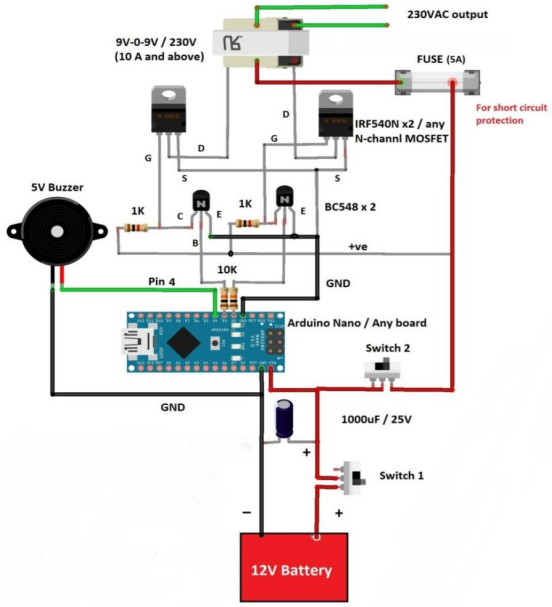
Figure 2: Program for Inverter Microcontroller

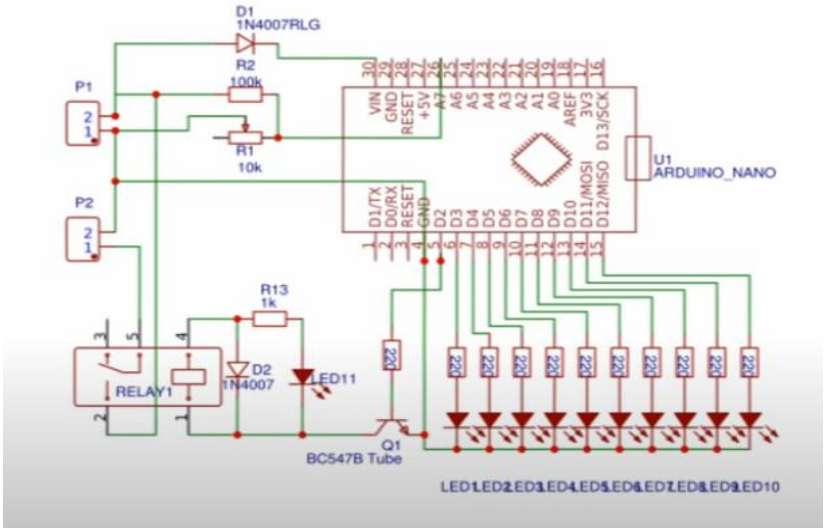
We are using Analog input pins with a high resistance to limit the current and checking sepcific voltage levels, we can also caliberate the led indicator when the battery is full using a potentiometer so that it takes a reference and displays readings according to it.

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a) Circiut Diagram of the Inverter Logic Board (left) and the Charge Controller and Indication Board (right)



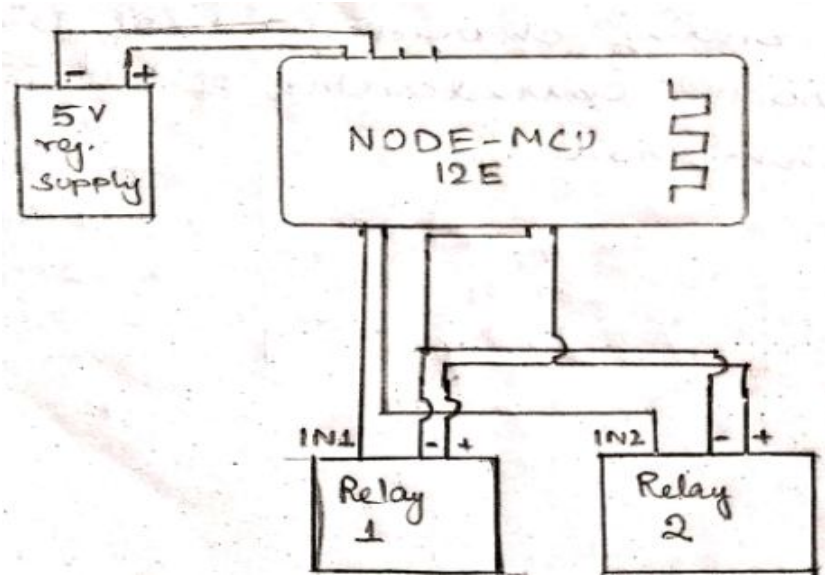


2) Wi-Fi Internet Controlled Alexa/Google Assistant Supported System: This portion comprises of an ESP-8266 Node MCU board that is using Fauxmo Library to emulate smart switches to be controlled by Smart Speakers. There are n number of Relays connected to the Node MCU to controlled desired appliances and it also uses WiFi Manager library to let the ESP's WiFi credentials get configured as per the custom WiFi SSID and password via local IP address.

a) Code

```
#include <Arduino.h>
#include <ESP8266WiFi.h>
#include "fauxmoESP.h"
#include "credentials.h"
#define SERIAL_BAUDRATE                 115200
#define LED                             2
fauxmoESP fauxmo;
void wifiSetup() {
    WiFi.mode(WIFI_STA);
    Serial.printf("[WIFI] Connecting to %s ", WIFI_SSID);
    WiFi.begin(WIFI_SSID, WIFI_PASS);
    while (WiFi.status() != WL_CONNECTED) {
        Serial.print(".");
        delay(100); }
    Serial.println();
    Serial.printf("[WIFI] STATION Mode, SSID: %s, IP address: %s\n", WiFi.SSID().c_str(), WiFi.localIP().toString().c_str());
}
    void setup() {
    Serial.begin(SERIAL_BAUDRATE);
    Serial.println();
    Serial.println();
    wifiSetup();
    pinMode(LED, OUTPUT);
    digitalWrite(LED, HIGH);
    fauxmo.addDevice("light one");
    fauxmo.addDevice("light two");
    fauxmo.addDevice("light three");
    fauxmo.addDevice("light four");
    fauxmo.onMessage([](unsigned char device_id, const char * device_name, bool state) {
        Serial.printf("[MAIN] Device #%d (%s) state: %s\n", device_id, device_name, state ? "ON" : "OFF");
        digitalWrite(LED, !state);
    });
}
void loop() {
    fauxmo.handle();
    static unsigned long last = millis();
    if (millis() - last > 5000) {
        last = millis();
        Serial.printf("[MAIN] Free heap: %d bytes\n", ESP.getFreeHeap());
    }
}
```

b) Circuit Diagram



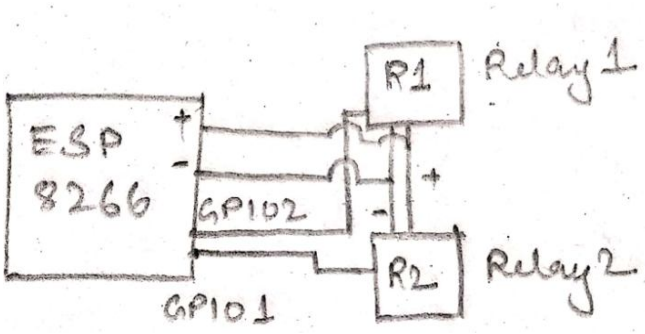
3) WiFi Server Initiator: The Wi-Fi initiator consists of an ESP-8266 board that starts a server to which local clients get connected to. It is connected to the relays and wait for signal from the clients to operate the relays accordingly. The output can be controlled via same relays of the home automation system or can be connected to different relays to get things done more accurately.

a) Code

```
#include <ESP8266WiFi.h>
#include <WiFiClient.h>
#include <ESP8266WebServer.h>
const char *ssid = "Smart Inverter";
const char *password = "12345678";
ESP8266WebServer server(80);
void handleRoot() {
  server.send(200, "text/html", "<h1>You are connected</h1>");
  }
void led()
{
  Serial.println("Link Requested from one of the device");
  for (int i = 0; i < 5; i++){
    digitalWrite(2, HIGH);
    delay(5000);
    digitalWrite(2, LOW);
    delay(500);
  }
}
void setup() {
  delay(1000);
  Serial.begin(115200);
  Serial.println();
  Serial.print("Configuring access point...");
  WiFi.softAP(ssid, password);
  pinMode(2, OUTPUT); //GPIO 2
  IPAddress myIP = WiFi.softAPIP();
  Serial.print("AP IP address: ");
  Serial.println(myIP);
  server.on("/", handleRoot);
  server.on("/led", led);
  server.begin();
  Serial.println("HTTP server started");
}
void loop() {
  Serial.println("Waiting for the link");
  server.handleClient();
}
```

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b) Circuit Diagram

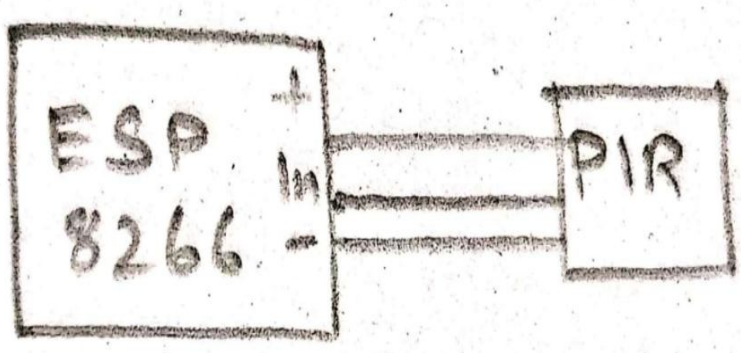


4) Wifi Clients to Monitor Power Wastage: These parts also consists of ESP8266 boards which are connected to PIR sensors to sense human activities and accordingly send data to the server. Whenever the PIR sensor gives a high signal it sends signal with respective actions. Please note that all types of sensors can be used to increase the accuracy and purpose.

a) Code

```
#include <ESP8266WiFi.h>
#include <ESP8266HTTPClient.h>
#define pir 0
const char* ssid ="Smart Inverter";
const char* password ="12345678";
void setup() {
 Serial.begin(115200);
    Serial.println();
    Serial.println();
    Serial.println();
  for(uint8_t t = 4; t > 0; t--) {
        Serial.printf("[SETUP] WAIT %d...\n", t);
        Serial.flush();
        delay(1000);
        }
      WiFi.mode(WIFI_STA);
      WiFi.disconnect(true);
    WiFi.begin(ssid,password);
    while (WiFi.status() != WL_CONNECTED) {
    delay(500);
    Serial.print(".");
    pinMode(pir,INPUT);
    delay(100);
    Serial.println("Connected");
  }
}
void loop() {
    if((WiFi.status() == WL_CONNECTED)) {
    HTTPClient http;
    if(digitalRead(pir) == HIGH)
        {
        Serial.print("[HTTP] begin...\n");
        http.begin("http://192.168.4.1/led");
        Serial.print("[HTTP] GET...\n");
        int httpCode = http.GET();
        http.end();
        }
      }
}
```

b) Circuit Diagram



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Volume 8 Issue IX Sep 2020- Available at www.ijraset.com

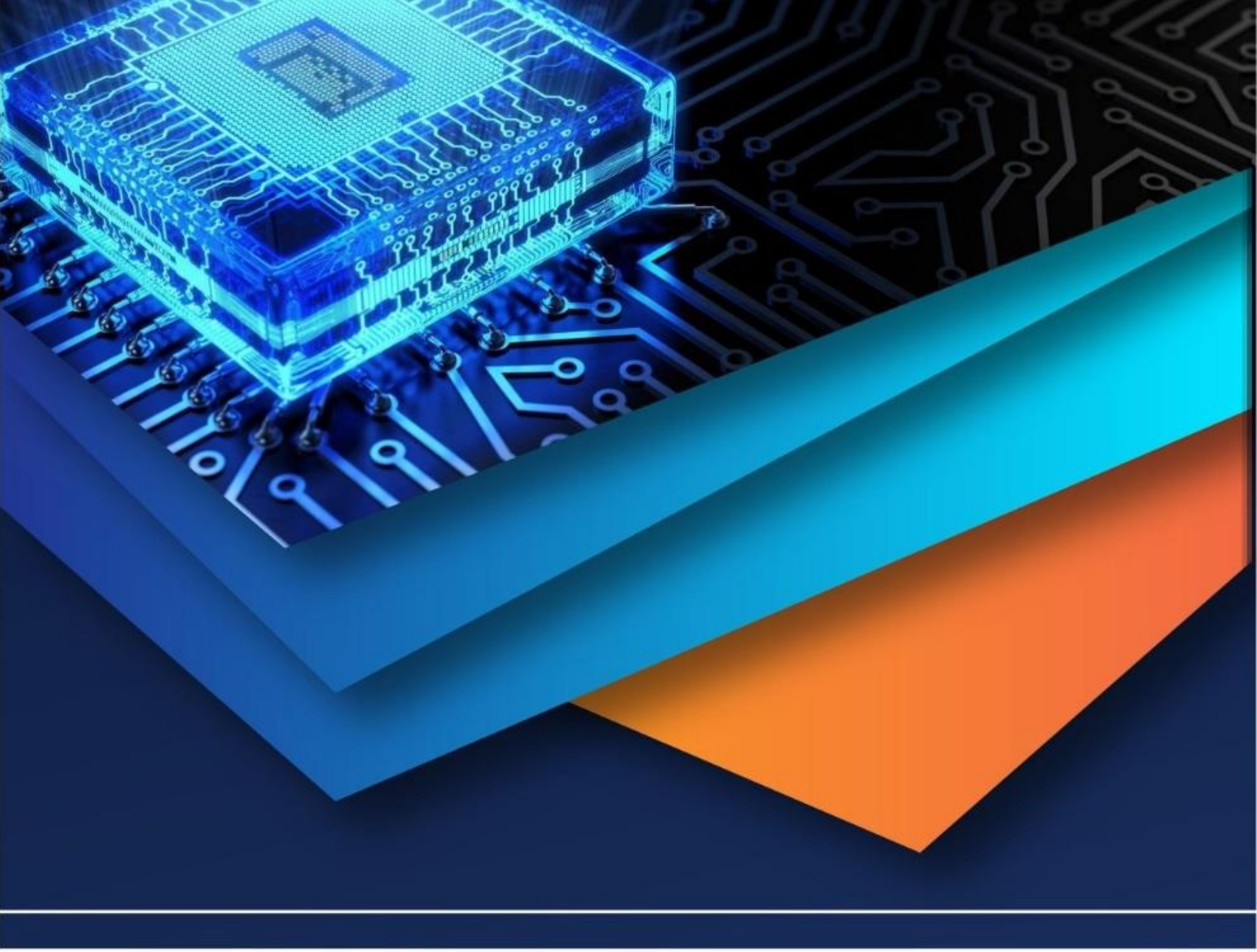
III. CONCLUSION

Hence, we are using this device to enhance power efficiency. This compiled device consisting of Power efficiency system and home automation can really help mankind to save huge amounts of energy getting spoiled unnecessarily especially when running on battery power. This device can be used even on mains power, we can use the power saving and automations even when running on mains power. Therefore any room using power without any use can be shut down automatically and again turned on when someone enters the room.

REFERENCES

[1] Fauxmo library by Kakopappa : https://github.com/simap/fauxmoesp

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