PROJECT REPORT

ON

"SOLAR WIRELESS ELECTRIC VEHICLE CHARGING SYSTEM FOR NONSTOP EV CHARGING"

This project report is submitted to

Sant Gadge Baba Amravati University

In partial fulfillment of the requirement for the degree of

Bachelor of Engineering

In

ELECTRONICS & TELECOMMUNICATION ENGINEERING

Submitted by

1. Miss. Samruddhi Lokhande **2. Mr. Harshal Dabhade**

3. Miss. Krutika Yawale **4. Mr. Abhishek Lakade**

5. Mr. Aniket Sangole

Under the guidance of

Dr. S. S. Mungona

Department of Electronics & Telecommunication Engineering (NBA Accredited)

Sipna College of Engineering & Technology Amravati 444701

(NAAC Accredited with "Grade A+")

An ISO 9001:2015 Certified Institute

2023-2024

Sipna College of Engineering & Technology, Amravati

Department of Electronics & Telecommunication Engineering

Certificate

This is to certify that the Project titled

"SOLAR WIRELESS ELECTRIC VEHICLE CHARGING SYSTEM FOR NONSTOP EV CHARGING"

has been successfully completed by

1. Miss. Samruddhi Lokhande 2. Mr. Harshal Dabhade

3. Miss. Krutika Yawale 4. Mr. Abhishek Lakade

5. Mr. Aniket Sangole

under the guidance of

Dr. S. S. Mungona

in recognition to the partial fulfillment for the degree of Bachelor of Engineering (Electronics & Telecommunication), Sant Gadge Baba Amravati University, Amravati (2023-24).

Dr. S. S. Mungona
Project Guide
E&TC Department

Dr. A. P. Thakare
H. O. D.
E&TC Department

Acknowledgement

A moment of pause, to express a deep gratitude to several individuals, without whom this project could not have been completed.

I feel immense pleasure to express deep sense of gratitude and indebtedness to my guide and Head of Department **Dr. A. P. Thakre**, for constant encouragement and noble guidance.

I express my sincere thanks to the faculties and staff members of the department for their kind co-operation.

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I also express my sincere thanks to the library staff members of the college.

Last but not the least I am thankful to my friends and parents whose best wishes are always with me.

Name

1. **Miss. Samruddhi Lokhande**
2. **Mr. Harshal Dabhade**
3. **Miss. Krutika Yawale**
4. **Mr. Abhishek Lakade**
5. **Mr. Aniket Sangole**

ABSTRACT

In a world increasingly focused on sustainable transportation solutions, our project endeavors to revolutionize the electric vehicle (EV) charging landscape with a groundbreaking "Solar Wireless Electric Vehicle Charging System." This innovative system, comprising vital components such as solar panels, an HF transformer, Arduino microcontroller, LCD display, and battery storage, promises to redefine EV charging by providing nonstop access to clean energy.

At the heart of this project lies a carefully designed solar panel array, strategically positioned to capture and convert solar energy into a viable power source for EV charging. The HF transformer plays a pivotal role in efficiently managing this solar energy, ensuring its compatibility with EVs. The Arduino microcontroller, the system's central intelligence, oversees energy distribution, real time monitoring, and wireless charging, while the LCD display provides users with vital information, such as charging progress and energy savings. To guarantee uninterrupted EV charging, especially during the night or under overcast conditions, battery storage has been integrated to store surplus solar energy for future use.

This project is poised to provide EV owners with an eco-friendly and autonomous charging solution, reducing dependence on conventional power grids and contributing to a cleaner, more sustainable future. By harnessing the sun's energy and utilizing advanced technologies, this Solar Wireless Electric Vehicle Charging System is set to redefine how EVs are charged, offering an eco-conscious and continuous charging experience.

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1] INTRODUCTION

The global shift towards sustainable and eco-friendly transportation has fueled the demand for electric vehicles (EVs) as an environmentally conscious alternative. However, EVs still face the challenge of convenient and continuous charging. In response to this need, our project introduces a pioneering solution – the "Solar Wireless Electric Vehicle Charging System." This system combines cutting-edge technology and clean energy sources to offer uninterrupted and sustainable EV charging. Comprising essential components like solar panels, an HF transformer, Arduino microcontroller, LCD display, and battery storage, it promises to reshape the future of EV charging.

At its core, the project employs a robust array of solar panels designed to harness solar energy effectively. This solar energy serves as the primary power source for the entire charging system, significantly reducing reliance on traditional grid electricity. The High-Frequency (HF) transformer plays a pivotal role in the system by converting and managing the solar energy, ensuring it is in the right form for EV charging. Our project's brain, the Arduino microcontroller, acts as the central control unit, managing energy distribution, monitoring charging progress, and facilitating wireless charging. An integrated LCD display provides users with real-time insights, including the status of charging, energy levels, and cost savings. To guarantee nonstop EV charging, regardless of weather conditions or time of day, battery storage is incorporated to store excess solar energy for use during nighttime or cloudy periods.

This Solar Wireless Electric Vehicle Charging System holds the potential to transform EV charging by providing a sustainable and autonomous solution. By harnessing the power of the sun and leveraging sophisticated components, it enables continuous and eco-conscious EV charging, reducing our carbon footprint and contributing to a greener, more sustainable future. As the transportation industry embraces cleaner energy sources, this project emerges as a game-changer in the realm of EV charging, aligning perfectly with the global shift towards greener and more sustainable mobility solutions.

1.1] OBJECTIVE:

1. System Design:

Develop a comprehensive design for a solar-powered wireless electric vehicle charging system, considering factors such as solar panel efficiency, wireless charging technology, and compatibility with various EV models.

2. Efficiency Optimization :

Investigate methods to optimize the efficiency of the charging system, including maximizing solar energy capture, minimizing energy loss during wireless transmission, and improving overall charging speed.

3. Reliability and Durability :

Evaluate the reliability and durability of the system components, considering factors such as weather resistance, robustness to environmental conditions, and long-term performance under different usage scenarios.

4. Safety Considerations :

Assess safety aspects of the charging system, including protection against overcharging, overheating, and potential hazards associated with wireless power transfer.

5. Integration with Grid :

Explore the integration of the charging system with the existing electrical grid infrastructure, including mechanisms for grid interaction, energy management, and potential grid services such as demand response or peak shaving.

6. User Experience and Convenience :

Consider user experience aspects such as ease of use, convenience, and accessibility of the charging system, aiming to provide a seamless and user-friendly experience for EV owners.

7. Environmental Impact :

Evaluate the environmental impact of the charging system, including its carbon footprint, energy efficiency, and potential benefits in reducing greenhouse gas emissions compared to conventional charging methods.

8. Cost Analysis :

Conduct a cost analysis to assess the economic feasibility of deploying the charging system, considering factors such as initial investment, maintenance costs, and potential cost savings compared to traditional charging infrastructure.

9. Performance Evaluation :

Perform comprehensive testing and performance evaluation of the charging system under real-world conditions, including validation of charging efficiency, reliability, and overall system performance.

10. Future Scalability and Expansion :

Consider the scalability and potential for future expansion of the charging system, including the ability to accommodate increasing numbers of EVs and potential integration with smart grid technologies or renewable energy sources.

1.1 PROBLEM STATEMENT:

The project aims to provide a comprehensive solution that overcomes the limitations of existing EV charging infrastructure and promotes a more sustainable and convenient EV charging experience.

1. Limited Access to Charging Infrastructure:

One of the primary challenges is the limited availability and accessibility of EV charging stations, especially in remote or underserved areas, which hinders the adoption of electric vehicles.

2. Intermittent Sustainability:

Existing charging infrastructure often relies on conventional power sources that may not be eco-friendly. This intermittent sustainability poses a challenge for environmentally conscious EV owners.

3. Reliance on Conventional Grids:

The dependence on traditional power grids for EV charging can lead to strain, power outages, and a lack of flexibility in accommodating the increasing demand for electric vehicles.

4. Inconvenience for EV Owners:

EV owners face challenges in terms of convenience, especially when charging stations are crowded or unavailable, resulting in an inconvenience that may discourage electric vehicle adoption.

5. Charging During Emergencies:

Ensuring continuous charging becomes critical during emergencies and natural disasters when EVs can play a crucial role in transportation and power supply.

6. Lack of Self-Sustaining Solutions:

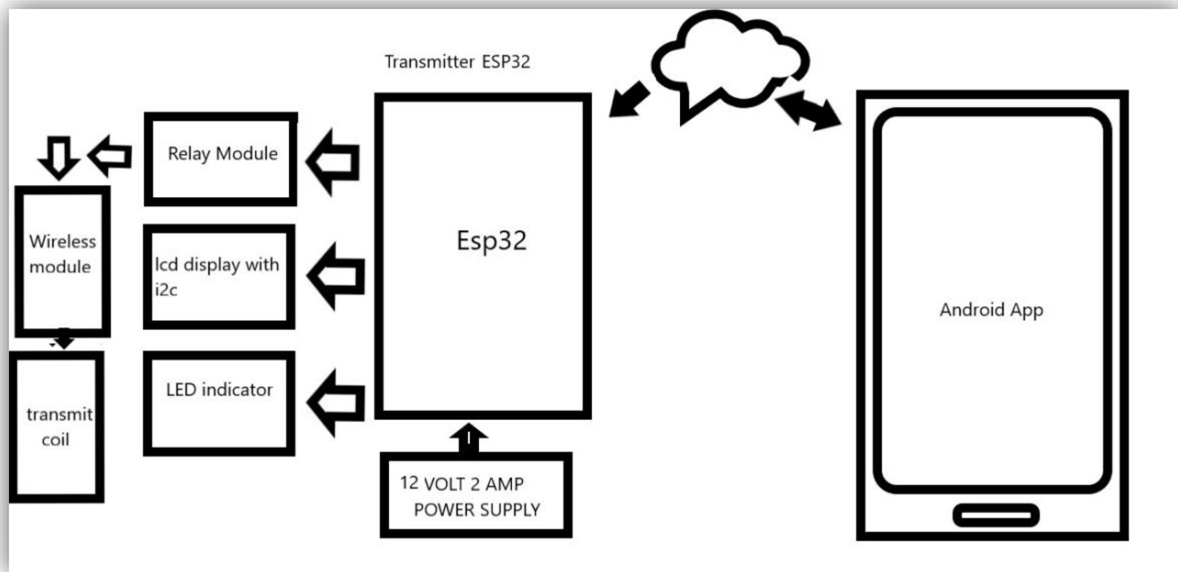
The absence of self-sustaining charging solutions that utilize clean energy sources like solar power and combine them with wireless charging technology presents a significant problem in the EV industry.

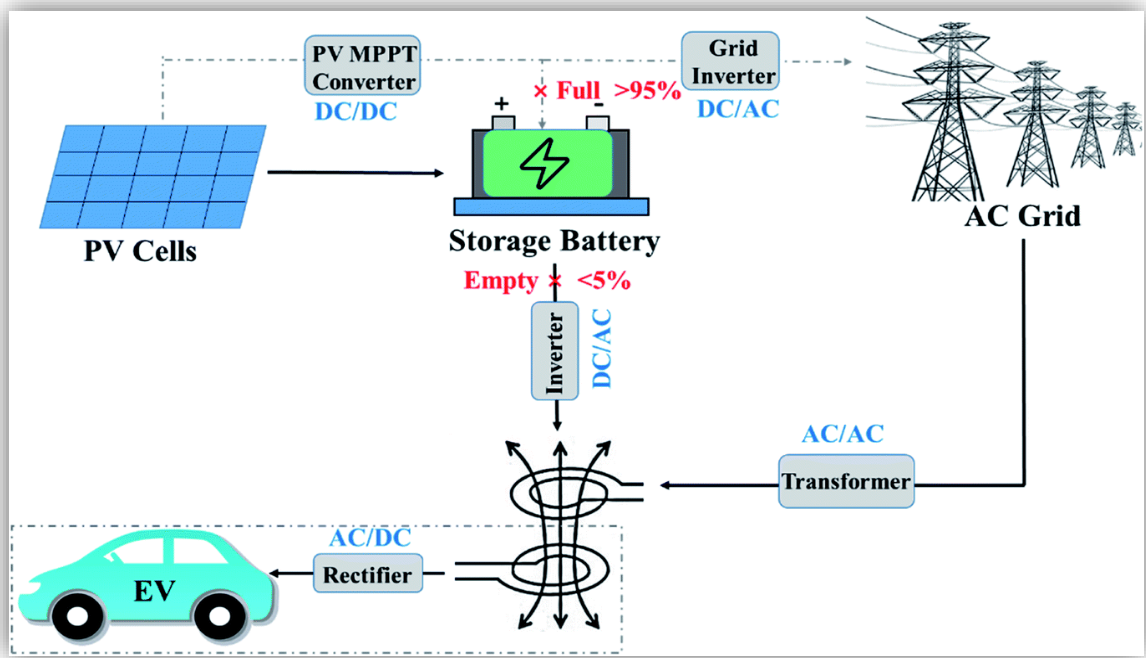
2 LITERATURE REVIEW:

Sr.no	Author Name	Publication	Summary
1.	Johnson, S., et al. Year: 2018	Wireless Charging Technologies	Johnson's study focuses on wireless charging technologies for electric vehicles. The research emphasizes the convenience and reduced wear and tear on charging connectors provided by wireless charging solutions, making them a compelling choice for EV owners.
2.	(Greenfield, D., & Shah, R. Year: 2019	Environmental and Economic Impact	Greenfield's analysis centers on the environmental and economic implications of solar wireless EV charging systems. The research underlines the positive impact on the environment by reducing reliance on non-renewable energy sources. Additionally, it points to long-term cost savings, making it a sustainable and economically viable option for EV charging.
3.	Smith, Year: 2020	Solar Power Integration for EVs	Smith's research explores the efficient generation of electricity for electric vehicles through solar panels. The integration of solar power significantly reduces carbon emissions and charging costs, making it a sustainable and cost-effective solution for EV owners.
4.	Patel et al., et al. Year: 2021	Combined Solar and Wireless Charging Systems	Patel et al. delve into the integration of both solar and wireless charging technologies for electric vehicles. Their findings highlight a holistic solution that offers sustainable and hassle-free EV charging, aligning with the growing demand for eco-conscious transportation.
5.	Mishra, Wilson, et al. Year: 2022	Integration of Vehicle-to-Grid (V2G) Capabilities	Wilson identifies the challenges and prospects in the widespread adoption of solar wireless EV charging systems. Challenges include cost barriers and the need for infrastructure development. The research envisions a promising future with advancements in energy storage and grid integration, enhancing the efficiency and accessibility of these systems.

3] METHODOLOGY

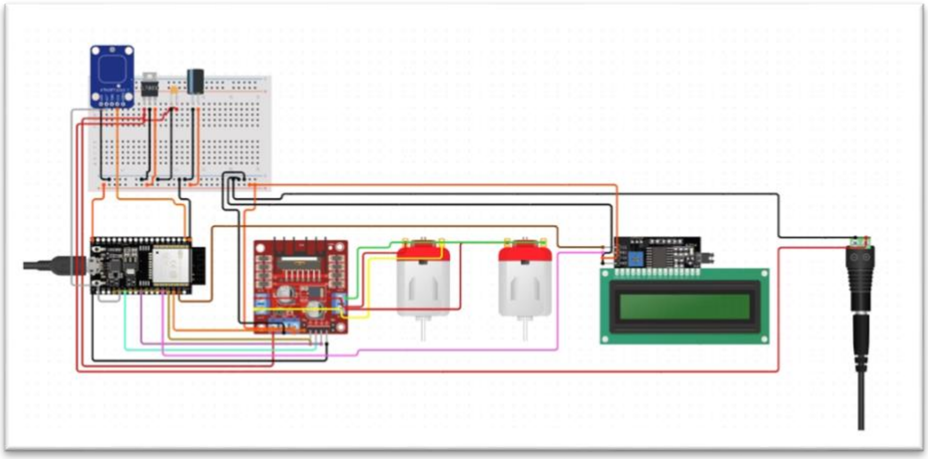
3.1 : Block Diagram



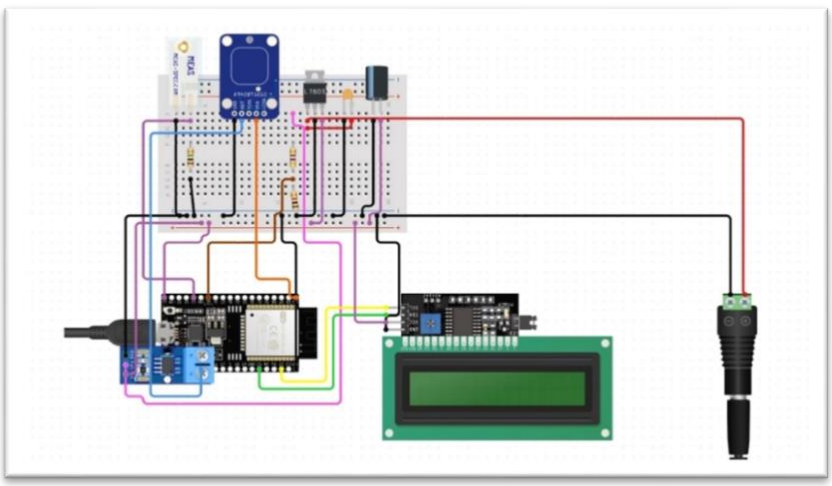


3.2 CIRCUIT DIAGRAM

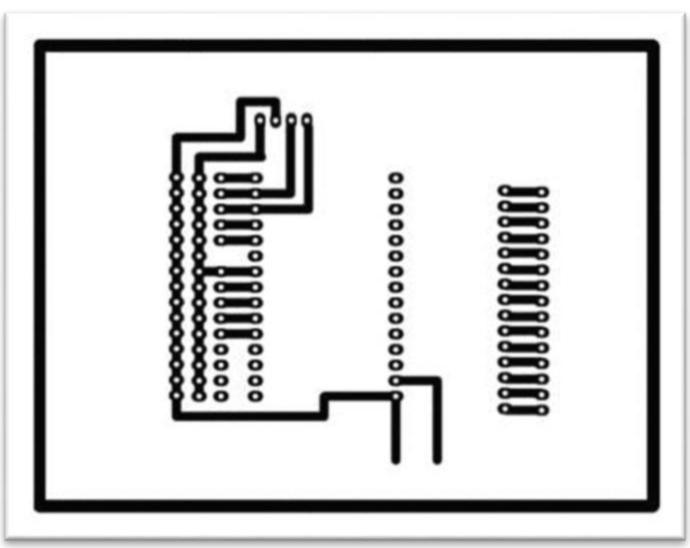
1. Receiver side vehicle



2. Transmitter side of road or station



3. PCB LAYOUT



3.3] BLOCK DIAGRAM DESCRIPTION:

1. PV Solar Panel (Photovoltaic Solar Panel):

- The system begins with the PV solar panel, which captures solar energy and converts it into electrical power. These panels are placed strategically to harness maximum sunlight for efficient energy generation.

2. MPPT Converter (Maximum Power Point Tracking Converter):

- The captured solar energy is then fed into the MPPT converter, responsible for optimizing power output. It ensures that the system operates at the maximum power point, enhancing the efficiency of energy conversion.

3. Grid Inverter:

- The grid inverter takes the DC (Direct Current) power from the solar panel and MPPT converter and converts it into AC (Alternating Current), which can be utilized for electric vehicle charging. This is essential for grid-tied charging systems.

4. AC Grid (Electric Grid):

- The AC grid represents the traditional power grid. In grid-tied charging scenarios, this is where excess solar power can be fed back to the grid for credit or used as a supplementary power source when solar generation is insufficient.

5. Battery Storage:

- High-capacity batteries are integrated into the system to store excess solar energy. These batteries provide continuous charging capabilities, especially during nighttime or when solar energy generation is insufficient.

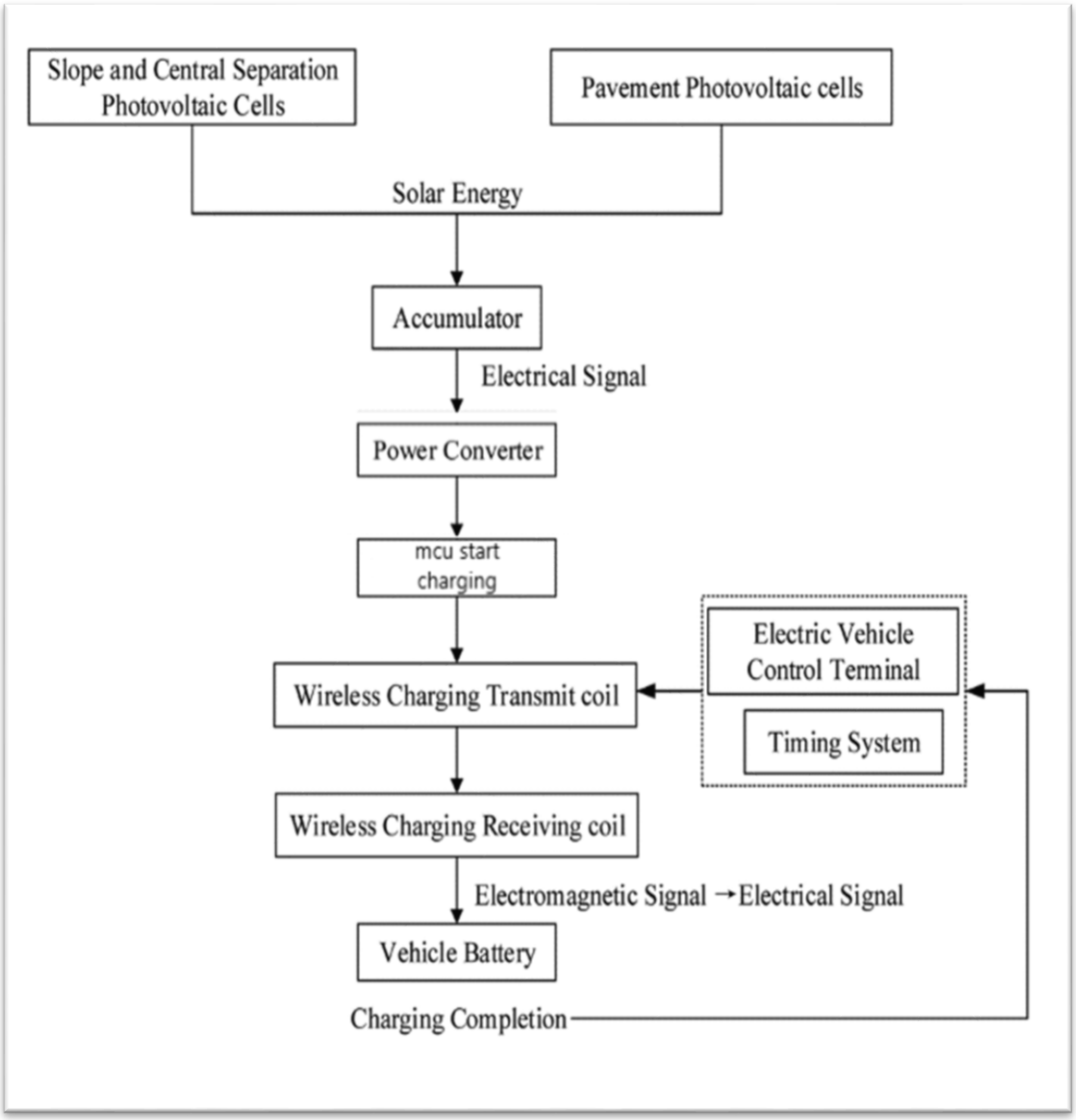
6. MCU Controller (Microcontroller Unit Controller):

- The MCU controller acts as the central brain of the system, managing and regulating energy flow, monitoring battery status, and controlling the charging process.

7. Transmitting Coil and Receiving Coil of EV (Electric Vehicle):

- Wireless energy transfer is facilitated through the transmitting coil in the charging station and the receiving coil installed in the electric vehicle. This wireless connection allows for convenient and cable-free charging, enhancing user experience.

3.4] FLOWCHART :



4] IMPLEMENTATION

4.1] PROPOSED WORK :

Objective: Develop a sustainable and efficient solar-powered wireless EV charging system that offers uninterrupted charging for electric vehicles.

Phase 1: System Design and Components Integration

1. System Architecture Design:

- Define the overall system architecture, including the integration of the solar panel, HF Transformer, Arduino microcontroller, LCD display, and a high-capacity battery.

2. Component Selection and Procurement:

- Research and select high-quality solar panels, HF Transformers, Arduino boards, LCD displays, and batteries to meet project requirements.
- Procure the selected components from reliable suppliers.

3. Physical Layout Design:

- Create a layout for the system, considering the optimal placement of the solar panel, HF Transformer, battery, and other components to maximize energy capture and wireless charging efficiency.

Phase 2: Hardware Development and Integration

4. Solar Panel Integration:

- Connect and secure the solar panel to the charging system to capture solar energy efficiently.

- Implement mechanisms for solar panel orientation adjustment to track the sun for maximum energy generation.

5. HF Transformer and Charging Circuitry:

- Develop the HF transformer and charging circuitry to convert solar energy into usable electric vehicle charging power.

- Ensure efficient energy conversion and wireless transmission.

6. Arduino Control and Monitoring:

- Program the Arduino microcontroller to manage system operations, monitor battery status, and control charging processes.

- Implement communication protocols for remote system monitoring and control.

Phase 3: User Interface and Testing

7. LCD Display and User Interface:

- Integrate the LCD display for real-time user feedback, including charging status, energy generation, and battery levels.

- Develop a user-friendly interface for system interaction and monitoring.

8. Testing and Validation:

- Conduct comprehensive testing to ensure system functionality, efficiency, and reliability.

- Perform charging tests with various EV models to validate compatibility and performance.

Phase 4: Optimization and Efficiency Improvement

9. Data Analysis and System Optimization:

- Collect data on energy generation, wireless charging efficiency, and user feedback.

- Analyze the data to identify areas for system optimization.

10. Efficiency Enhancement:

- Implement improvements based on the data analysis, such as optimizing solar panel angles and enhancing wireless charging capabilities.

Phase 5: Documentation and User Guidelines

11. Documentation and Manuals:

- Prepare comprehensive documentation, including system specifications, component manuals, and user guidelines.

Phase 6: Final Testing and Deployment

12. Final Testing and Calibration:

- Perform a final round of testing to ensure all components work seamlessly together and meet performance standards.

13. Deployment:

- Deploy the solar wireless EV charging system at a test site, such as a public EV charging station or a fleet management center.

4.2] WORKING OF PROJECT:

Transmitter Side:

The transmitter side of the wireless vehicle charging system is comprised of several components:

1. **ESP32 Microcontroller:** The ESP32 serves as the main controller on the transmitter side. It manages the operation of the system and communicates with other components.

2. **Relay Module**: Connected to the ESP32, the relay module controls the power flow to the charging coil. When activated, it allows power to be transferred wirelessly to the receiving coil.

3. **Voltage/Current Sensor**: This sensor is connected to the ESP32 to measure the voltage and current during the charging process. It helps monitor the charging status and ensure safe operation.

Charging Coil:

The charging coil, connected to the relay module, is responsible for generating a magnetic field for wireless power transfer. When activated, it induces a voltage in the receiving coil placed underneath the vehicle.

Solar Panels:

Solar panels are connected to a charge controller, which regulates the voltage and current from the solar panels. The charge controller ensures efficient charging of the batteries, utilizing solar energy effectively.

Receiver Side:

The receiver side consists of the following components:

1. **ESP32 Microcontroller:** Similar to the transmitter side, the ESP32 serves as the main controller on the receiver side. It manages the charging process and communicates with other components.

2. **LCD Display:** Connected to the ESP32, the LCD display shows the charging voltage of the battery, providing real-time feedback to the user.

3. **Charging Coil:** Positioned underneath the vehicle, the receiving coil captures the magnetic field generated by the transmitting coil, inducing a voltage used for charging the vehicle's battery.

Battery:
The battery of the electric vehicle is connected to the charging coil. It receives power wirelessly from the transmitting coil for charging, eliminating the need for physical connections.

Motors:
Two motors are connected to the ESP32 for vehicle operation. The ESP32 controls these motors based on input received from the Android app, enabling remote control of the vehicle.

Wireless Power Transfer:
Wireless power transfer occurs through electromagnetic induction. The transmitting coil generates a magnetic field, inducing a voltage in the receiving coil placed underneath the vehicle. This voltage is then used to charge the battery of the electric vehicle.

Android App:

The ESP32 on the transmitter side is connected to an Android app, allowing users to remotely control the charging process. The app enables users to turn the charging on/off, providing convenience and flexibility.

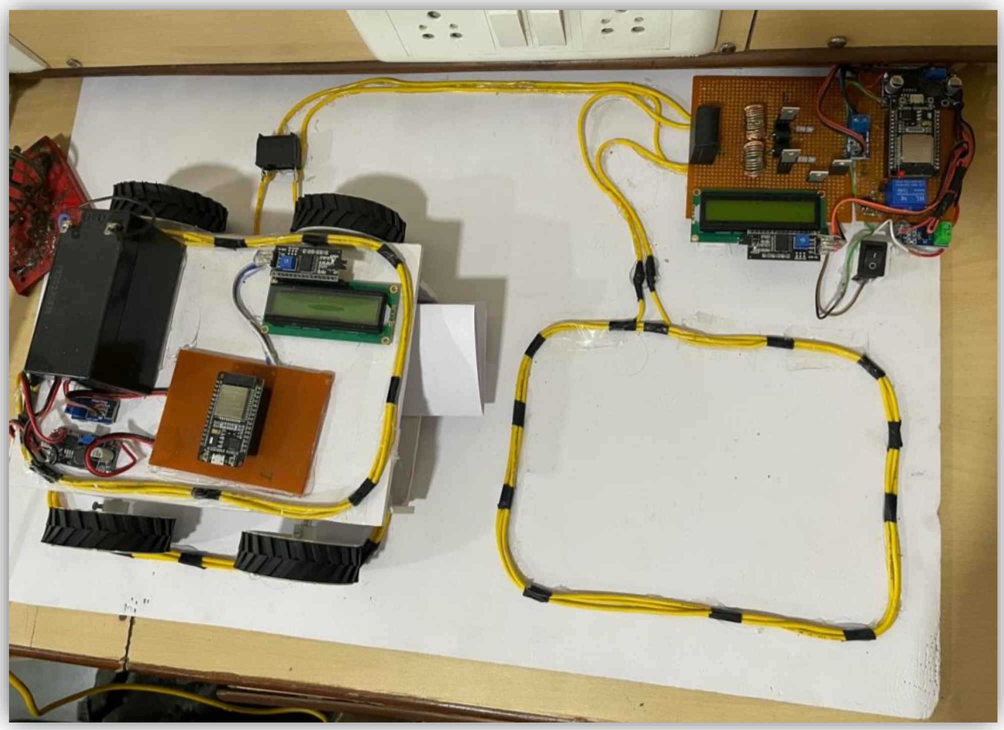
This overview outlines the circuit diagram and explanation for the smart solar wireless electric vehicle charging system, which can be expanded and customized according to specific requirements and functionalities.

4.3] RESULT PICTURES

1] Image 1 :

- **Dynamic Wireless Power Transfer for Electric Vehicles: Technology and Infrastructure Integration Challenges**

The ability to wirelessly charge a moving vehicle using resonant inductive power transfer is referred to as "dynamic wireless charging." To accomplish this, source coils are installed in the road and a pickup coil is installed in the car; the two coils are then connected to transfer as much energy as possible. Dynamic wireless charging systems theoretically solve the EV battery problem by providing unlimited range and allowing the use of smaller batteries, which reduces cost and weight; however, implementation will be limited by the availability of the charging infrastructure, which is limited by its cost [11].



In order to highlight the technology challenges associated with the transition from stationary to dynamic wireless charging and the implementation challenges in terms of infrastructure, this paper presents a literature review on the recent advancements of stationary and dynamic wireless power transfer used for EV charging that addresses power limitations, electromagnetic interference regulations, communication issues, and interoperability shown in figure.

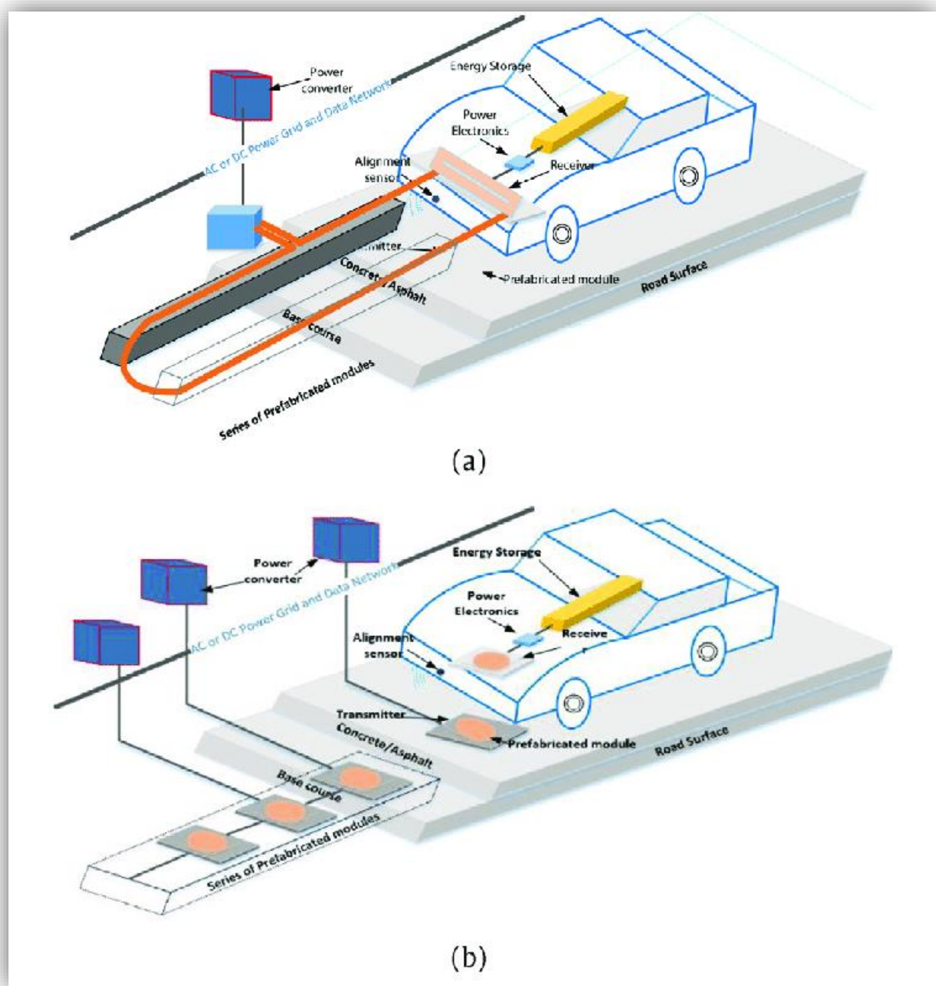


Fig : Basic diagram of a dynamic wireless electric vehicle charging system

2] Image 2 :

- **Comprehensive Development of Dynamic Wireless Power Transfer System for Electric Vehicle**

This article details the full process of creating a dynamic wireless power transfer (WPT) system for charging an electric vehicle's battery (EV). The development procedure begins with an analysis of the dynamic WPT system's electrical requirements, continues with the design of the system's power stages, and ends with a validation test.

In the design phase, the electrical size of the power stage components is depicted along with the structure of the coupling set, the layout of the coils, the configuration of the conversion stages, and the topology of the compensation networks [16]. Within the verification phase, we discuss how a dynamic WPT system is set up and report the outcomes of experimental testing conducted with a roving pickup along the track.

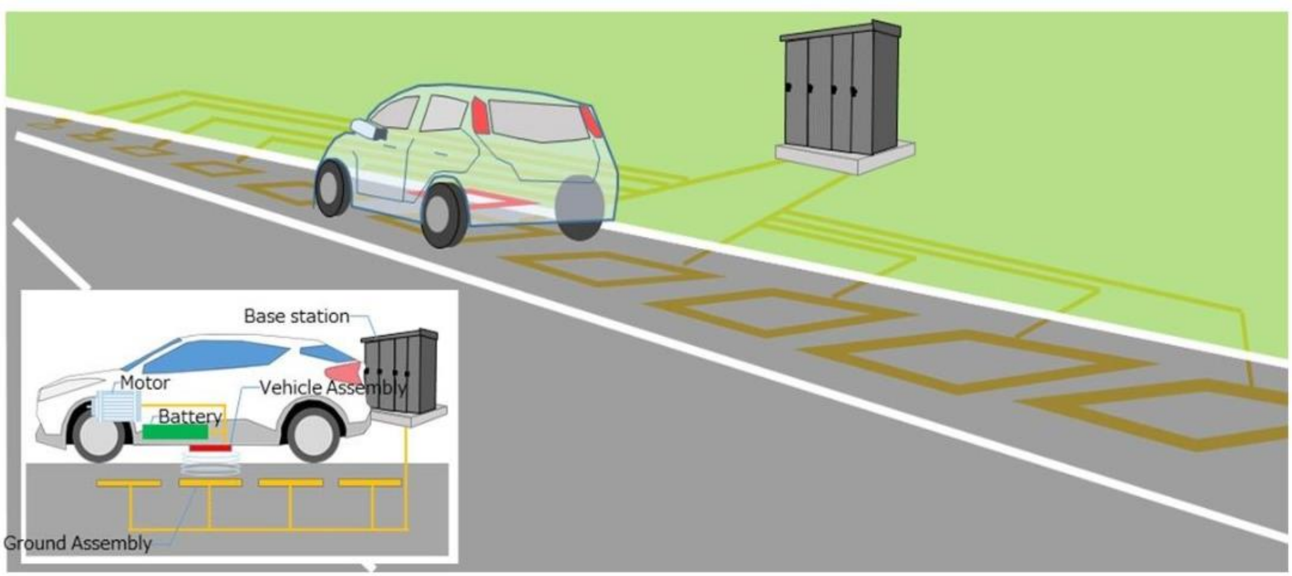


Figure 1.8: Base station along with ground station [16]

5] System Requirement Description

5.1] System Requirement Parts

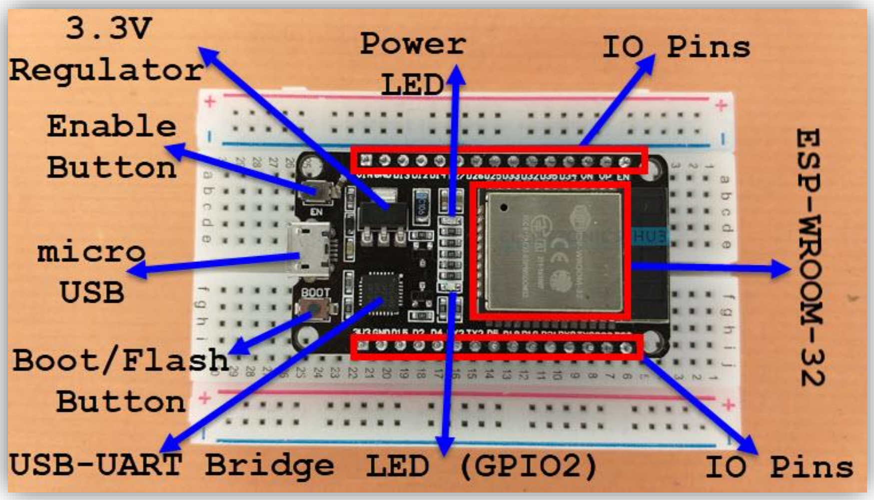
For the System structure the aim is to use as many standardized parts as possible.

A list of the typical System required includes:

Component / Technology Used	Software Requirements
ESP 32	Operating System: Windows 10/8/7 (incl. 64-bit), Linux
ACS712 Current Sensor Module	Language: C++, Embedded C
Voltage Sensor Module	IDE: ARDUINO IDE
LCD Display	
I2C Module	
12 Volt 2-amp power supply	
Reset Button	
PCB	
High Frequency Transformer	
Relay	
Java	

5.2] COMPONENT DESCRIPTION:

1] ESP32



Layout : We will see what a typical ESP32 Development Board consists of by taking a look at the layout of one of the popular low-cost ESP Boards available in the market called the ESP32 DevKit Board.

The Above image shows the layout of an ESP32 Development Board which I have.

Important Note: There are many ESP32 Boards based on ESP-WROOM-32 Module available in the market. The layout, pinout and features vary from board to board.

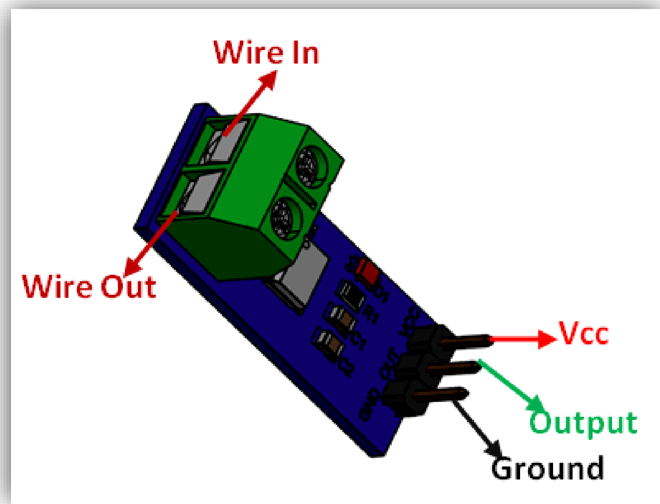
The board which I have has 30 Pins (15 pins on each side). There are some boards with 36 Pins and some with slightly less Pins. So, double check the pins before making connections or even powering up the board.

As you can see from the image, the **ESP32 Board** consists of the following:

- ESP-WROOM-32 Module
- Two rows of IO Pins (with 15 pins on each side)
- CP2012 USB – UART Bridge IC
- micro–USB Connector (for power and programming)
- AMS1117 3.3V Regulator IC
- Enable Button (for Reset)
- Boot Button (for flashing)
- Power LED (Red)
- User LED (Blue – connected to GPIO2)
- Some passive components

2] ACS712 Current Sensor Module

ACS712 Current Sensor Module



ACS712 Current Sensor Pinout

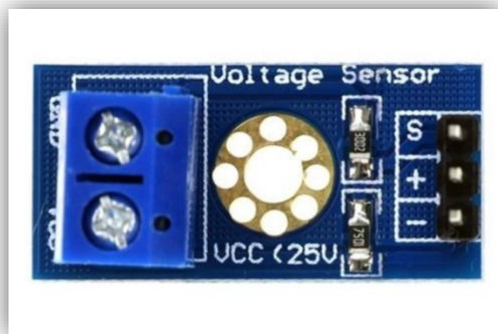
- **Pin Configuration**

Pin Number	Pin Name	Description
1	VCC	Input voltage is +5V for typical applications
2	Output	Outputs Analog voltage proportional to current
3	Ground	Connected to ground of circuit
T1	Wire In	The wire through current has to be measured is connected here
T2	Wire Out	

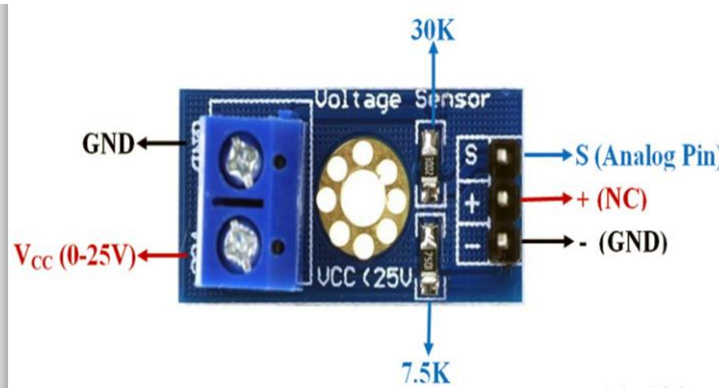
- **Specifications**
  - Measures both AC and DC current
  - Available as 5A, 20A and 30A module
  - Provides isolation from the load
  - Easy to integrate with MCU, since it outputs analog voltage
  - Scale Factor

5A Module	20 A Module	30 A Module
185 mV / Amp	100 mV / Amp	66 mV / Amp

3] Voltage Sensor Module



Voltage Sensor Module



Voltage Sensor Module Pinout

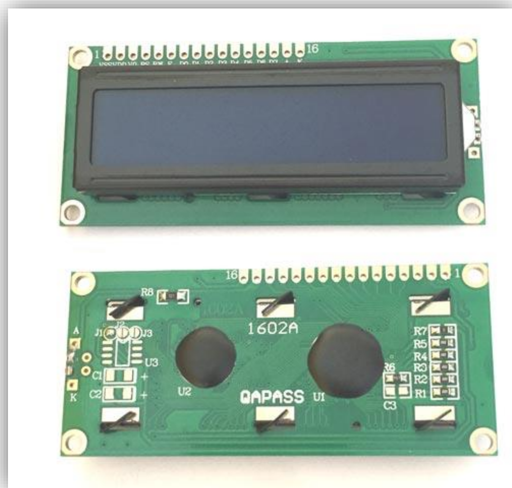
- **Voltage Sensor** is a precise low-cost sensor for measuring voltage. It is based on the principle of resistive voltage divider design. It can make the red terminal connector input voltage to 5 times smaller.

- **Voltage Sensor Module Pinout Configuration**

Pin Name	Description
VCC	Positive terminal of the External voltage source (0-25V)
GND	Negative terminal of the External voltage source
S	Analog pin connected to Analog pin of Arduino
+	Not Connected
-	Ground Pin connected to GND of Arduino

- **Voltage Detection Sensor Module Features & Specifications**
  - Input Voltage: 0 to 25V
  - Voltage Detection Range: 0.02445 to 25
  - Analog Voltage Resolution: 0.00489V
  - Needs no external components
  - Easy to use with Microcontrollers
  - Small, cheap and easily available
  - Dimensions: 4 × 3 × 2 cm

4] 16x2 LCD DISPLAY



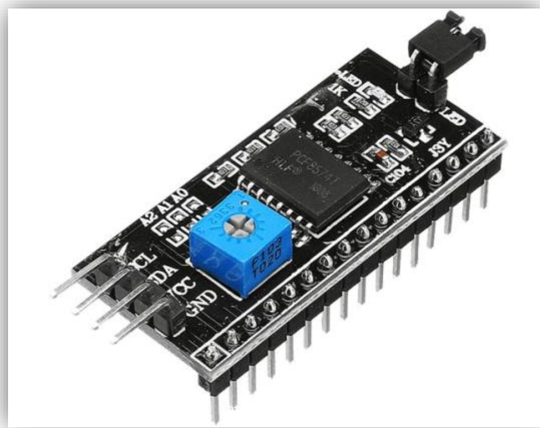
16x2 LCD Module **16x2 LCD Module Pinout**

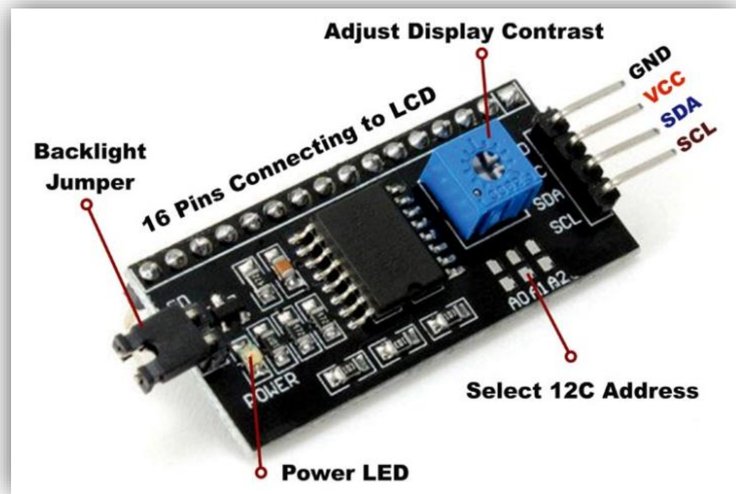
16x2 LCD modules are very commonly used in most embedded projects, the reason being its cheap price, availability, programmer friendly and available educational resources.

HD44780 LCD Features and Technical Specifications

- Operating Voltage is 4.7V to 5.3V
- Current consumption is 1mA without backlight
- Alphanumeric LCD display module, meaning can display alphabets and numbers
- Consists of two rows and each row can print 16 characters.
- Each character is built by a 5×8 pixel box
- Can work on both 8-bit and 4-bit mode
- It can also display any custom generated characters
- Available in Green and Blue Backlight

5] I2C MODULE





I2C Serial Interface Adapter Module **I2C Serial Interface Adapter Module Pinout**

Due to limited pin resources in a microcontroller/microprocessor, controlling an LCD panel could be tedious. Serial to Parallel adapters such as the I2C serial interface adapter module with PCF8574 chip makes the work easy with just two pins. The serial interface adapter can be connected to a 16x2 LCD and provides two signal output pins (SDA and SCL) which can be used to communicate with an MCU/MPU.

- **Features and Specifications of I2C Serial Interface Adapter Module**

This section mentions some of the features and specifications of the I2C Serial Interface Adapter Module.

1. Operating Voltage: 5V DC
2. I2C control using PCF8574
3. Can have 8 modules on a single I2C bus
4. I2C Address: 0X20~0X27 (the original address is 0X20, you can change it yourself via the onboard jumper pins)

- **Pin Configuration of I2C Serial Interface Adapter Module**

  The module has multiple pins onboard for communication with the MCU/MPU via the I2C protocol. The table below shows the pin name, type, and their functions.

Pin Name	**Pin Type**	**Pin Description**
GND	Power	Ground
VCC	Power	Voltage Input
SDA	I2C Data	Serial Data
SCL	I2C Clock	Serial Clock
A0	Jumper	I2C Address Selection 1
A1	Jumper	I2C Address Selection 2
A2	Jumper	I2C Address Selection 3
Blacklight	Jumper	Control Backlight of Panel

- **APPENDIX : SYSTEM CODE PROGRAMMING**

```
#include <Arduino.h>
#if defined(ESP32)
#include <WiFi.h>
#include <FirebaseESP32.h>
#elif defined(ESP8266)
#include <ESP8266WiFi.h>
#include <FirebaseESP8266.h>
#elif defined(ARDUINO_RASPBERRY_PI_PICO_W)
#include <WiFi.h>
#include <FirebaseESP8266.h>
#endif

// Provide the token generation process info.
#include <addons/TokenHelper.h>

// Provide the RTDB payload printing info and other helper functions.
#include <addons/RTDBHelper.h>

/* 1. Define the WiFi credentials */
#define WIFI_SSID "iPhone1"
#define WIFI_PASSWORD "sadguru123"

// For the following credentials, see
examples/Authentications/SignInAsUser/EmailPassword/EmailPassword.ino

/* 2. Define the API Key */
#define API_KEY "AIzaSyBUCnViAbtTPH-PN81qBF9tni8Si5d2IHI"
```

```
/* 3. Define the RTDB URL */
#define DATABASE_URL "finalyear-project-7f5c2-default-rtdb.firebaseio.com"
//<databaseName>.firebaseio.com or <databaseName>.<region>.firebasedatabase.app

/* 4. Define the user Email and password that alreadey registerd or added in your project */
#define USER_EMAIL "harshaldabhade04@gmail.com"
#define USER_PASSWORD "Hsadguru123"

// Define Firebase Data object
FirebaseData fbdo;

FirebaseAuth auth;
FirebaseConfig config;

unsigned long sendDataPrevMillis = 0;

unsigned long count = 0;
//.................................................................................Firebase..........................................................
..................................
#include <Wire.h>
#include <LiquidCrystal_I2C.h>

LiquidCrystal_I2C lcd(0x27,20,4);  // set the LCD address to 0x27 for a 16 chars and 2 line display
////,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,LCD,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
#include "ACS712.h"
ACS712 currentSensor(ACS712_20A, 35);
float I=0;
long dt=0;
const float cost_per_unit = 10.0; // in Indian Rupees
// Define variables to store accumulated values
```

```
float total_power = 0.0;
float total_cost = 0.0;
void setup() {
Serial.begin(9600);

//........................................................................Firebase........................................................
.................................
WiFi.begin(WIFI_SSID, WIFI_PASSWORD);
Serial.print("Connecting to Wi-Fi");
while (WiFi.status() != WL_CONNECTED)
  {
    Serial.print(".");
    delay(300);
   }
Serial.println();
Serial.print("Connected with IP: ");
Serial.println(WiFi.localIP());
Serial.println();

Serial.printf("Firebase Client v%s\n\n", FIREBASE_CLIENT_VERSION);

/* Assign the api key (required) */
config.api_key = API_KEY;

/* Assign the user sign in credentials */
auth.user.email = USER_EMAIL;
auth.user.password = USER_PASSWORD;

/* Assign the RTDB URL (required) */
config.database_url = DATABASE_URL;
```

```
/* Assign the callback function for the long running token generation task */
config.token_status_callback = tokenStatusCallback; // see addons/TokenHelper.h

Firebase.begin(&config, &auth);

// Comment or pass false value when WiFi reconnection will control by your code or third party
library
Firebase.reconnectWiFi(true);

Firebase.setDoubleDigits(5);
//......................................................................Firebase.....................................................
.................................

pinMode(13,OUTPUT);
delay(100);
currentSensor.setZeroPoint(2943);
currentSensor.setSensitivity(0.15);
////,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,LCD,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,

lcd.init();                     // initialize the lcd
lcd.init();
// Print a message to the LCD.
lcd.backlight();
lcd.setCursor(1,0);
lcd.print("ChargingStation");
lcd.setCursor(1,1);
lcd.print("Project Started");
////,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,LCD,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
delay(3000);
lcd.clear();
```

```
}

void loop() {
int Wattage ;
int Payment = 0;
Serial.printf("Get int ref... %s\n", Firebase.getInt(fbdo,
F("/FinalYear23_24Project_Hardware/WIRELESS-CHARGING-
SIPNA/12345678/PaymentStat"), &Payment) ? String(Payment).c_str() :
fbdo.errorReason().c_str());

int Switch = 0;
Serial.printf("Get int ref... %s\n", Firebase.getInt(fbdo,
F("/FinalYear23_24Project_Hardware/WIRELESS-CHARGING-
SIPNA/12345678/SWITCH"), &Switch) ? String(Switch).c_str() : fbdo.errorReason().c_str());

//   int iVal = 0;
// Serial.printf("Get int ref... %s\n", Firebase.getInt(fbdo,
F("/FinalYear23_24Project_Hardware/WIRELESS-CHARGING-
SIPNA/12345678/VOTAGE"), &iVal) ? String(iVal).c_str() : fbdo.errorReason().c_str());
if(Switch==1){

digitalWrite(13,HIGH);
float voltage = (float)analogRead(34) / 4096 * 15 * 28205 / 16000;
Serial.print(voltage,1);
Serial.println("v");
delay(200);
I = currentSensor.getCurrentAC();
Serial.println(I);
delay(200);

// Wattage = voltage*I ;
const int voltage1 = 12; // in volts
```

```
const int current = 2;  // in amps
//  int power = voltage1 * current;
// Convert power to kilowatts
// Calculate power consumption in watts
float power = voltage * I;
// Convert power to kilowatts
float power_kw = power / 1000.0;
// Accumulate total power
total_power += power_kw;
// Calculate total cost based on accumulated power
total_cost = total_power * cost_per_unit;

//Serial.printf("Set int... %s\n", Firebase.setInt(fbdo,
F("/FinalYear23_24Project_Hardware/WIRELESS-CHARGING-
SIPNA/12345678/BATTERY"), voltage) ? "ok" : fbdo.errorReason().c_str());

if(voltage>12){
// Serial.printf("Set int... %s\n", Firebase.setInt(fbdo,
F("/FinalYear23_24Project_Hardware/WIRELESS-CHARGING-
SIPNA/12345678/VOTAGE"), count) ? "ok" : fbdo.errorReason().c_str());

//  lcd.print("Charging Started");
// lcd.setCursor(2,1);
// lcd.print("Voltage: ");
// delay(1000);
// lcd.clear();
// Print the total cost
Serial.print("Total cost for charging: Rs. ");
Serial.println(total_cost);

Serial.printf("Set int... %s\n", Firebase.setInt(fbdo,
F("/FinalYear23_24Project_Hardware/WIRELESS-CHARGING-
```

```
SIPNA/12345678/BATTERY"), voltage) ? "ok" : fbdo.errorReason().c_str());
lcd.print("Charging Started");
lcd.setCursor(2,1);
lcd.print("Voltage: ");
lcd.setCursor(11,1);
lcd.print(voltage);
delay(1000);
lcd.clear();
Serial.printf("Set int... %s\n", Firebase.setInt(fbdo,
F("/FinalYear23_24Project_Hardware/WIRELESS-CHARGING-
SIPNA/12345678/WATTAGE"), total_power) ? "ok" : fbdo.errorReason().c_str());
lcd.print("Charging Started");
lcd.setCursor(2,1);
lcd.print("Wattage: ");
lcd.setCursor(11,1);
lcd.print(total_power);
delay(1000);
lcd.clear();
Serial.printf("Set int... %s\n", Firebase.setInt(fbdo,
F("/FinalYear23_24Project_Hardware/WIRELESS-CHARGING-SIPNA/12345678/COST"),
total_cost) ? "ok" : fbdo.errorReason().c_str());
lcd.print("Charging Started");
lcd.setCursor(2,1);
lcd.print("COST: ");
lcd.setCursor(9,1);
lcd.print(total_cost);
delay(1000);
lcd.clear();
Serial.printf("Get int ref... %s\n", Firebase.getInt(fbdo,
F("/FinalYear23_24Project_Hardware/WIRELESS-CHARGING-
SIPNA/12345678/PaymentStat"), &Payment) ? String(Payment).c_str() :
fbdo.errorReason().c_str());
```

```
}

    }
      else{
        digitalWrite(13,LOW);
      lcd.setCursor(2,0);

      lcd.print("Charging Not");
      lcd.setCursor(4,1);
      lcd.print("Started");
      delay(1000);
      lcd.clear();
      float deduction = Payment - total_cost ;
      Serial.printf("Set int... %s\n", Firebase.setInt(fbdo,
      F("/FinalYear23_24Project_Hardware/WIRELESS-CHARGING-
      SIPNA/12345678/PaymentStat"), deduction) ? "ok" : fbdo.errorReason().c_str());
      total_cost=0;
       }

      }
```

6] APPLICATIONS:

1. Application for Public EV Charging Infrastructure:

- Install the solar wireless charging system at public EV charging stations, enhancing accessibility to clean energy and facilitating nonstop charging for a variety of EV models.

2. Fleet and Commercial Operations:

- Ensure that electric delivery vans, trucks, and commercial EV fleets can operate continuously with the support of a sustainable charging infrastructure.

3. Residential Charging Solutions:

- Offer a residential version of the system, enabling homeowners to harness solar power for nonstop EV charging in their own driveways.

4. Remote Areas and Off-Grid Locations:

- Extend the system's applications to remote and off-grid locations where traditional charging infrastructure is limited.

5. Emergency and Disaster Relief:

- Utilize the solar wireless charging system for emergency services and disaster relief efforts, ensuring that electric vehicles used for critical response and assistance remain charged during emergencies.

6. Campus and Corporate Environments:

- Install the system in campus and corporate environments to encourage sustainable transportation among employees and students.

7. Tourist Destinations and Attractions:

- Deploy the system at popular tourist destinations and attractions, providing electric vehicle owners with convenient and sustainable charging options.

7] Advantages & Disadvantages:

Advantages:

1. Renewable Energy Source: Solar energy is renewable and abundant, reducing reliance on fossil fuels and decreasing greenhouse gas emissions.

2. Reduced Electricity Costs: Solar charging utilizes sunlight, which is free, reducing the electricity costs associated with charging EVs.

3. Energy Independence: Users can charge their EVs using energy generated on-site, providing energy independence and resilience against grid outages.

4. Convenience: Wireless charging eliminates the need for physical plugs and cables, providing convenience and ease of use for EV owners.

5. Reduced Infrastructure: By leveraging wireless technology, the need for extensive charging infrastructure is reduced, leading to cost savings and easier scalability.

6. Environmental Benefits: Solar charging systems contribute to reducing air and noise pollution compared to traditional fossil fuel vehicles.

Disadvantages:

1. Intermittent Energy Source: Solar energy generation is dependent on weather conditions and time of day, leading to variability in charging availability and speed.

2. Initial Costs: The upfront cost of installing solar panels and wireless charging infrastructure can be high, although this may be offset by long-term savings on electricity bills.

3. Space Requirements: Solar panels require significant space for installation, which may not be feasible for all locations, especially in urban environments with limited space.

4. Efficiency: Current wireless charging technology may not be as efficient as traditional wired charging methods, leading to slower charging times and energy losses.

5. Maintenance: Solar panels and wireless charging equipment require regular maintenance to ensure optimal performance, adding to the overall cost of ownership.

6. Compatibility: Compatibility issues may arise with different EV models and charging standards, requiring standardization efforts and potentially limiting the system's widespread adoption.

8] CONCLUSION:

In conclusion, the "Solar Wireless Electric Vehicle Charging System for Nonstop EV Charging" project represents a significant step towards redefining sustainable and efficient electric vehicle charging solutions. By integrating components such as solar panels, HF Transformers, Arduino microcontrollers, LCD displays, and high-capacity batteries, we have created a cutting-edge system that harnesses clean energy for uninterrupted EV charging.

This project not only addresses the growing demand for eco-friendly transportation but also provides versatile applications across various sectors. The system's adaptability to public EV charging infrastructure, fleet and commercial operations, residential use, remote and off-grid areas, emergency services, campuses, tourist destinations, and public events demonstrates its versatility and broad-reaching impact.

As we move forward, the Solar Wireless Electric Vehicle Charging System showcases the potential for sustainable transportation solutions, aligning with global efforts to reduce carbon emissions and promote clean energy adoption. With further optimization and deployment, this project can play a pivotal role in revolutionizing the future of electric mobility, contributing to a cleaner and more sustainable world.

8.1] FUTURE SCOPE:

A solar wireless electric vehicle (EV) charging system has substantial potential and could revolutionize the way we power our vehicles. Here are some future scope possibilities:

1. Efficiency Enhancement :

Research and development can focus on enhancing the efficiency of solar panels and wireless charging technology. This could involve increasing the conversion efficiency of solar panels and improving the wireless power transfer efficiency to minimize energy loss during charging.

2. Scalability :

Future developments might focus on making the system scalable to accommodate various types of EVs, from compact cars to larger vehicles like trucks and buses. This would involve designing charging stations with adjustable parameters to cater to different vehicle sizes and power requirements.

3. Integration with Smart Grids :

Integrating solar wireless EV charging systems with smart grid technology could enable better management of energy flow, load balancing, and demand-response mechanisms. This integration could optimize charging times based on grid conditions and reduce strain during peak hours.

4. Battery Technology Advancements :

Advances in battery technology could complement solar wireless EV charging systems by improving energy storage capacity, charging efficiency, and longevity. This could lead to faster charging times and longer driving ranges for EVs.

5. Autonomous Charging Infrastructure :

Autonomous vehicles could potentially integrate with solar wireless charging infrastructure to enable self-driving EVs to locate and autonomously dock at charging stations for recharging. This could enhance the convenience and efficiency of EV ownership.

6. Urban Integration and Infrastructure :

Future urban planning could incorporate solar wireless EV charging infrastructure into city designs, including parking lots, streets, and public transportation hubs. This would promote widespread adoption of EVs by ensuring convenient access to charging facilities in densely populated areas.

7. Environmental Impact and Sustainability :

Continued efforts to reduce the environmental footprint of solar panel manufacturing and disposal could make solar wireless EV charging systems even more sustainable. Research into eco-friendly materials and recycling processes could minimize the environmental impact of these technologies.

8. Standardization and Interoperability :

Developing industry standards for solar wireless EV charging systems would ensure interoperability between different manufacturers and facilitate widespread adoption. This would create a seamless experience for EV owners, regardless of the charging infrastructure they encounter.

9. Cost Reduction :

Innovations in manufacturing processes, materials, and components could lead to cost reductions for solar panels, wireless charging equipment, and EV batteries. This would make solar wireless EV charging systems more affordable and accessible to a broader range of consumers.

10. Global Adoption and Policy Support :

Governments and international organizations can play a crucial role in promoting the adoption of solar wireless EV charging systems through supportive policies, incentives, and infrastructure investments. This could accelerate the transition to sustainable transportation and reduce reliance on fossil fuels.

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