物聯網裝置與平台
IoT Devices and Platforms

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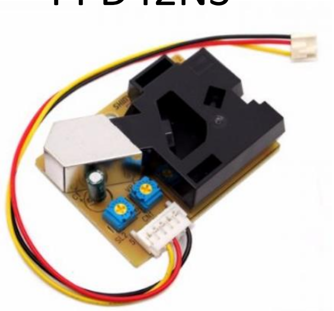
	日期	主題
1	9/17	(加退選9/13-27) 課程介紹, arduino簡介
2	9/24	物聯網裝置: Arduino basic introduction
3	10/1	物聯網裝置: Arduino Digital Interface
4	10/8	物聯網裝置: Arduino Analog Interface
5	10/15	sensor介紹 part 1
6	10/22	sensor介紹 part 2
7	10/29	sensor介紹 part 3
8	11/5	(期中考周11/1-5) sensor介紹 part 4
9	11/12	期中考
10	11/19	Sensor介紹; 通訊模組 Bluetooth, Lora
11	11/26	Sensor介紹; 通訊模組 wifi
12	12/3	Proposal
13	12/10	物聯網平台 - IoT Cloud Platform
14	12/17	AI應用 (SVM)
15	12/24	(期末考周 12/24-30) Project 準備周
16	12/31	(國定假日)
17	1/7	(彈性補充教學) Final demo
18	1/14	(彈性補充教學) Final demo part 2 (如果需要兩周進行)

Last week

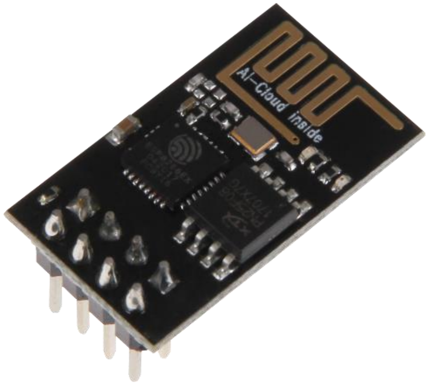
- □ Dust Sensor: Use PPD42NS to measure Particulate Matter level (PM level) in the air.
- □ Water Level Sensor: Read the current water level value
- □ Wi-Fi module: Use ESP8266 WiFi module to upload sensing data to IoT cloud platform

PPD42NS



Dust Sensor

Water Level Sensor



ESP8266

This week

- PIR motion Sensor: Use HC-SR505 to detect if there is any human
- Sound Sensor: Use KY-038 to show the sound intensity of surroundings with digital or analog output.
- ThingSpeak APP: Use TalkBack to enable any device to act upon queued commands.

PIR Motion Sensor

KY-038

Sound Sensor

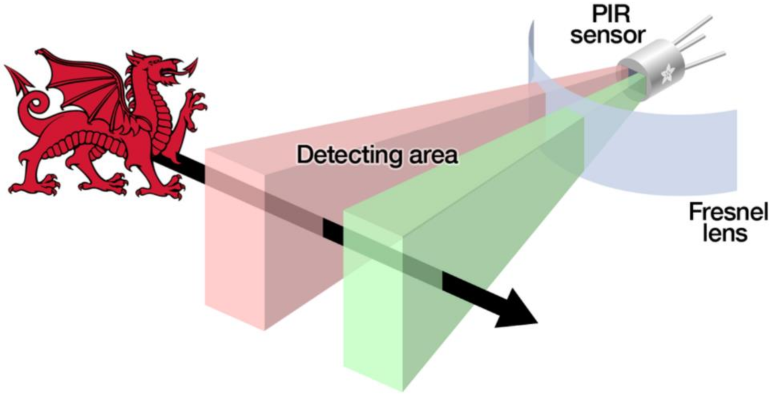
ThingSpeak

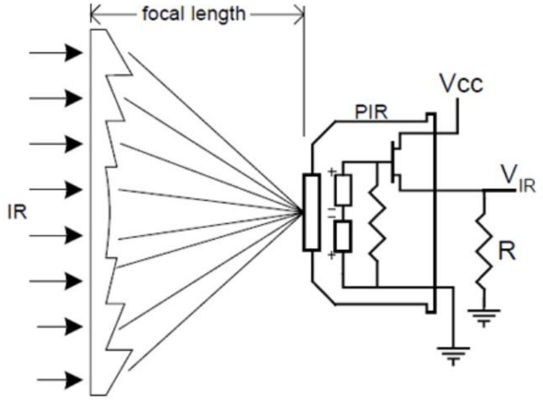
Lab. 1. PIR motion Sensor

Use HC-SR505 to detect if there is any human https://learn.adafruit.com/pir-passive-infrared-proximity-motion-sensor/how-pirs-work

Hc-sr505 pir motion sensor

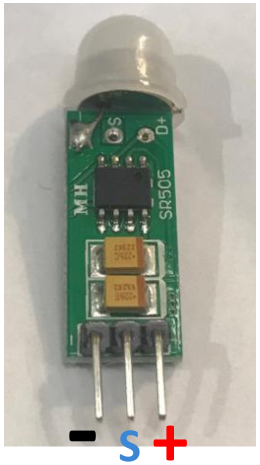
- PIR motion sensors consist of two main parts: a pyroelectric sensing element and a fresnel lens. The pyroelectric sensing element can detect infrared radiation.
- All the objects having a temperature above absolute zero release heat energy. This energy is in the form of infrared radiation. HC-SR505 sensor detects the motions of the object by measuring the changes in the level of infrared light radiations that is radiating from objects.

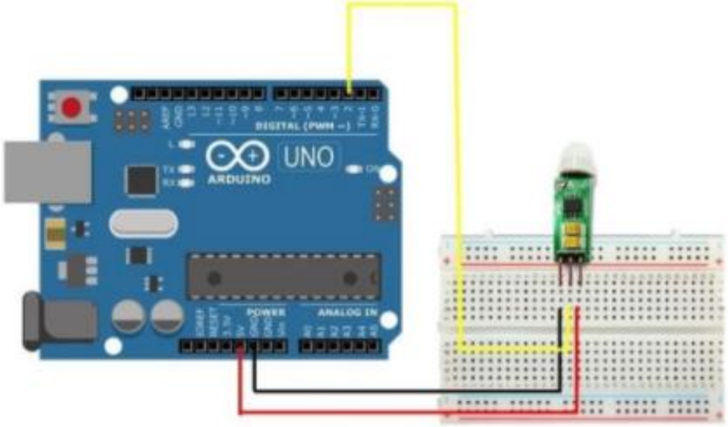




PIR motion Sensor

- Goal: Use HC-SR505 to detect if there is human passing or not.
- Hardware Required
  - HC-SR505 pir motion sensor
  - Arduino
- HC-SR505 Features
  - It has a maximum sensing distance of 3 meters.
  - It requires temperature in a range of -20 °C to 80 °C.
  - The induction angle is less than 100 degrees.

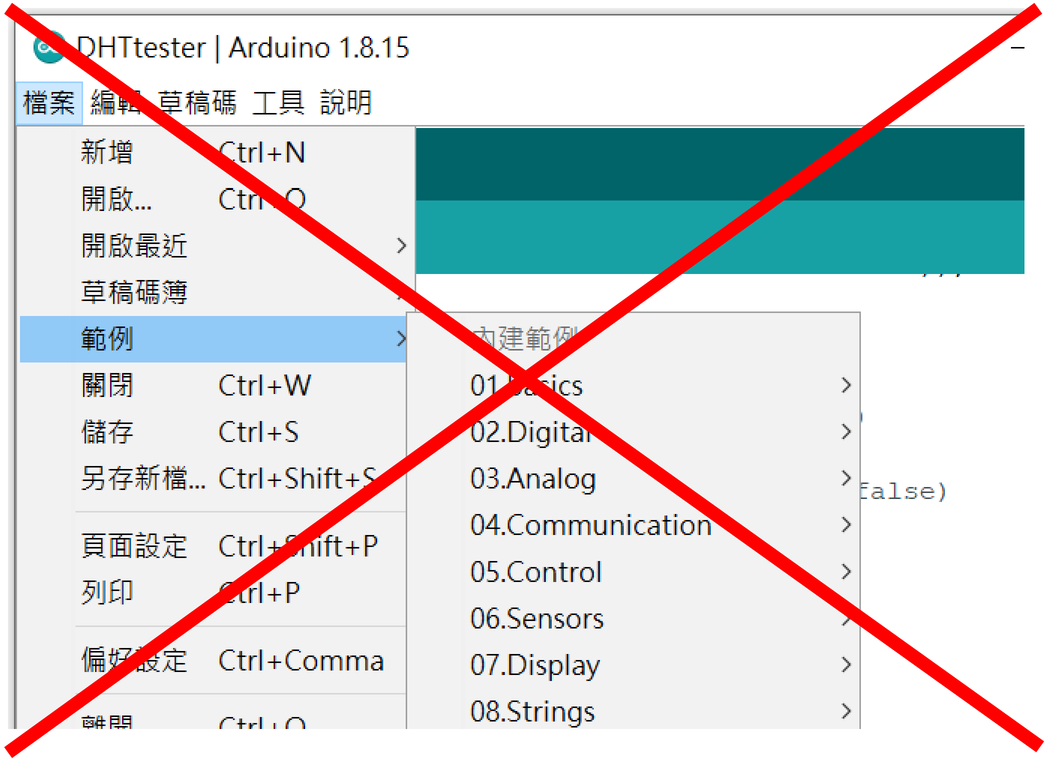




PIR Sensor

Arduino IDE

- No build-in example
- Try to write the code by yourself (Refer to the slides)



Sample code

```
#define PIROUT 2

void setup()
{
   begin(9600);
   pinMode(PIROUT, INPUT);
}

void loop()
{
   If (digitalRead(PIROUT)==HIGH) {
      println("Some body is here");
   }
   else  {
      println("Nothing Detected by PIR Sensor");
   }
   delay(1000);
}
```

Quiz 1

- Design a lighting switch as follows:
  - It will not turn on the light when it is bright enough.
  - When it is dark, turn on the light if someone walk through.
  - When it is dark, turn off the light if no one walk through.
- Hint: We will use photocell, LED, pir motion sensor

Discussion 1

- □ If a human holds still in front of HC-SR505 for a while, can the sensor detect the human?
- □ Can only human motion be detected by HC-SR505? Is there any other object that can trigger the PIR motion sensor or not?

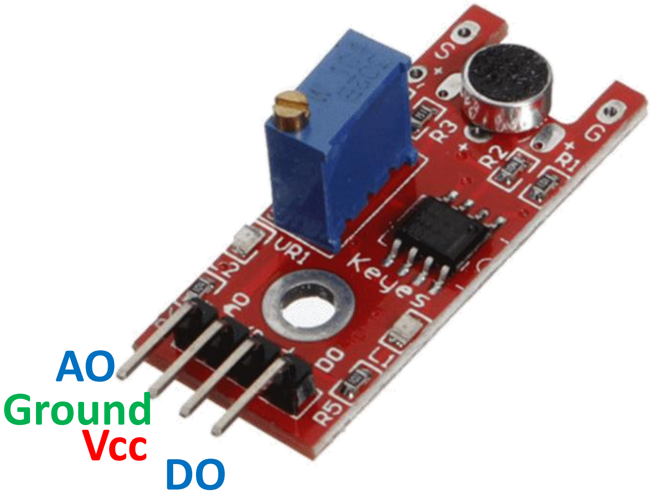
Lab. 2. Sound Sensor

Use KY-038 to show the sound intensity of surroundings with digital or analog output

KY-038 Sound Sensor

- For sound detection Module has two outputs:
  - AO (analog output) : Real-time output voltage signal of the microphone
  - DO (digital output) : When the sound intensity reaches a certain threshold , the output high and low signal

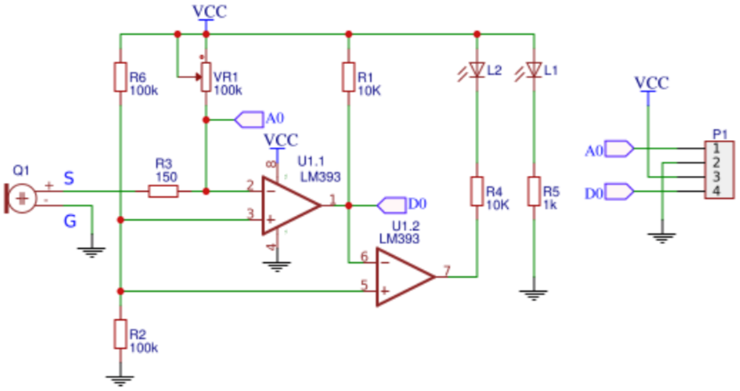
- Sound Sensor has four pins :
  - Pin + to Arduino 5V
  - Pin Gnd to Arduino Ground
  - Pin A0 to Arduino A0 (for analog program)
  - Pin D0 to Arduino 3 (for digital program)

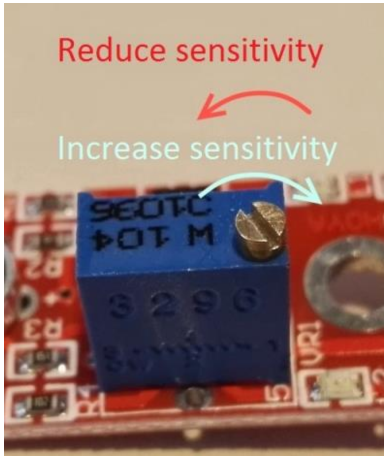


https://www.youtube.com/watch?v=CbovaHqvdsM

KY-038 Sound Sensor (CONT.)

- The threshold-sensitivity can be adjusted via potentiometer on the sensor
- This sensor doesn't show absolute values
  - Ex: temperature in °C or magnetic field strength in mT).

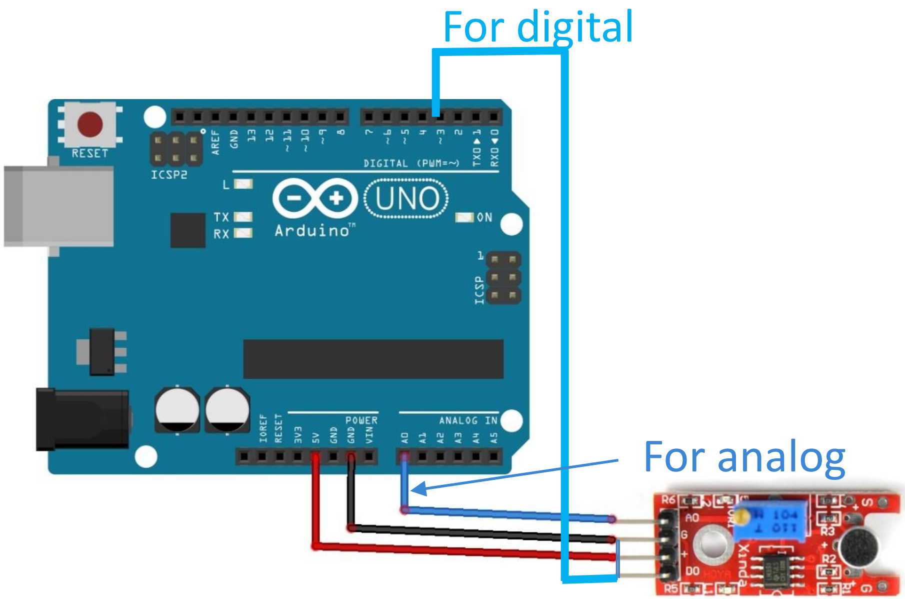




http://arduinolearning.com/code/ky038-microphone-module-and-arduino-example.php

Sound Sensor

- □ Goal: Use KY-038 to measure sound volume.
- □ Hardware Required
  - KY-038 sound Sensor
  - Arduino

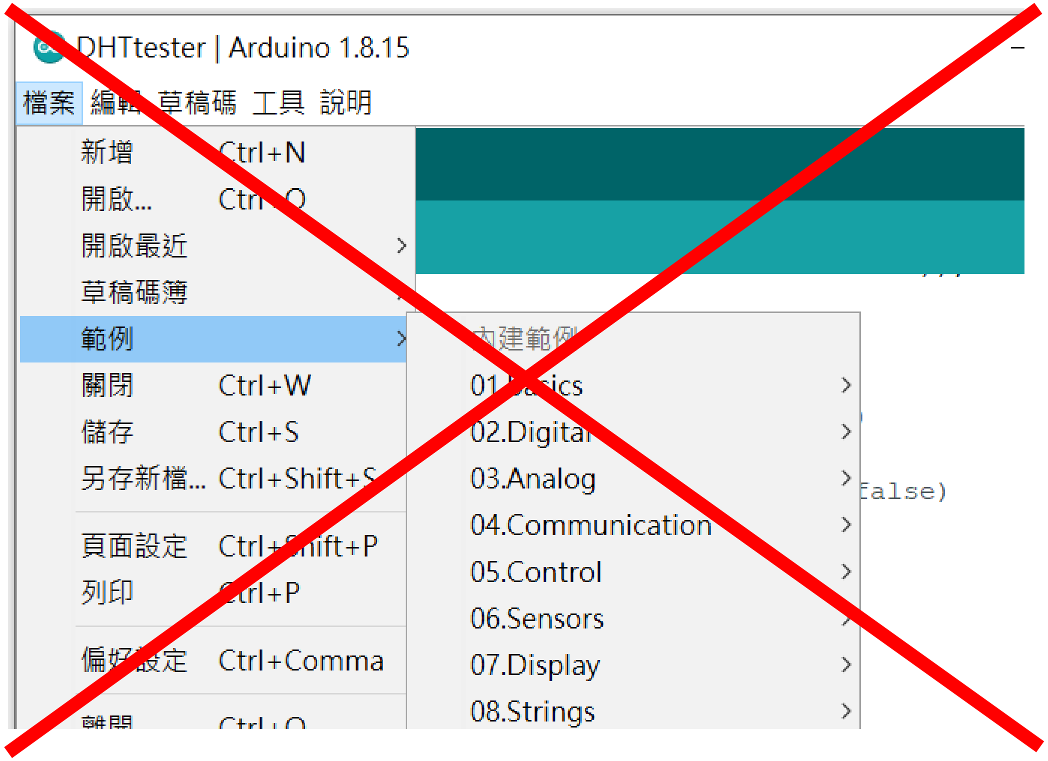

For digital

For analog

Sound Sensor

Arduino IDE

- No build-in example
- Try to write the code by yourself (Refer to the slides)



Sample code (digital version)

```
int Led = 13 ;              // define LED Interface
int soundpin = 3;           // define D0 Sensor Interface
int val = 0;                // define numeric variables val

void setup ()
{
    pinMode (Led, OUTPUT) ;         // define LED as output interface
    pinMode (soundpin, INPUT) ;     // output interface D0 is defined sensor
}

void loop ()
{
    val = digitalRead(soundpin);    // digital sensor interface
    if (val == HIGH) /*When the sound detection module detects a signal, LED flashes*/
    {
         digitalWrite (Led, HIGH);
    }
    else
    {
        digitalWrite (Led, LOW);
    }
}
```

Sample code (analog version)

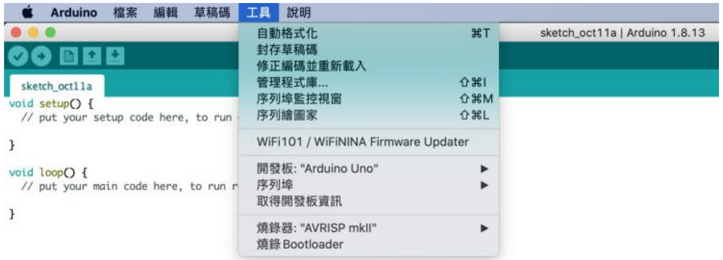
```
int sensorPin = A0;      // select the input pin for the potentiometer
int ledPin = 13;         // select the pin for the LED
int sensorValue = 0;     // variable to store the value coming from the sensor

void setup ()
{
   pinMode (ledPin, OUTPUT);
   Serial.begin (9600);
}

void loop ()
{
   sensorValue = analogRead (sensorPin);
   digitalWrite (ledPin, HIGH);
   delay (sensorValue);
   digitalWrite (ledPin, LOW);
   delay (sensorValue);
   Serial.println (sensorValue, DEC);
}
```

Quiz 2

- LED volume indicator
  - 1. Use 3 Led to show the different sound level
  - 2. Turn off 3 led when sound don’t exceed threshold
  - 3. Set 3 sound level and turn on corresponding number of led
  - 4. Use Serial Plotter to show the diagram

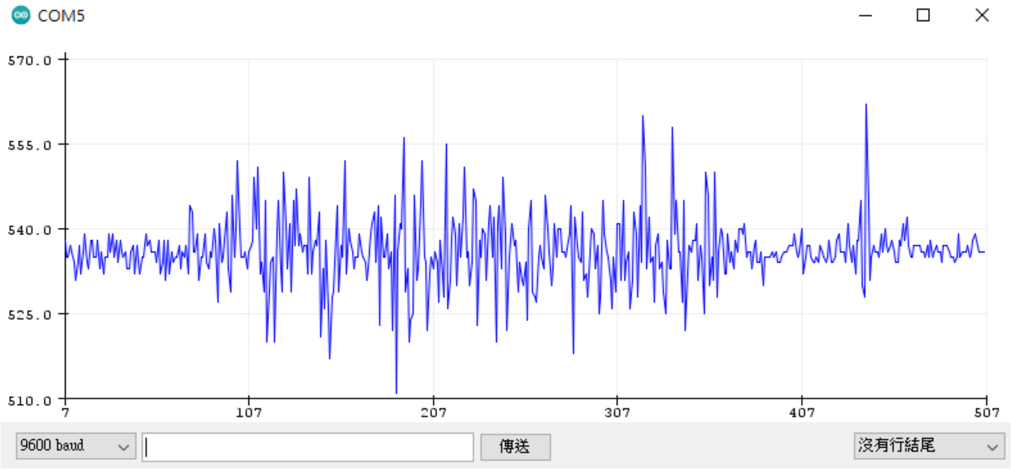


```
void setup() {
  // put your setup code here, to run

}

void loop() {
  // put your main code here, to run r

}
```



Lab. 3. ThingSpeak APP

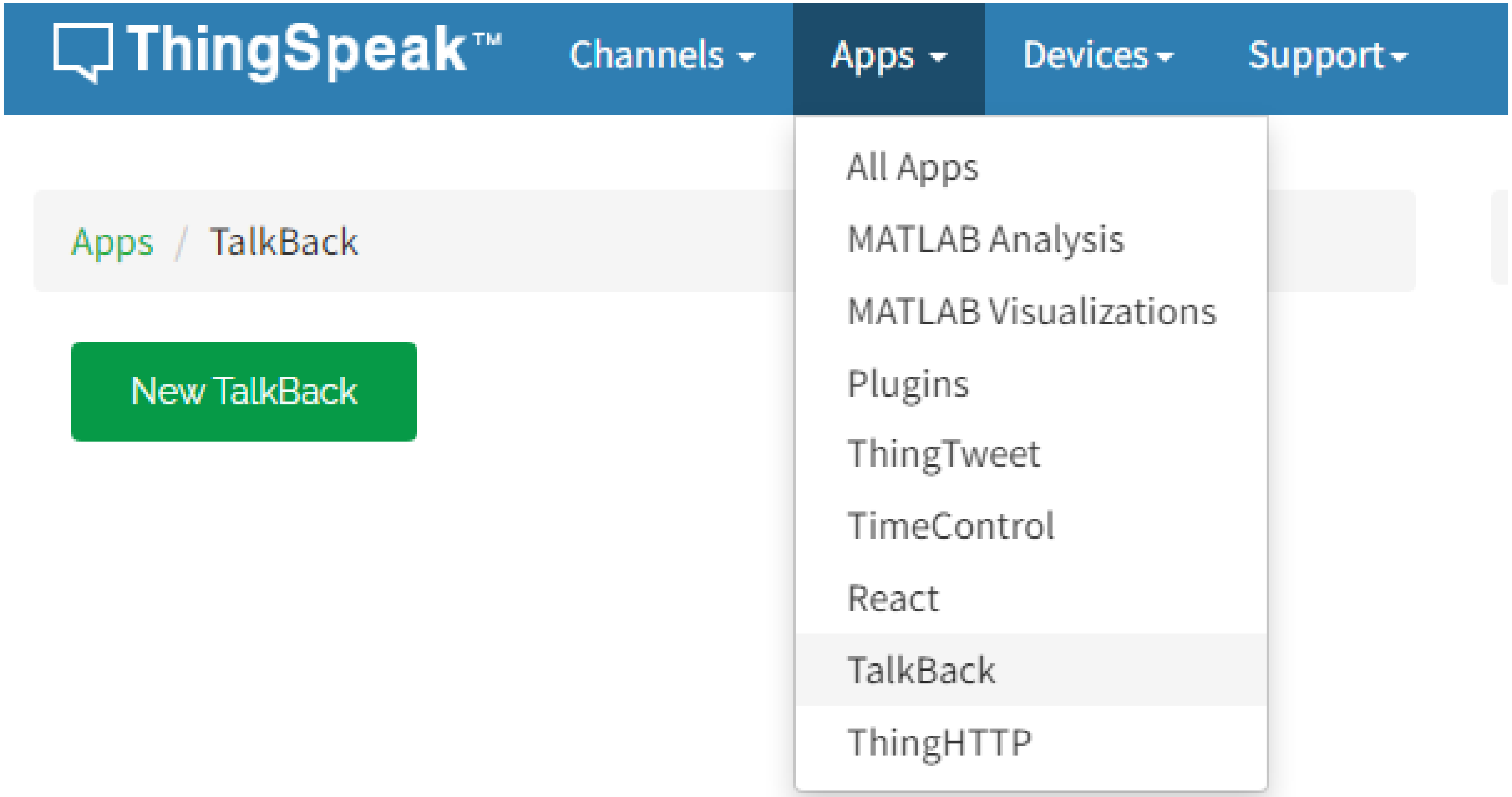
Use TalkBack to enable any device to act upon queued commands.

https://www.mathworks.com/help/thingspeak/talkback-app.html

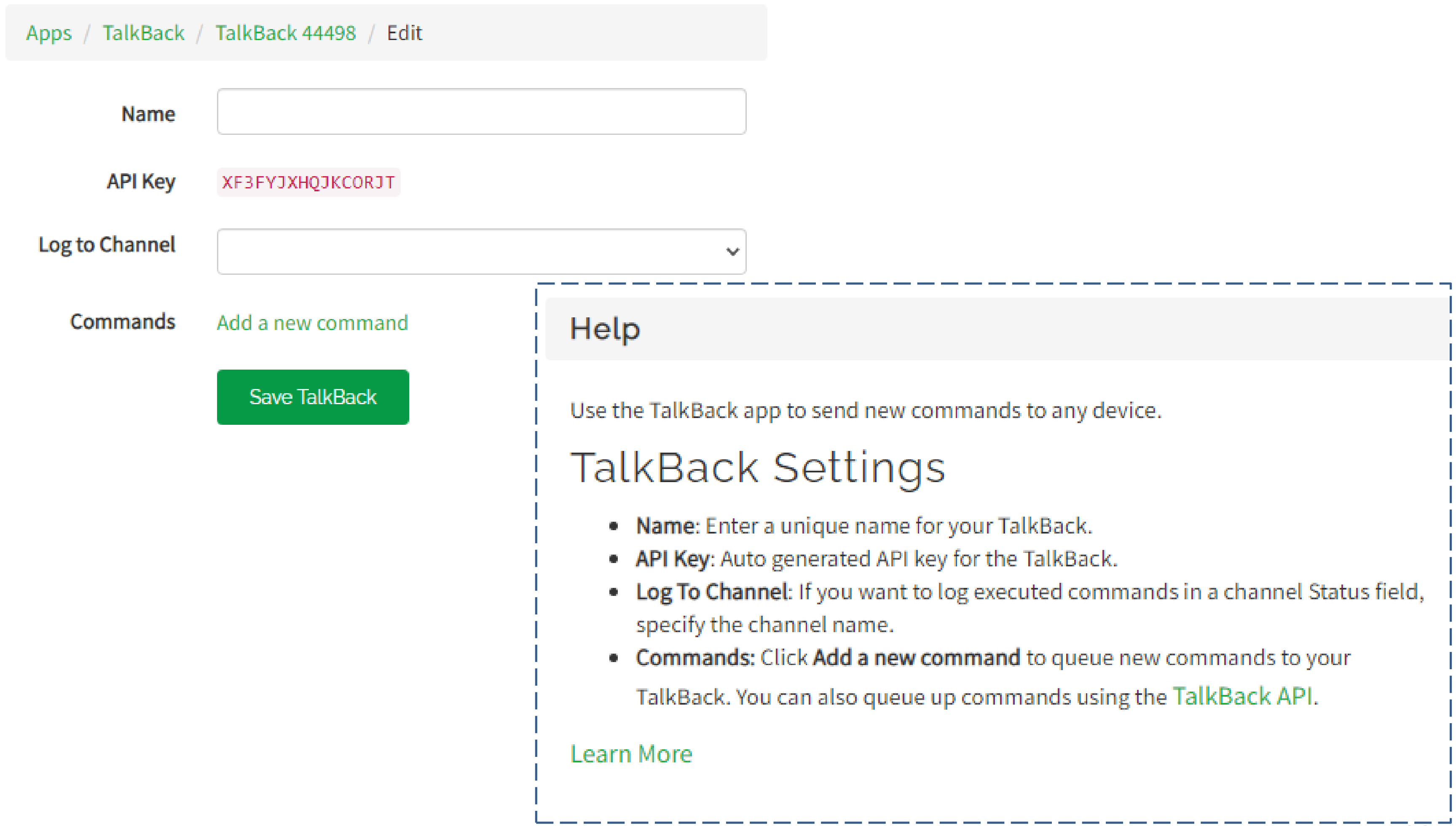
TalkBack App

- TalkBack enables any device to act upon queued commands.
- For example, if you have a door that is outfitted with Wi-Fi and a motion sensor, you can queue up commands to open and close the door. When the door senses someone nearby, open the door. After a specified period of time, close the door. If there are no more commands in the TalkBack queue, the door does not open when the next person approaches.

ThingSpeak


ThingSpeak™
Channels
Apps
Devices
Support
All Apps
MATLAB Analysis
MATLAB Visualizations
Plugins
ThingTweet
TimeControl
React
TalkBack
ThingHTTP
Apps / TalkBack
New TalkBack

ThingSpeak - TalkBack



Apps / TalkBack / TalkBack 44498 / Edit

Name	
API Key	XF3FYJXHQJKCORJT
Log to Channel	
Commands	Add a new command

Help

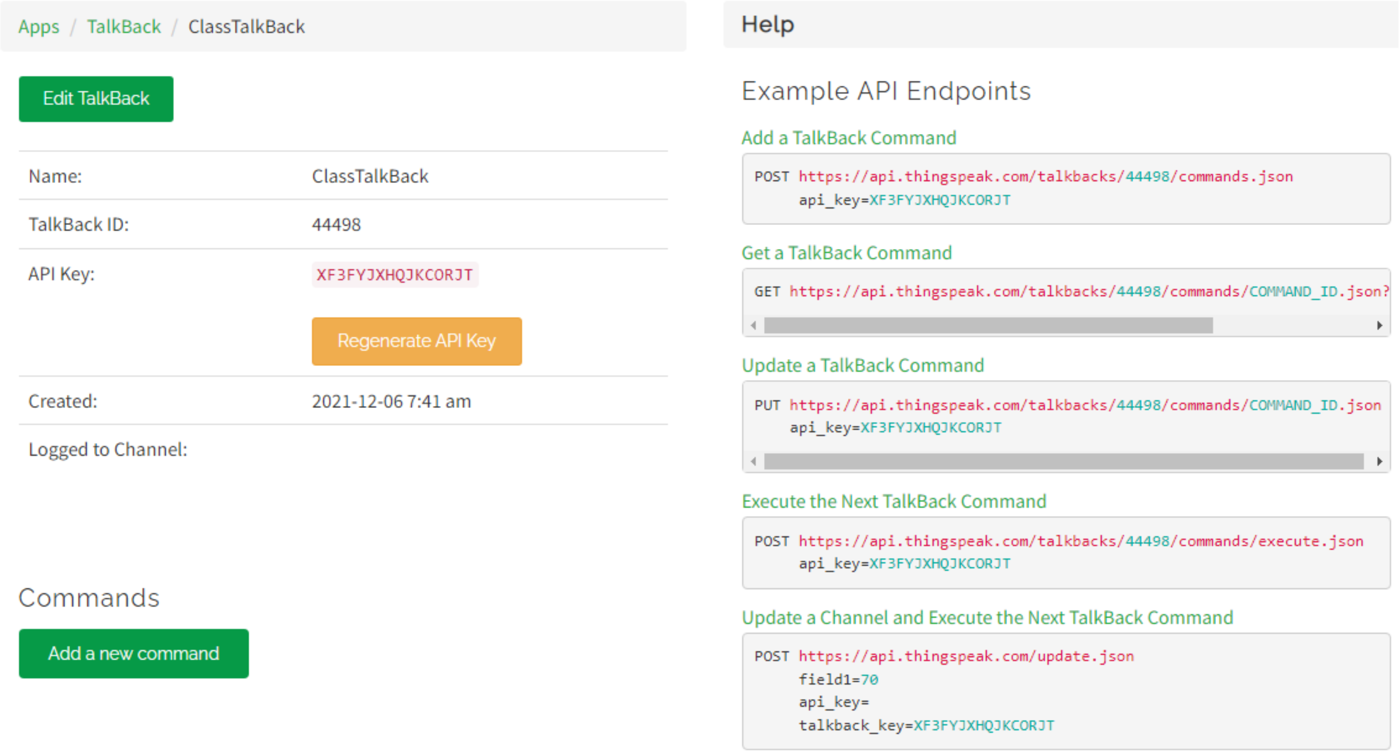
Use the TalkBack app to send new commands to any device.

TalkBack Settings

- **Name**: Enter a unique name for your TalkBack.
- **API Key**: Auto generated API key for the TalkBack.
- **Log To Channel**: If you want to log executed commands in a channel Status field, specify the channel name.
- **Commands:** Click **Add a new command** to queue new commands to your TalkBack. You can also queue up commands using the TalkBack API.

Learn More

ThingSpeak - TalkBack



Name:	ClassTalkBack
TalkBack ID:	44498
API Key:	XF3FYJXHQJKCORJT
	Regenerate API Key
Created:	2021-12-06 7:41 am
Logged to Channel:	

Commands

Help

Example API Endpoints

Add a TalkBack Command

```
POST https://api.thingspeak.com/talkbacks/44498/commands.json
     api_key=XF3FYJXHQJKCORJT
```

Get a TalkBack Command

```
GET https://api.thingspeak.com/talkbacks/44498/commands/COMMAND_ID.json?
```

Update a TalkBack Command

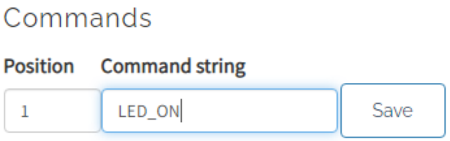
```
PUT https://api.thingspeak.com/talkbacks/44498/commands/COMMAND_ID.json
     api_key=XF3FYJXHQJKCORJT
```

Execute the Next TalkBack Command

```
POST https://api.thingspeak.com/talkbacks/44498/commands/execute.json
     api_key=XF3FYJXHQJKCORJT
```

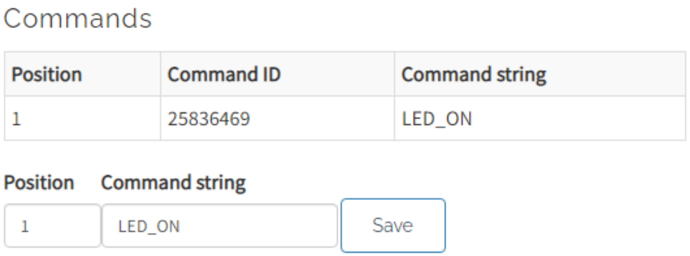
Update a Channel and Execute the Next TalkBack Command

```
POST https://api.thingspeak.com/update.json
     field1=70
     api_key=
     talkback_key=XF3FYJXHQJKCORJT
```



Commands

Position	Command string	
1	LED_ON	Save

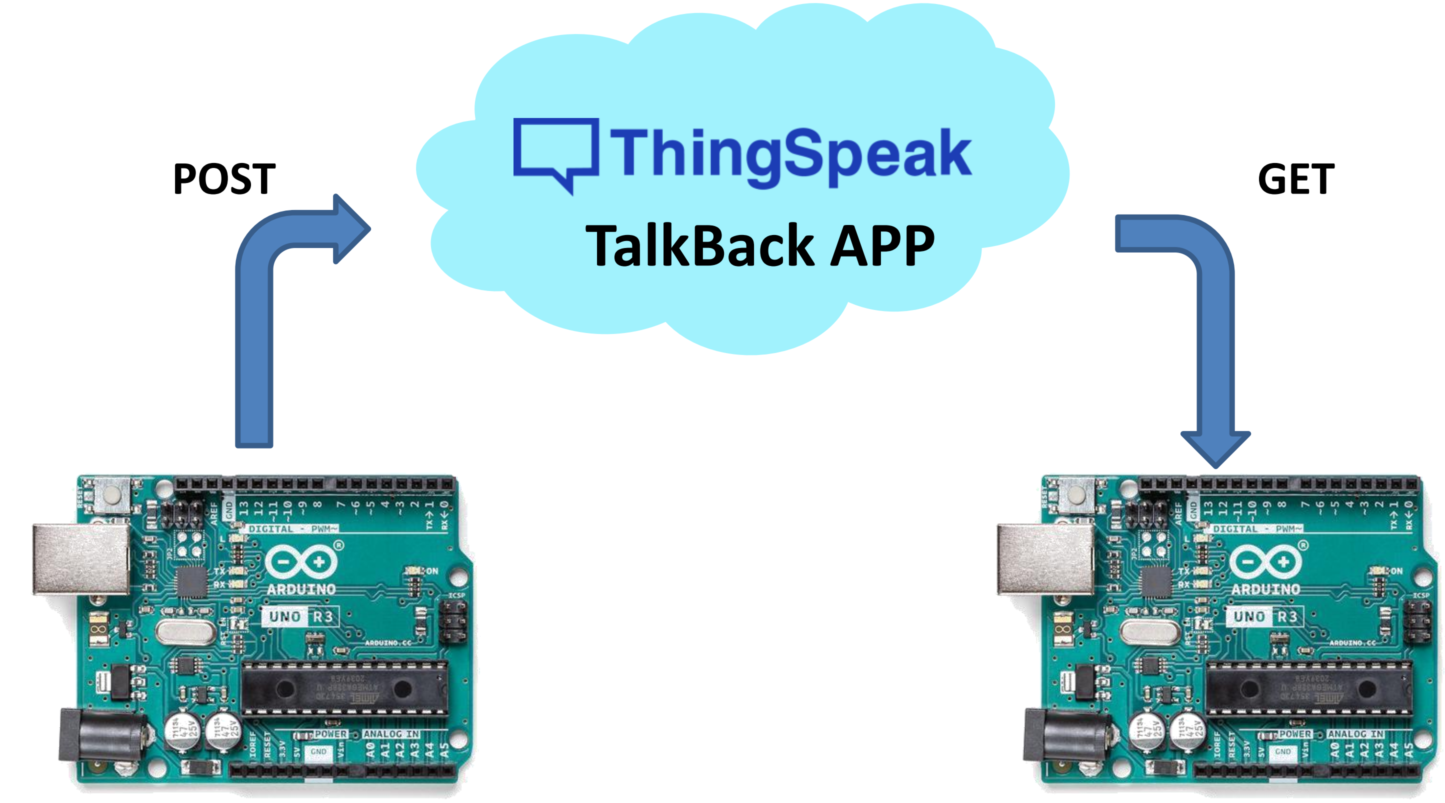


Commands

Position	Command ID	Command string
1	25836469	LED_ON

Position	Command string	
1	LED_ON	Save

Work flow



POST

ThingSpeak

TalkBack APP

GET

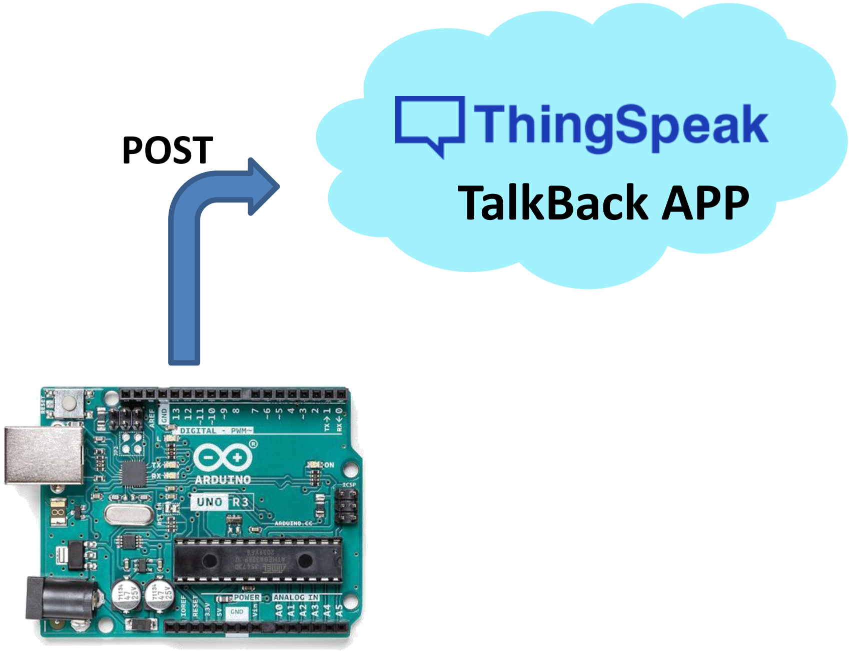
Send the command string to Thingspeak

Get the command string from Thingspeak

A. TalkBack by POST

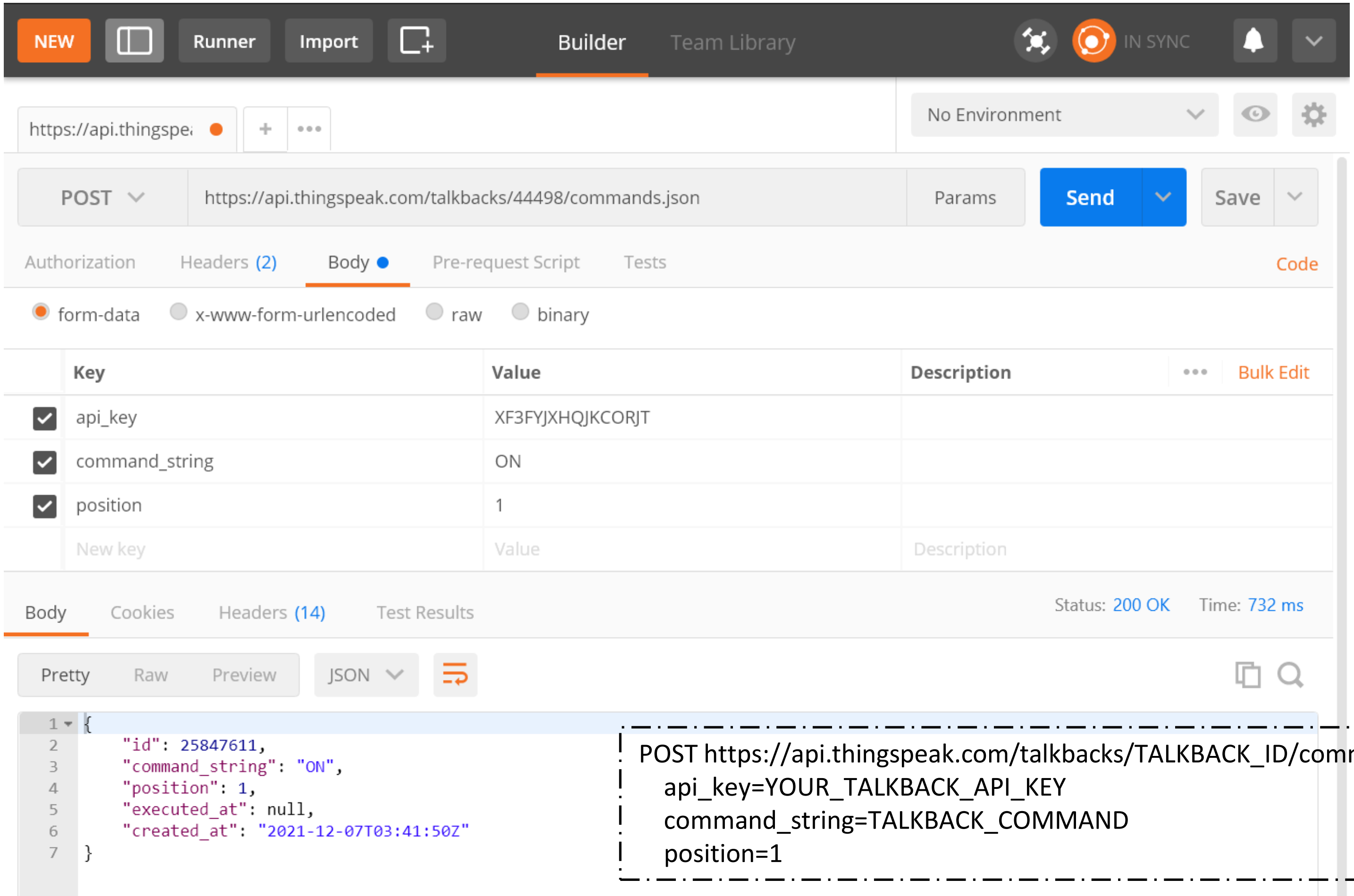
□ Goal: Use HTTP/POST method to execute command on the cloud server and then get the http status to turn on your LED on the Arduino

□ Hardware Required
  - Arduino Board
  - ESP01



Send the command string
to Thingspeak

A. Test POST by POSTMAN



POST https://api.thingspeak.com/talkbacks/44498/commands.json

Body: ● form-data ○ x-www-form-urlencoded ○ raw ○ binary

	Key	Value	Description
☑	api_key	XF3FYJXHQJKCORJT	
☑	command_string	ON	
☑	position	1	
	New key	Value	Description

Status: 200 OK Time: 732 ms

```
{
    "id": 25847611,
    "command_string": "ON",
    "position": 1,
    "executed_at": null,
    "created_at": "2021-12-07T03:41:50Z"
}
```

```
POST https://api.thingspeak.com/talkbacks/TALKBACK_ID/commands
  api_key=YOUR_TALKBACK_API_KEY
  command_string=TALKBACK_COMMAND
  position=1
```

記得指定position=1, 後面使用GET才會抓到最新的資料

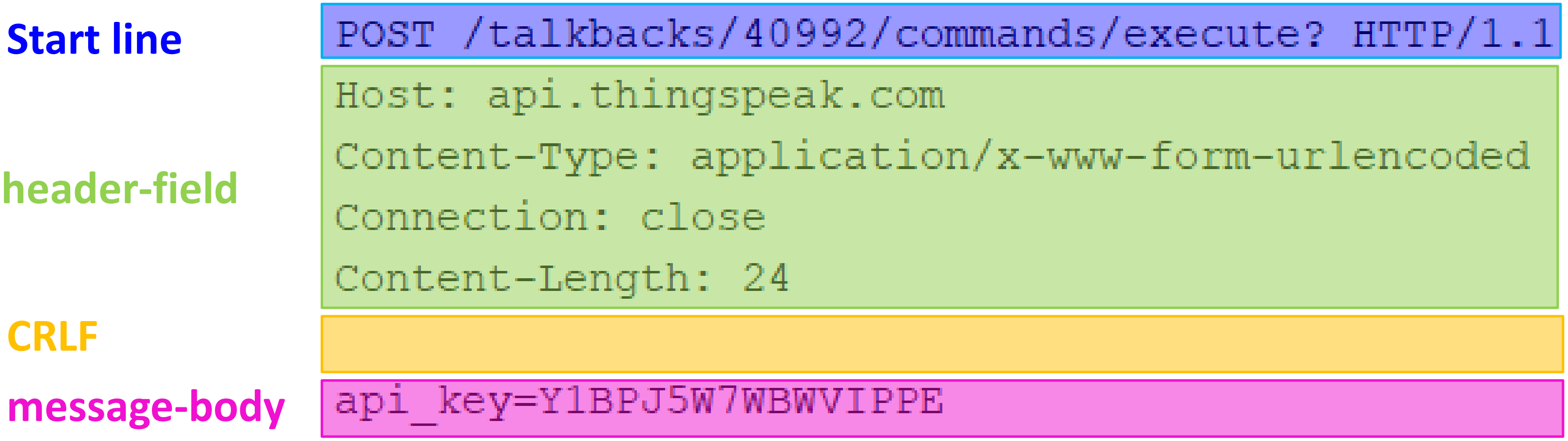
A. Sample code

- Similar to last week, we use ESP-01 to send a TCP message.
- The following code generates a POST message.

```
String postCommand (String uri, String postMessage){
//   postMessage += "&headers=false";
   String Headers =  String("POST ") + uri + String(" HTTP/1.1\r\n") +
                String("Host: api.thingspeak.com\r\n") +
                String("Content-Type: application/x-www-form-urlencoded\r\n") +
                String("Connection: close\r\n") +
                String("Content-Length: ") + String(postMessage.length()) +
                String("\r\n\r\n");
   delay(1000);
   return Headers + postMessage;
}
```

```
postMessage = "api_key=" + API_Key;
postStr = postCommand(uri, postMessage);
talkBackSendCommand(postStr); // Sent Get request via ESP01
// use WiFi_Serial.println(getStr) to send
```

A. POST Message Format



Start line

```
POST /talkbacks/40992/commands/execute? HTTP/1.1
```

header-field

```
Host: api.thingspeak.com
Content-Type: application/x-www-form-urlencoded
Connection: close
Content-Length: 24
```

CRLF

```

```

message-body

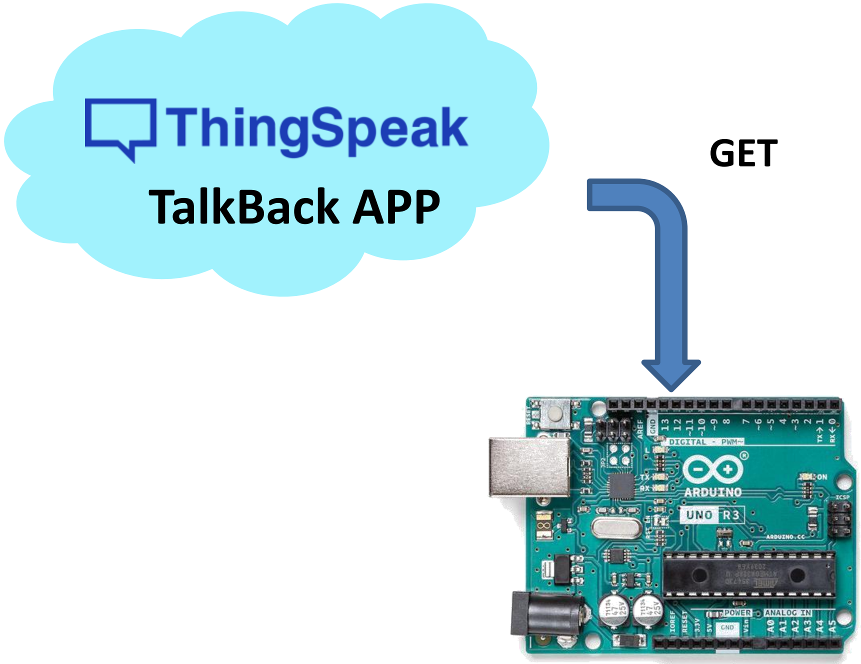
```
api_key=Y1BPJ5W7WBWVIPPE
```

CRLF: carriage return followed by line feed (\r\n)

Read more: https://notfalse.net/39/http-message-format

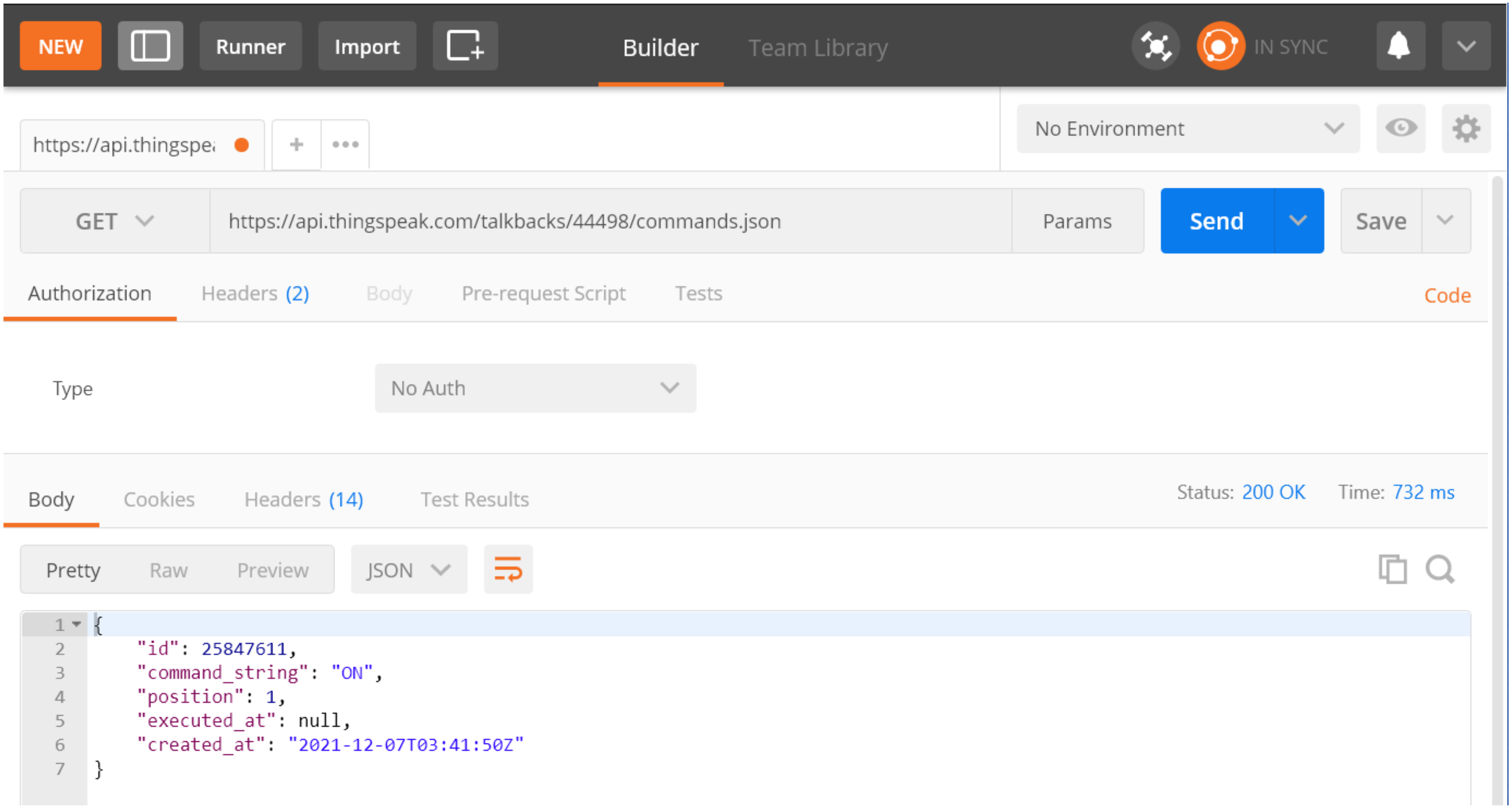
B. TalkBack by GET

- □ Goal: Use HTTP/GET method to execute command on the cloud server and then get the command string to turn on your LED on the Arduino
- □ Hardware Required
  - □ Arduino Board
  - □ ESP01



Get the command string from Thingspeak

B. Test GET by POSTMAN



GET https://api.thingspeak.com/talkbacks/44498/commands.json

Type: No Auth

Status: 200 OK Time: 732 ms

JSON

```
{
    "id": 25847611,
    "command_string": "ON",
    "position": 1,
    "executed_at": null,
    "created_at": "2021-12-07T03:41:50Z"
}
```

GET https://api.thingspeak.com/talkbacks/TALKBACK_ID/commands/execute.json?api_key=TalkAPIkey

B. Sample code

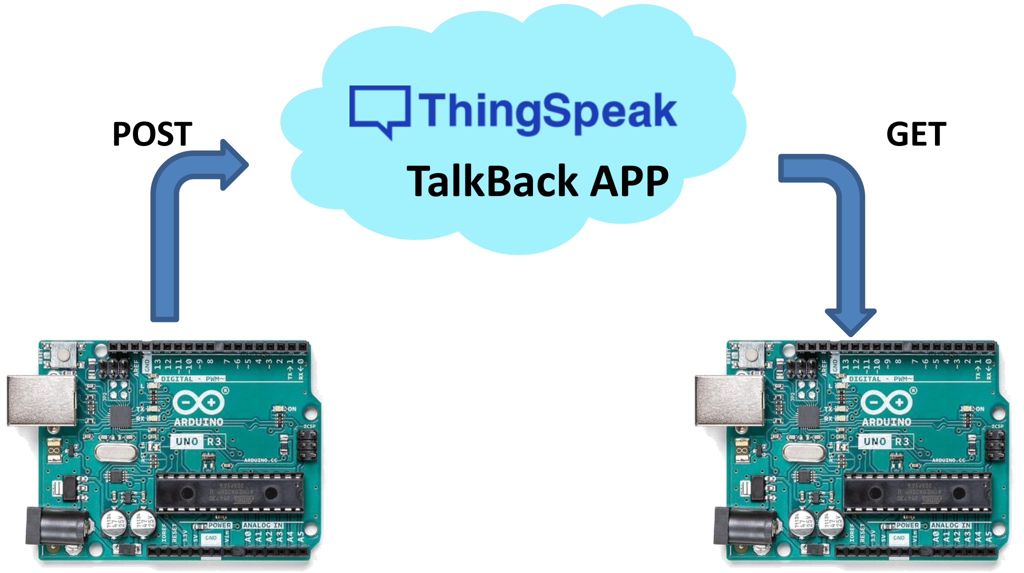
- Similar to last week, we use ESP-01 to send a TCP message.
- The following code generates a GET message.

```
getStr = "GET /talkbacks/"+TalkBack_ID+"/commands/execute?api_key=" + API_Key +"\r\n";
talkBackSendCommand(getStr); // Sent Get request via ESP01
```

GET https://api.thingspeak.com/talkbacks/TALKBACK_ID/commands/execute.json?api_key=TalkAPIkey

Quiz 3

- Use PIR Motion Sensor to detect human and the turn on LED.
  - A. If a person passes the PIR sensor, it send a message to cloud.
  - B. The LED will check the command on TalkBack, it will turn on/off LED according to the command.

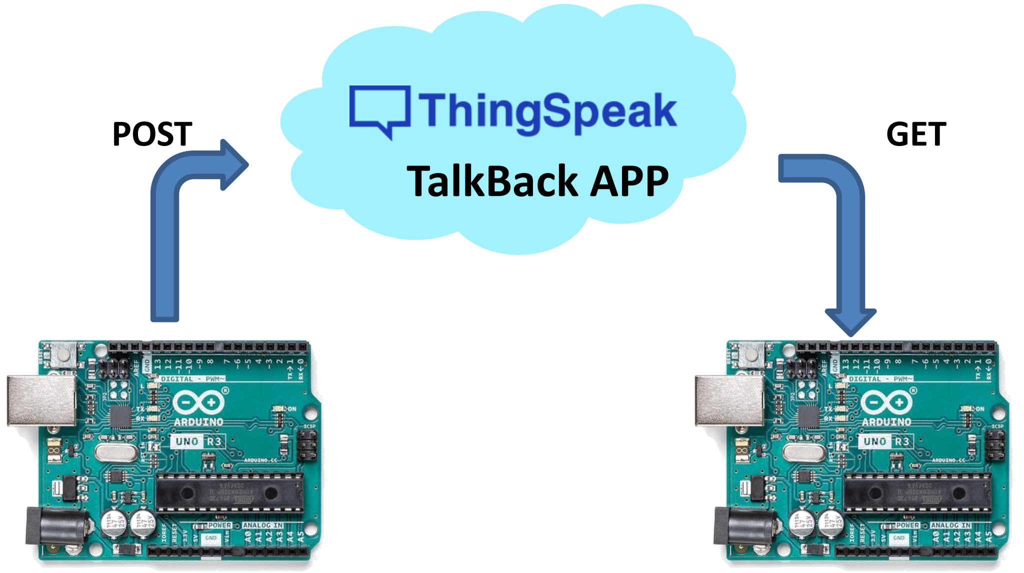


Send the command string to Thingspeak

Get the command string from Thingspeak

Quiz 3

- □ In this quiz, we need two Arduino to connect to ThingSpeak
- □ If you are alone (QQ), you can demo part A and part B separately.



ThingSpeak

TalkBack APP

POST

GET

Send the command string
to Thingspeak

Get the command string
from Thingspeak

Summary

Summary

- **“請記得填寫”教室座位實聯制**
  - https://docs.google.com/spreadsheets/d/1k4q-JP9Pk9cLGY70V04Nbc6XbUbBdYu_TXqJtHF6rGk

- **Practice Labs by yourself**

- **Write Answers for Discussion**
  - Upload to e3 before next class

- **Quiz: Write code for quiz, then demonstrate to TAs**
  - Quiz 1. Air monitor with color notification
  - Quiz 2. Imitate a water pump
  - Quiz 3. Send the sensing data to ThingSpeak