https://www.halvorsen.blog

Arduino UNO R4 WiFi

ThingSpeak – IoT Cloud Platform for Datalogging and Monitoring

Hans-Petter Halvorsen

Contents

https://www.halvorsen.blog

Introduction to Arduino UNO R4 WiFi

Hans-Petter Halvorsen

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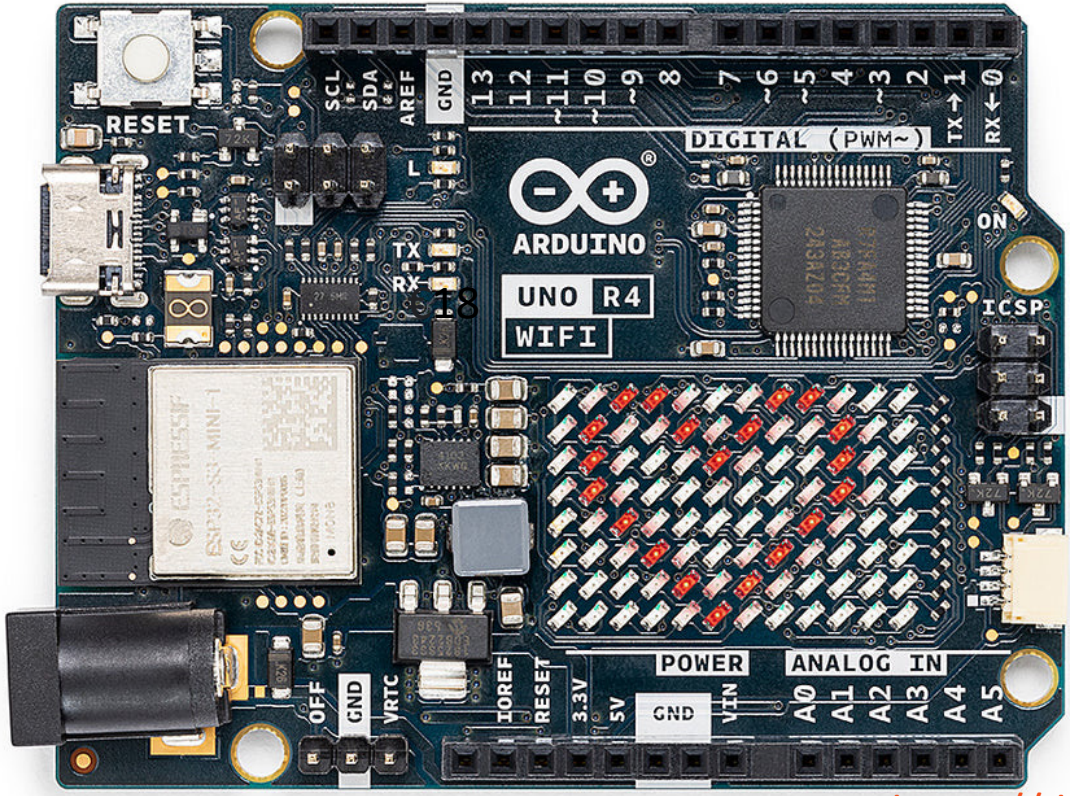
Arduino UNO R4

- In mid 2023 a new version of the popular Arduino UNO R3 was released
- Arduino UNO R4 comes in 2 different versions:
  - Arduino UNO R4 Minima
  - Arduino UNO R4 WiFi

Arduino UNO R4 WiFi



https://docs.arduino.cc/hardware/uno-r4-wifi

Arduino IDE

Hans-Petter Halvorsen

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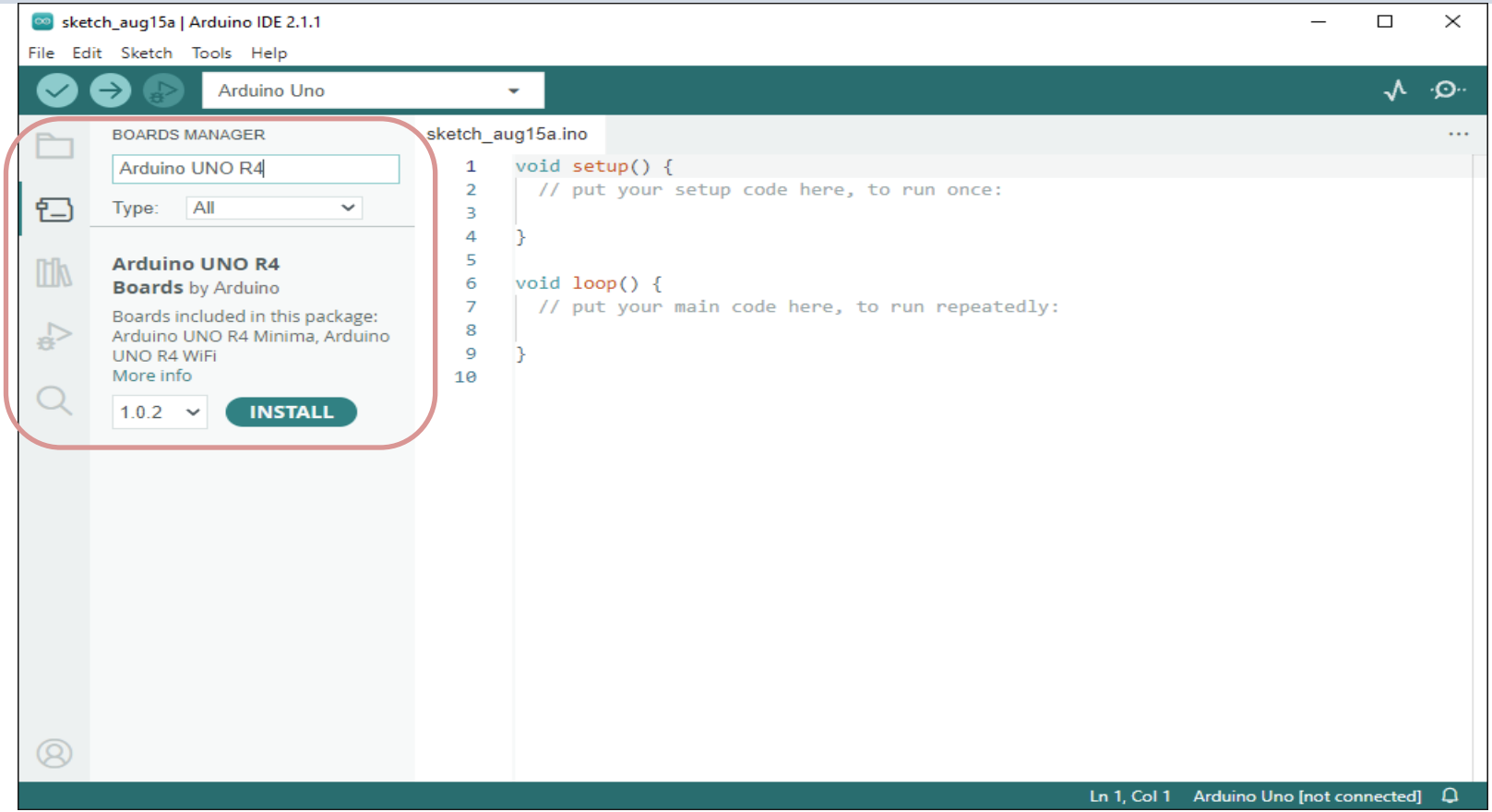
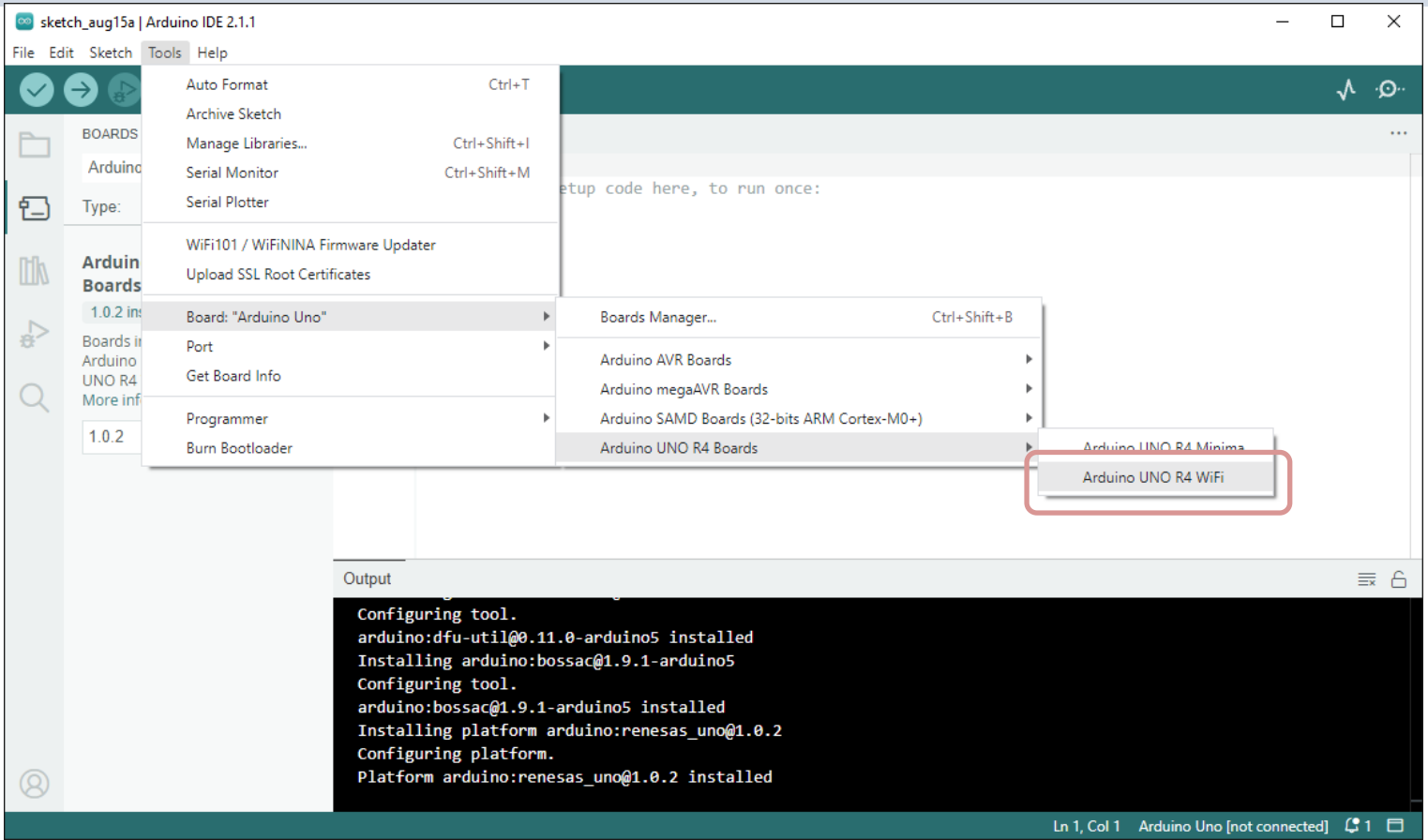
Arduino IDE

https://www.arduino.cc/en/software

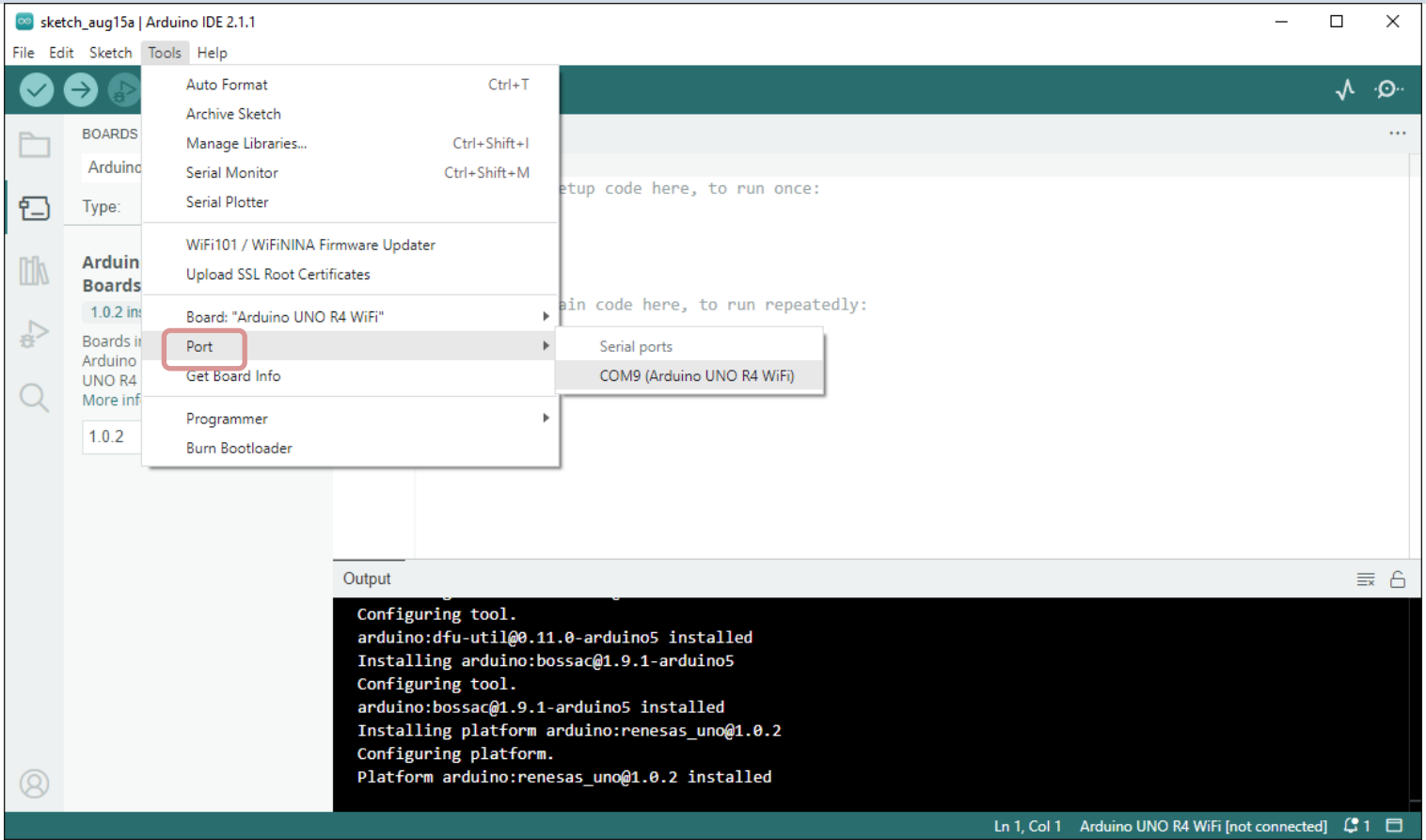
Install Arduino UNO R4 Board



Select Arduino UNO R4 Board



Select Port


sketch_aug15a | Arduino IDE 2.1.1
File
Edit
Sketch
Tools
Help
Auto Format Ctrl+T
Archive Sketch
Manage Libraries... Ctrl+Shift+I
Serial Monitor Ctrl+Shift+M
Serial Plotter
WiFi101 / WiFiNINA Firmware Updater
Upload SSL Root Certificates
Board: "Arduino UNO R4 WiFi"
Port
Get Board Info
Programmer
Burn Bootloader
Serial ports
COM9 (Arduino UNO R4 WiFi)
BOARDS
Type:
Output
Configuring tool.
arduino:dfu-util@0.11.0-arduino5 installed
Installing arduino:bossac@1.9.1-arduino5
Configuring tool.
arduino:bossac@1.9.1-arduino5 installed
Installing platform arduino:renesas_uno@1.0.2
Configuring platform.
Platform arduino:renesas_uno@1.0.2 installed
Ln 1, Col 1
Arduino UNO R4 WiFi [not connected]

WiFi

Connection Arduino UNO R4 WiFi to WiFi/Internet

Hans-Petter Halvorsen

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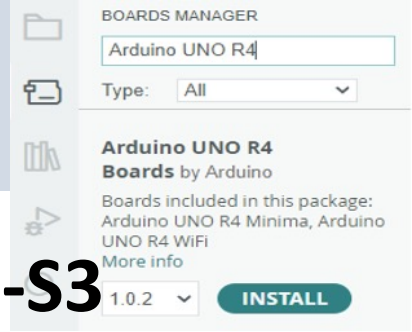
WiFi



- **Arduino UNO R4 WiFi** has a built in **ESP32-S3** module that enables you to connect to Wi-Fi networks and perform network operations.
- Wi-Fi support is enabled via the built-in **WiFiS3 library** that is shipped with the Arduino UNO R4 Core.
- Installing the Arduino UNO R4 Core automatically installs the WiFiS3 library.

https://docs.arduino.cc/tutorials/uno-r4-wifi/wifi-examples

```
#include <WiFiS3.h>
#include "secrets.h"

char ssid[] = SECRET_SSID;
char pass[] = SECRET_PASS;
int status = WL_IDLE_STATUS;

void setup()
{
  Serial.begin(9600);
  ConnectWiFi();
}

void loop() {
  delay(10000);
  PrintNetwork();
}
```

Basic Arduino UNO R4 WiFi Example that connects to a given WiFi Network

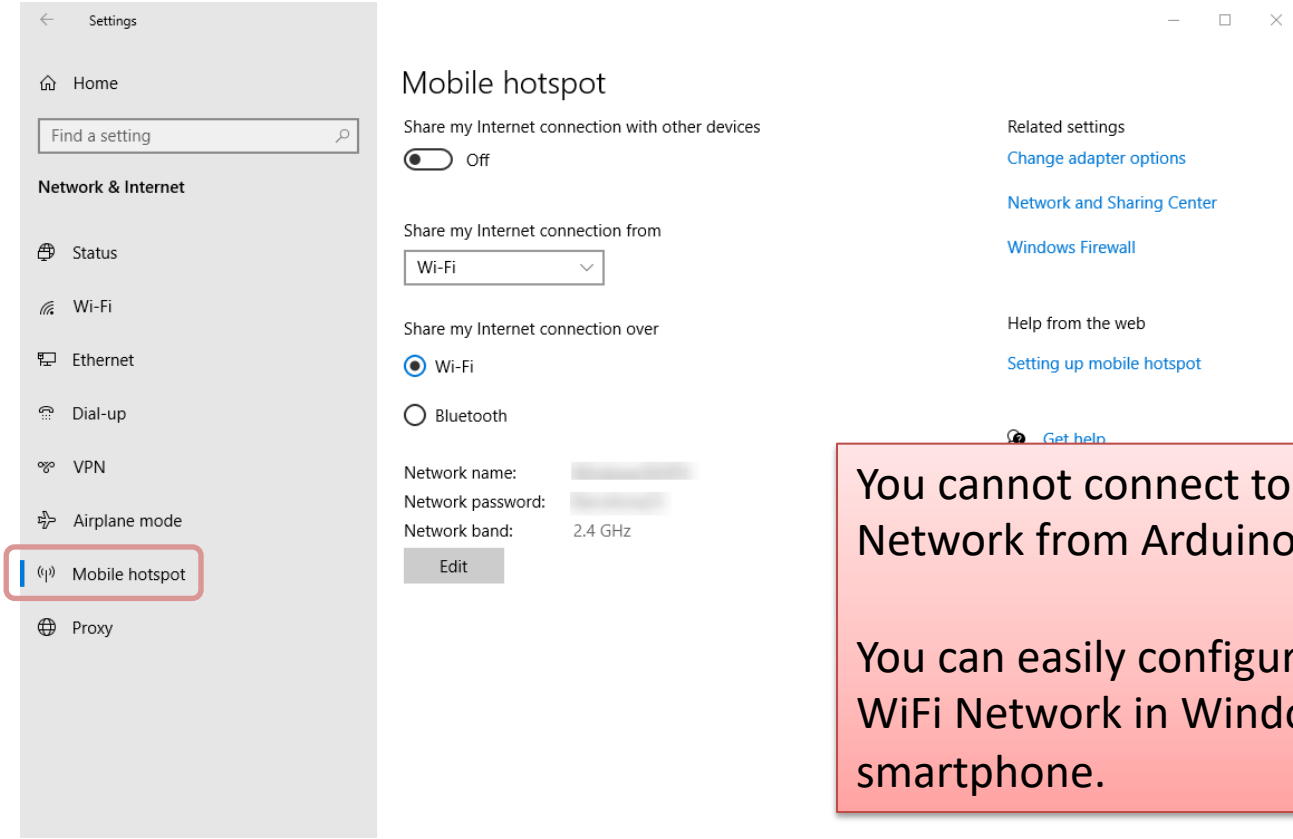
```
void PrintNetwork()
{
  Serial.print("WiFi Status: ");
  Serial.println(WiFi.status());

  Serial.print("SSID: ");
  Serial.println(WiFi.SSID());

  IPAddress ip = WiFi.localIP();
  Serial.print("IP Address: ");
  Serial.println(ip);
}
```

```
void ConnectWiFi()
{
  // check for the WiFi module:
  if (WiFi.status() == WL_NO_MODULE) {
    Serial.println("Communication with WiFi module failed!");
    while (true);
  }

  String fv = WiFi.firmwareVersion();
  if (fv < WIFI_FIRMWARE_LATEST_VERSION) {
    Serial.println("Please upgrade the firmware");
  }

  // Attempt to connect to WiFi network:
  while (status != WL_CONNECTED) {
    Serial.print("Attempting to connect to WPA SSID: ");
    Serial.println(ssid);
    // Connect to WPA/WPA2 network:
    status = WiFi.begin(ssid, pass);

    // wait 10 seconds for connection:
    delay(10000);
  }

  // You're connected now, so print out the data:
  Serial.println("You're connected to Wifi");
  PrintNetwork();
}
```

“secrets.h”:

```
#define SECRET_SSID "xxx"
#define SECRET_PASS "xxx"
```

Setting up a Mobile Hotspot WiFi Network



You cannot connect to your Eduroam Network from Arduino.

You can easily configure a Mobile Hotspot WiFi Network in Windows 10/11 or on your smartphone.

https://www.halvorsen.blog

ThingSpeak

IoT Cloud Platform for Datalogging and Monitoring

Hans-Petter Halvorsen

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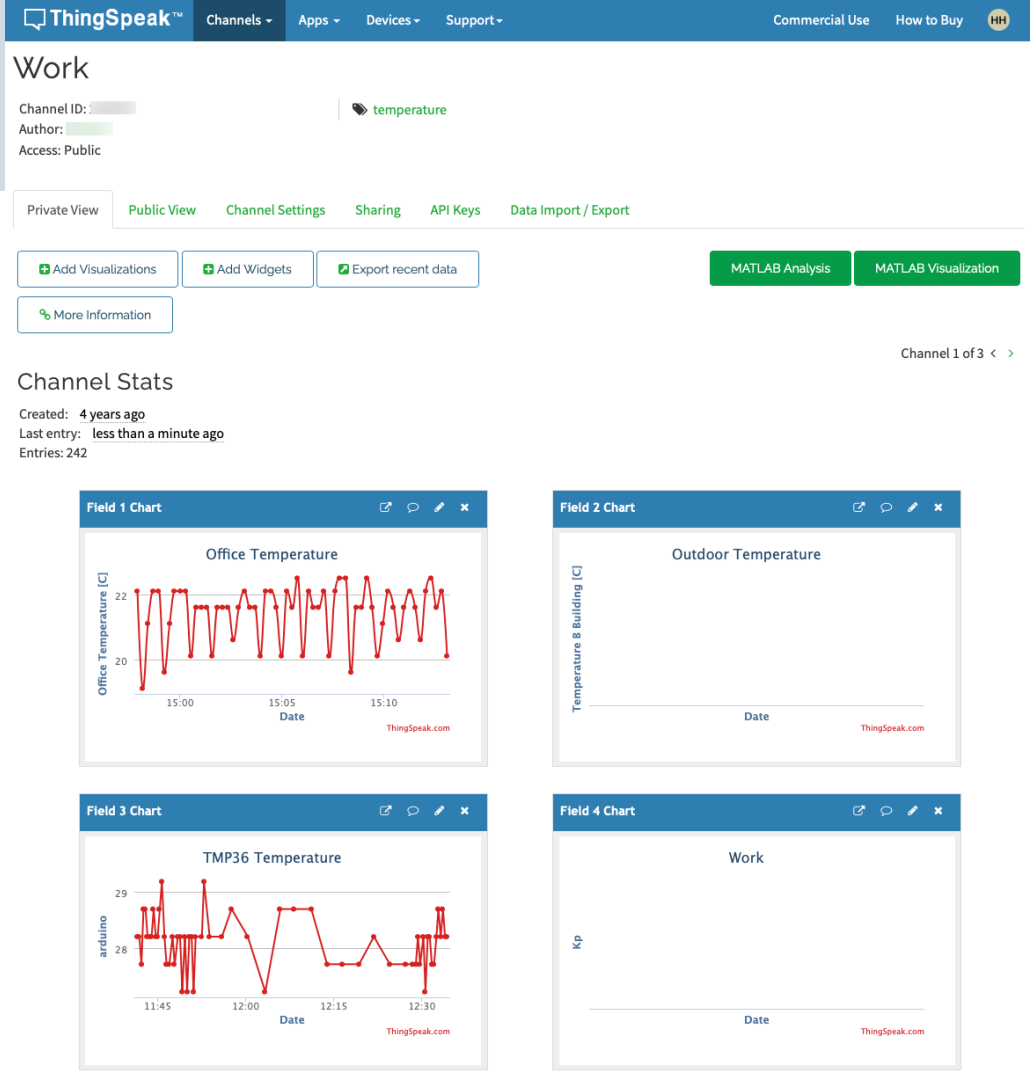
ThingSpeak

- ThingSpeak is an IoT service that lets you collect and store sensor data in the cloud and develop Internet of Things applications.
- ThingSpeak is free for small non-commercial projects
- In addition, they offer different types of licenses where you pay a monthly fee
- ThingSpeak is owned by MathWorks, the same vendor that develop the MATLAB software
- https://thingspeak.com

ThingSpeak

Here you see an example of how Data can be presented in the ThingSpeak Web page

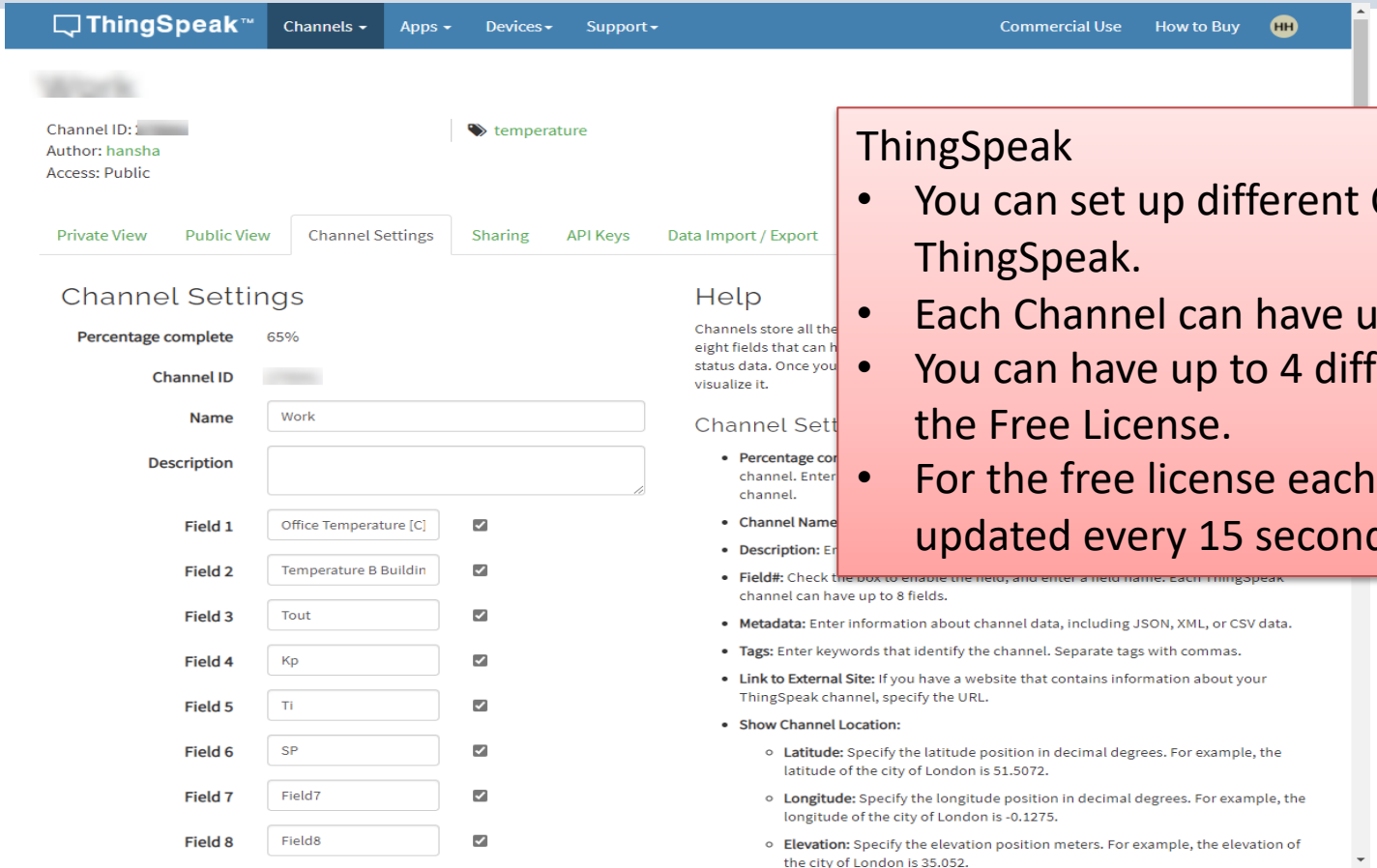
https://thingspeak.com



ThingSpeak

- It works with Arduino, Raspberry Pi and MATLAB
  - Premade Libraries and APIs exists
- But it should work with all kind of Programming Languages, since it uses a **REST API** and **HTTP**.

ThingSpeak – Channel Settings



ThingSpeak

- You can set up different Channels in ThingSpeak.
- Each Channel can have up to 8 Fields.
- You can have up to 4 different Channels for the Free License.
- For the free license each channel can only be updated every 15 seconds.

https://www.halvorsen.blog

ThingSpeak Example 1

Using the ThingSpeak Library by MathWorks

Hans-Petter Halvorsen

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ThingSpeak Library by MathWorks

thingspeak_ex | Arduino IDE 2.2.0

File Edit Sketch Tools Help

Arduino UNO R4 WiFi

LIBRARY MANAGER

ThingSpeak

Type: All

Topic: All

ThingSpeak by MathWorks...

2.0.1 installed

ThingSpeak Communication Library for Arduino, ESP8266 & ESP32 ThingSpeak (...

More info

2.0.1 REMOVE

ThingSpeak_asukiaaa

by Asuki Kono

An API manager for ThingSpeak It writes field values for ThinkgSpeak.

More info

1.0.1 INSTALL

thingspeak_ex.ino secrets.h

```
#include <WiFiS3.h>
#include "secrets.h"
#include "ThingSpeak.h"

WiFiClient client;

char ssid[] = SECRET_SSID;
char pass[] = SECRET_PASS;
int status = WL_IDLE_STATUS;

void setup()
{
  Serial.begin(9600);
  ConnectWiFi();
  ThingSpeak.begin(client);
}

void loop()
{
  float temperature;
  temperature = random(2000,3000)/100.0;
  Serial.println(temperature);
  ThingSpeakWrite(temperature);
  delay(20000);
}
```

Output Serial Monitor

Ln 26, Col 1 Arduino UNO R4 WiFi on COM9

Start by installing the ThingSpeak Arduino Library made by MathWorks

https://www.arduino.cc/reference/en/libraries/thingspeak/

ThingSpeak Functions

```
#include "ThingSpeak.h"
```

The ThingSpeak Arduino Library has different functions that we can use, e.g.,:

- **WriteSingleField**: Writing a value to a single field on ThingSpeak.
- **WriteMultipleFields**: Writing values to multiple fields and status in one transaction with ThingSpeak.
- **ReadField**: Reading from a public channel and a private channel on ThingSpeak.
- **ReadMultipleFields**: Reading values from multiple fields, status, location, created-at timestamp from a public channel on ThingSpeak.

https://github.com/mathworks/thingspeak-arduino

ThingSpeak Functions

```
int writeField(channelNumber, field, value, writeAPIKey)
```

We will only focus on sending/writing one value at the time to ThingSpeak and therefore we will only focus on the **writeField** function in this Tutorial. See GitHub Documentation for more information about the different functions available.

https://github.com/mathworks/thingspeak-arduino

Basic Code Structure

```
#include <WiFiS3.h>
#include "secrets.h"
#include "ThingSpeak.h"

WiFiClient client;

..

void setup() {
  ConnectWiFi();
  ThingSpeak.begin(client);
}

void loop() {
  ThingSpeak.writeField(channelID, channelField, channelValue, writeAPIKey);
  ..
}
..
```

secrets.h

```
#define SECRET_SSID "xxxxx"
#define SECRET_PASS “xxxxx"

#define SECRET_CH_ID xxxxxx
#define SECRET_WRITE_APIKEY "xxxxxxxxxx"
```

It is recommended to put WiFi and ThingSpeak credentials in a separate file called, e.g., secrets.h

ThingSpeak – Write API Key

Channel ID:
Author:
Access: Public

temperature

Private View | Public View | Channel Settings | Sharing | API Keys | Data I

Key needed to Write Data to the Channel

Key needed to Read Data from the Channel

Write API Key

Key

Generate New Write API Key

Read API Keys

Key

Note

Save Note | Delete API Key

Add New Read API Key

Help

API Keys Settings

- **Write API Key:** Use this key to write data to a channel. If you feel your key has been compromised, click **Generate New Write API Key.**
- **Read API Keys:** Use this key to allow other people to view your private channel feeds and charts. Click **Generate New Read API Key** to generate an additional read key for the channel.
- **Note:** Use this field to enter information about channel read keys. For example, add notes to keep track of users with access to your channel.

API Requests

Write a Channel Feed

```
GET https://api.thingspeak.com/update?api_key=&field
```

Read a Channel Feed

```
GET https://api.thingspeak.com/channels/ /feeds.json?results=2
```

Read a Channel Field

```
GET https://api.thingspeak.com/channels/ /fields/1.json?results
```

Basic Code Structure - Explained

```
#include <WiFiS3.h>
#include "secrets.h"
#include "ThingSpeak.h"

WiFiClient client;

..

void setup() {
  ConnectWiFi();
  ThingSpeak.begin(client);
}

void loop() {
  ThingSpeak.writeField(channelID, channelField, channelValue, writeAPIKey);
  ..
}
..
```

Arduino UNO R4 WiFi uses **WiFiS3.h** WiFi Library for WiFi Communication. For other Arduino boards you need to use other WiFi Libraries

Put your WiFi Password, your ThingSpeak ChannelID and WriteAPIKey in **secrets.h**

Number between 1 and 8. Each Channel in ThingSpeak has 8 Fields

Here is the **writeField()** Function used

You find ChannelID and the WriteAPIKey on your ThingSpeak website

Main Program

secrets.h

```
#define SECRET_SSID "xxxxx"
#define SECRET_PASS "xxxxx"

#define SECRET_CH_ID xxxxxx
#define SECRET_WRITE_APIKEY "xxxxxxxxxx"
```

```
#include <WiFiS3.h>
#include "secrets.h"
#include "ThingSpeak.h"

WiFiClient client;

char ssid[] = SECRET_SSID;
char pass[] = SECRET_PASS;
int status = WL_IDLE_STATUS;

void setup() {
  Serial.begin(9600);
  ConnectWiFi();
  ThingSpeak.begin(client);
}

void loop()
{
  float temperature;
  temperature = random(2000,3000)/100.0;
  Serial.println(temperature);
  ThingSpeakWrite(temperature);
  delay(20000);
}
```

```
void ConnectWiFi()
{
  // check for the WiFi module:
  if (WiFi.status() == WL_NO_MODULE) {
    Serial.println("Communication with WiFi module failed!");
    while (true);
  }

  String fv = WiFi.firmwareVersion();
  if (fv < WIFI_FIRMWARE_LATEST_VERSION) {
    Serial.println("Please upgrade the firmware");
  }

  // Attempt to connect to WiFi network:
  while (status != WL_CONNECTED) {
    Serial.print("Attempting to connect to WPA SSID: ");
    Serial.println(ssid);
    // Connect to WPA/WPA2 network:
    status = WiFi.begin(ssid, pass);

    // wait 10 seconds for connection:
    delay(10000);
  }

  // You're connected now, so print out the data:
  Serial.println("You're connected to Wifi");
  PrintNetwork();
}
```

Functions for connection to WiFi

```
void PrintNetwork()
{
  Serial.print("WiFi Status: ");
  Serial.println(WiFi.status());

  Serial.print("SSID: ");
  Serial.println(WiFi.SSID());

  IPAddress ip = WiFi.localIP();
  Serial.print("IP Address: ");
  Serial.println(ip);
}
```

Function for Writing Data to ThingSpeak

Function for writing Data to ThingSpeak

```
void ThingSpeakWrite(float channelValue)
{
  unsigned long myChannelNumber = SECRET_CH_ID;
  const char * myWriteAPIKey = SECRET_WRITE_APIKEY;
  int channelField = 1;
  int x = ThingSpeak.writeField(myChannelNumber, channelField, channelValue, myWriteAPIKey);
  if(x == 0){
    Serial.println("Channel updated successfully.");
  }
  else{
    Serial.println("Problem updating channel. HTTP error code " + String(x));
  }
}
```

The Function **writeField()** is part of the Arduino ThingSpeak library which we have downloaded and are using by including ThingSpeak.h on top of our Arduino code

Final Results

ThingSpeak™

Channel ID: [redacted]
Author: [redacted]
Access: Private

Private View | Public View | Channel Settings | Sharing | API Keys | Data Import / Export

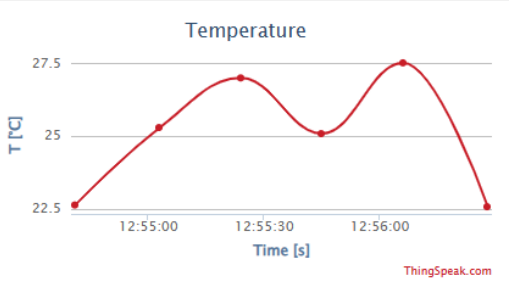
Add Visualizations | Add Widgets | MATLAB Analysis | MATLAB Visualization | Export recent data | More Information

Channel 1 of 3

Channel Stats

Created: 6 years ago
Last entry: less than a minute ago
Entries: 6

Field 1 Chart



Arduino UNO R4 WiFi

thingspeak_ex.ino | secrets.h

```
#include <WiFiS3.h>
#include "secrets.h"
#include "ThingSpeak.h"

WiFiClient client;

char ssid[] = SECRET_SSID;
char pass[] = SECRET_PASS;
int status = WL_IDLE_STATUS;

void setup()
{
  Serial.begin(9600);
  ConnectWiFi();
  ThingSpeak.begin(client);
}

void loop()
{
  float temperature;
  temperature = random(2000,3000)/100.0;
  Serial.println(temperature);
  ThingSpeakWrite(temperature);
  delay(20000);
}
```

Output | Serial Monitor

Message (Enter to send message to 'Arduino UNO R4 WiFi' on '... | New Line | 9600 baud

```
Channel updated successfully.
25.29
Channel updated successfully.
27.00
Channel updated successfully.
25.08
Channel updated successfully.
```

ThingSpeak Example 2

Using HTTP and the available REST API

Hans-Petter Halvorsen

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ThingSpeak - REST API

Channel ID:
Author:
Access: Public

temperature

Private View | Public View | Channel Settings | Sharing | API Keys | Data I

Key needed to Write Data to the Channel

Key needed to Read Data from the Channel

Write API Key

Key

Generate New Write API Key

Read API Keys

Key

Note

Save Note | Delete API Key

Add New Read API Key

Help

API Keys Settings

- **Write API Key:** Use this key to write data to a channel. If you feel your key has been compromised, click **Generate New Write API Key.**
- **Read API Keys:** Use this key to allow other people to view your private channel feeds and charts. Click **Generate New Read API Key** to generate an additional read key for the channel.
- **Note:** Use this field to enter information about channel read keys. For example, add notes to keep track of users with access to your channel.

API Requests

Write a Channel Feed

```
GET https://api.thingspeak.com/update?api_key=  &field
```

Read a Channel Feed

```
GET https://api.thingspeak.com/channels/  /feeds.json?results=2
```

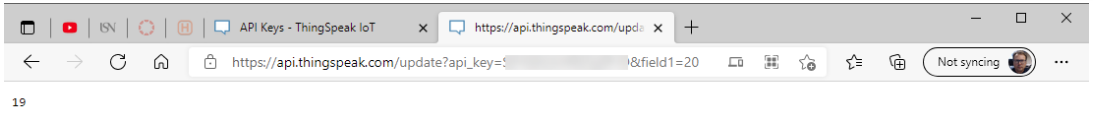
Read a Channel Field

```
GET https://api.thingspeak.com/channels/  /fields/1.json?results
```

REST API – Write Data

Use your standard Web Browser (e.g., Microsoft Edge, or Google Chrome) and enter the following:

https://api.thingspeak.com/update?api_key=XXXXXXXXXXXXXXXXX&field1=20



Value

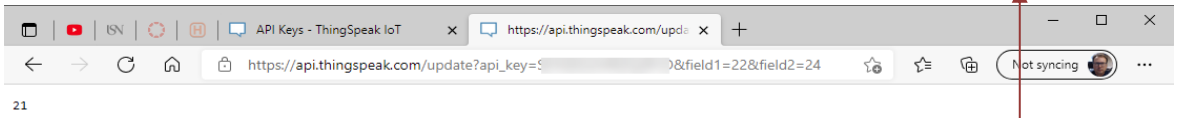
Field Number 1-8

Your **Write API Key**

REST API – Write Multiple Fields

Use your standard Web Browser (e.g., Microsoft Edge, or Google Chrome) and enter the following:

https://api.thingspeak.com/update?api_key=XXXXXXXXXXXXXXXXX&field1=21&field2=24



Your **Write API Key**

Field + Value

Field + Value

Etc.

REST API – Read Data

Use your standard Web Browser (e.g., Microsoft Edge, or Google Chrome) and enter the following:

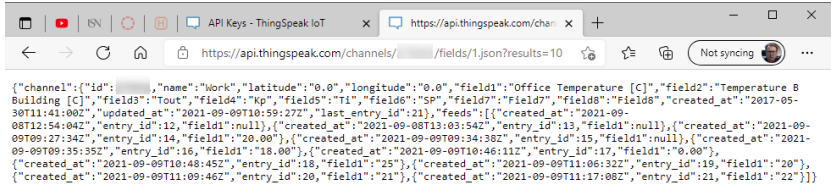
Data Format (JSON or XML)

https://api.thingspeak.com/channels/xxxxxx/fields/1.json?results=10

Your **Channel ID**

Field Number

Number of Data Points, e.g., 1 for only the last value, 10 for the last 10 values, etc.



Resulting JSON String with Data

Main Program

```
#include <WiFiS3.h>
#include "secrets.h"

WiFiClient client;

char ssid[] = SECRET_SSID;
char pass[] = SECRET_PASS;
int status = WL_IDLE_STATUS;

void setup()
{
  Serial.begin(9600);
  ConnectWiFi();
}

void loop()
{
  float temperature;
  temperature = random(2000,3000)/100.0;
  Serial.println(temperature);
  ThingSpeakWrite(temperature);
  delay(20000);
}
```

```
void ConnectWiFi()
{
  // check for the WiFi module:
  if (WiFi.status() == WL_NO_MODULE) {
    Serial.println("Communication with WiFi module failed!");
    while (true);
  }

  String fv = WiFi.firmwareVersion();
  if (fv < WIFI_FIRMWARE_LATEST_VERSION) {
    Serial.println("Please upgrade the firmware");
  }

  // Attempt to connect to WiFi network:
  while (status != WL_CONNECTED) {
    Serial.print("Attempting to connect to WPA SSID: ");
    Serial.println(ssid);
    // Connect to WPA/WPA2 network:
    status = WiFi.begin(ssid, pass);

    // wait 10 seconds for connection:
    delay(10000);
  }

  // You're connected now, so print out the data:
  Serial.println("You're connected to Wifi");
  PrintNetwork();
}
```

Functions for connection to WiFi

```
void PrintNetwork()
{
  Serial.print("WiFi Status: ");
  Serial.println(WiFi.status());

  Serial.print("SSID: ");
  Serial.println(WiFi.SSID());

  IPAddress ip = WiFi.localIP();
  Serial.print("IP Address: ");
  Serial.println(ip);
}
```

```
void ThingSpeakWrite(float fieldValue)
{
  char server[] = "api.thingspeak.com";
  unsigned long channelNumber = SECRET_CH_ID;
  String writeAPIKey = SECRET_WRITE_APIKEY;
  int channelField = 1;

  if (client.connect(server, 80))
  {
    String postData= "api_key=“ + writeAPIKey + "&field" + String(channelField) + "=" + String(fieldValue);

    client.println( "POST /update HTTP/1.1" );
    client.println( "Host: api.thingspeak.com" );
    client.println( "Connection: close" );
    client.println( "Content-Type: application/x-www-form-urlencoded" );
    client.println( "Content-Length: " + String( postData.length() ) );
    client.println();
    client.println( postData );
  }
  else
  {
    Serial.println ( "Connection Failed" );
  }
}
```

Function for writing Data to ThingSpeak

https://api.thingspeak.com/update?api_key=xxxxxx&field1=20

Final Results

ThingSpeak™

Channel ID: [redacted]
Author: [redacted]
Access: Private

Private View | Public View | Channel Settings | Sharing | API Keys | Data Import / Export

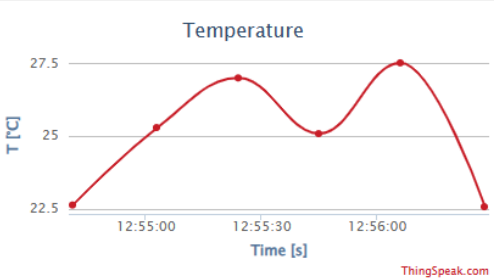
Add Visualizations | Add Widgets | MATLAB Analysis | MATLAB Visualization | Export recent data | More Information

Channel 1 of 3

Channel Stats

Created: 6 years ago
Last entry: less than a minute ago
Entries: 6

Field 1 Chart



Arduino UNO R4 WiFi

thingspeak_ex2.ino | secrets.h

```
#include <WiFiS3.h>
#include "secrets.h"

WiFiClient client;

char ssid[] = SECRET_SSID;
char pass[] = SECRET_PASS;
int status = WL_IDLE_STATUS;

void setup()
{
  Serial.begin(9600);
  ConnectWiFi();
}

void loop()
{
  float temperature;
  temperature = random(2000,3000)/100.0;
  Serial.println(temperature);
  ThingSpeakWrite(temperature);
  delay(20000);
}

void ConnectWiFi()
```

Output | Serial Monitor

Message (Enter to send message to 'Arduino UNO R4 WiFi' on '... | New Line | 9600 baud

```
Attempting to connect to WPA SSID: Windows10HPH
You're connected to Wifi
WiFi Status: 3
SSID:
IP Address: 192.168.137.57
29.33
27.43
22.62
```

Ln 5, Col 1 | Arduino UNO R4 WiFi on COM9

Hans-Petter Halvorsen

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Web: https://www.halvorsen.blog