# Research on Wireless and Thin-Wire Power Solutions for ESP32 IoT Systems

This document explores wireless and thin-wire charging solutions for powering IoT devices such as ESP32-based media controllers and LED displays. It covers wireless charging (Qi standard), thin wire charging, and optimal battery technologies.

## Connectivity Technologies

• Wi-Fi (802.11)  
• Bluetooth (Classic & BLE)  
• LoRa (Long Range, 10+ km, ultra-low power)  
• Low-power microcontrollers — ESP32

## Optimal Battery Technologies

Different lithium-based batteries offer trade-offs in terms of energy density, safety, and application suitability:

• Lithium-Ion (Li-ion) 🔥 — High energy density, widely used.  
• Lithium Polymer (LiPo) 🚀 — Lightweight, high discharge rate, flexible form factor.  
• LiFePO4 (Lithium Iron Phosphate) ⚡ — Longer lifespan, higher thermal stability, safer chemistry.

## Inductive Wireless Charging (Best for No Physical Wires)

Wireless charging eliminates the need for direct wiring. Using Qi wireless charging modules, a coil is placed under the LED display (transmitter), while a receiver coil is attached to the battery pack.

### Required Components:

• Wireless Charging Transmitter Module (5V, 1A)  
• Wireless Charging Receiver Module (5V, 1A)  
• Boost Converter (MT3608) to step up voltage if needed

### Basic Circuit Diagram:

Power Source (12V) → Wireless Charging Transmitter → Receiver Coil → Battery Pack

### Advantages:

• No need for direct wiring.  
• Can be implemented without battery removal.  
• Works through non-metallic surfaces (plastic, glass).

## Thin Wire Charging (Best for High Power Needs)

Thin enameled copper wires can be used to reliably transfer higher current for fast charging applications.

### Implementation Steps:

• Use 0.1mm or 0.2mm enameled copper wires.  
• Route the wire along the edges of the display to the battery.

### Required Components:

• Boost Converter (MT3608)  
• DC-DC Step-Down Module (LM2596)

### Basic Circuit Diagram:

Power Source (12V) → Boost Converter → Thin Wire → Battery

### Advantages:

• More reliable than wireless.  
• Can provide higher current for fast charging.

## Conclusion

Both inductive wireless charging and thin wire charging have their unique strengths. Wireless charging is ideal for user-friendly, wire-free setups, while thin wire charging supports higher power needs and reliability. The choice depends on the specific requirements of the IoT system.