**TRƯỜNG ĐẠI HỌC GIAO THÔNG VẬN TẢI**

**KHOA ĐIỆN – ĐIỆN TỬ**

**BỘ MÔN KỸ THUẬT ĐIỆN TỬ**

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**ĐỒ ÁN TỐT NGHIỆP**

**HỆ THỐNG TRANG TRẠI THÔNG MINH TỪ XA TÍCH HỢP LORA**

**Giảng viên hướng dẫn : ThS Trần Văn Hưng**

**Sinh viên thực hiện: Nguyễn Ngọc Thắng**

**Lớp : Kỹ thuật điện tử và Tin học công nghiệp 2**

**Khoá : K61**

**Hà Nội, tháng 01 năm 2025**

**LỜI NÓI ĐẦU**

Trong bối cảnh công nghệ ngày càng phát triển, việc ứng dụng các giải pháp tiên tiến vào nông trại gia đình không chỉ nâng cao hiệu quả sản xuất mà còn cải thiện chất lượng cuộc sống của người nông dân. Công nghệ **LoRa** (Long Range) đã chứng tỏ ưu thế vượt trội với khả năng truyền tải dữ liệu tầm xa, tiêu thụ năng lượng thấp và hoạt động ổn định trong môi trường nông thôn nơi kết nối mạng thường không đáng tin cậy.

Đồ án này tập trung vào việc thiết kế và triển khai một hệ thống tích hợp giám sát các yếu tố môi trường như nhiệt độ, độ ẩm và nồng độ khí NH₃, đồng thời điều khiển các thiết bị điện như đèn chiếu sáng, quạt thông gió và máy bơm nước. Dữ liệu từ các cảm biến được truyền về vi điều khiển qua giao tiếp LoRa để xử lý và hiển thị. Hệ thống được thiết kế để tự động hóa toàn bộ quá trình, từ giám sát đến điều khiển, dựa trên các ngưỡng giá trị được cài đặt trước, giúp tối ưu hóa việc sử dụng tài nguyên và đảm bảo môi trường phát triển tốt nhất cho cây trồng và vật nuôi.

Việc áp dụng hệ thống này không chỉ mang lại lợi ích về kinh tế thông qua tăng năng suất và giảm lãng phí mà còn giúp người nông dân dễ dàng quản lý công việc hàng ngày, giảm thiểu gánh nặng lao động. Hơn nữa, với thiết kế thân thiện và dễ sử dụng, hệ thống phù hợp với mọi đối tượng, từ những người trẻ quen thuộc với công nghệ đến các nông dân lớn tuổi.

Đồ án không chỉ đơn thuần là một giải pháp kỹ thuật mà còn là bước tiến quan trọng trong hiện đại hóa nông nghiệp. Việc ứng dụng công nghệ LoRa vào giám sát và điều khiển trong nông trại gia đình thể hiện sự kết hợp giữa khoa học công nghệ và thực tiễn đời sống, góp phần xây dựng một mô hình nông nghiệp bền vững, hiện đại và mang lại lợi ích thiết thực cho cộng đồng.Top of Form

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**LỜI CẢM ƠN**

**MỤC LỤC**

**DANH MỤC CÁC HÌNH ẢNH**

# CHƯƠNG 1 TỔNG QUAN VỀ ĐỀ TÀI

## 1.1 Đặt vấn đề

Trong những năm gần đây, sự phát triển vượt bậc của công nghệ đã mở ra nhiều cơ hội mới cho ngành nông nghiệp. Tuy nhiên, việc áp dụng các công nghệ tiên tiến vào nông nghiệp, đặc biệt là tại các nông trại gia đình, vẫn còn gặp nhiều khó khăn do hạn chế về kiến thức kỹ thuật và nguồn lực tài chính. Truyền thống canh tác nông nghiệp phụ thuộc nhiều vào kinh nghiệm và công việc thủ công, dẫn đến hiệu suất sản xuất không ổn định và khó kiểm soát.

Nông trại gia đình thường gặp phải các vấn đề như:

* **Khó khăn trong giám sát môi trường:** Việc giám sát các yếu tố môi trường như nhiệt độ, độ ẩm,… thường được thực hiện thủ công, không liên tục và thiếu chính xác. Điều này dẫn đến việc khó kiểm soát điều kiện canh tác tối ưu cho cây trồng và vật nuôi.
* **Điều khiển thiết bị điện thiếu hiệu quả:** Các thiết bị như bơm nước, quạt, và đèn chiếu sáng thường được vận hành thủ công hoặc bằng các bộ hẹn giờ cố định, không thể phản ứng kịp thời theo biến động của môi trường, dẫn đến lãng phí năng lượng và tài nguyên.
* **Thiếu tính tự động hóa:** Hầu hết các hoạt động nông nghiệp vẫn dựa vào sức lao động thủ công, khiến người nông dân mất nhiều thời gian và công sức, đồng thời khó có thể phản ứng nhanh trước các thay đổi đột ngột của điều kiện môi trường.

Để giải quyết các vấn đề trên, việc áp dụng công nghệ truyền thông LoRa vào nông nghiệp gia đình được xem là một giải pháp hiệu quả. LoRa cho phép truyền tải dữ liệu ở khoảng cách xa với mức tiêu thụ năng lượng thấp, tạo ra một hệ thống giám sát và điều khiển thông minh. Công nghệ này không yêu cầu kết nối internet trực tiếp, rất phù hợp với môi trường nông thôn nơi mạng internet thường không ổn định

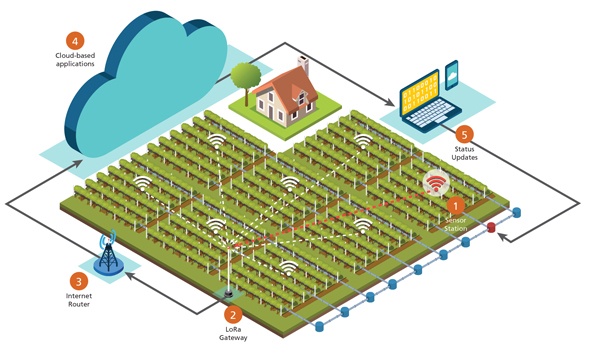
## 1.2 Tổng quan về LoRA

### 1.2.1 Khái niệm LoRA

LoRa, viết tắt của *Long Range Radio*, là một công nghệ truyền thông không dây tiên tiến, sử dụng kỹ thuật điều chế sóng vô tuyến do các chip thu phát của Semtech LoRa tạo ra. Đặc trưng nổi bật của kỹ thuật này là khả năng truyền tải dữ liệu tầm xa với băng thông thấp, mức tiêu thụ năng lượng tối thiểu và khả năng chống nhiễu vượt trội. Nhờ vậy, LoRa trở thành lựa chọn lý tưởng cho các thiết bị IoT (Internet of Things) vốn yêu cầu hiệu suất cao và thời lượng pin lâu dài.

**Những ưu điểm nổi bật của LoRa:** LoRa cho phép truyền dữ liệu ở khoảng cách lên đến 10 km (tùy thuộc vào thiết kế anten và môi trường vật cản), đây là một lợi thế lớn so với các công nghệ như Wi-Fi hoặc 3G/4G. Công nghệ này tiết kiệm năng lượng tối ưu, giúp thiết bị hoạt động bền bỉ trong thời gian dài mà không cần thay pin. Mỗi gateway LoRa có khả năng xử lý hàng triệu node, đồng thời tín hiệu có thể bao phủ phạm vi rộng lớn mà không cần các mạch khuếch đại công suất, giảm đáng kể chi phí xây dựng hạ tầng mạng.

Các tính năng ưu việt của LoRa giúp giải quyết các thách thức trong việc phát triển IoT, bao gồm: hạn chế về dung lượng mạng, yêu cầu tuổi thọ pin dài và khả năng bảo mật cao trong truyền tải dữ liệu. Nhờ đó, LoRa không chỉ thúc đẩy sự phát triển mạnh mẽ của IoT mà còn phù hợp với các ứng dụng như mạng cảm biến (sensor network), nơi các sensor node có thể gửi dữ liệu đo đạc về trung tâm cách xa hàng km mà vẫn duy trì hiệu suất vượt trội và tiêu hao năng lượng thấp.



Hình 1.1 Mô hình mạng LoRA

### 1.2.2 Nguyên lý hoạt động của LoRA

LoRa sử dụng kỹ thuật điều chế gọi là *Chirp Spread Spectrum* (CSS). Nguyên lý cơ bản của CSS là dữ liệu gốc sẽ được "băm" thành các xung cao tần (chipped), tạo ra tín hiệu có dải tần số cao hơn nhiều so với dữ liệu ban đầu. Sau đó, tín hiệu này được mã hóa bằng chuỗi tín hiệu chirp (*chirp signals*) – là các sóng hình sin có tần số thay đổi theo thời gian.

**Loại tín hiệu chirp:** Có hai dạng chirp signal chính:

* *Up-chirp*: Tần số tăng dần theo thời gian, biểu thị cho bit 1.
* *Down-chirp*: Tần số giảm dần theo thời gian, biểu thị cho bit 0.

Trước khi truyền qua anten, dữ liệu sẽ được mã hóa theo các chirp signal này.

**Ưu điểm kỹ thuật của CSS:**

1. **Giảm độ phức tạp của bộ thu:** Theo Semtech, kỹ thuật này làm giảm yêu cầu về độ chính xác và độ phức tạp của mạch thu khi giải mã và tái tạo dữ liệu.
2. **Hiệu quả ở công suất thấp:** LoRa có thể truyền dữ liệu ở khoảng cách xa mà không cần công suất phát lớn, vì tín hiệu vẫn được nhận dù cường độ tín hiệu thấp hơn mức nhiễu môi trường.
3. **Khả năng chống nhiễu vượt trội:** Nhờ sử dụng chirp signal với các tốc độ chirp (*chirp rates*) khác nhau, nhiều tín hiệu LoRa có thể hoạt động đồng thời trong cùng một khu vực mà không gây nhiễu lẫn nhau. Điều này giúp nhiều thiết bị LoRa trao đổi dữ liệu qua các kênh riêng biệt, mỗi kênh tương ứng với một tốc độ chirp khác nhau.

**Tần số hoạt động toàn cầu của LoRa:** LoRa sử dụng các băng tần không cần giấy phép khác nhau tùy theo khu vực:

* **430 MHz – 433 MHz:** Phổ biến tại châu Á, trong đó bao gồm cả Việt Nam.
* **780 MHz: Được sử dụng** riêng tại Trung Quốc.
* **433 MHz hoặc 866 MHz:** Sử dụng tại châu Âu, với 433 MHz cho các ứng dụng công suất thấp và 866 MHz (thực tế là 863–870 MHz) dành cho mạng LoRaWAN.
* **915 MHz:** Dành cho Hoa Kỳ, Australia và một số quốc gia ở châu Mỹ.

Nhờ các đặc điểm ưu việt này, LoRa không chỉ giúp tối ưu hóa chi phí và năng lượng tiêu thụ mà còn đảm bảo khả năng truyền dữ liệu ổn định trong các ứng dụng IoT, đặc biệt là trong môi trường có nhiều thiết bị cùng hoạt động.

## 1.3 Tổng quan về LoRAWAN

### 1.3.1 Khái niệm về LoRaWAN

**LoRaWAN (Long Range Wide Area Network)** là một giao thức mạng được xây dựng trên công nghệ LoRa (Long Range Radio). Nó được thiết kế để hỗ trợ các thiết bị IoT (Internet of Things) trong việc truyền dữ liệu qua khoảng cách xa với mức tiêu thụ năng lượng thấp. LoRaWAN là một giao thức mở, được phát triển và tiêu chuẩn hóa bởi **Liên minh LoRa (LoRa Alliance)**, nhằm tối ưu hóa khả năng kết nối trong các ứng dụng IoT.

Cấu trúc software cơ bản của một thiết bị hỗ trợ LoRaWAN như sau:

Chart, table

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**Hình 1.2:** Cấu trúc LoRaWAN

* **Application (Ứng dụng):**
* Đây là lớp trên cùng, nơi triển khai các ứng dụng thực tế, như giám sát môi trường, quản lý đô thị thông minh, hoặc theo dõi sức khỏe.
* **LoRa MAC (Medium Access Control):**
* Quản lý giao tiếp giữa các thiết bị trong mạng. LoRaWAN có các chế độ hoạt động khác nhau (Class A, B, C):
  + **Class A (Baseline):**
    - Thiết bị chỉ gửi dữ liệu khi cần (theo yêu cầu hoặc thời gian định kỳ).
    - Đây là chế độ tiết kiệm năng lượng nhất.
  + **Class B (Baseline):**
    - Thêm các khung thời gian nhận dữ liệu định kỳ để thiết bị có thể nhận lệnh từ máy chủ.
  + **Class C (Continuous):**
    - Luôn mở để nhận dữ liệu, tiêu thụ năng lượng cao hơn nhưng thích hợp cho các ứng dụng cần phản hồi nhanh.
* **LoRa Modulation:**
* Sử dụng kỹ thuật điều chế LoRa để truyền dữ liệu qua sóng vô tuyến. Kỹ thuật này cho phép truyền ở khoảng cách xa với độ bền tín hiệu cao.
* **Regional ISM Band (Băng tần ISM theo khu vực):**
* LoRa hoạt động trên các băng tần ISM khác nhau tùy khu vực:

**EU 868:** Băng tần 863-870 MHz (châu Âu).

**EU 433:** Băng tần 433 MHz (châu Âu và một số khu vực khác).

**US 915:** Băng tần 902-928 MHz (Hoa Kỳ).

**AS 430:** Băng tần 430 MHz (châu Á, bao gồm Việt Nam).

### **1.3.2 Mô hình mạng LoRaWAN**

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Hình 1.3 Mô hình mạng LoRaWAN

LoRaWAN được triển khai theo mô hình **Client-Server**, bao gồm các thành phần chính:

1. **End Devices (Thiết bị cuối):**
   * Là các thiết bị IoT như cảm biến, đồng hồ đo, hoặc bộ điều khiển.
   * Chúng giao tiếp với Gateway thông qua sóng LoRa và gửi dữ liệu đo đạc hoặc lệnh điều khiển.
2. **Gateways (Cổng kết nối):**
   * Là các thiết bị trung gian, thu thập dữ liệu từ các End Devices qua LoRa và chuyển tiếp đến Network Server thông qua các giao thức IP (như Wi-Fi, Ethernet, hoặc 4G).
3. **Network Server (Máy chủ mạng):**
   * Quản lý kết nối giữa các thiết bị và đảm bảo truyền tải dữ liệu đúng địa chỉ.
   * Loại bỏ dữ liệu trùng lặp, quản lý bảo mật và phân bổ tài nguyên.
4. **Application Server (Máy chủ ứng dụng):**
   * Xử lý dữ liệu nhận được từ Network Server và gửi đến ứng dụng hoặc giao diện người dùng cuối cùng.

### **1.3.3 Ưu và nhược điểm của LoRaWAN**

#### 1.3.3.1 Ưu điểm của LoRaWAN

* Công nghệ LoRa/LoRaWAN nổi bật với vùng phủ sóng rộng lên đến hàng km, tiêu thụ công suất thấp, cho phép tuổi thọ pin dài (2-5 năm đối với thiết bị Lớp A và B), hoạt động trên tần số miễn phí không cần cấp phép.
* Hỗ trợ quy mô lớn: Một gateway LoRa duy nhất có thể quản lý hàng ngàn node hoặc thiết bị đầu cuối.
* Tính đơn giản và dễ triển khai: Nhờ kiến trúc không dây, LoRa dễ dàng cài đặt và triển khai nhanh chóng.
* Ứng dụng rộng rãi trong IoT/M2M: Phù hợp với các hệ thống băng thông thấp và lượng dữ liệu truyền không đổi.
* Hiệu suất vượt trội: Hỗ trợ tải trọng dữ liệu lớn hơn (100 byte) và không giới hạn số tin nhắn hàng ngày, trong khi đối thủ SigFox bị giới hạn ở mức 12 byte/tin nhắn và tối đa 140 tin nhắn/ngày.
* Công nghệ mở: Được phát triển bởi liên minh LoRa, gồm các thành viên lớn như CISCO, IBM và hơn 500 công ty, đảm bảo tính linh hoạt và không độc quyền.
* Ứng dụng đa dạng: Đáp ứng tốt các giải pháp thành phố thông minh, nông nghiệp, công nghiệp, và các hệ thống IoT quy mô lớn khác.
* Chi phí thấp và bảo mật cao: Kết nối tiết kiệm chi phí, đi kèm bảo mật kép với mã hóa AES (một lớp cho mạng và một lớp cho ứng dụng).
* Hỗ trợ giao tiếp hai chiều đầy đủ: Nâng cao khả năng quản lý và tối ưu hóa hệ thống IoT.

#### 1.3.3.2 Nhược điểm của LoRaWAN

* Giới hạn tải trọng dữ liệu: Chỉ hỗ trợ tối đa 100 byte mỗi gói tin, không phù hợp với nhu cầu truyền dữ liệu lớn.
* Không thích hợp cho giám sát liên tục: Chỉ các thiết bị Class C mới hỗ trợ tính năng này, trong khi Class A và B không đáp ứng được.
* Không lý tưởng cho ứng dụng thời gian thực: Độ trễ cao và khả năng đáp ứng kém đối với các hệ thống đòi hỏi sự ràng buộc thiết bị và độ trễ thấp.
* Thách thức trong môi trường đô thị: Việc mở rộng mạng LoRaWAN trong khu vực đông dân cư có thể dẫn đến cạnh tranh tần số và ảnh hưởng hiệu suất.
* Nhược điểm của tần số mở: Dễ bị nhiễu tín hiệu và tốc độ dữ liệu thấp hơn so với tần số có cấp phép, vốn đảm bảo chất lượng nhờ chi phí license cao.

### 1.3.4 Một số hệ thống sử dụng của mạng LoRa

#### 1.3.4.1 Ứng dụng LoRa trong tòa nhà thông minh (Smart Building)

* **Quản lý năng lượng**: LoRaWAN tập hợp tất cả các hệ thống liên quan đến năng lượng để quả lý tòa nhà thông minh: chiếu sáng, sưởi ấm, làm mát, an toàn cháy nổ. Giao thức truyền thông LoRaWAN kết nối chúng một cách hiệu quả để giúp kiểm soát và giảm mức tiêu thụ điện năng.
* **An ninh nhà thông minh**: Văn phòng, nhà máy, tổ chưc hành chính và tất cả các tòa nhà thông minh khác cần được bảo vệ chống cháy, thiên tai và lối vào trái phép. Sử dụng LoRaWAN, cửa sổ, cửa ra vào chuông báo cháy, cảm biến phát hiện chuyển động và các nút khẩn cấp có thể được tổ chức thành một hệ thống báo động an toàn.
* **Tối ưu hóa không gian**: Dữ liệu được thi thập bở các thiết bị hổ trợ LoRa giúp tối ưu hóa mặt bằng văn phòng. Môi trường văn phòng có thể được định hình lại. Điều này giúp năng cao sự hài lòng của nhân viên.

#### 1.3.4.2 Ứng dụng LoRa trong nông nghiệp thông minh

Lợi ích của LoRaWAN trong nông nghiệp thông minh:

* **Định vị địa lý:** Công nghệ LoRa sử dụng công nghệ định vị địa lý không có GPS mà không cần nguồn điện bổ sung.
* **phí kết nối thấp:** Chi Công nghệ LoRa hoạt động trong dải ISM không được cấp phép, có nghĩa là không có hoặc phổ rất thấp.
* **Tận dụng các tài sản được triển khai:** Tín hiệu mạnh mẽ của công nghệ LoRa có thể thâm nhập vào phạm vi phủ sóng rộng ngay cả trong vùng nông thôn.

Diagram

Description automatically generated

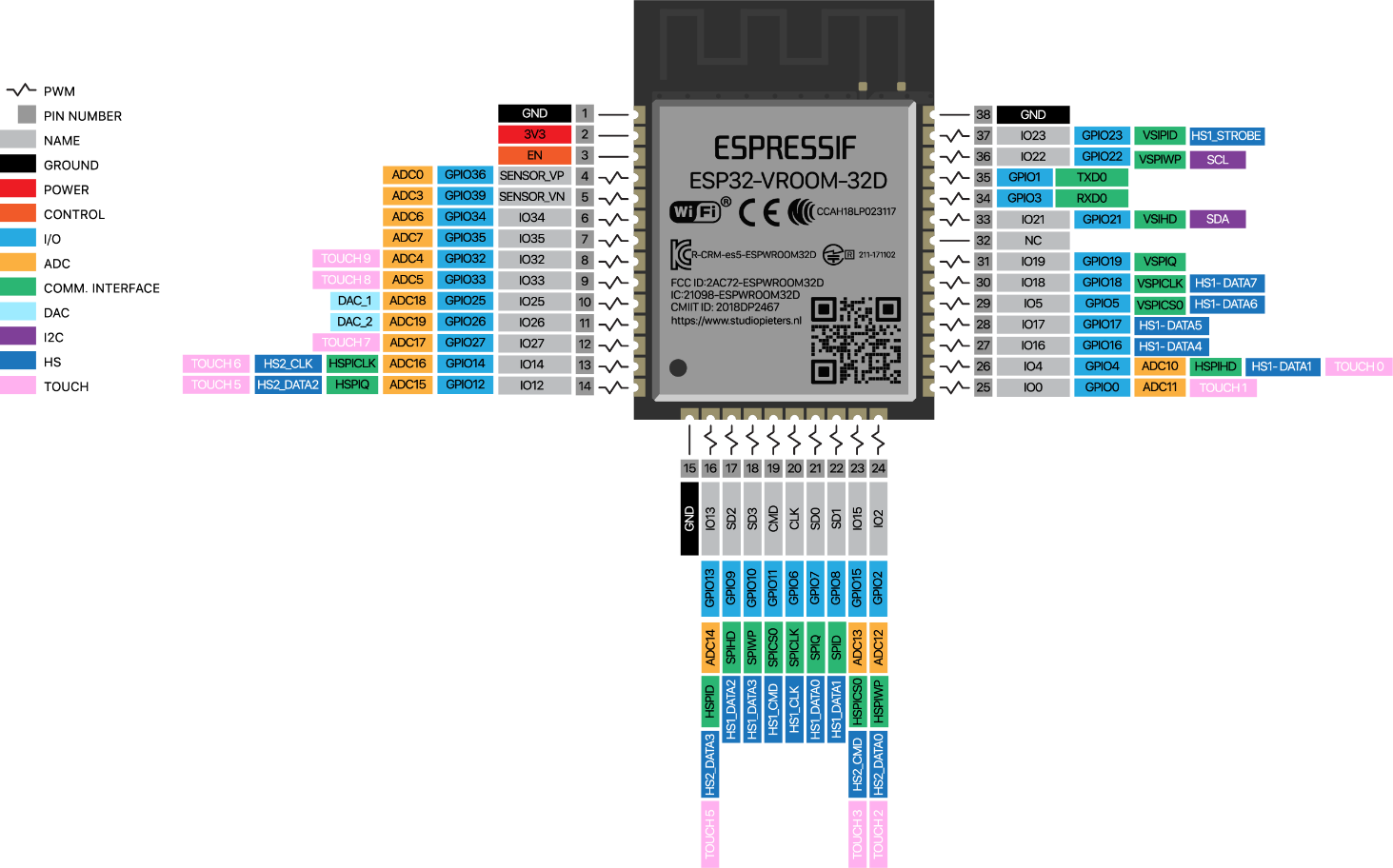
**Hình 1.4:** Ứng dụng LoRa trong nông nghiệp

# CHƯƠNG 2 CƠ SỞ LÝ THUYẾT

## THIẾT BỊ PHẦN CỨNG

### 2.1.1 ESP32

ESP32 là một SoC giá rẻ của Espressif Systems, kế thừa từ ESP8266, tích hợp bộ vi xử lý 32-bit Xtensa LX6 với cả Wi-Fi và Bluetooth. Ưu điểm chính của ESP32 là tích hợp các thành phần RF như bộ khuếch đại, công tắc ăng-ten và bộ lọc, giúp thiết kế phần cứng dễ dàng hơn. Sản xuất bằng công nghệ 40 nm công suất cực thấp của TSMC, ESP32 rất phù hợp cho các ứng dụng chạy bằng pin như thiết bị đeo, thiết bị âm thanh, và đồng hồ thông minh.



Hình 2.1 ESP32

**Thông số kỹ thuật**

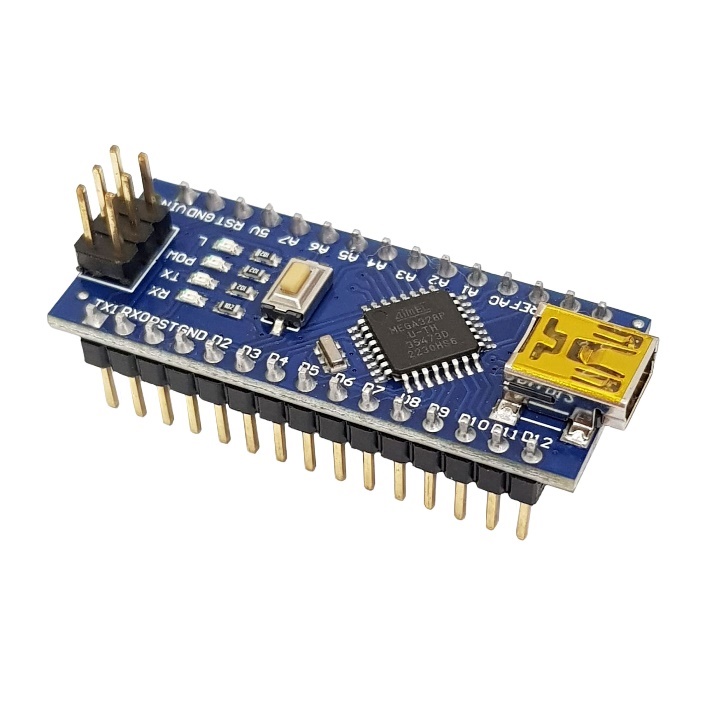
* Bộ vi xử lý: LX6 32-bit lõi đơn hoặc lõi kép với xung nhịp lên đến 240 MHz.
* Bộ nhớ: 520 KB SRAM, 448 KB ROM, và 16 KB SRAM RTC.
* Wi-Fi: Hỗ trợ kết nối Wi-Fi 802.11 b/g/n với tốc độ lên đến 150 Mbps.
* Bluetooth: Hỗ trợ Bluetooth v4.2 và BLE cổ điển.
* GPIO: 34 GPIO có thể lập trình.
* ADC/DAC: 18 kênh SAR ADC 12 bit và 2 kênh DAC 8 bit.
* Kết nối nối tiếp: 4 x SPI, 2 x I2C, 2 x I2S, 3 x UART.
* Ethernet: Ethernet MAC cho giao tiếp mạng LAN vật lý (yêu cầu PHY bên ngoài).
* SD/SDIO/MMC: 1 bộ điều khiển host cho SD/SDIO/MMC và 1 bộ điều khiển slave cho SDIO/SPI.
* PWM: Động cơ PWM và 16 kênh LED PWM.
* Bảo mật: Khởi động an toàn và mã hóa Flash, tăng tốc phần cứng mật mã cho AES, Hash (SHA-2), RSA, ECC và RNG.

**Bảng 2.1 Chức năng các chân ESP32**

|  |  |  |  |
| --- | --- | --- | --- |
| **GPIO** | **Input** | **Output** | **Ghi chú** |
| 0 | pulled up | OK | Xuất tín hiệu PWM khi khởi động, phải ở mức LOW để vào chế độ flash. |
| 1 | TX pin | OK | Xuất thông tin debug khi khởi động. |
| 2 | OK | OK | Kết nối với LED on-board, phải để floating hoặc LOW để vào chế độ flash. |
| 3 | OK | RX pin | Ở mức HIGH khi khởi động. |
| 4 | OK | OK |  |
| 5 | OK | OK | Xuất tín hiệu PWM khi khởi động, là chân strapping. |
| 6 | x | x | Kết nối với bộ nhớ flash SPI tích hợp. |
| 7 | x | x | Kết nối với bộ nhớ flash SPI tích hợp. |
| 8 | x | x | Kết nối với bộ nhớ flash SPI tích hợp. |
| 9 | x | x | Kết nối với bộ nhớ flash SPI tích hợp. |
| 10 | x | x | Kết nối với bộ nhớ flash SPI tích hợp. |
| 11 | x | x | Kết nối với bộ nhớ flash SPI tích hợp. |
| 12 | OK | OK | Khởi động thất bại nếu bị kéo lên mức HIGH, là chân strapping. |
| 13 | OK | OK |  |
| 14 | OK | OK | Xuất tín hiệu PWM khi khởi động. |
| 15 | OK | OK | Xuất tín hiệu PWM khi khởi động, là chân strapping. |
| 16 | OK | OK |  |
| 17 | OK | OK |  |
| 18 | OK | OK |  |
| 19 | OK | OK |  |
| 21 | OK | OK |  |
| 22 | OK | OK |  |
| 23 | OK | OK |  |
| 25 | OK | OK |  |
| 26 | OK | OK |  |
| 27 | OK | OK |  |
| 32 | OK | OK |  |
| 33 | OK | OK |  |
| 34 | OK | Input only | Chỉ hỗ trợ đầu vào. |
| 35 | OK | Input only | Chỉ hỗ trợ đầu vào. |
| 36 | OK | Input only | Chỉ hỗ trợ đầu vào. |
| 39 | OK | Input only | Chỉ hỗ trợ đầu vào. |

### 2.1.2 ARDUINO NANO

Arduino Nano ATmega328P là phiên bản thu nhỏ của Arduino Uno với thiết kế nhỏ gọn, linh hoạt, phù hợp cho các breadboard nhỏ và các dự án yêu cầu kích thước tối giản. Board sử dụng vi điều khiển ATmega328-AU, hỗ trợ thêm 2 chân Analog A6 và A7, tăng khả năng kết nối cảm biến. Đặc biệt, board được tích hợp op-amp để tự động chuyển đổi nguồn giữa USB và nguồn ngoài khi phát hiện điện áp cao hơn, đảm bảo an toàn và tiện lợi. Ngoài ra, Arduino Nano sử dụng chip giao tiếp CH340, giúp tiết kiệm chi phí mà vẫn đảm bảo hiệu năng ổn định, lý tưởng cho các dự án IoT và điều khiển tự động.



Hình 2.2 ARDUINO NANO

**THÔNG SỐ KỸ THUẬT ARDUINO NANO V3.0 ATmega328P**

* Vi điều khiển Vi điều khiển ATmega328
* Điện áp hoạt động 5V
* Điện áp đầu vào (khuyên dùng) 7-12V
* Điện áp đầu vào (giới hạn) 6-20V
* Chân Digital I/O 14 (Với 6 chân PWM output)
* Chân PWM Digital I/O 6
* Chân đầu vào Analog 8 (thêm A6, A7) so với UNO
* Dòng sử dụng I/O Pin 20 mA (tối đa 40mA)
* Bộ nhớ Flash 32 KB (ATmega328)
* SRAM 2 KB (ATmega328)
* EEPROM 1 KB (ATmega328)
* Clock Speed 16 MHz
* Chiều dài 43.2 mm
* Chiều rộng 18.5 mm
* Trọng lượng 5g

**Bảng 2.2 Chức năng các chân ARDUINO NANO**

|  |  |  |  |
| --- | --- | --- | --- |
| **GPIO** | **Input** | **Output** | **Ghi chú** |
| D0 | RX | Không | Dùng để nhận dữ liệu UART. |
| D1 | TX | Không | Dùng để truyền dữ liệu UART. |
| D2 | OK | OK | Hỗ trợ ngắt ngoài (Interrupt). |
| D3 | OK (Interrupt) | PWM | Hỗ trợ PWM (analogWrite) và ngắt ngoài. |
| D4 | OK | OK |  |
| D5 | OK | PWM | Hỗ trợ PWM. |
| D6 | OK | PWM | Hỗ trợ PWM. |
| D7 | OK | OK |  |
| D8 | OK | OK |  |
| D9 | OK | PWM | Hỗ trợ PWM. |
| D10 | OK (SS) | PWM | Dùng làm Slave Select (SS) trong giao tiếp SPI. |
| D11 | OK (MOSI) | PWM | Dùng làm Master Out Slave In (MOSI) trong giao tiếp SPI. |
| D12 | OK (MISO) | OK | Dùng làm Master In Slave Out (MISO) trong giao tiếp SPI. |
| D13 | OK (SCK) | OK | Kết nối với LED on-board, dùng làm Serial Clock (SCK) trong giao tiếp SPI. |
| A0-A5 | Analog Input | OK | Hỗ trợ đọc tín hiệu analog (10-bit) hoặc dùng làm digital I/O. |
| A6-A7 | Analog Input | Không | Chỉ đọc được tín hiệu analog, không hỗ trợ digital I/O. |
| RESET | Không | Không | Đưa board về trạng thái ban đầu. |
| 3.3V | Không | Nguồn đầu ra | Cung cấp nguồn 3.3V cho các module hoặc cảm biến. |
| 5V | Không | Nguồn đầu ra | Cung cấp nguồn 5V từ USB hoặc nguồn ngoài. |
| GND | Ground | Ground | Chân nối đất (Ground). |
| VIN | Nguồn đầu vào | Không | Cung cấp nguồn ngoài (từ 7V-12V). |

### 2.1.3 Màn hình TFT 2.2 SPI ILT9341

**Màn hình LCD TFT 2.2 Inch 240x320 SPI ILI9341** là một màn hình nhỏ gọn, chất lượng cao, thường được sử dụng trong các dự án IoT, Arduino, và ESP32 nhờ khả năng hiển thị màu sắc sống động và giao tiếp qua SPI, giúp giảm số chân kết nối.



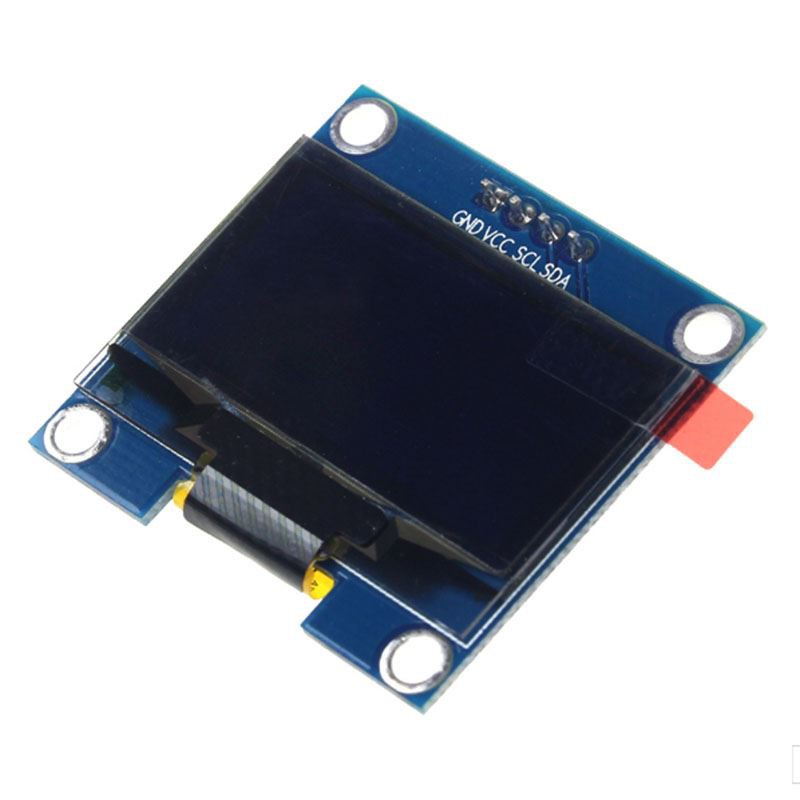
Hình 2.3 Màn hình TFT 2.2 SPI ILT9341

**Thông số kĩ thuật**

* Điện áp hoạt động: 5V/3V3
* Nhiệt độ hoạt động: -20-70°C
* IC điều khiển: ILI9341
* Giao tiếp: SPI
* Mật độ điểm ảnh: QVGA 240x320
* Khả năng hiển thị màu: 262K/65K
* Kích thước màn hình: 2.2 inch
* Kích thước: 67x40mm/2.63x1.57inch
* Trọng lượng: 18.43gram
* Chất liệu: nhựa
* Màn hình không cảm ứng

### 2.1.4 Màn hình OLED 1,3 INH

Màn hình Oled 1.3 inch giao tiếp I2C cho khả năng hiển thị đẹp, sang trọng, rõ nét vào ban ngày và khả năng tiết kiệm năng lượng tối đa với mức chi phí phù hợp, màn hình sử dụng giao tiếp I2C cho chất lượng đường truyền ổn định và rất dễ giao tiếp chỉ với 2 chân GPIO.



Hình 2.4 Màn Hình Oled 1.3 INH I2C

**Thông tin kỹ thuật:**

* Điện áp sử dụng: 2.2~5.5VDC
* Công suất tiêu thụ: 0.04w
* Góc hiển thị: lớn hơn 160 độ
* Số điểm hiển thị: 128x64 điểm.
* Độ rộng màn hình: 1.3 inch.
* Màu hiển thị: Trắng / Xanh Dương.
* Giao tiếp: I2C
* Driver: SH1106

### 2.1.5 LORA AS32-TTL-100

Module thu phát AS32-TTL-100 sử dụng chip Semtech SX1278 của chuẩn LoRaTM không dây, module ngoài sử dụng công nghệ GFSK truyền thống, nó cũng sử dụng công nghệ Lora (long range) chống nhiễu và giảm dòng tiêu thụ .Module hỗ trợ chuẩn giao tiếp UART, độ mạnh tín hiệu phát lớn 100mW, truyền tải được khoảng cách xa mà điện năng tiêu thụ thấp.

Module thu phát AS32-TTL-100 thích hợp cho bất kỳ môi trường ứng dụng phức tạp nào cần truyền tải dữ liệu không dây, chẳng hạn như: điều khiển nhà thông minh, ô tô điện tử, báo động an ninh, giám sát và kiểm soát hệ thống công nghiệp, hệ thống điều khiển từ xa cho các ứng dụng tưới tiêu… Module có thể truyền xa lên đến vài km tùy vào mục đích sử dụng và năng lượng tiêu tốn.

![A close-up of a wireless port

Description automatically generated](data:image/jpeg;base64,/9j/4AAQSkZJRgABAQEASABIAAD/4SXoRXhpZgAATU0AKgAAAAgAEQEAAAMAAAABCiAAAAEBAAMAAAABBsAAAAECAAMAAAADAAAI5gEGAAMAAAABAAIAAAEPAAIAAAAGAAAI7AEQAAIAAAAPAAAI8gESAAMAAAABAAEAAAEVAAMAAAABAAMAAAEaAAUAAAABAAAJAgEbAAUAAAABAAAJCgEoAAMAAAABAAIAAAExAAIAAAAeAAAJEgEyAAIAAAAUAAAJMAITAAMAAAABAAIAAIdpAAQAAAABAAAJRIglAAQAAAABAAAVCOocAAcAAAgMAAAA2gAAFRwc6gAAAAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAIAAgACENhbm9uAENhbm9uIEVPUyA3MDBEAAAACvyAAAAnEAAK/IAAACcQQWRvYmUgUGhvdG9zaG9wIENTNiAoV2luZG93cykAMjAxNzowODowMiAwMzoyMDoxMwAAJoKaAAUAAAABAAATHoKdAAUAAAABAAATJogiAAMAAAABAAEAAIgnAAMAAAABAGQAAIgwAAMAAAABAAIAAIgyAAQAAAABAAAAZJAAAAcAAAAEMDIzMJADAAIAAAAUAAATLpAEAAIAAAAUAAATQpEBAAcAAAAEAQIDAJIBAAoAAAABAAATVpICAAUAAAABAAATXpIEAAoAAAABAAATZpIHAAMAAAABAAMAAJIJAAMAAAABABAAAJIKAAUAAAABAAATbpKGAAcAAAEIAAATdpKQAAIAAAADOTEAAJKRAAIAAAADOTEAAJKSAAIAAAADOTEAAKAAAAcAAAAEMDEwMKABAAMAAAABAAEAAKACAAQAAAABAAAFFKADAAQAAAABAAAEEKAFAAQAAAABAAAUfqIOAAUAAAABAAAUnqIPAAUAAAABAAAUpqIQAAMAAAABAAIAAKQBAAMAAAABAAAAAKQCAAMAAAABAAEAAKQDAAMAAAABAAAAAKQGAAMAAAABAAAAAKQwAAIAAAABAAAAAKQxAAIAAAANAAAUrqQyAAUAAAAEAAAUvKQ0AAIAAAAdAAAU3KQ1AAIAAAALAAAU+uocAAcAAAgMAAALEgAAAAAc6gAAAAgAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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Hình 2.5 Module Lora AS32-TTL-100

**Thông số kỹ thuật**

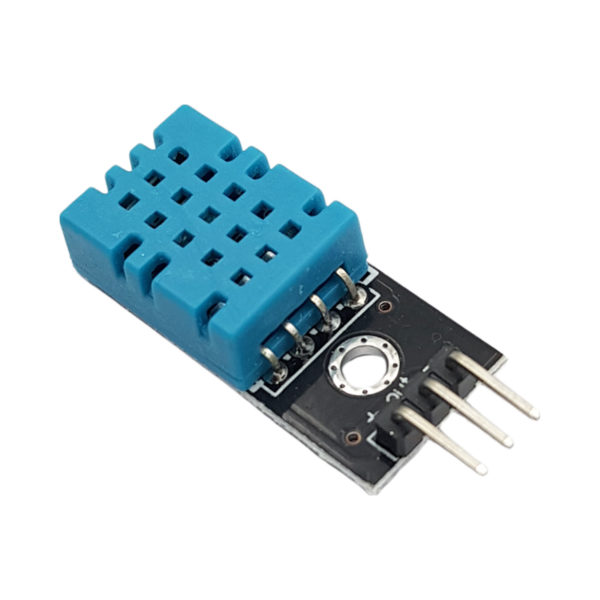
* **Kích thước**: 20x36mm (không bao gồm anten và đầu nối SMA)
* **Tần số hoạt động**: 410 - 441MHz, bước tần số 1000 KHz, tần số mặc định là 433MHz
* **Điện áp hoạt động**: 2 ~ 5.5 VDC
* **Giao tiếp**: UART
* **Khoảng cách truyền dẫn**: Lên tới khoảng 3000m trong điều kiện lý tưởng
* **Công suất phát tối đa**: 20 dBm (~100mW), có thể điều chỉnh 4 mức (0 - 3), tăng hoặc giảm mỗi bước 3 dBm
* **Tốc độ truyền trong không khí**: 2.4 kbps (mặc định), có thể cấu hình ở các mức 0.3, 1.2, 2.4, 4.8, 9.6, 19.2 Kbps
* **Dòng nghỉ**: 1.5uA (MD1 = 1; MD0 = 1)
* **Dòng truyền**: 670mA @ 30dBm
* **Dòng nhận**: 14.5 mA (Chế độ 0 hoặc 1), tối thiểu 30mA (Chế độ 2 với thời gian thức dậy 2s)
* **Giao tiếp**: UART
* **Bộ đệm**: 512 byte
* **Hỗ trợ RSSI** (Chỉ số cường độ tín hiệu nhận)
* **Dạng anten**: Anten SMA hoặc anten lò xo
* **Nhiệt độ hoạt động**: -40 ~ 85°C
* **Độ ẩm**: 10 – 90%
* **Nhiệt độ bảo quản**: -40 ~ 125°C

**Bảng 2.3 Chế độ làm việc**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Chế độ** | **M0** | **M1** | **Mô tả** | **Ghi chú** |
| Mode 0  Normal | 0 | 0 | Giao tiếp UART và kênh truyền không dây hoạt động. Quá trình truyện nhận dữ liệu hoạt động | Bên nhận phải làm việc ở Mode 1 hoặc Mode 2 |
| Mode 1  Wake-up | 0 | 1 | Giao tiếp UART và kênh truyền không dây hoạt động. Khác với Mode 0, ở Mode 1 có thêm 1 đoạn mã hóa tự động ban đầu trước khi dữ liệu được truyền đi nên nó có thể thông báo bên nhận làm việc ở chế độ 2. | Bên nhận có thể làm việc Mode 0, Mode 1, hoặc Mode 2 |
| Mode 2  Power Saving | 1 | 0 | UART không hoạt động, Module không dây làm việc ở chế độ WOR (Work on Radio). Thiết bị sẽ mở UART và truyền dữ liệu sau khi nhận được thông tin đánh thức | Bên truyền phải làm việc ở chế độ 1, không làm việc ở chế độ này. |
| Mode 3  Sleep | 1 | 1 | Cài đặt thông số. |  |

### 2.1.6 MODULE DHT11

[Cảm biến độ ẩm nhiệt độ DHT11](https://nshopvn.com/product/module-cam-bien-do-am-nhiet-do-dht11/) ra chân được tích hợp sẵn điện trở 5,1k giúp người dùng dễ dàng kết nối và sử dụng hơn so với cảm biến DHT11 chưa ra chân, module lấy dữ liệu thông qua giao tiếp 1 wire (giao tiếp 1 dây). Bộ tiền xử lý tín hiệu tích hợp trong [cảm biến](https://nshopvn.com/category/cam-bien/) giúp bạn có được dữ liệu chính xác mà không cần phải qua bất kỳ tính toán nào. Module được thiết kế hoạt động ở mức điện áp 5VDC.



Hình 2.6 Module DHT11

**Thông số kỹ thuật:**

* Điện áp hoạt động: 5VDC
* Chuẩn giao tiếp: TTL, 1 wire.
* Khoảng đo độ ẩm: 20%-80%RH sai số ± 5%RH
* Khoảng đo nhiệt độ: 0-50°C sai số ± 2°C
* Tần số lấy mẫu tối đa 1Hz (1 giây / lần)
* Kích thước: 28mm x 12mm x10m

### 2.1.7 MODULE MQ135

Cảm biến chất lượng không khí MQ – 135 dùng để kiểm tra chất lượng không khí của môi trường có các khi nhà ở, văn phòng hoặc xưởng công nghiệp. Cảm biến có thể nhận biết được các chất như NH3, Nox, Ancol, Benzen, khói, CO2, Gas….



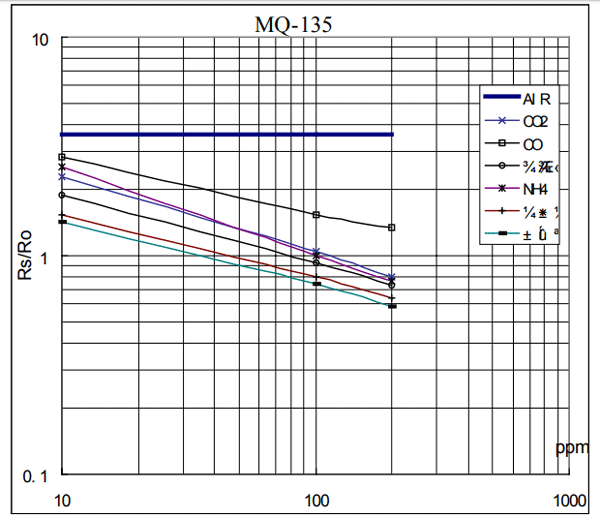
Hình 2.7 Cảm biến chất lượng không khí MQ135

**Thông số kỹ thuật:**

* Điện áp nguồn: 5V DC
* Điện áp của heater: 5V±0.1 AC/DC
* Điện trở tải: thay đổi được (2kΩ-47kΩ)
* Điện trở của heater: 33Ω±5%
* Công suất tiêu thụ của heater: ít hơn 800mW
* Khoảng phát hiện: 10 - 300 ppm NH3, 10 - 1000 ppm Benzene, 10 - 300 Alcol
* Kích thước: 32mm\*20mm
* Khoảng đo rộng
* Bền, tuổi thọ cao
* Phát hiện nhanh, độ nhạy cao
* Mạch đơn giản

**Nguyên lý hoạt động**

Cảm biến MQ – 135 sử dụng SnO2 có điện trở cao hơn trong không khí làm vật liệu cảm biến khí. Khi có sự gia tăng các khí gây ô nhiễm điện trở của cảm biến khí sẽ giảm cùng với đó. Để đo ppm bằng cảm biến MQ – 135 chúng ta cần xem xét biểu đồ ppm (Rs/Ro) lấy từ dữ liệu MQ – 135.



**Hình 2.5:** Đặc tính của MQ - 135

Hình trên cho thấy các đặc tính nhậy cảm điển hình của MQ – 135 đối với một số loại khí. Giá trị Ro là giá trị điện trở của cảm biến ở 100 ppm của NH3 trong không khí sạch, Rs là điện trở của cảm biến ở các nồng độ khí khác nhau.

Trước tiên chúng ta nên hiệu chỉnh cảm biến bằng cách tìm các giá trị của Ro trong không khí trong lành và sau đó sử dụng giá trị đó để tìm Rs theo công thức:

* Rs = (Vc/VRL - 1) x RL

Khi chúng ta đã tính được Rs và Ro, chúng ta có thể tìm ra tỷ lệ và sử dụng đồ thị ở trên chúng ta có thể tính giá trị tương đương ppm của loại khí cụ thể đó.

## PHẦN MỀM ỨNG DỤNG

### 2.2.1 Arduino IDE

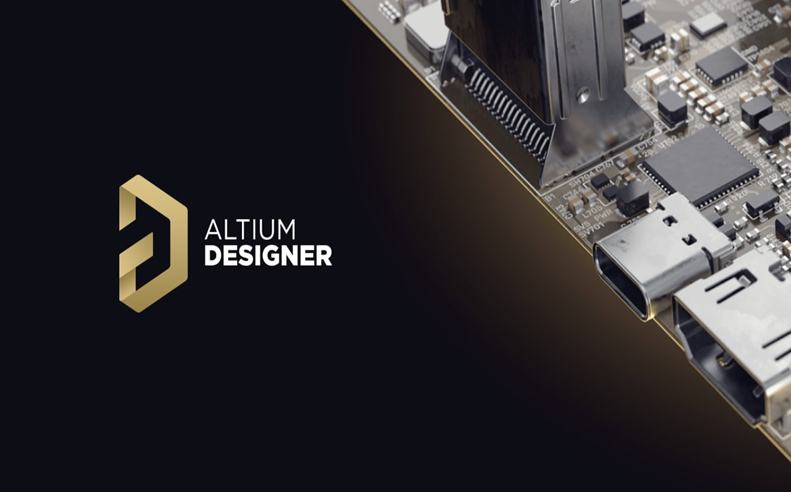


Hình 2.8 Arduino IDE

Arduino IDE là một môi trường lập trình tích hợp đa nền tảng (Windows, MacOS, Linux) được viết dựa trên ngôn ngữ C và C++. Sử dụng để lập trình và nạp chương trình vào các board Arduino thích hợp, nhưng với sự trợ giúp từ các nhà phát triển bên thứ ba, nhiều loại board phát triển khác cũng đã được hỗ trợ.

Mã nguồn của IDE được phát hành dựa trên GNU General Public License, phiên bản thứ 2. Arduino IDE hỗ trợ ngôn ngữ C và C++, sử dụng các cú pháp đặc trưng của mình. Arduino IDE cung cấp một bộ thư viện phần mềm từ các dự án Wiring, nhờ đó cung cấp nhiều thục tục đầu vào và đầu ra cơ bản. Người dùng khi viết code chỉ cần sử dụng hai hàm đơn giản: một hàm khi khởi động chương trình và một hàm lặp vô hạn được biên dịch và liên kết tới chương trình chính. Arduino IDE triển khai chương trình avrdude bằng cách chuyển đổi code thực thi thành một file text ở dạng mã hóa hexadecimal mà được tải vào firmware của các board.

### 2.2.2 Phần mềm thiết kế mạch Altium Designer



Hình 2.9 Phần mềm ALTIUM DESIGNER

Altium Designer là phần mềm thiết kế PCB dựa trên đám mây, được sử dụng để tạo sơ đồ mạch, mô hình 3D, bản vẽ lắp ráp và mô phỏng. Nó cho phép chia sẻ thiết kế trực tiếp với khách hàng và nhận phản hồi theo thời gian thực, cải thiện hiệu quả thiết kế. Altium nổi bật với các tính năng nâng cao và khả năng thiết kế mạch phức tạp, thân thiện với cả người mới bắt đầu và chuyên gia. Giao diện trực quan và khả năng hỗ trợ mẫu nâng cao giúp tối ưu hóa quá trình thiết kế PCB.

Ngoài ra, Altium Designer hỗ trợ các tính năng như thiết kế mạch nhiều lớp, quản lý chuỗi cung ứng, và hệ thống BOM để tạo, chỉnh sửa và chia sẻ tệp nguyên vật liệu với nhà cung cấp linh kiện. Các tính năng 3D của phần mềm cũng là điểm mạnh, giúp quá trình thiết kế và sản xuất trở nên hiệu quả hơn.

**Ưu điểm của Altium Designer:**

* **Giao diện thân thiện và dễ sử dụng**: Altium Designer có giao diện trực quan, dễ tiếp cận cho cả người mới bắt đầu và chuyên gia. Các tính năng được thiết kế dễ hiểu, giúp người dùng dễ dàng thao tác và học hỏi.
* **Tính năng 3D mạnh mẽ**: Altium hỗ trợ mô hình 3D, giúp người dùng xem và kiểm tra thiết kế PCB trong không gian 3D. Điều này giúp tránh được các lỗi liên quan đến không gian và vị trí linh kiện trên bảng mạch.
* **Tích hợp toàn diện**: Altium Designer cung cấp một giải pháp CAD hoàn chỉnh, bao gồm thiết kế sơ đồ, thiết kế PCB và bố trí mạch. Các công cụ mạnh mẽ như mô phỏng, kiểm tra DRC (Design Rule Check) và ERC (Electrical Rule Check) giúp tối ưu hóa quy trình thiết kế.
* **Quản lý chuỗi cung ứng**: Hệ thống quản lý chuỗi cung ứng của Altium giúp theo dõi chi tiết linh kiện và giá cả của chúng, giúp các nhà thiết kế dễ dàng hơn trong việc lựa chọn và mua linh kiện.
* **Hỗ trợ BOM (Bill of Materials)**: Altium Designer cung cấp công cụ để tạo, chỉnh sửa và chia sẻ tệp BOM, giúp việc quản lý nguyên vật liệu và tương tác với nhà cung cấp linh kiện trở nên đơn giản hơn.

**Nhược điểm của Altium Designer:**

* **Chi phí cao**: Altium Designer là phần mềm cao cấp với chi phí sử dụng tương đối lớn, điều này có thể là một yếu tố hạn chế đối với các công ty nhỏ hoặc người mới bắt đầu.
* **Yêu cầu cấu hình máy tính cao**: Với các tính năng 3D và mô phỏng mạnh mẽ, Altium Designer đòi hỏi phần cứng máy tính mạnh mẽ để hoạt động mượt mà, điều này có thể tạo ra khó khăn cho người dùng có cấu hình máy tính yếu.
* **Cần thời gian học hỏi**: Mặc dù giao diện thân thiện, nhưng các tính năng mạnh mẽ của Altium Designer có thể đòi hỏi một thời gian học hỏi, đặc biệt là đối với người mới bắt đầu với thiết kế PCB.
* **Không hoàn toàn miễn phí**: Phiên bản Altium Designer không có phiên bản miễn phí đầy đủ, điều này có thể khiến những người muốn thử phần mềm phải cân nhắc kỹ lưỡng về chi phí đầu tư.

### 2.2.4 Nền tảng Arduino Cloud



Hình 2.10 Nền Tảng Arduino Cloud

**Arduino Cloud** là nền tảng đám mây của Arduino, được thiết kế để giúp người dùng dễ dàng phát triển, quản lý và triển khai các dự án IoT (Internet of Things) thông qua việc kết nối các thiết bị Arduino với internet. Nền tảng này mang đến một bộ công cụ trực tuyến cho phép người dùng xây dựng, giám sát và điều khiển các thiết bị từ xa.

**Các tính năng nổi bật của Arduino Cloud:**

* Dễ dàng kết nối và giám sát thiết bị: Arduino Cloud cho phép người dùng kết nối các board Arduino với các dịch vụ đám mây, điều khiển và giám sát thiết bị từ bất kỳ đâu thông qua giao diện web hoặc ứng dụng di động.
* Arduino IoT Cloud Dashboard: Bạn có thể tạo bảng điều khiển tùy chỉnh để theo dõi và điều khiển các cảm biến, thiết bị hoặc cảm biến IoT của mình một cách dễ dàng, với giao diện đồ họa trực quan.
* Khả năng lưu trữ và quản lý dữ liệu: Arduino Cloud cung cấp các công cụ để thu thập và lưu trữ dữ liệu từ các cảm biến, giúp người dùng dễ dàng theo dõi thông tin môi trường, nhiệt độ, độ ẩm, hoặc bất kỳ thông số nào từ xa.
* Tích hợp với dịch vụ Webhooks: Bạn có thể sử dụng Webhooks để gửi hoặc nhận dữ liệu giữa Arduino Cloud và các dịch vụ web bên ngoài, tạo ra các ứng dụng thông minh như hệ thống cảnh báo hoặc tự động hóa.
* Điều khiển từ xa và tự động hóa: Arduino Cloud hỗ trợ điều khiển từ xa thiết bị thông qua các ứng dụng, và người dùng có thể lập trình các hành động tự động dựa trên điều kiện cụ thể, chẳng hạn như bật tắt đèn hoặc điều chỉnh nhiệt độ trong nhà.
* Bảo mật và quyền truy cập: Nền tảng này đảm bảo bảo mật cao với tính năng quản lý quyền truy cập cho người dùng và các nhóm, giúp kiểm soát ai có thể xem và thay đổi thiết bị.
* Hỗ trợ cho các board Arduino: Arduino Cloud hỗ trợ nhiều board Arduino khác nhau, bao gồm các phiên bản phổ biến như Arduino Uno, MKR, Nano 33 IoT, giúp bạn dễ dàng kết nối và phát triển các dự án IoT.
* Arduino Cloud là công cụ mạnh mẽ và linh hoạt cho các nhà phát triển, học sinh, sinh viên, và những ai muốn thử nghiệm và triển khai các dự án IoT với Arduino một cách nhanh chóng và hiệu quả.

# CHƯƠNG 3 THI CÔNG VÀ THIẾT KẾ PHẦN CỨNG

* 1. SƠ ĐỒ KHỐI TỔNG QUÁT
     1. Nguyên lý hoạt động của hệ thống
  2. THIẾT KẾ PHẦN CỨNG
     1. Sơ đồ nguyên lý

A diagram of electrical wiring

Description automatically generated

A diagram of electrical wiring

Description automatically generated

* + 1. Thi công mô hình

A red circuit board with blue and red lines

Description automatically generated

A computer chip with a black pipe

Description automatically generated

A blue circuit board with many wires and a yellow and red dot

Description automatically generated with medium confidence

A close-up of a circuit board

Description automatically generated

* 1. SẢN PHẨM PHẦN CỨNG