



# CodeZoo CATM1 Hands-On

- Arduino -

version 1.0

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[www.CodeZoo.co.kr](http://www.CodeZoo.co.kr)

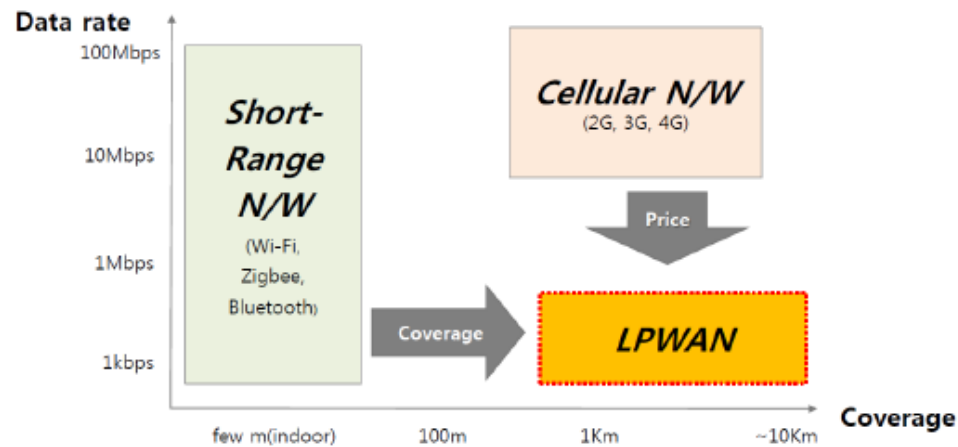
- CAT.M1 특징
- CAT.M1 하드웨어 구성 및 설계 살펴보기
- CAT.M1 어떻게 개발 하나요? (AT Command)
- CAT.M1 실습 (다운로드, Basic, Socket, Cloud)

# 1. Cat.M1 일반적인 특징 - LPWA

폭발적으로 증가하는 IoT 회선 수에 대응하기 위해, 데이터 전송 속도가 낮고 전력 소모량이 적으며 넓은 지역을 커버할 수 있는 LPWA\* 기술이 필요

\* LPWA: Low Power Wide Area

## LPWA의 특징

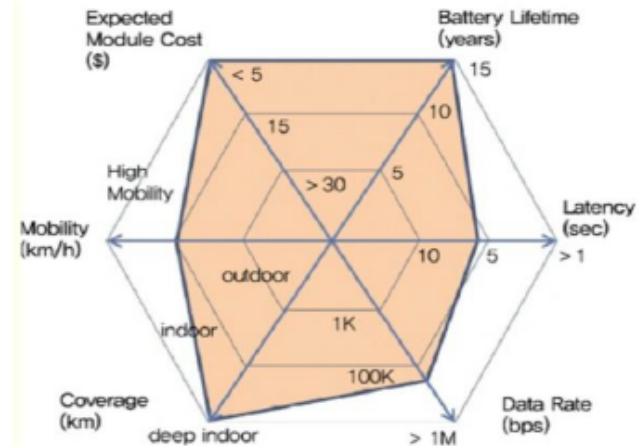


1 | 넓은 커버리지

2 | 낮은 가격

3 | 낮은 소비전력

## LPWA의 핵심 요구사항



| 요구 사항                             | 비고                              |
|-----------------------------------|---------------------------------|
| 저전력 소모 / Long battery life        | 10년                             |
| 저가 단말기 공급 / Low cost chipset      | 기기 당 \$5 이하                     |
| 낮은 구축 비용 / Low cost Network       | HW 추가 보다는 간단한 SW 업그레이드          |
| 안정적 커버리지 / Wide area connectivity | 빌딩 내, 지하, 외곽지역 등                |
| 대규모 단말기 접속                        | 동시 접속/수용 (10 만↑ 디바이스 per cell)* |

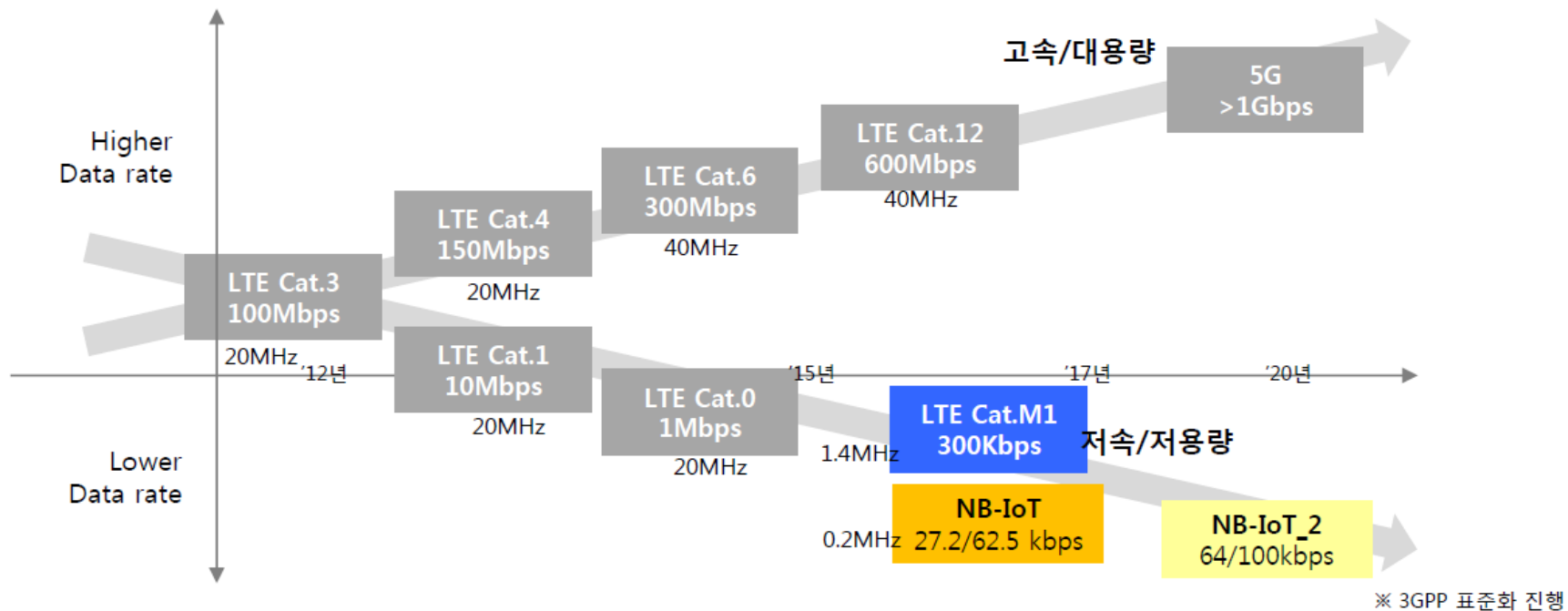
# 1. Cat.M1 일반적인 특징 - Cat.M1 & NB-IoT

## LPWA : 표준 기술의 진화 방향

무선 통신망 기술은 고속/대용량과 저속/소용량의 양방향으로 동시에  
기술 발전이 진행되고 있음

고속/대용량 : 멀티미디어 서비스 → 4G, 5G

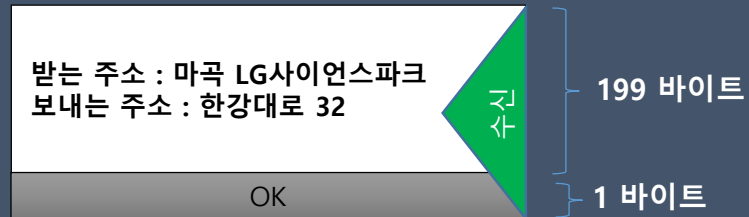
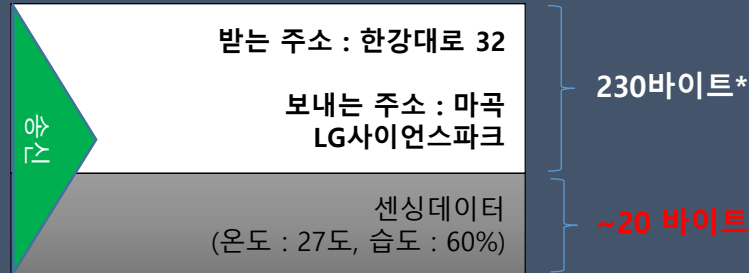
저속/소용량 : IoT 서비스 → LPWA (NB-IoT)



## 2. CAT.M1 소프트웨어 개발자 측면의 특징

### 1회 전송 데이터 TCP Sample

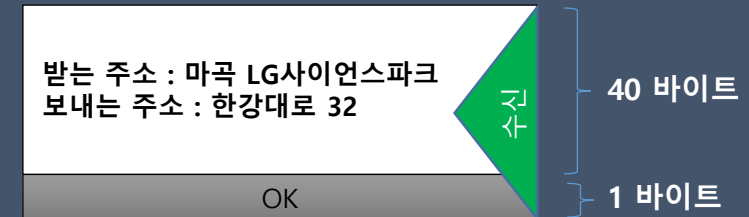
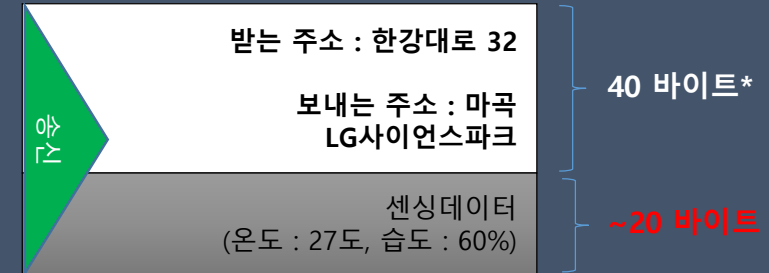
“TCP 패킷헤더(주소 정보) + 보내고자 하는 데이터”



TCP 송신 헤더패킷 사이즈 : 230byte  
TCP 수신 헤더패킷 사이즈 : 199byte

### 1회 전송 데이터 UDP Sample

“UDP 패킷헤더(주소 정보) + 보내고자 하는 데이터”



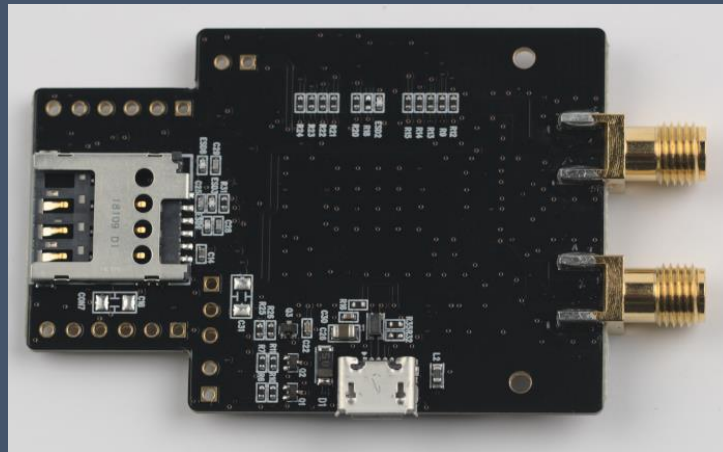
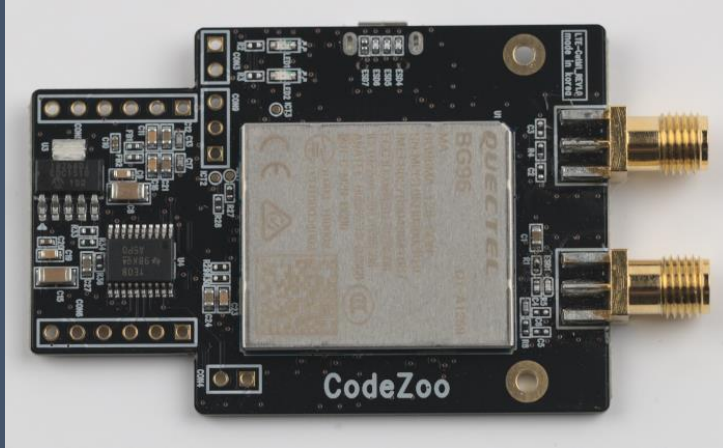
UDP 송신 헤더패킷 사이즈 : 40byte  
UDP 수신 헤더패킷 사이즈 : 40byte

BG96 TCP(IP) AT Commands Manual V1.1

Send Size The maximum data length is 1460 bytes

Read Size The maximum data length is 1500 bytes

### 3. CAT.M1 하드웨어 구성 및 설계 살펴보기



### 3. CAT.M1 하드웨어 구성 및 설계 살펴보기

LTE\_ANTENNA

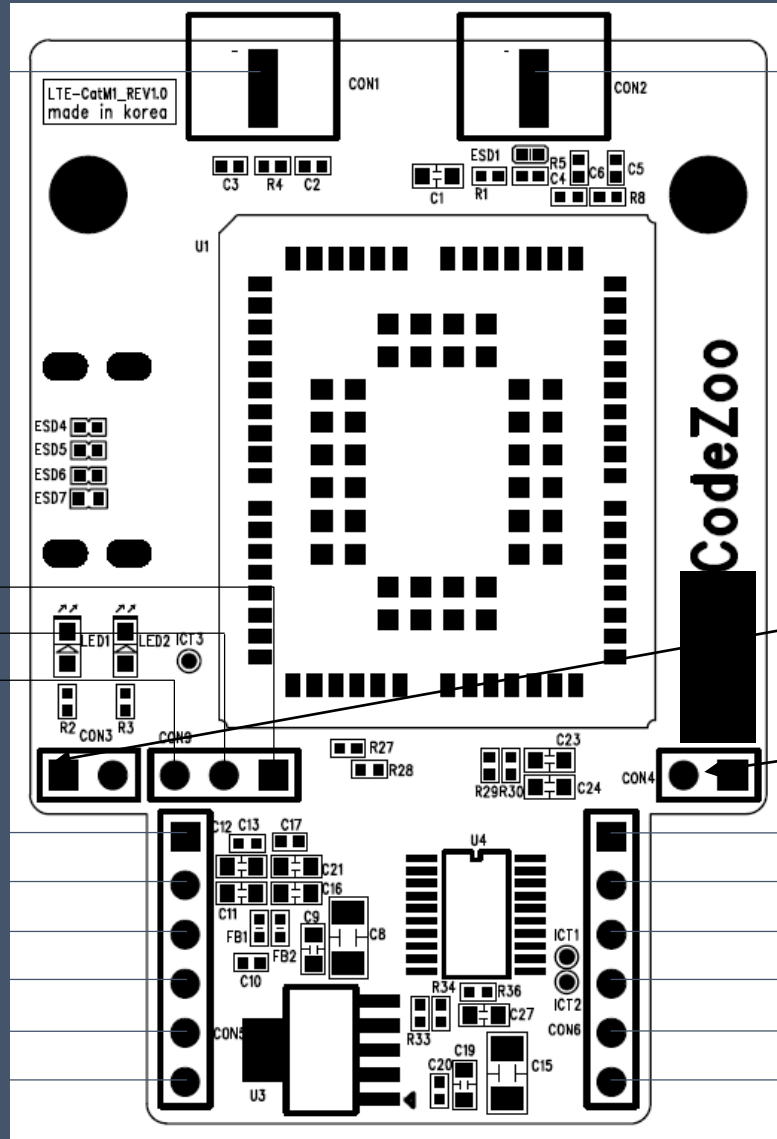
GNSS\_ANTENNA

GNSS\_TXD  
GNSS\_RXD  
GND

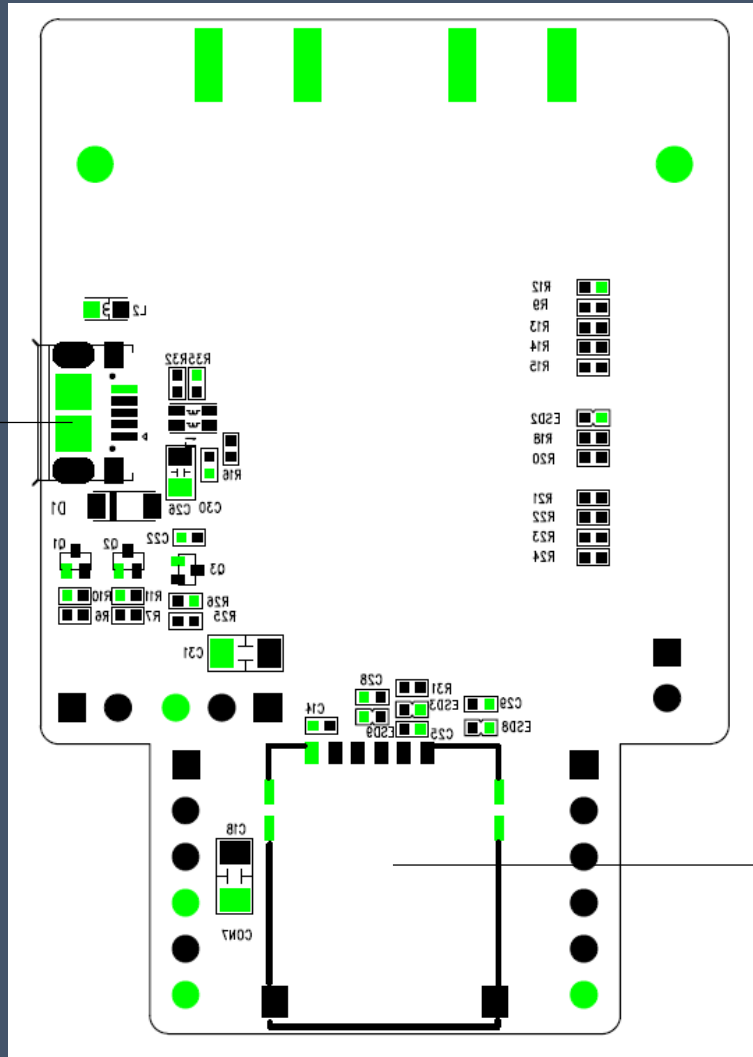
TTL LEVEL SELECT (3.3 or 5V)  
CON3 (CLOSE) & CON4 (OPEN) 3.3V  
CON3 (OPEN) & CON4 (CLOSE) 5V

STATUS  
POWER\_KEY  
RI(Ring Indicator)  
GND  
+3.3V  
GND

CTS  
RTS  
TXD  
RXD  
+5V  
GND



### 3. CAT.M1 하드웨어 구성 및 설계 살펴보기



Micro USB Connector

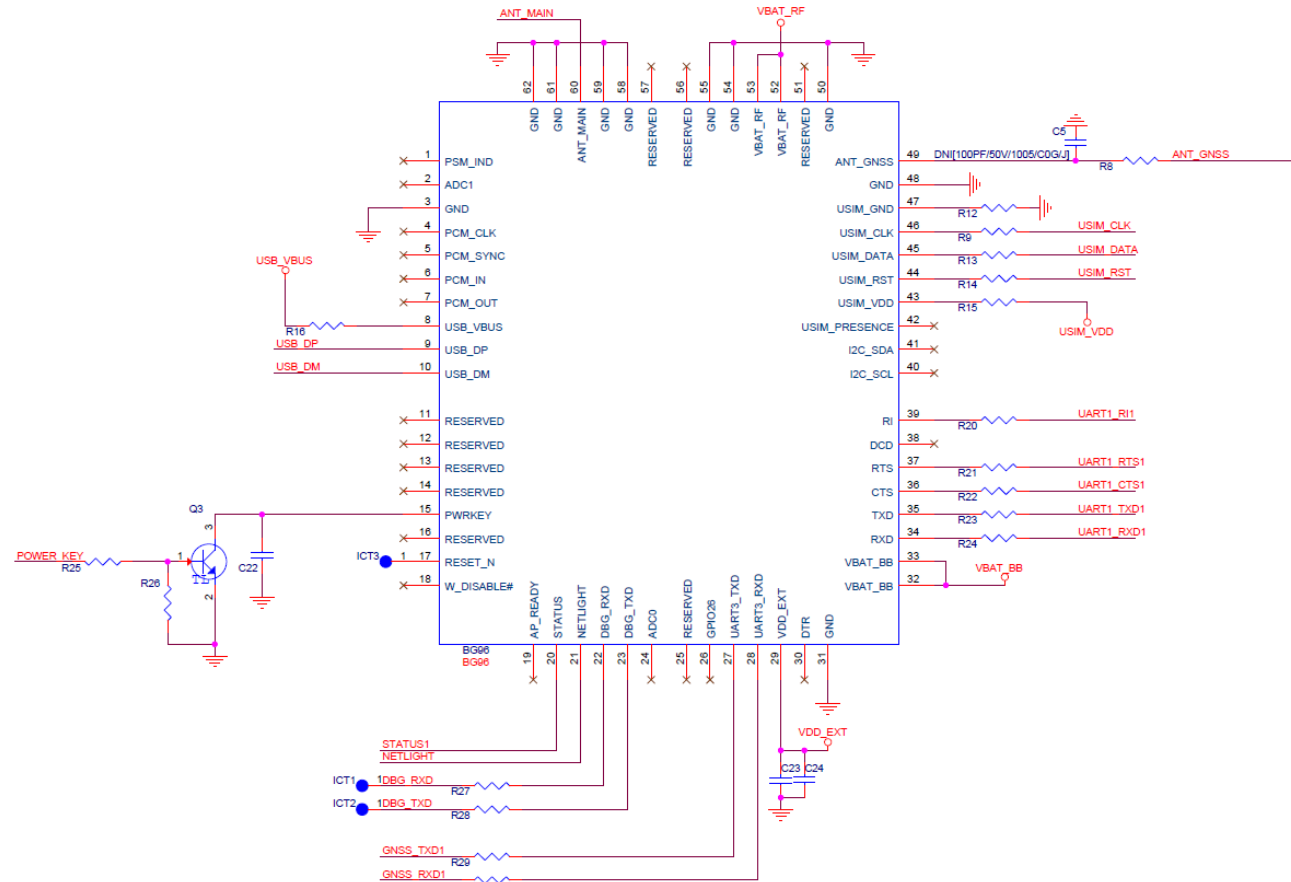
Micro SIM Slot



### 3. CAT.M1 하드웨어 구성 및 설계 살펴보기

| 구분 (classification)                    | 규격 (Standard)                       |
|--|-------------------------------------|
| 1. 제품명 (Product Name)                  | CodeZoo LTE-CAT.M1 Board            |
| 2. 제품 모델명 (Product Model)              | CZ-CATM1                            |
| 3. 제품 제조사 (Product Manufacturer)       | CodeZoo                             |
| 4. 통신모듈 모델명/제조사 (Module Model/Vendor)  | BG96 / Quectel                      |
| 5. 통신칩셋 모델명/제조사 (Chipset Model/Vendor) | MDM9206 / Qualcomm                  |
| 6. 외형크기 (Dimension) [단위: mm]           | Width(38.0)*Height(65.0)*Depth(4.0) |
| 7. 기능용도 (Function-Use)                 | LTE 통신 모듈                           |
| 8. 전원 타입 (Power Supply Type)           | USB, 3.3~5V                         |
| 9. 동작 전압/전류 (Voltage/Ampere)           | ( 5 V ), (0.25A)                    |
| 10. 안테나 타입 (Antenna Type)              | 외장형                                 |
| 11. 지원 통신규격 주파수 (Frequency Band)       | LTE Cat1                            |

# 3. CAT.M1 하드웨어 구성 및 설계 살펴보기



> 회로도 다운로드 (제품 도면 dxf 파일 포함)

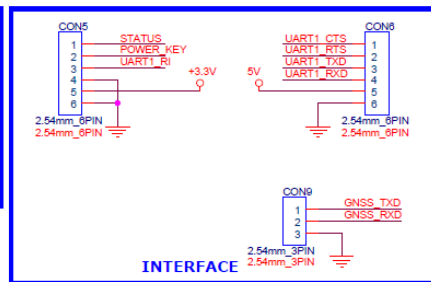
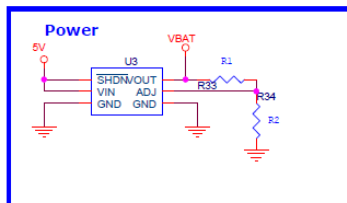
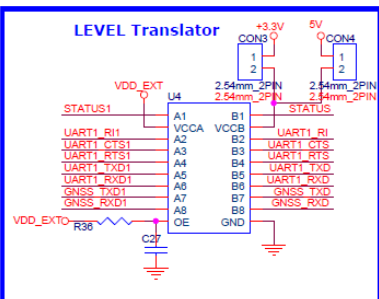
[https://github.com/codezoo-ltd/CodeZoo\\_CATM1\\_Arduino/tree/master/Schematics\\_Dimension/BG96 Module 회로도.pdf](https://github.com/codezoo-ltd/CodeZoo_CATM1_Arduino/tree/master/Schematics_Dimension/BG96%20Module%20회로도.pdf)

> 메뉴얼 다운로드 (하드웨어, 소프트웨어)

[https://github.com/codezoo-ltd/CodeZoo\\_CATM1\\_Arduino/tree/master/BG96\\_Manual](https://github.com/codezoo-ltd/CodeZoo_CATM1_Arduino/tree/master/BG96_Manual)

> 제품 사양서

[https://github.com/codezoo-ltd/CodeZoo\\_CATM1\\_Arduino/tree/master/Product\\_Specification](https://github.com/codezoo-ltd/CodeZoo_CATM1_Arduino/tree/master/Product_Specification)



## 4. CAT.M1 어떻게 개발 하나요? (AT Command)

The “AT” or “at” prefix must be set at the beginning of each command line. To terminate a command line enter <CR>. Commands are usually followed by a response that includes “<CR><LF><response><CR><LF>”. Throughout this document, only the responses are presented, “<CR><LF>” are omitted intentionally.

“AT”또는“at”접두사는 각 명령 줄의 시작 부분에 설정해야합니다. 명령 행을 종료하려면 <CR>을 입력하십시오. 명령 뒤에는 일반적으로“<CR> <LF> <response> <CR> <LF>”가 포함 된 응답이 이어집니다. 이 문서 전체에서“<CR> <LF>”는 의도적으로 생략된 답변만 제공됩니다.

Quectel\_BG96\_AT\_Commands  
\_Manual\_V2.3.pdf, 10page

## 4. CAT.M1 어떻게 개발 하나요? (AT Command)

Table 1: Types of AT Commands and Responses

|                   |              |  |
|-------------------|--------------|--|
| Test Command      | AT+<x>=?     | This command returns the list of parameters and value ranges set by the corresponding Write Command or internal processes. |
| Read Command      | AT+<x>?      | This command returns the currently set value of the parameter or parameters.   |
| Write Command     | AT+<x>=<...> | This command sets the user-definable parameter values.   |
| Execution Command | AT+<x>       | This command reads non-variable parameters affected by internal processes in the UE.                                       |

Quectel\_BG96\_AT\_Commands  
\_Manual\_V2.3.pdf, 11page

## 4. CAT.M1 어떻게 개발 하나요? (AT Command)

### 1.5. Unsolicited Result Code

As an Unsolicited Result Code and a report message, URC is not issued as part of the response related to an executed AT command. URC is issued by BG96 without being requested by the TE and it is issued automatically when a certain event occurs. Typical events leading to URCs are incoming calls (**RING**), received short messages, high/low voltage alarm, high/low temperature alarm, etc.

요청하지 않은 결과 코드 및 보고서 메시지로 URC는 실행된 AT 명령과 관련된 응답의 일부로 발행되지 않습니다. URC는 TE의 요청없이 BG96에 의해 발행되며 특정 이벤트가 발생하면 자동으로 발행됩니다. URC로 이어지는 일반적인 이벤트는 수신 전화 (RING), 수신된 짧은 메시지, 고 / 저 전압 경고, 고 / 저 온도 경고 등입니다.

언제 들어올지 알 수 없는 모뎀 메시지에 대한 처리 루틴을 어떻게 만들 것 인지?

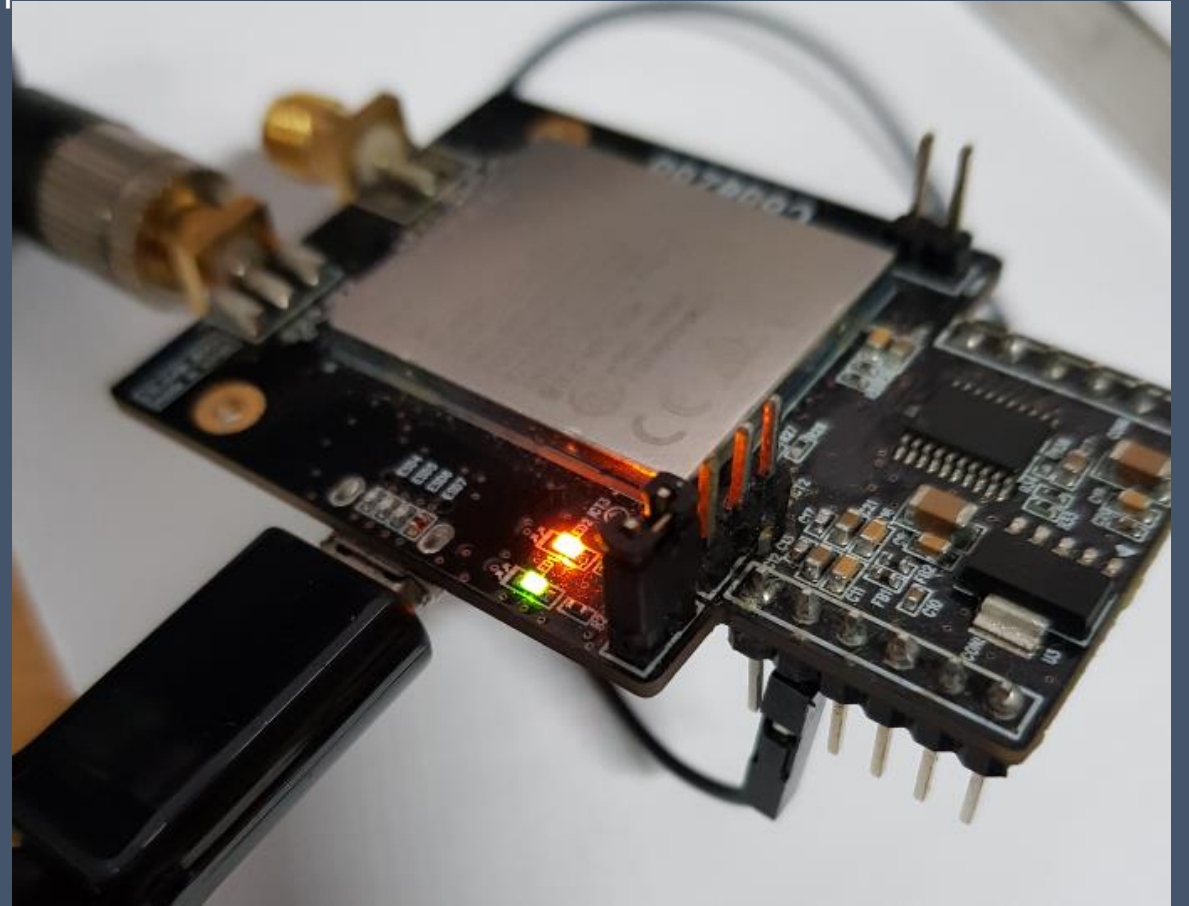
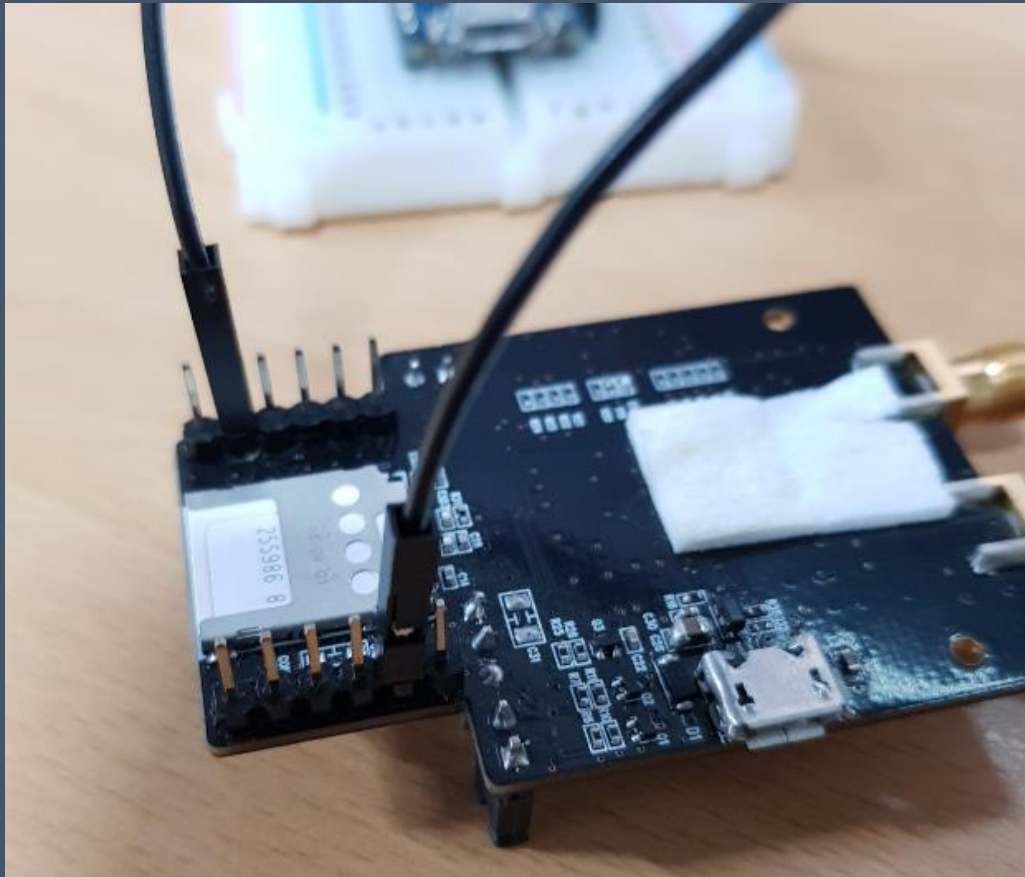
1. 인터럽트
2. RTOS 태스크
3. 상황에 맞는 소프트웨어 설계

Quectel\_BG96\_AT\_Commands  
\_Manual\_V2.3.pdf, 12page

## 4. CAT.M1 어떻게 개발 하나요? (AT Command)

USB 연결 후 AT Command 테스트 절차

1. 후면 좌측 5번과 우측 2번을 점퍼선으로 연결
2. USB 드라이버 설치 ([https://github.com/codezoo-ltd/CodeZoo\\_CATM1\\_Arduino/tree/master/Driver/Quectel\\_LTE5G\\_Windows\\_USB\\_Driver\\_V2.1.zip](https://github.com/codezoo-ltd/CodeZoo_CATM1_Arduino/tree/master/Driver/Quectel_LTE5G_Windows_USB_Driver_V2.1.zip) PC설치)
3. Micro USB 케이블을 꼽고 PC에 연결



## 4. CAT.M1 어떻게 개발 하나요? (AT Command)

### 2.9. AT+CGSN Request Product Serial Number Identification

The command returns International Mobile Equipment Identity (IMEI). It is identical with **AT+GSN**.

#### AT+CGSN Request Product Serial Number Identification

|                                     |                                     |
|-------------------------------------|-------------------------------------|
| Test Command<br><b>AT+CGSN=?</b>    | Response<br><b>OK</b>               |
| Execution Command<br><b>AT+CGSN</b> | Response<br><IMEI><br><br><b>OK</b> |
| Maximum Response Time               | 300ms                               |
| Reference<br>3GPP TS 27.007         |                                     |

#### Parameter

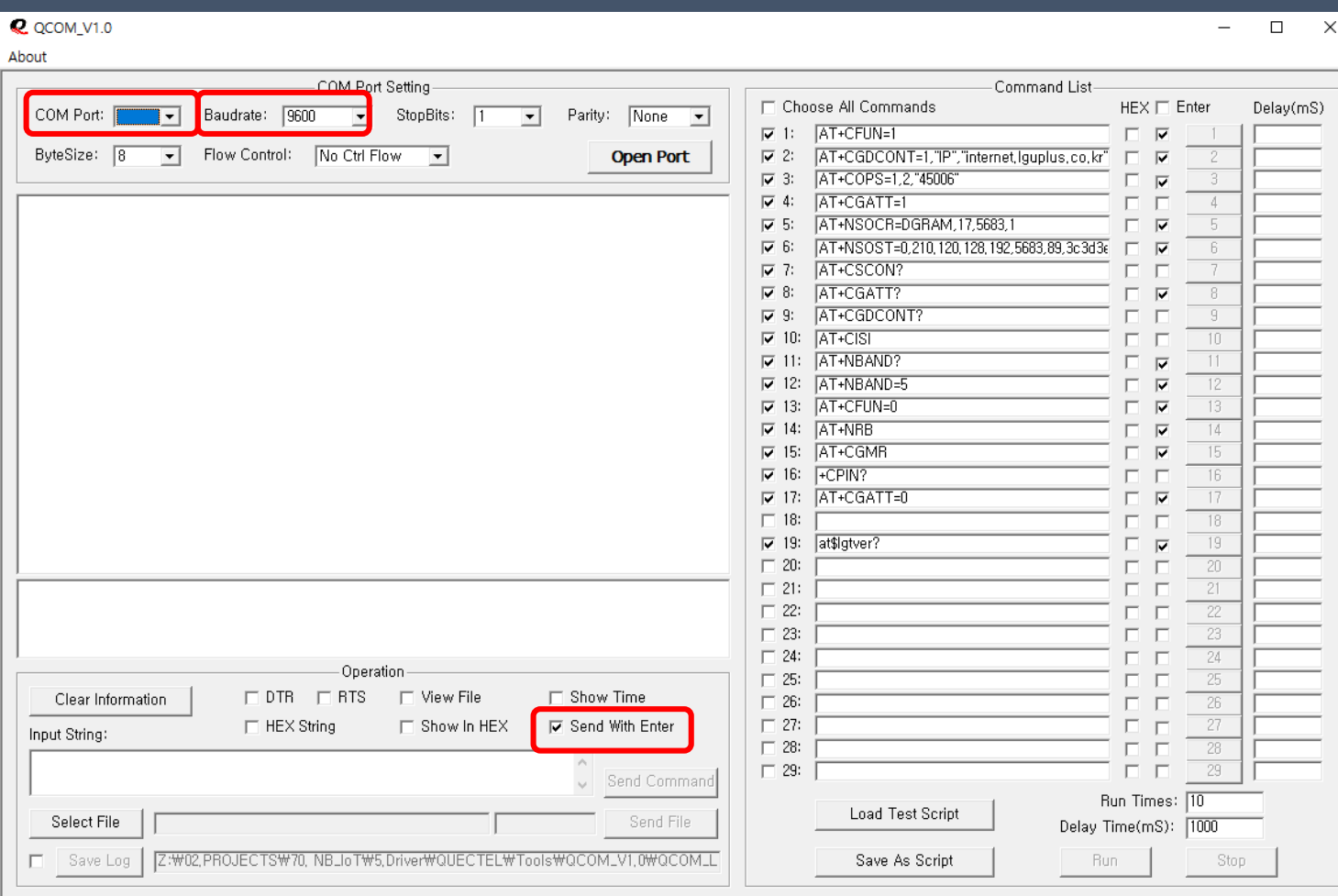
<IMEI>      IMEI of the ME

#### NOTE

The serial number (IMEI) varies with the individual ME device.

Quectel\_BG96\_AT\_Commands  
\_Manual\_V2.3.pdf, 18page

# 4. CAT.M1 어떻게 개발 하나요? (AT Command)



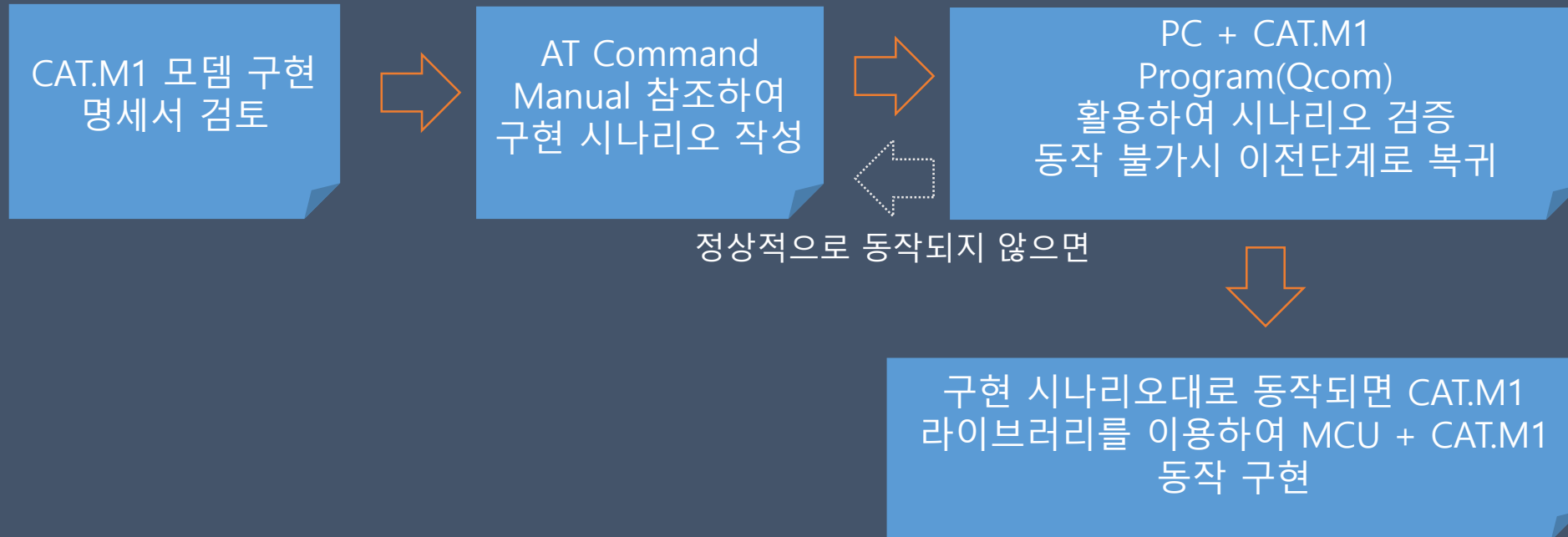
[https://github.com/codezoo-ltd/CodeZoo\\_CATM1\\_Arduino/tree/master/Tool/](https://github.com/codezoo-ltd/CodeZoo_CATM1_Arduino/tree/master/Tool/)

QCOM\_V1.6.zip 압축 해제 후 사용

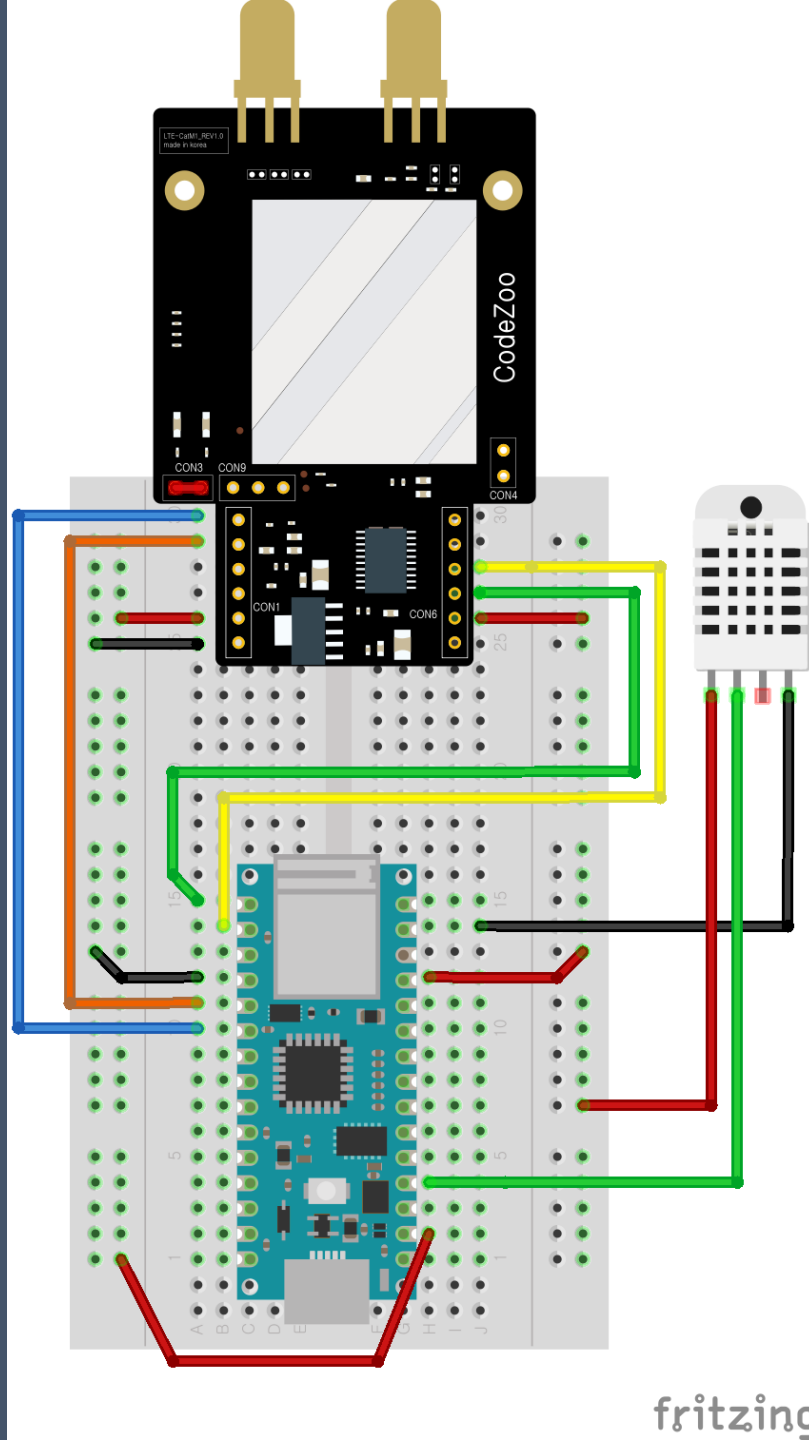
1. COM Port : 장치관리자 포트 정보에서 AT Port
2. Baudrate : 115200bps
3. Send With Enter : 체크표시



## 4. CAT.M1 어떻게 개발 하나요? (AT Command)

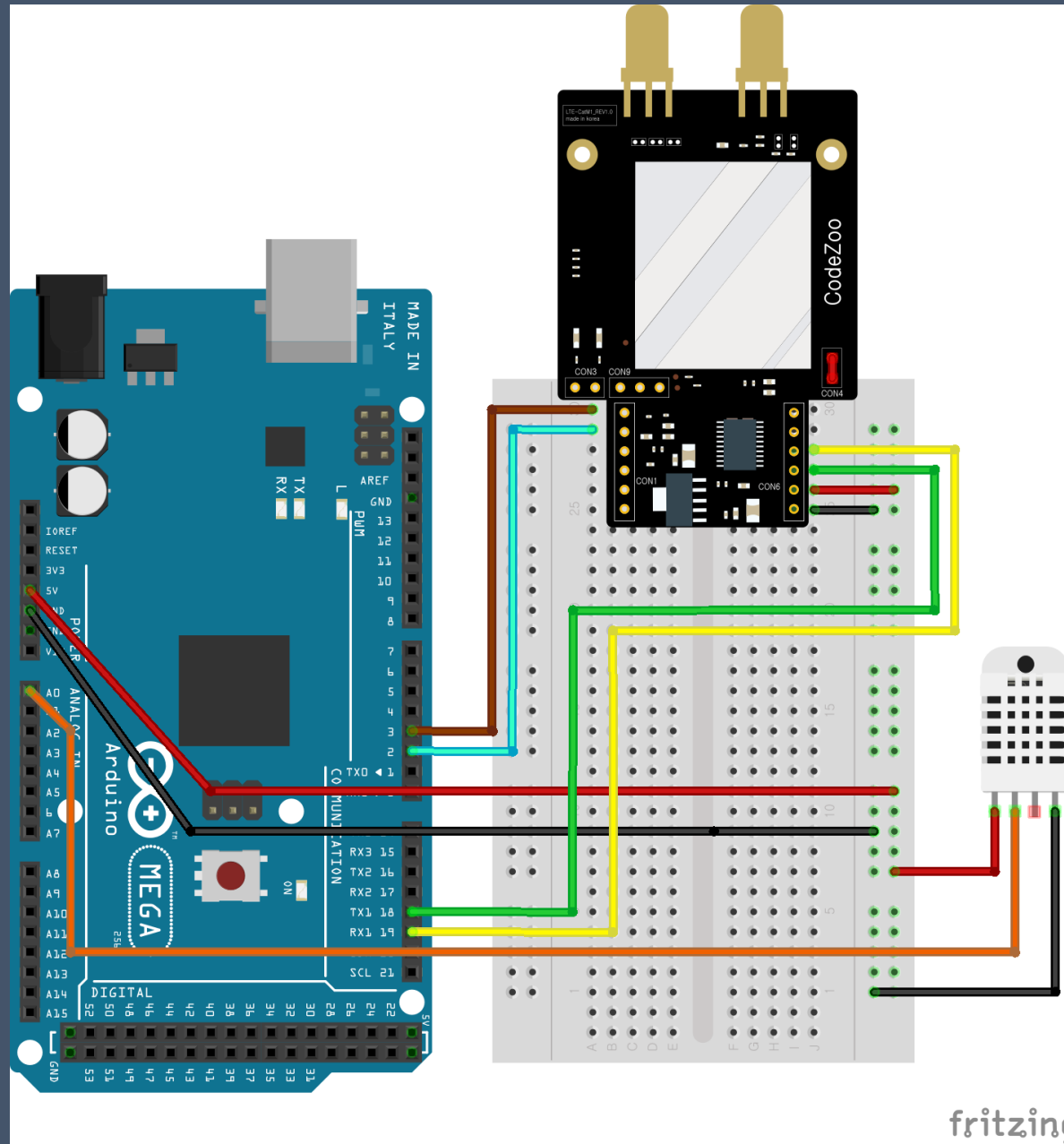


## 5. CAT.M1 실습



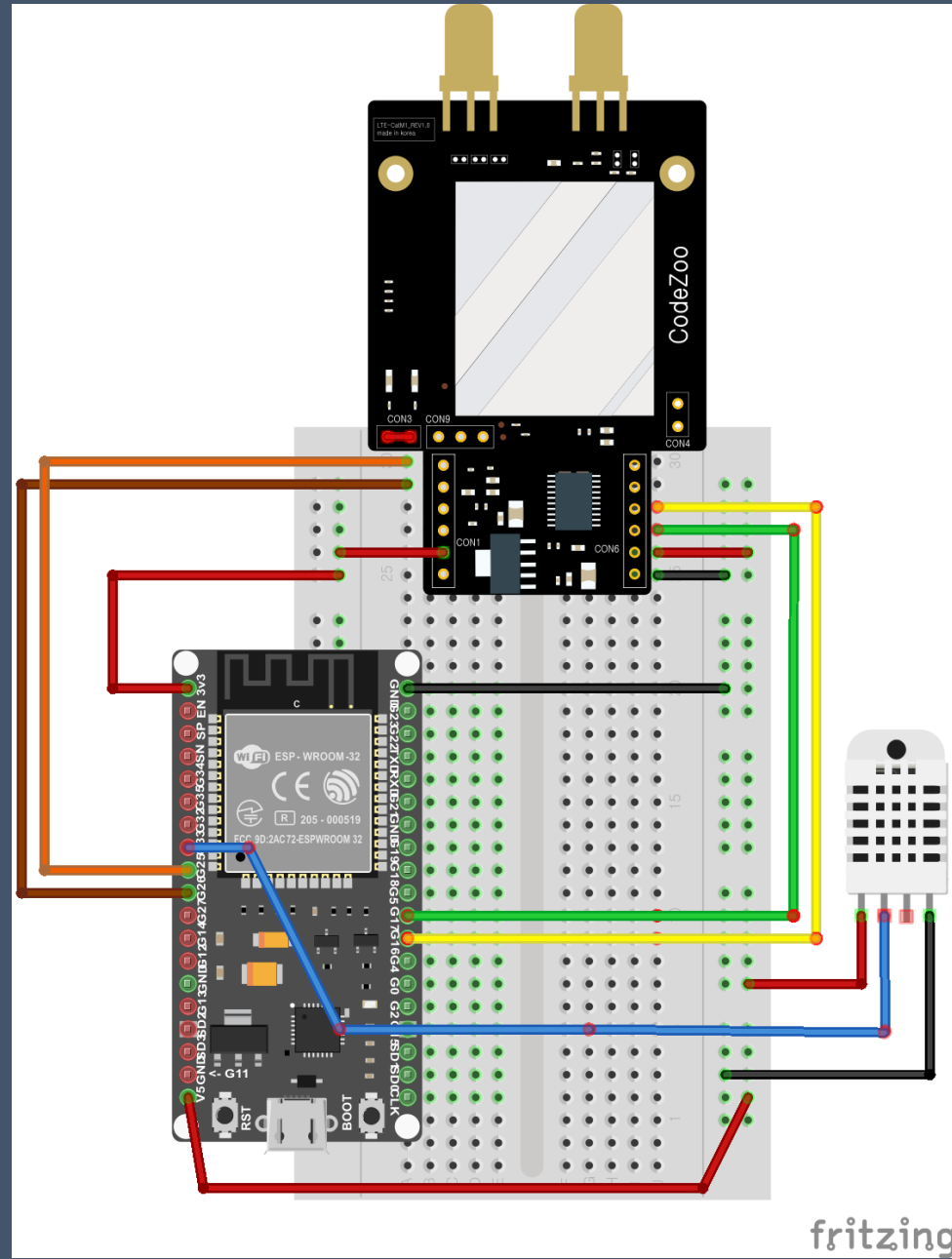
Arduino Nano 33 IoT 배선도

## 5. CAT.M1 실습



## Arduino MEGA2560 배선도

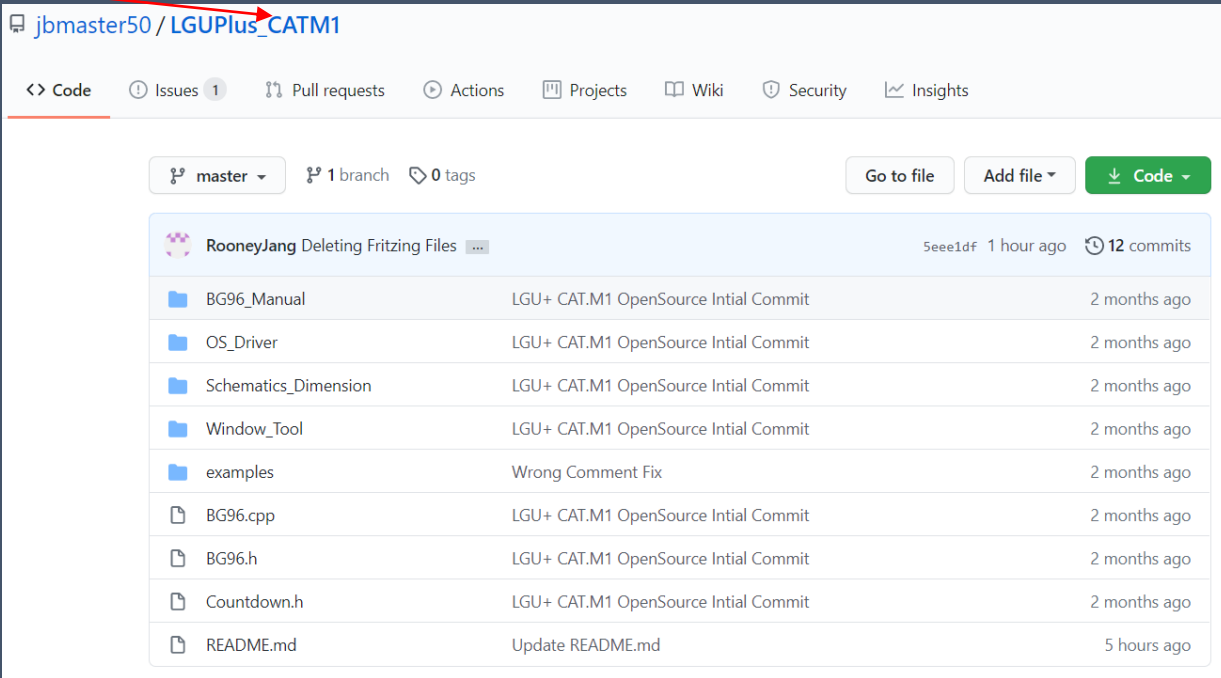
## 5. CAT.M1 실습



## ESP32 배선도

# 5. CAT.M1 실습 (개발 리소스 다운로드)

1. 유플러스 유심 사용 : [https://github.com/jbmaster50/LGUPlus\\_CATM1](https://github.com/jbmaster50/LGUPlus_CATM1)



jbmaster50 / LGUPlus\_CATM1

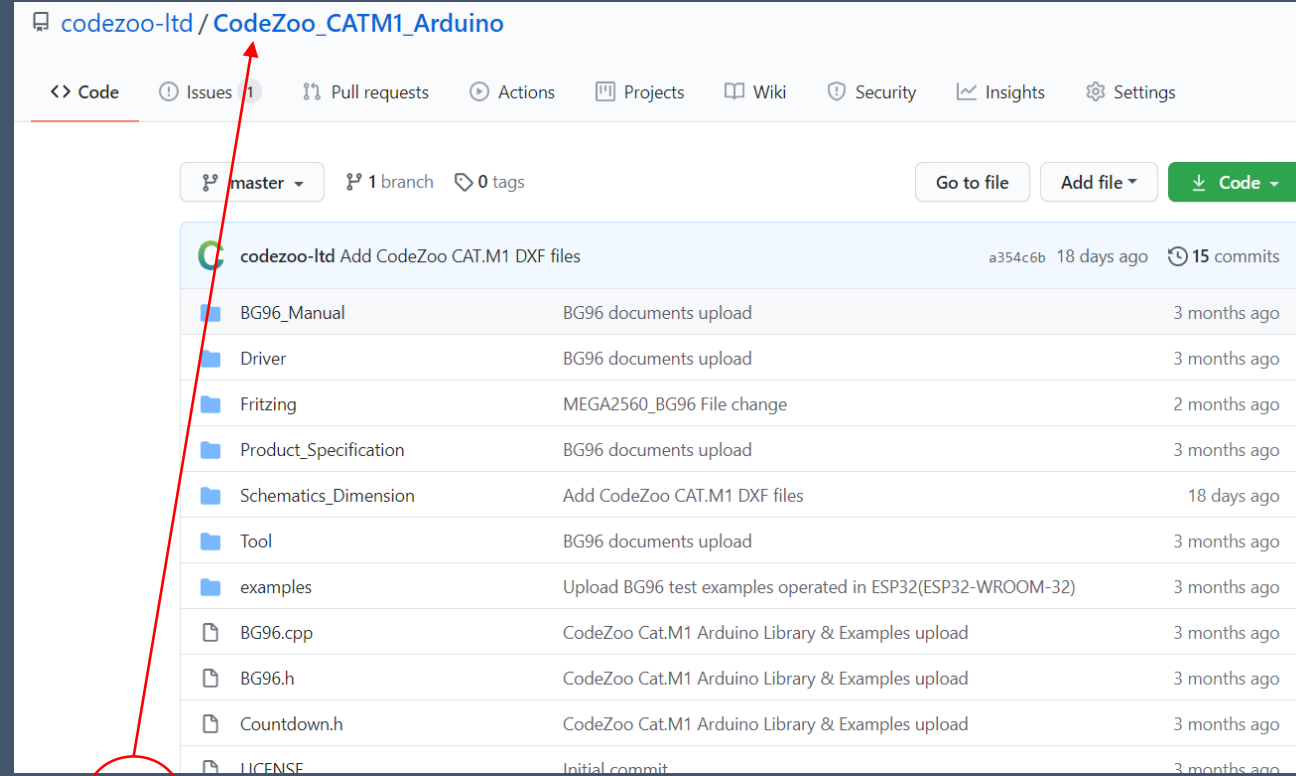
<> Code Issues 1 Pull requests Actions Projects Wiki Security Insights

master 1 branch 0 tags

Go to file Add file Code

RooneyJang Deleting Fritzing Files 5eee1df 1 hour ago 12 commits

|                      |                                      |              |
|----------------------|--------------------------------------|--------------|
| BG96_Manual          | LGU+ CAT.M1 OpenSource Intial Commit | 2 months ago |
| OS_Driver            | LGU+ CAT.M1 OpenSource Intial Commit | 2 months ago |
| Schematics_Dimension | LGU+ CAT.M1 OpenSource Intial Commit | 2 months ago |
| Window_Tool          | LGU+ CAT.M1 OpenSource Intial Commit | 2 months ago |
| examples             | Wrong Comment Fix                    | 2 months ago |
| BG96.cpp             | LGU+ CAT.M1 OpenSource Intial Commit | 2 months ago |
| BG96.h               | LGU+ CAT.M1 OpenSource Intial Commit | 2 months ago |
| Countdown.h          | LGU+ CAT.M1 OpenSource Intial Commit | 2 months ago |
| README.md            | Update README.md                     | 5 hours ago  |



codezoo-ltd / CodeZoo\_CATM1\_Arduino

<> Code Issues 1 Pull requests Actions Projects Wiki Security Insights Settings

master 1 branch 0 tags

Go to file Add file Code

codezoo-ltd Add CodeZoo CAT.M1 DXF files a354c6b 18 days ago 15 commits

|                       |   |              |
|-----------------------|---|--------------|
| BG96_Manual           | BG96 documents upload                                       | 3 months ago |
| Driver                | BG96 documents upload                                       | 3 months ago |
| Fritzing              | MEGA2560_BG96 File change                                   | 2 months ago |
| Product_Specification | BG96 documents upload                                       | 3 months ago |
| Schematics_Dimension  | Add CodeZoo CAT.M1 DXF files                                | 18 days ago  |
| Tool                  | BG96 documents upload                                       | 3 months ago |
| examples              | Upload BG96 test examples operated in ESP32(ESP32-WROOM-32) | 3 months ago |
| BG96.cpp              | CodeZoo Cat.M1 Arduino Library & Examples upload            | 3 months ago |
| BG96.h                | CodeZoo Cat.M1 Arduino Library & Examples upload            | 3 months ago |
| Countdown.h           | CodeZoo Cat.M1 Arduino Library & Examples upload            | 3 months ago |
| LICENSE               | Initial commit  | 3 months ago |

2. 텔레노어 유심 사용 : [https://github.com/codezoo-ltd/CodeZoo\\_CATM1\\_Arduino](https://github.com/codezoo-ltd/CodeZoo_CATM1_Arduino)

## 5. CAT.M1 실습 (다운로드)

Code Issues 1 Pull requests Actions Projects Wiki Security Insights

master 1 branch 0 tags

Go to file Add file Code

RooneyJang Deleting Fritzing Files

| File/Folder          | Commit Message                       | Time Ago     |
|----------------------|--------------------------------------|--------------|
| BG96_Manual          | LGU+ CAT.M1 OpenSource Intial Comm   |              |
| OS_Driver            | LGU+ CAT.M1 OpenSource Intial Comm   |              |
| Schematics_Dimension | LGU+ CAT.M1 OpenSource Intial Comm   |              |
| Window_Tool          | LGU+ CAT.M1 OpenSource Intial Comm   |              |
| examples             | Wrong Comment Fix                    | 2 months ago |
| BG96.cpp             | LGU+ CAT.M1 OpenSource Intial Commit | 2 months ago |
| BG96.h               | LGU+ CAT.M1 OpenSource Intial Commit | 2 months ago |
| Countdown.h          | LGU+ CAT.M1 OpenSource Intial Commit | 2 months ago |
| README.md            | Update README.md                     | 5 hours ago  |

Clone with HTTPS Use SSH

Use Git or checkout with SVN using the web URL.

[https://github.com/jbmaster50/LGUPlus\\_](https://github.com/jbmaster50/LGUPlus_)

Open with GitHub Desktop

**Download ZIP**

## 5. CAT.M1 실습 (다운로드)

LGUPlus\_BG96\_Basic\_test | 아두이노 1.8.13

파일 편집 스케치 툴 도움말

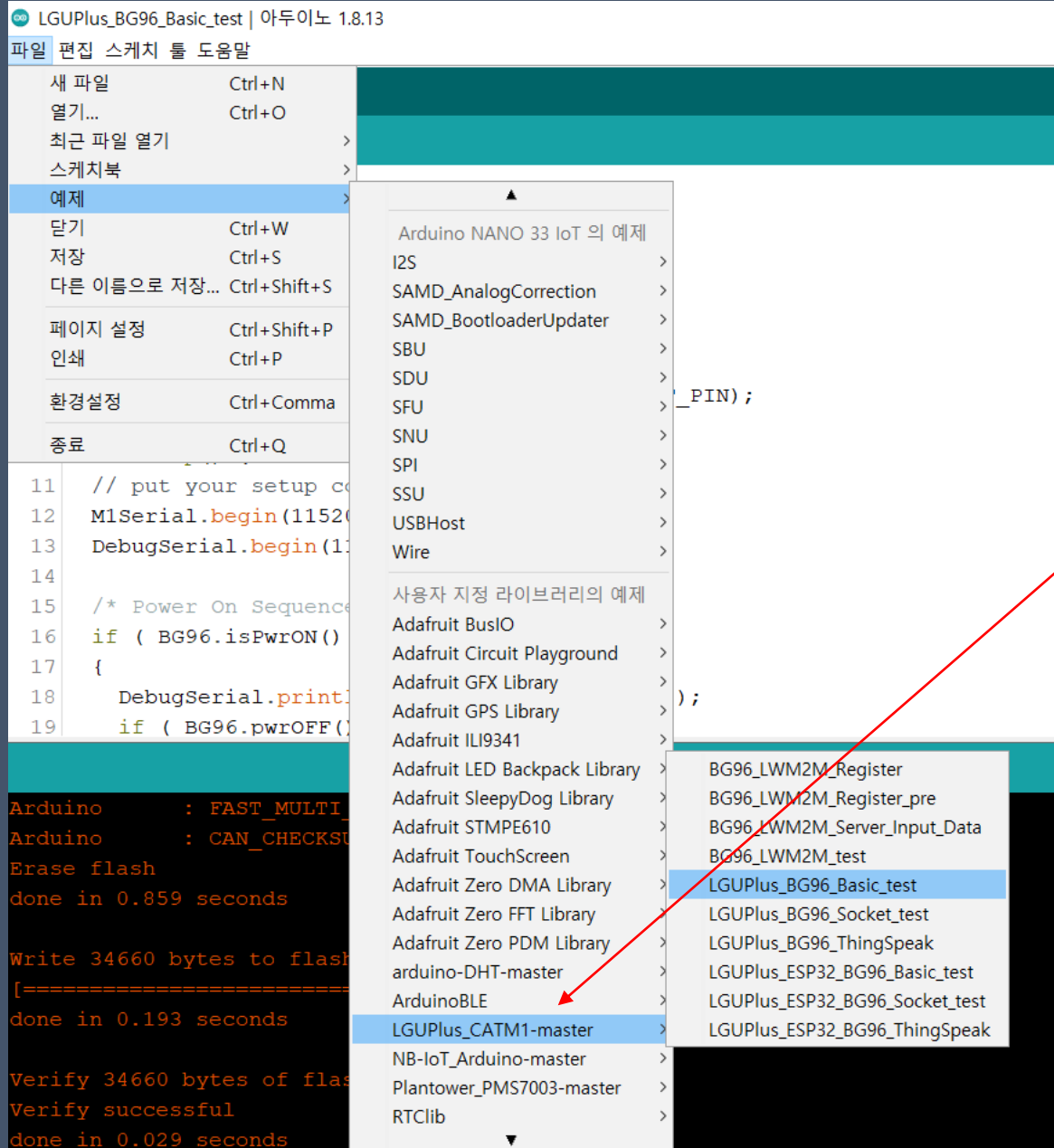
확인/컴파일 Ctrl+R  
업로드 Ctrl+U  
프로그래머를 이용해 업로드 Ctrl+Shift+U  
컴파일된 바이너리 내보내기 Ctrl+Alt+S  
스케치 폴더 보기 Ctrl+K  
라이브러리 포함하기  
파일 추가...

라이브러리 관리... Ctrl+Shift+I  
.ZIP 라이브러리 추가...  
아두이노 라이브러리  
ArduinoBLE  
Bridge  
Esplora  
Ethernet  
Firmata  
GSM  
HID  
I2S  
Keyboard  
LiquidCrystal  
Mouse  
RTCZero  
Robot Control  
Robot IR Remote  
Robot Motor  
SAMD\_AnalogCorrection  
SAMD\_BootloaderUpdater  
SBU  
SD  
SDU

```
1 #include <Arduino.h>
2
3 #define PWR_PIN 2
4 #define STAT_PIN 3
5
6 BG96 BG96(M1Serial, DebugSerial,
7
8 void setup() {
9     // put your setup code here, to
10     M1Serial.begin(115200);
11     DebugSerial.begin(115200);
12
13     /* Power On Sequence */
14     if ( BG96.isPwrON() )
15     {
16         DebugSerial.println("BG96 Pow
17         if ( BG96.pwrOFF() ) {
```

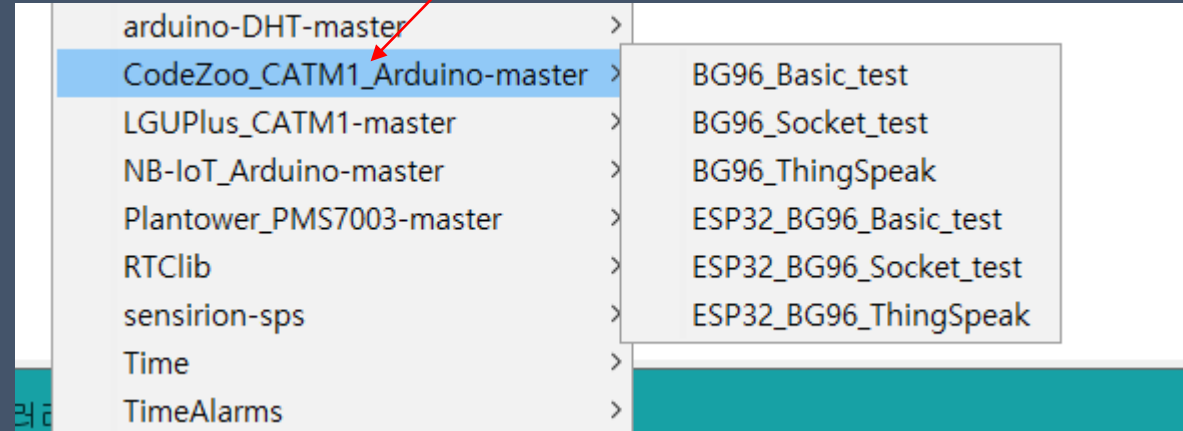
Arduino : FAST\_MULTI\_PAGE\_WRITE  
Arduino : CAN\_CHECKSUM\_MEMORY\_BU  
Erase flash  
done in 0.859 seconds

# 5. CAT.M1 실습 (실습예제)



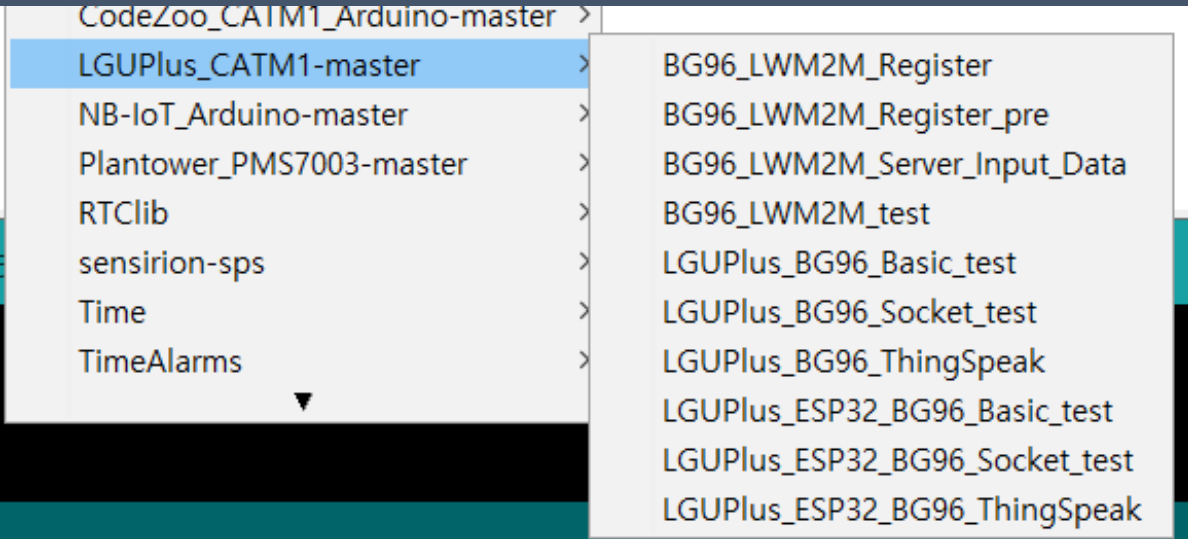
유플러스 CatM1 예제 (유플러스 유심 사용시)

CatM1 예제 (텔레노어 유심 사용시)





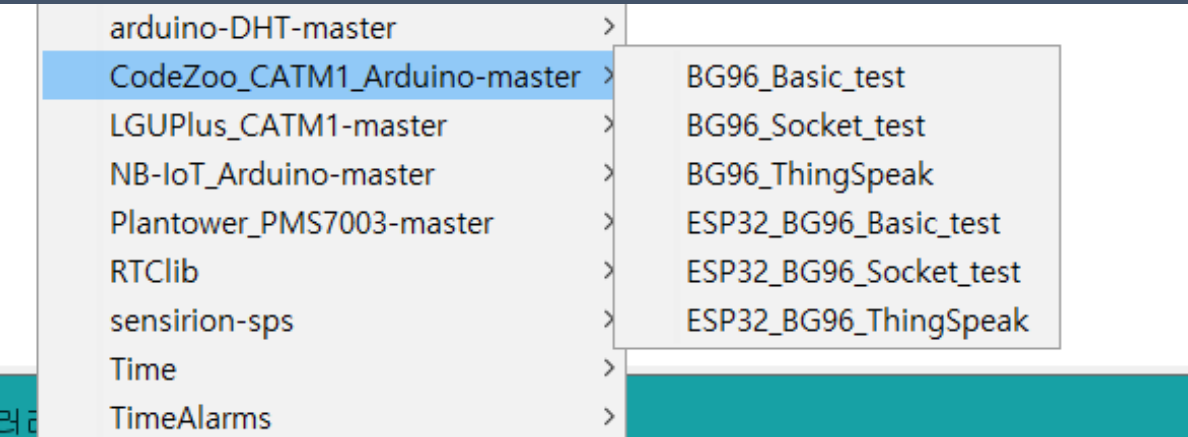
## 5. CAT.M1 실습 (실습예제)



유플러스 유심용 사용예제

1. Basic\_test : CATM1 모뎀 기본설정 테스트
2. Socket\_test : 에코서버 연동 TCP, UDP 소켓 통신 테스트
3. ThingSpeak : DHT22 센서를 사용하여 지정한 시간주기에 ThingSpeak.com에 온도, 습도 데이터 업로드

(\*)ESP32를 사용할 경우 ESP32\_\*\*\* 예제 사용



텔레노어 유심용 사용예제

## 5. CAT.M1 실습 (실습예제)

### Thing Speak.com (TCP & HTTP Protocol)

<Source Code>

1. 유플러스 유심 사용시

[https://github.com/jbmaster50/LGUPlus\\_CATM1/tree/master/examples/LGUPlus\\_BG96\\_ThingSpeak](https://github.com/jbmaster50/LGUPlus_CATM1/tree/master/examples/LGUPlus_BG96_ThingSpeak)

2. 텔레노어 유심 사용시

[https://github.com/codezoo-ltd/CodeZoo\\_CATM1\\_Arduino/tree/master/examples/BG96\\_ThingSpeak](https://github.com/codezoo-ltd/CodeZoo_CATM1_Arduino/tree/master/examples/BG96_ThingSpeak)

(\*)ESP32의 경우 ESP32\_BG96\_ThingSpeak

<사전에 설치해야 할 라이브러리>

DHT22 Sensor Temperature & Humidity

<https://github.com/markruys/arduino-DHT>

Time

<https://github.com/PaulStoffregen/Time>

TimeAlarms

<https://github.com/PaulStoffregen/TimeAlarms>

# Thing Speak.com (TCP & HTTP Protocol)

The image is a promotional banner for the ThingSpeak website. At the top is a blue navigation bar with the ThingSpeak logo and links for Channels, Apps, Support, Commercial Use, How to Buy, Sign In, and Sign Up. The Sign Up link is circled in red. Below the navigation bar is a large background image of a hand holding a tablet. The tablet screen displays several weather-related data visualizations, including bar charts for median temperature and line graphs for wind and pressure. Overlaid on the left side of the background image is the text 'ThingSpeak for IoT Projects' and 'Data collection in the cloud with advanced data analysis using MATLAB'. At the bottom left are two buttons: 'Get Started For Free' (green) and 'Learn More' (white with a black border).

**ThingSpeak™** Channels Apps Support Commercial Use How to Buy Sign In **Sign Up**

# ThingSpeak for IoT Projects

Data collection in the cloud with advanced data analysis using MATLAB

[Get Started For Free](#) [Learn More](#)

# Thing Speak.com (TCP & HTTP Protocol)

ThingSpeak™ Channels Apps Support Commercial

My Channels

New Channel

My Channels  
Watched Channels  
Public Channels

Search by tag

| Name           | Created    | Updated          |
|----------------|------------|------------------|
| CodeZoo_NB-IoT | 2019-08-18 | 2019-08-18 15:54 |

Private View Public View Channel Settings Sharing AI

## Channel Settings

Percentage complete 30%

Channel ID 875206

Name Test\_NB\_IoT\_Class

Description

Field 1 Temperature ☒

Field 2 Humidity ☒

Field 4  ☐

Field 5  ☐

Field 6  ☐

# Thing Speak.com (TCP & HTTP Protocol)

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

## Write API Key

Key

~~HF05F313EEFKQ9M~~

Generate New Write API Key

## Read API Keys

Key

~~9542D687FE34VU~~

Note

Save Note

Delete API Key

Generate New Read API Key

## Help

API keys enable you to write data to a channel or read data from a private channel. API keys are auto-generated when you create a new channel.

## 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=~~

GET ~~https://api.thingspeak.com/channels/875206/feeds.j~~

ThingSpeak.com에  
데이터가 입력 되는지  
웹브라우저 주소창에 GET...  
복사 -> 붙여넣기 해서 확인

## 5. CAT.M1 실습 (실습예제)

아두이노 소스코드 수정

```
15  /*
16  * Be careful !!!
17  * Keep the communication cycle with ThingSpeak.com for at least 3 minutes.
18  */
19  #define ALARM_CYCLE 3600 /* Seconds, 1hour */
20  //#define ALARM_CYCLE 180 /*Seconds, 3min */
21
```

1시간(3600초) 주기로 센서 측정 데이터 송신

3분(180초) 최소 시간주기로 센서 측정 데이터 송신,  
주석 해제 후 사용, 윗줄은 주석 처리

## 5. CAT.M1 실습 (실습예제)

아두이노 소스코드 수정

```
22 String WApiKey = "*****"; //Thing Speak Write API Key 16Character
23 float temp = 0.0; //Stores temperature value
24 float humi = 0.0; //Stores humidity value
```

Write API Key 입력

Private View Public View Channel Settings Sharing API Keys Data In

### Write API Key

Key

[Generate New Write API Key](#)

### Help

API keys enable y private channel. A channel.

### API Keys S

- Write API K your key ha Key.

# 동작화면

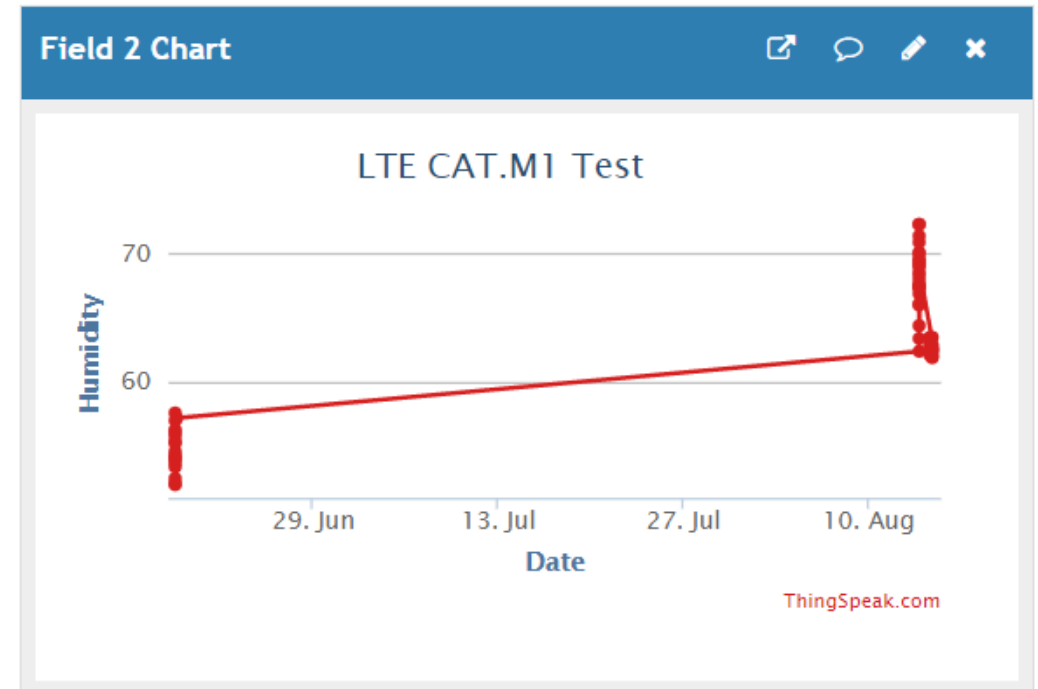
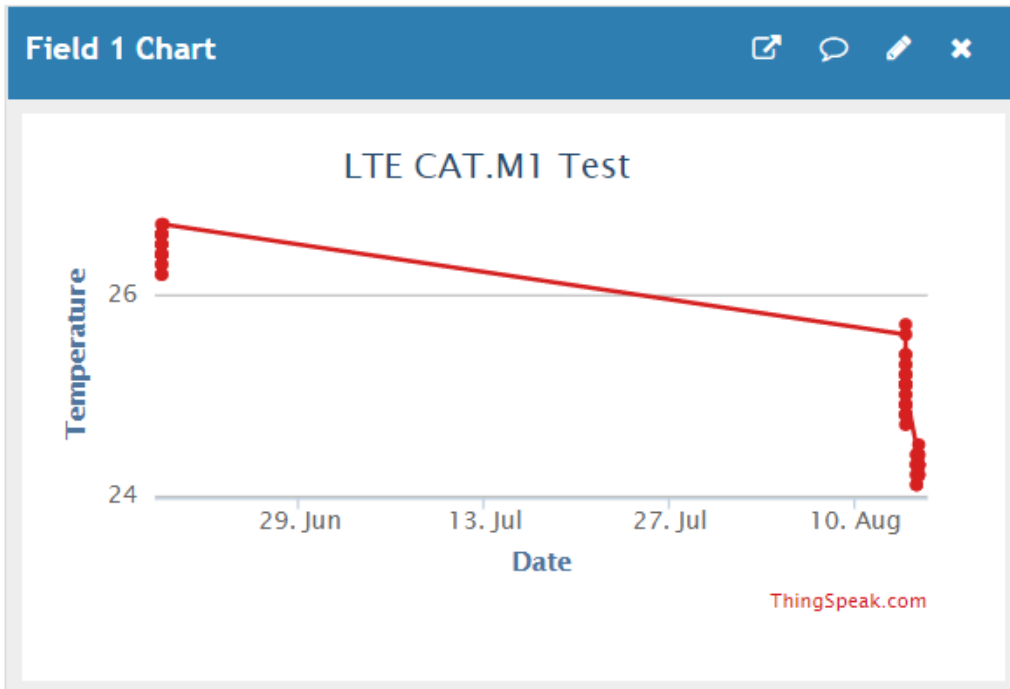
Channel 3 of 4

## Channel Stats

Created: [6 months ago](#)

Last entry: [21 days ago](#)

Entries: 366





*감사합니다.*