



# CodeZoo CATM1 Hands-On

## - Raspberry Pi (with Python)-

version 1.0

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

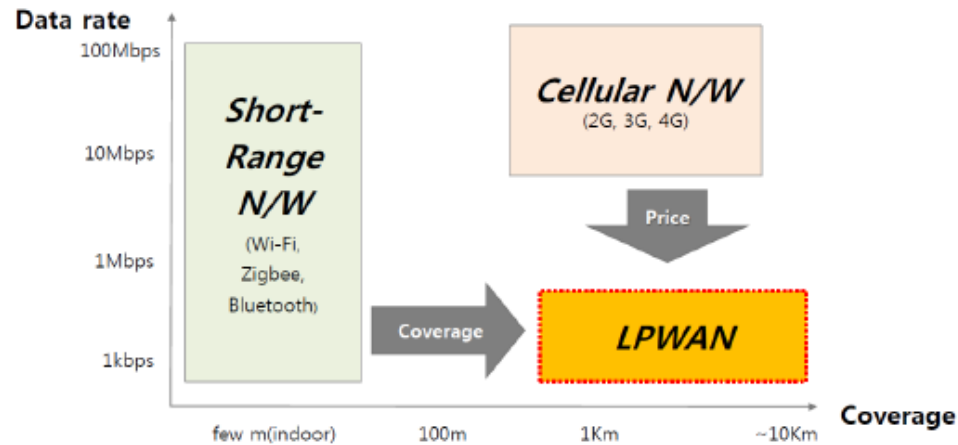
- CAT.M1 특징
- CAT.M1 하드웨어 구성 및 설계 살펴보기
- CAT.M1 어떻게 개발 하나요? (AT Command)
- CAT.M1 실습 (RaspberryPi준비, 소스코드 다운로드, Basic, Socket)

# 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

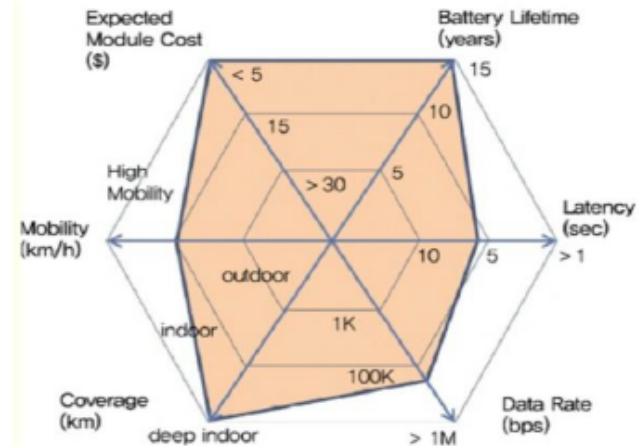


1 | 넓은 커버리지

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)*

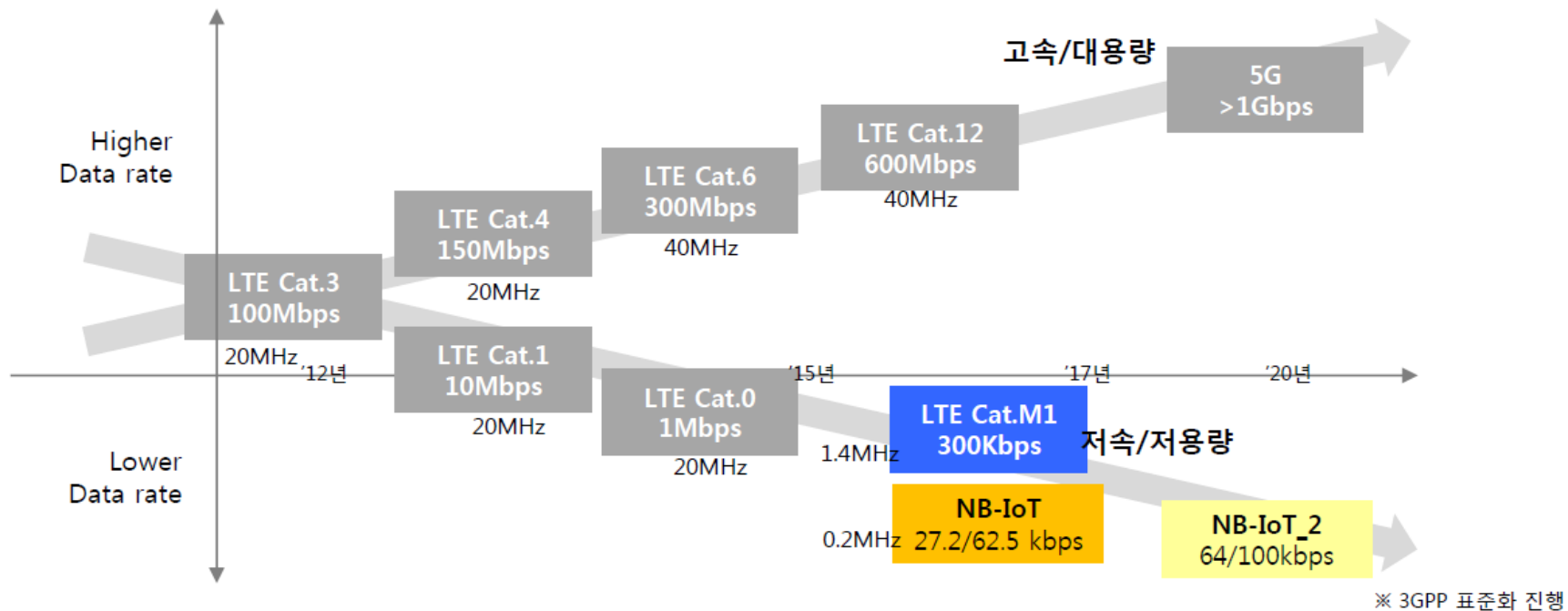
# 1. Cat.M1 일반적인 특징 - Cat.M1 & NB-IoT

## LPWA : 표준 기술의 진화 방향

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

고속/대용량 : 멀티미디어 서비스 → 4G, 5G

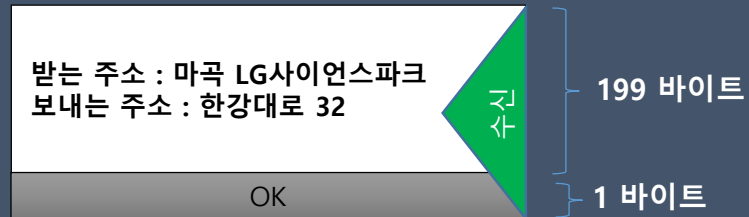
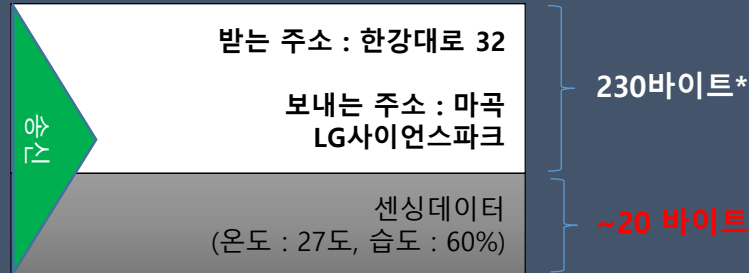
저속/소용량 : IoT 서비스 → LPWA (NB-IoT)



## 2. CAT.M1 소프트웨어 개발자 측면의 특징

### 1회 전송 데이터 TCP Sample

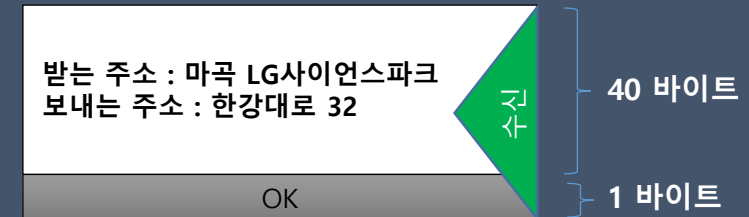
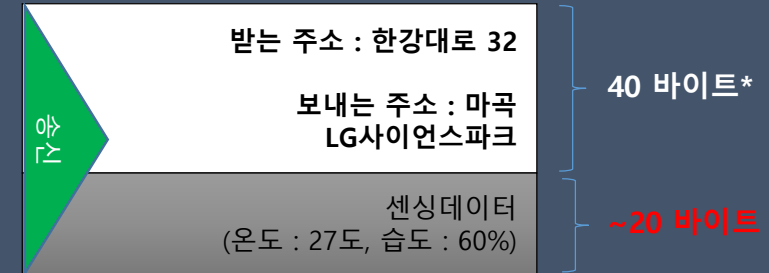
“TCP 패킷헤더(주소 정보) + 보내고자 하는 데이터”



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

### 1회 전송 데이터 UDP Sample

“UDP 패킷헤더(주소 정보) + 보내고자 하는 데이터”



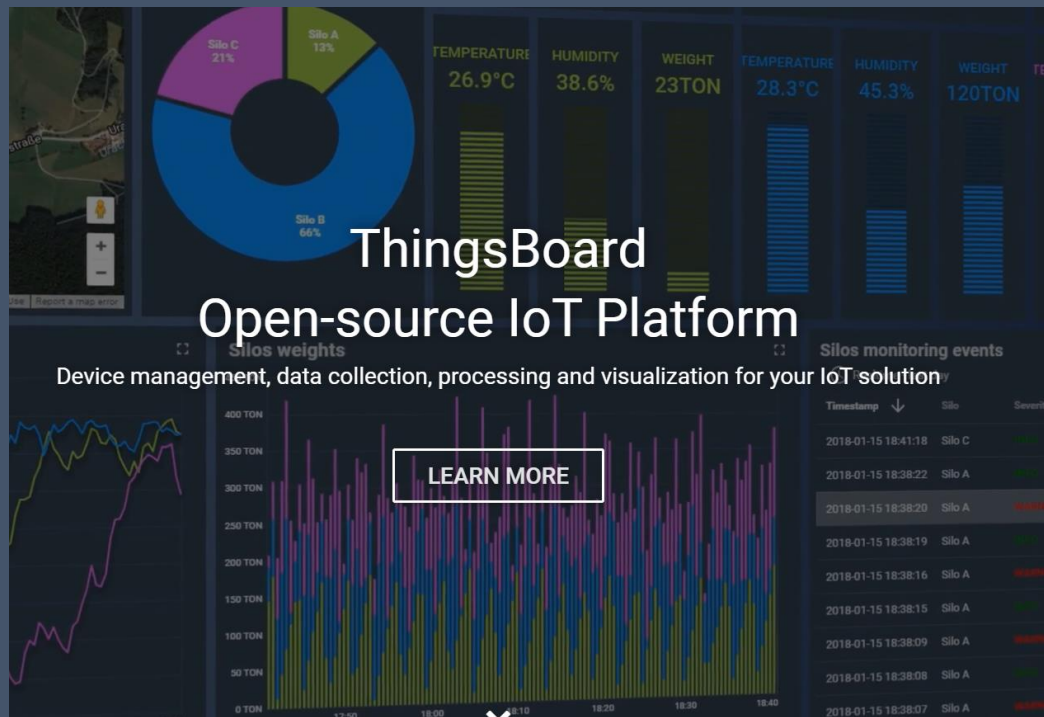
UDP 송신 헤더패킷 사이즈 : 40byte  
UDP 수신 헤더패킷 사이즈 : 40byte

BG96 TCP(IP) AT Commands Manual V1.1

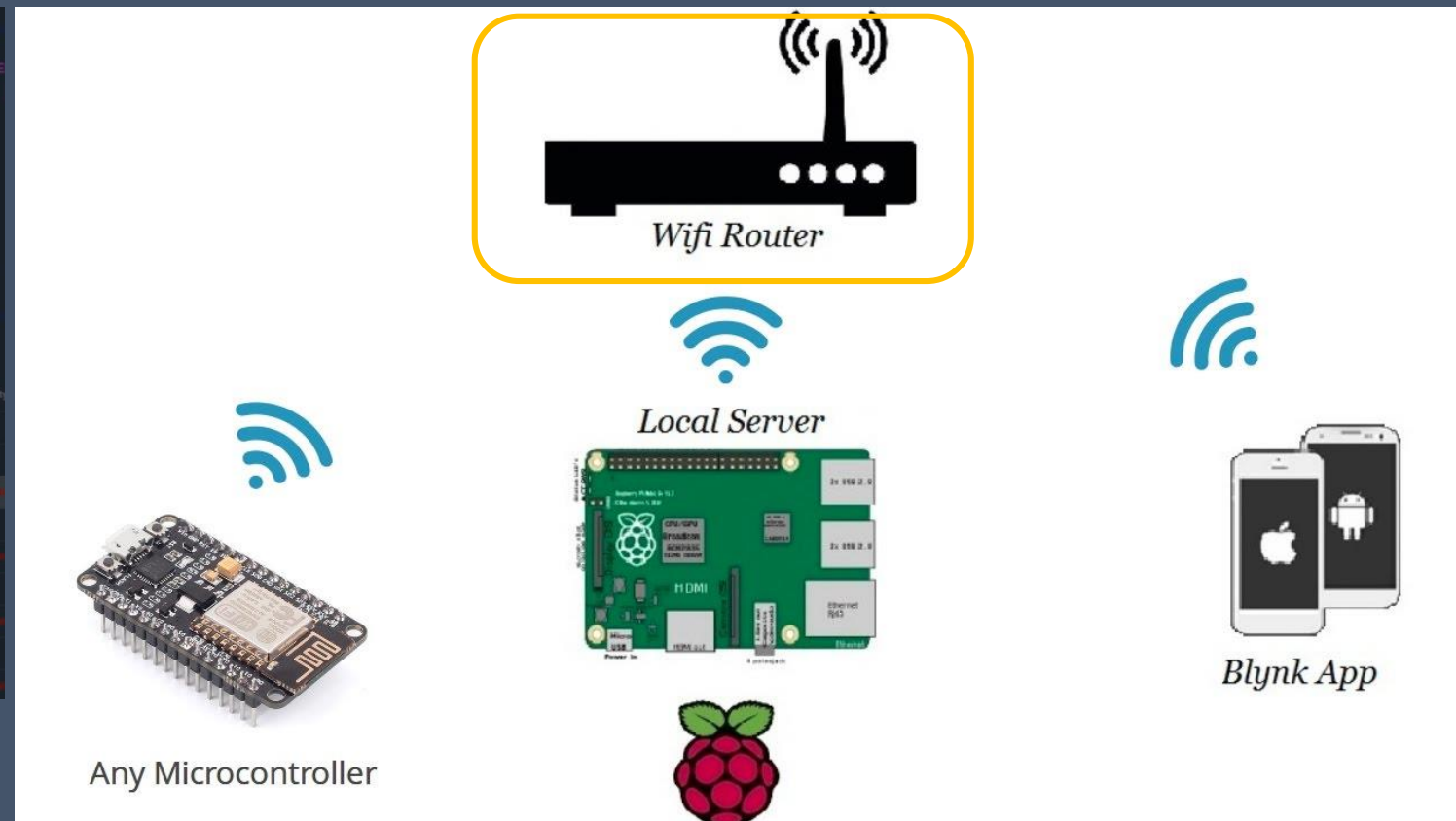
Send Size The maximum data length is 1460 bytes

Read Size The maximum data length is 1500 bytes

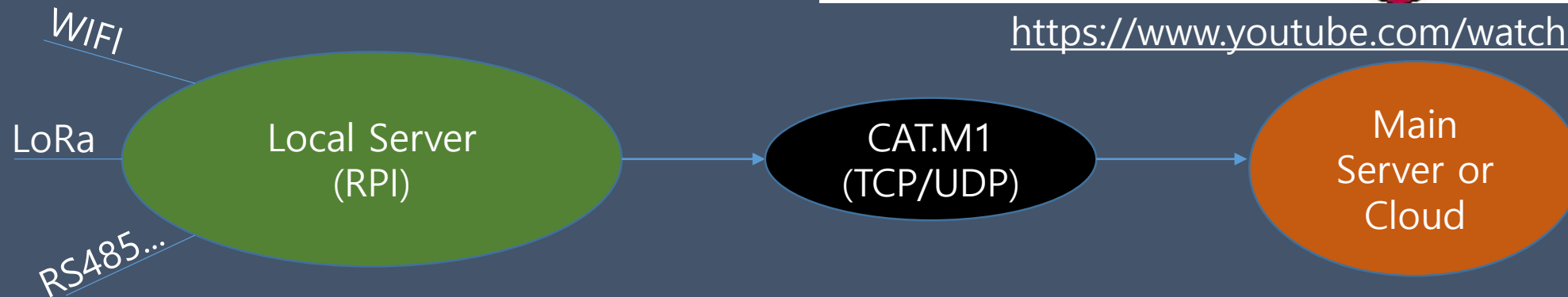
### 3. RaspberryPi CAT.M1 소프트웨어 특징



<https://thingsboard.io/>

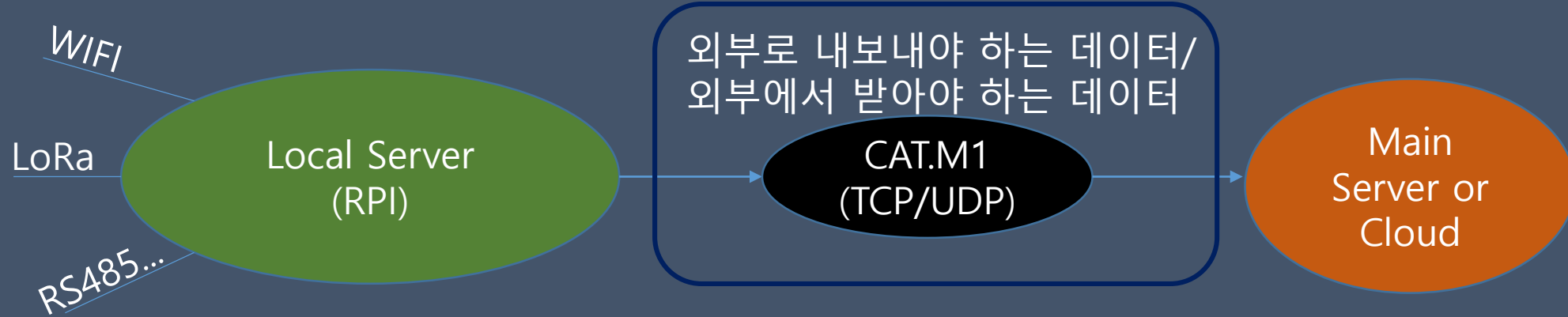


<https://www.youtube.com/watch?v=sLPbp49LB6g>





### 3. RaspberryPi CAT.M1 소프트웨어 특징



<http://www.libelium.com/>



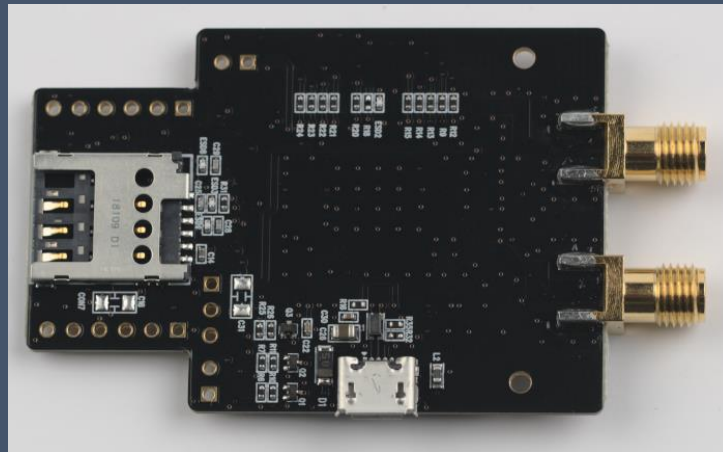
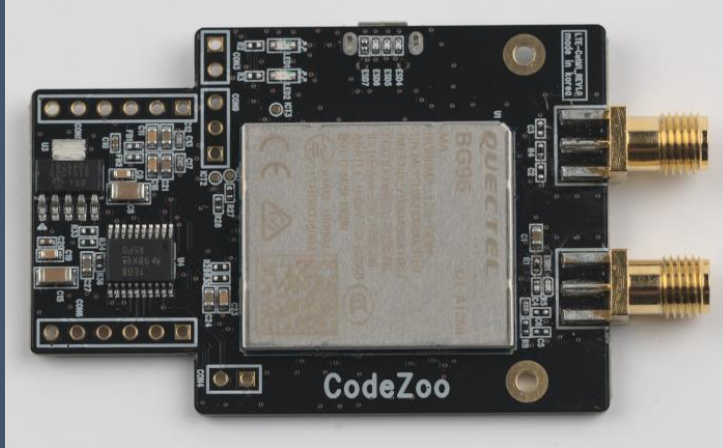
<http://news.samsungdisplay.com/16707>



<https://www.industrynews.co.kr/news/articleView.html?idxno=28113>

www.CodeZoo.co.kr

### 3. CAT.M1 하드웨어 구성 및 설계 살펴보기





### 3. CAT.M1 하드웨어 구성 및 설계 살펴보기

LTE\_ANTENNA

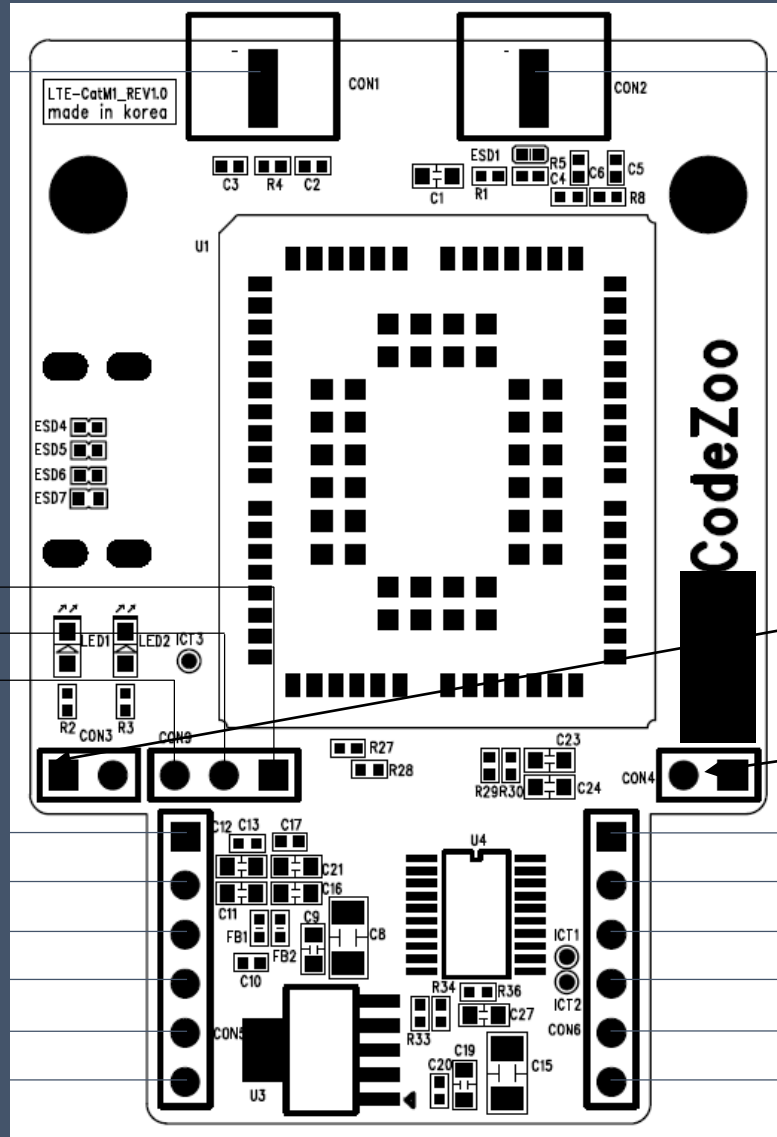
GNSS\_ANTENNA

GNSS\_TXD  
GNSS\_RXD  
GND

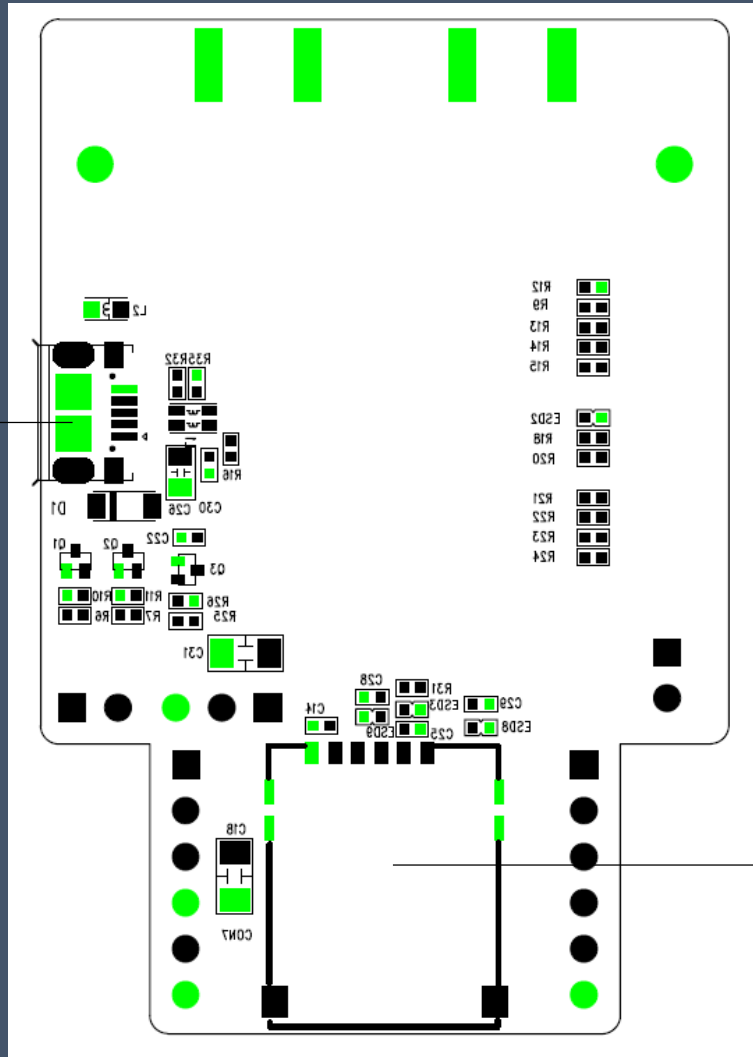
TTL LEVEL SELECT (3.3 or 5V)  
CON3 (CLOSE) & CON4 (OPEN) 3.3V  
CON3 (OPEN) & CON4 (CLOSE) 5V

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

CTS  
RTS  
TXD  
RXD  
+5V  
GND



### 3. CAT.M1 하드웨어 구성 및 설계 살펴보기



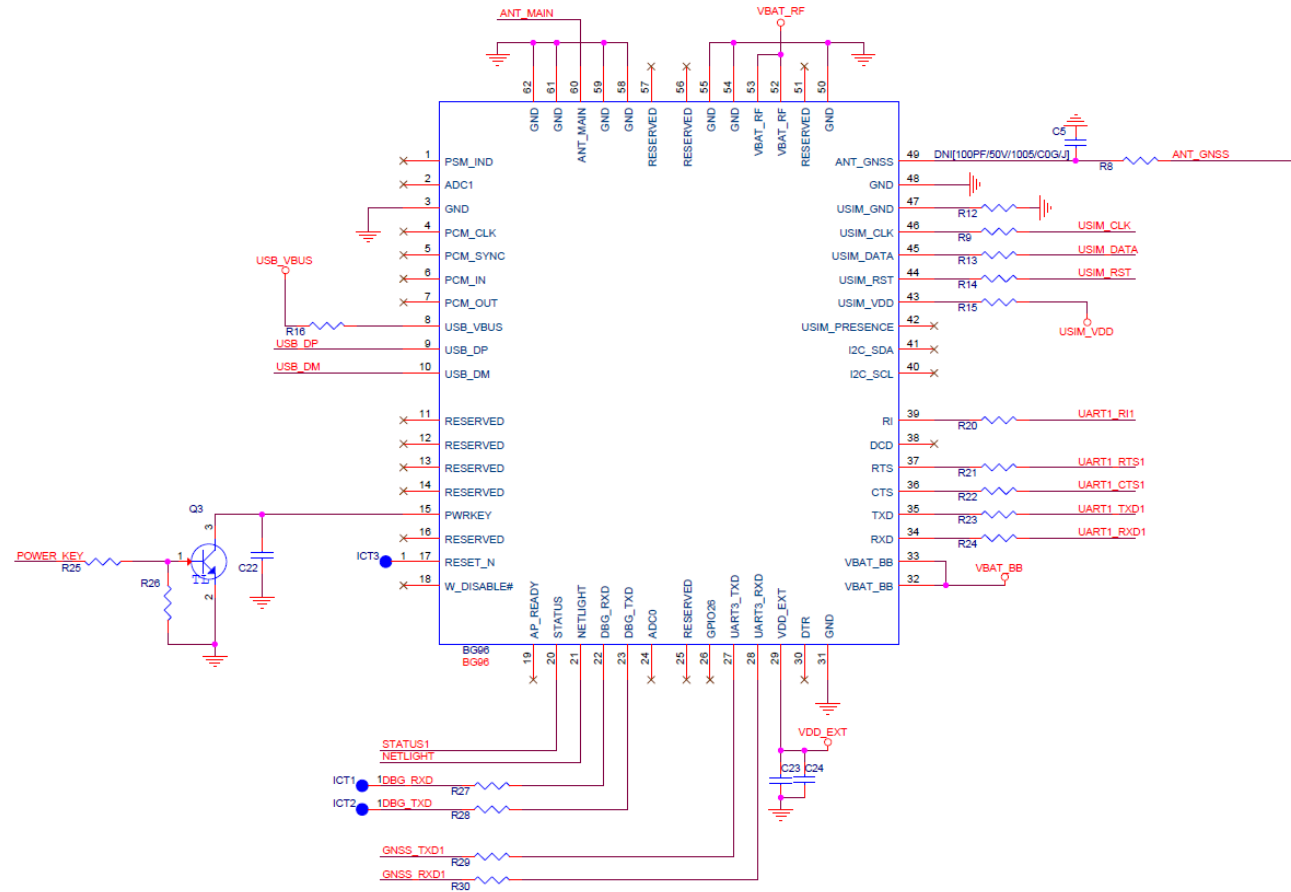
Micro USB Connector

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/](https://github.com/codezoo-ltd/CodeZoo_CATM1_Arduino/tree/master/Schematics_Dimension/)

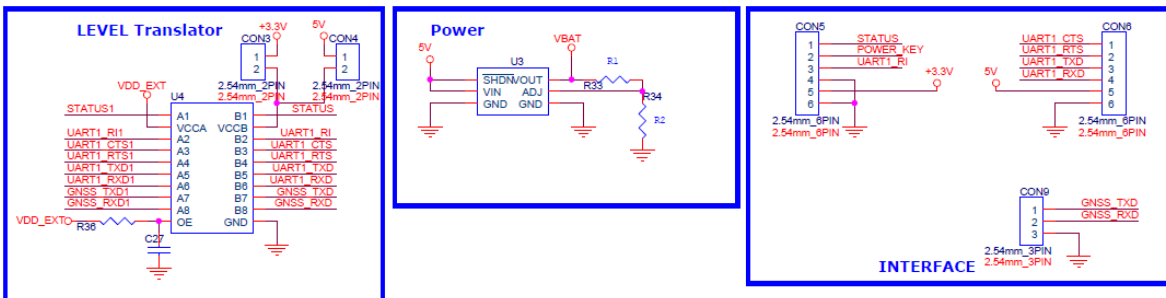
*BG96 Module 회로도.pdf*

> 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.

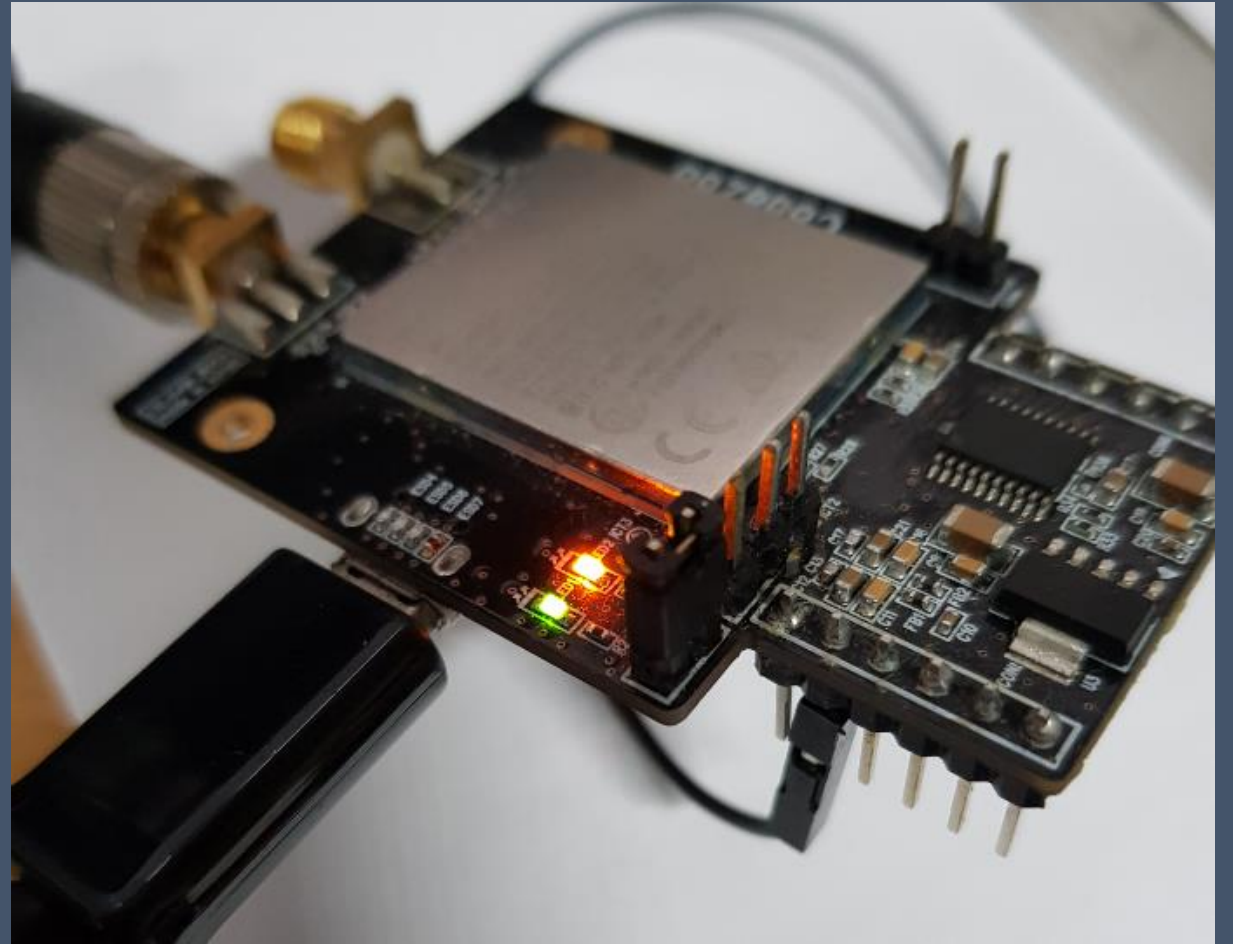
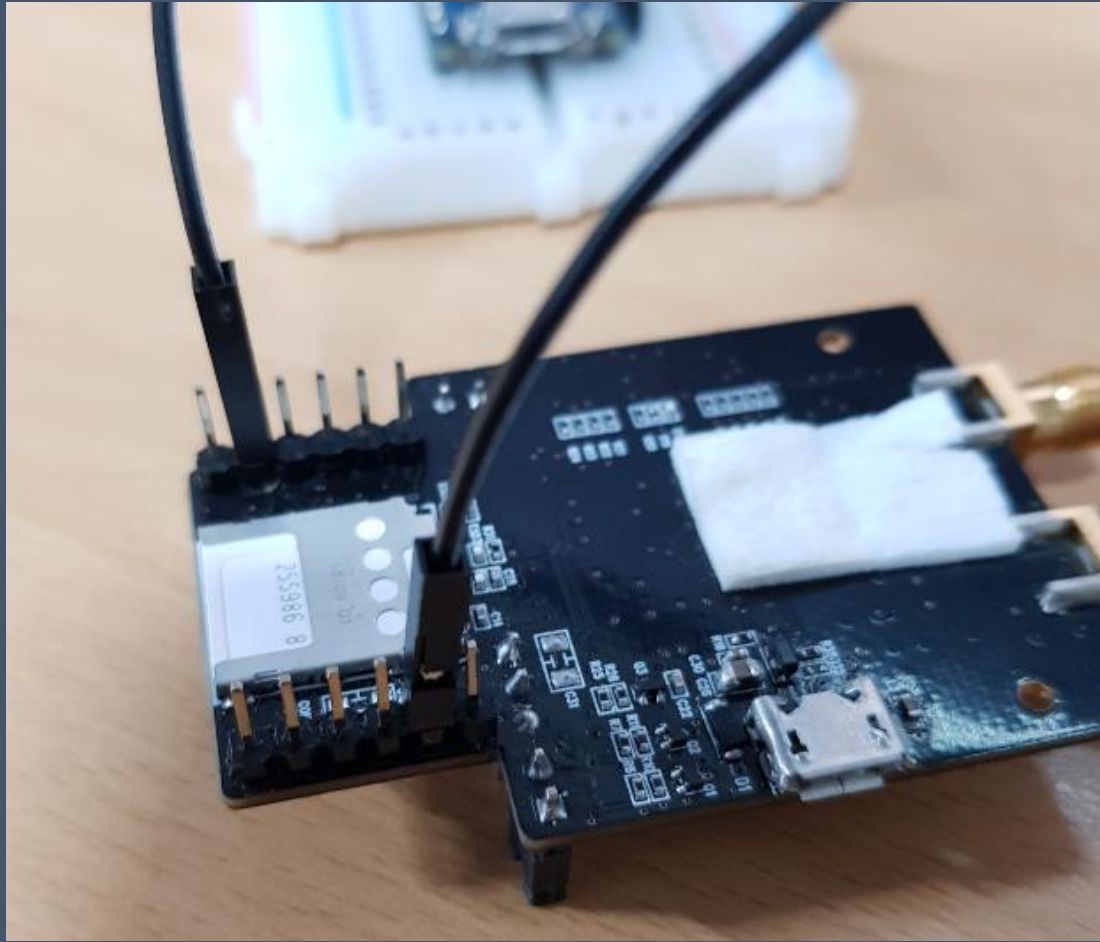
요청하지 않은 결과 코드 및 보고서 메시지로 URC는 실행된 AT 명령과 관련된 응답의 일부로 발행되지 않습니다. URC는 TE의 요청없이 BG96에 의해 발행되며 특정 이벤트가 발생하면 자동으로 발행됩니다. URC로 이어지는 일반적인 이벤트는 수신 전화 (RING), 수신된 짧은 메시지, 고 / 저 전압 경고, 고 / 저 온도 경고 등입니다.

언제 들어올지 알수 없는 모뎀 메시지에 대한 처리 루틴을 어떻게 만들것 인지?

1. Python 쓰레드
2. Daemon Process
3. 상황에 맞는 소프트웨어 설계

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

## 4. CAT.M1 어떻게 개발 하나요? (AT Command)



## 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 <b>AT+CGSN=?</b>	Response <b>OK</b>
Execution Command <b>AT+CGSN</b>	Response <IMEI>  <b>OK</b>
Maximum Response Time	300ms
Reference 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)

QCOM\_V1.0

About

COM Port Setting

COM Port:  Baudrate: 9600 StopBits: 1 Parity: None

ByteSize: 8 Flow Control: No Ctrl Flow

Open Port

Operation

Clear Information ☐ DTR ☐ RTS ☐ View File ☐ Show Time

Input String: ☐ HEX String ☐ Show In HEX ☒ Send With Enter

Send Command

Select File

Send File

☐ Save Log Z:\W02\PROJECTS\W70\_NB\_IoT\W5\_Driver\WQUECTEL\Tools\QCOM\_V1.0\QCOM.L

Command List

☐ Choose All Commands

		HEX	<input type="checkbox"/> Enter	Delay(mS)
<input checked="" type="checkbox"/> 1:	AT+CFUN=1	<input type="checkbox"/>	<input checked="" type="checkbox"/>	1
<input checked="" type="checkbox"/> 2:	AT+CGDCONT=1,"IP","internet.lguplus.co.kr"	<input type="checkbox"/>	<input checked="" type="checkbox"/>	2
<input checked="" type="checkbox"/> 3:	AT+COPS=1,2,"45006"	<input type="checkbox"/>	<input checked="" type="checkbox"/>	3
<input checked="" type="checkbox"/> 4:	AT+CGATT=1	<input type="checkbox"/>	<input type="checkbox"/>	4
<input checked="" type="checkbox"/> 5:	AT+NSOCR=DGRAM,17,5683,1	<input type="checkbox"/>	<input checked="" type="checkbox"/>	5
<input checked="" type="checkbox"/> 6:	AT+NSOST=0,210,120,128,192,5683,89,3c3d3e	<input type="checkbox"/>	<input checked="" type="checkbox"/>	6
<input checked="" type="checkbox"/> 7:	AT+CSCON?	<input type="checkbox"/>	<input type="checkbox"/>	7
<input checked="" type="checkbox"/> 8:	AT+CGATT?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	8
<input checked="" type="checkbox"/> 9:	AT+CGDCONT?	<input type="checkbox"/>	<input type="checkbox"/>	9
<input checked="" type="checkbox"/> 10:	AT+CISI	<input type="checkbox"/>	<input type="checkbox"/>	10
<input checked="" type="checkbox"/> 11:	AT+NBAND?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	11
<input checked="" type="checkbox"/> 12:	AT+NBAND=5	<input type="checkbox"/>	<input checked="" type="checkbox"/>	12
<input checked="" type="checkbox"/> 13:	AT+CFUN=0	<input type="checkbox"/>	<input checked="" type="checkbox"/>	13
<input checked="" type="checkbox"/> 14:	AT+NRB	<input type="checkbox"/>	<input checked="" type="checkbox"/>	14
<input checked="" type="checkbox"/> 15:	AT+CGMR	<input type="checkbox"/>	<input checked="" type="checkbox"/>	15
<input checked="" type="checkbox"/> 16:	+CPIN?	<input type="checkbox"/>	<input type="checkbox"/>	16
<input checked="" type="checkbox"/> 17:	AT+CGATT=0	<input type="checkbox"/>	<input checked="" type="checkbox"/>	17
<input type="checkbox"/> 18:		<input type="checkbox"/>	<input type="checkbox"/>	18
<input checked="" type="checkbox"/> 19:	at\$gtver?	<input type="checkbox"/>	<input checked="" type="checkbox"/>	19
<input type="checkbox"/> 20:		<input type="checkbox"/>	<input type="checkbox"/>	20
<input type="checkbox"/> 21:		<input type="checkbox"/>	<input type="checkbox"/>	21
<input type="checkbox"/> 22:		<input type="checkbox"/>	<input type="checkbox"/>	22
<input type="checkbox"/> 23:		<input type="checkbox"/>	<input type="checkbox"/>	23
<input type="checkbox"/> 24:		<input type="checkbox"/>	<input type="checkbox"/>	24
<input type="checkbox"/> 25:		<input type="checkbox"/>	<input type="checkbox"/>	25
<input type="checkbox"/> 26:		<input type="checkbox"/>	<input type="checkbox"/>	26
<input type="checkbox"/> 27:		<input type="checkbox"/>	<input type="checkbox"/>	27
<input type="checkbox"/> 28:		<input type="checkbox"/>	<input type="checkbox"/>	28
<input type="checkbox"/> 29:		<input type="checkbox"/>	<input type="checkbox"/>	29

Load Test Script

Save As Script

Run Times: 10

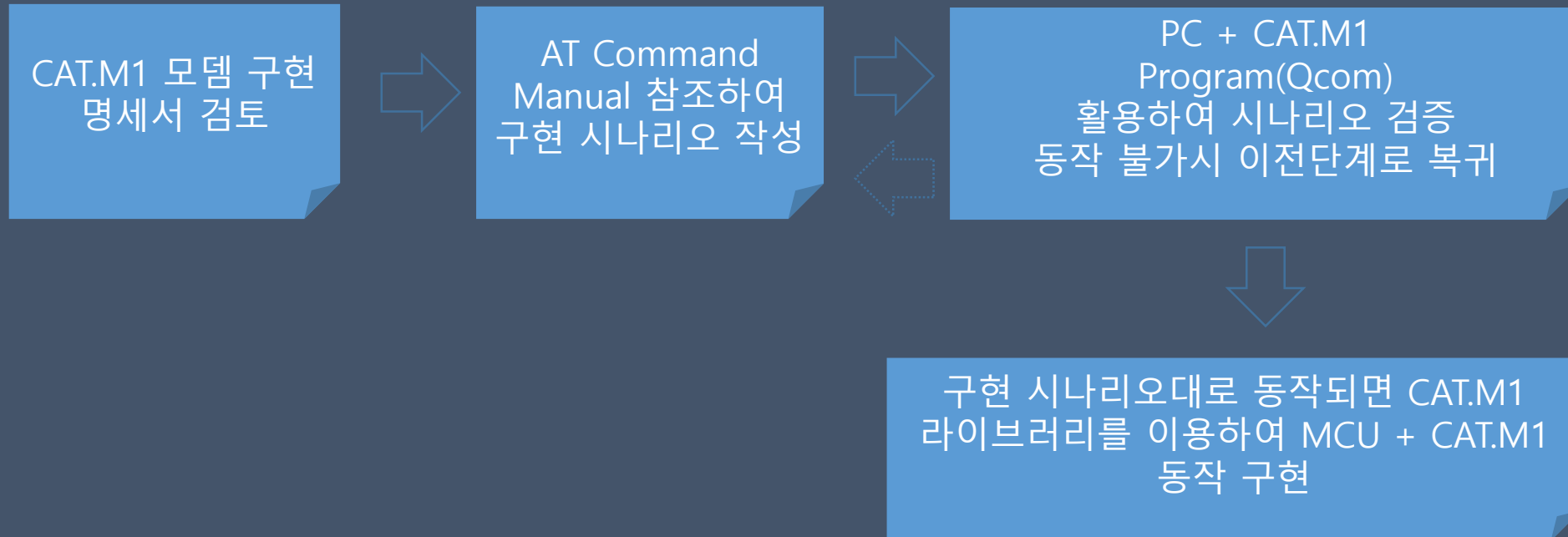
Delay Time(mS): 1000

Run

Stop



## 4. CAT.M1 어떻게 개발 하나요? (AT Command)



## 5. CAT.M1 실습 (RPI3 Raspberry Pi OS install)

### Downloads

**Raspberry Pi OS** (previously called Raspbian) is our official operating system for **all** models of the Raspberry Pi.

Use **Raspberry Pi Imager** for an easy way to install Raspberry Pi OS and other operating systems to an SD card ready to use with your Raspberry Pi:

- [Raspberry Pi Imager for Windows](#)
- [Raspberry Pi Imager for macOS](#)
- [Raspberry Pi Imager for Ubuntu](#)

Version: 1.4

Install **Raspberry Pi Imager** to **Raspberry Pi OS** by running

```
sudo apt install rpi-imager
```

 in a terminal window

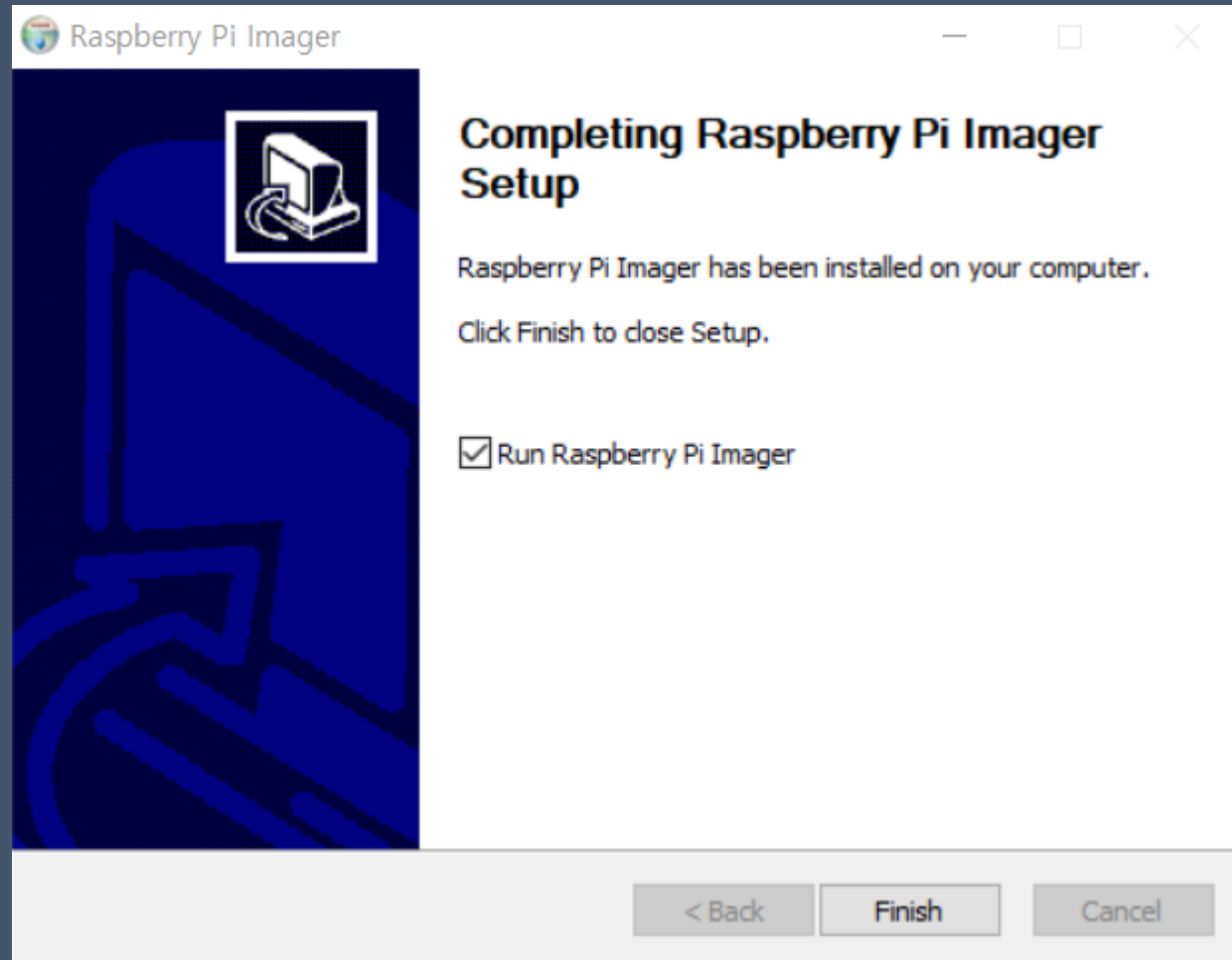
Alternatively, use the links below to download OS images which can be manually copied to an SD card.

<https://www.raspberrypi.org/downloads/>

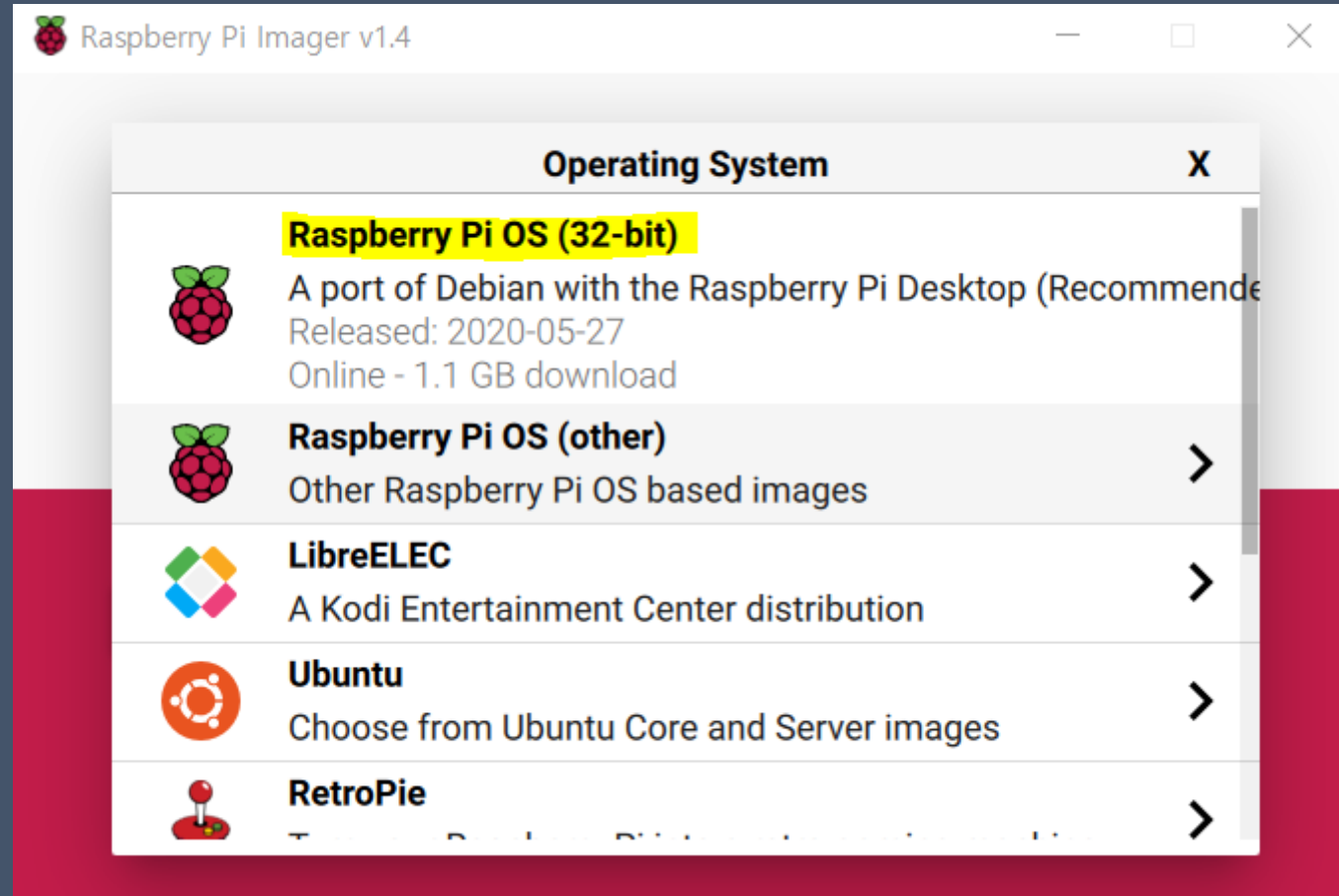
## 5. CAT.M1 실습 (RPI3 Raspberry Pi OS install)



## 5. CAT.M1 실습 (RPI3 Raspberry Pi OS install)

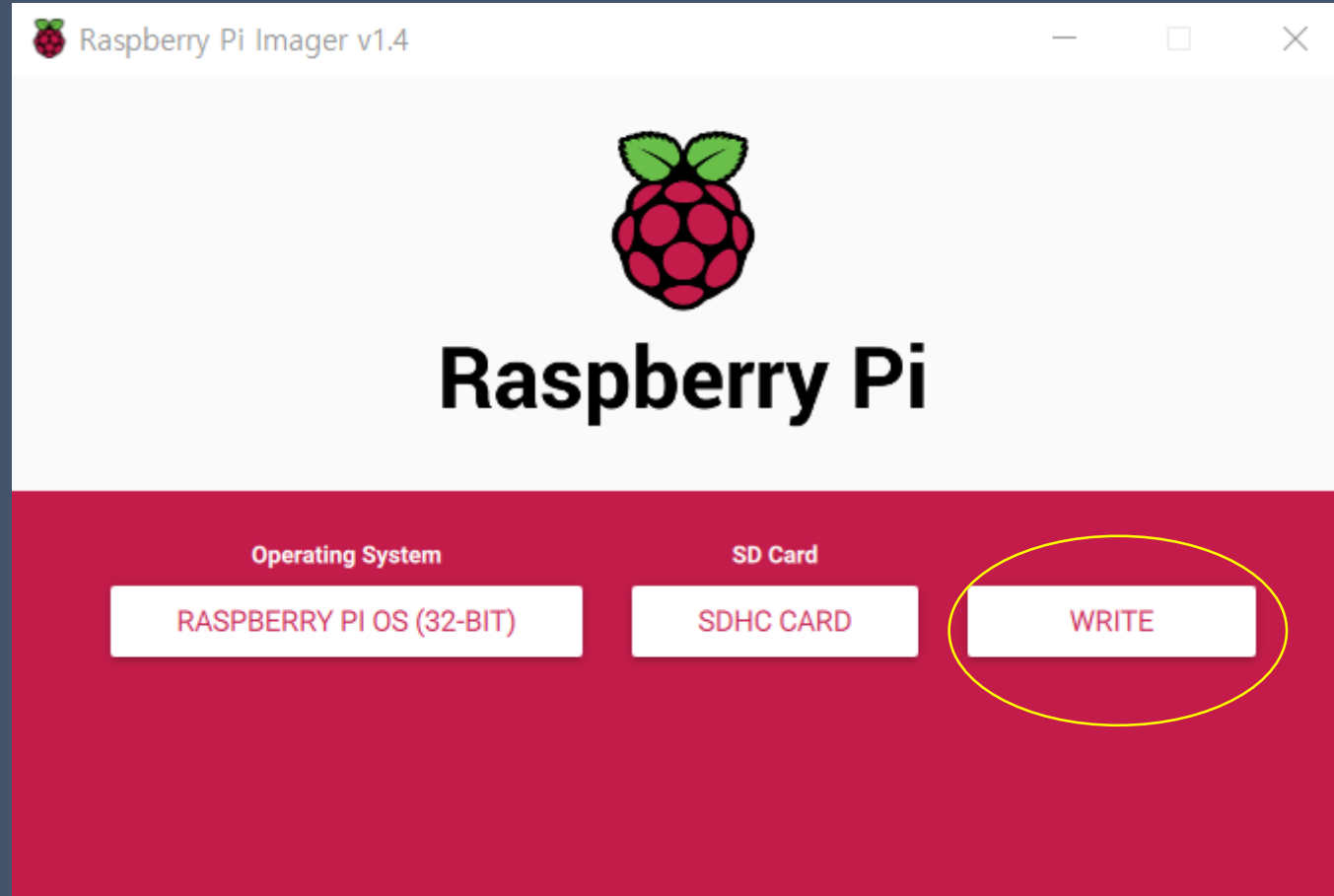


## 5. CAT.M1 실습 (RPI3 Raspberry Pi OS install)

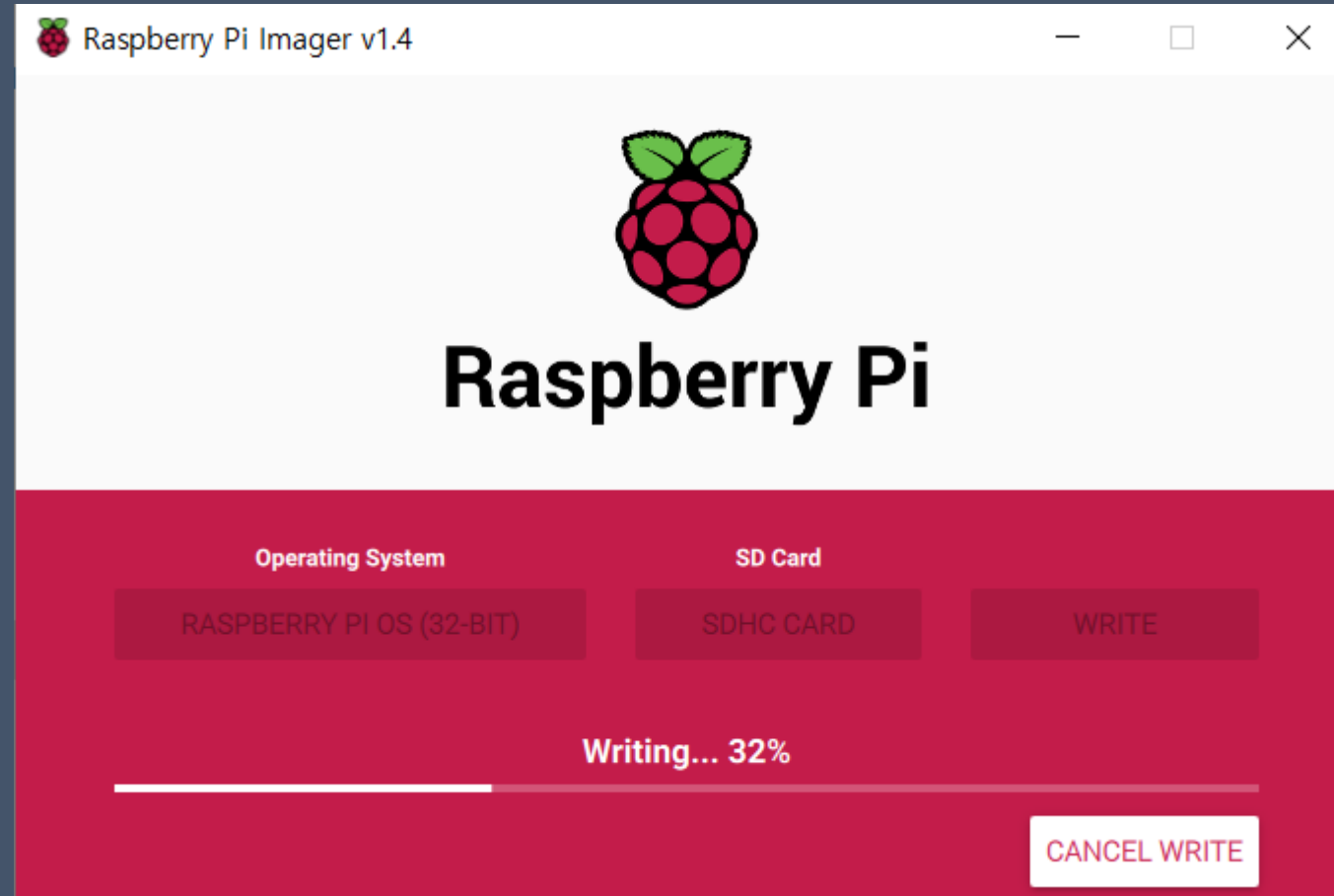




## 5. CAT.M1 실습 (RPI3 Raspberry Pi OS install)



## 5. CAT.M1 실습 (RPI3 Raspberry Pi OS install)

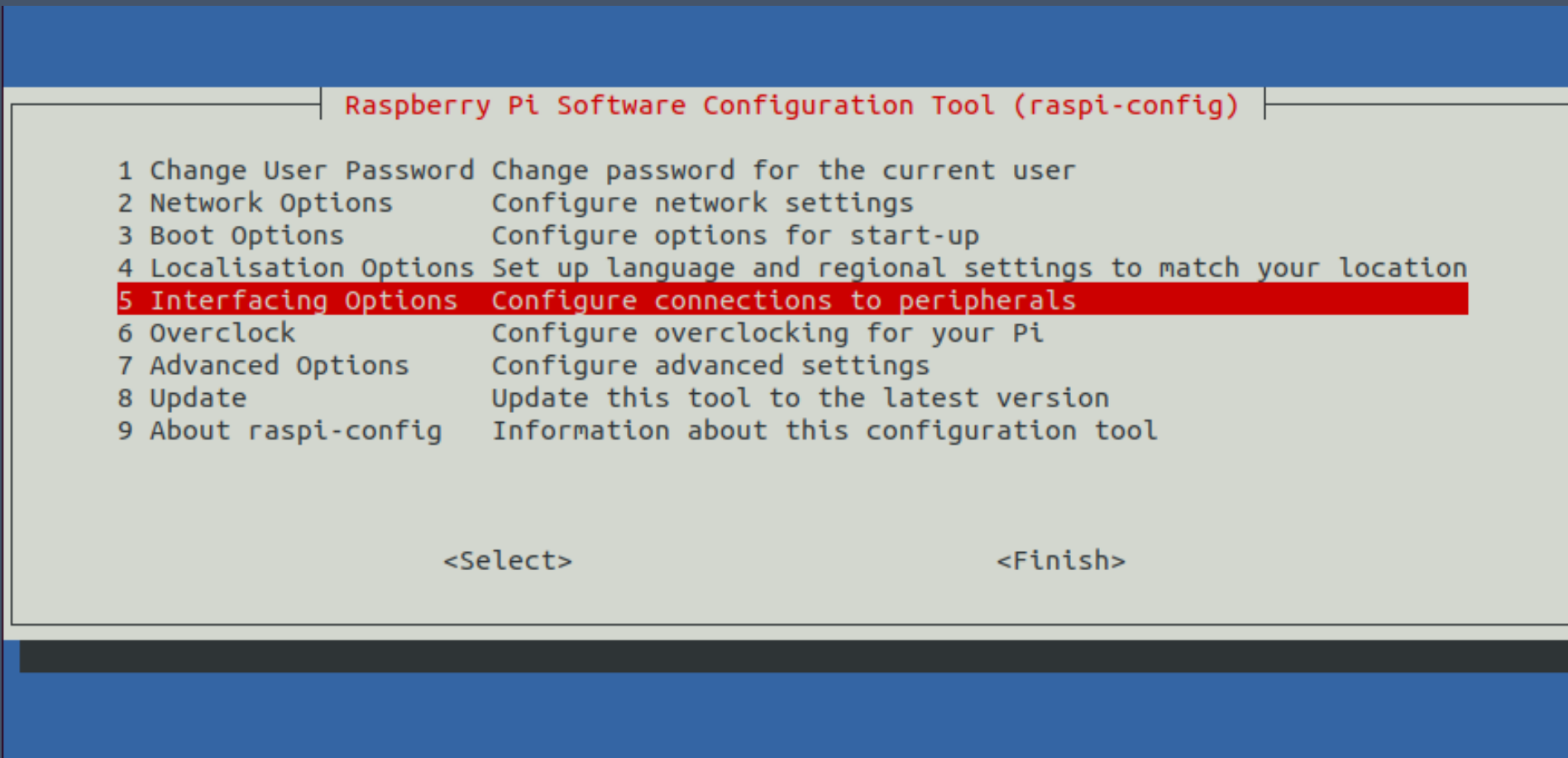


## 5. CAT.M1 실습 (RPI3 Raspberry Pi OS install)

시리얼 포트 설정 라즈베리파이 터미널에서

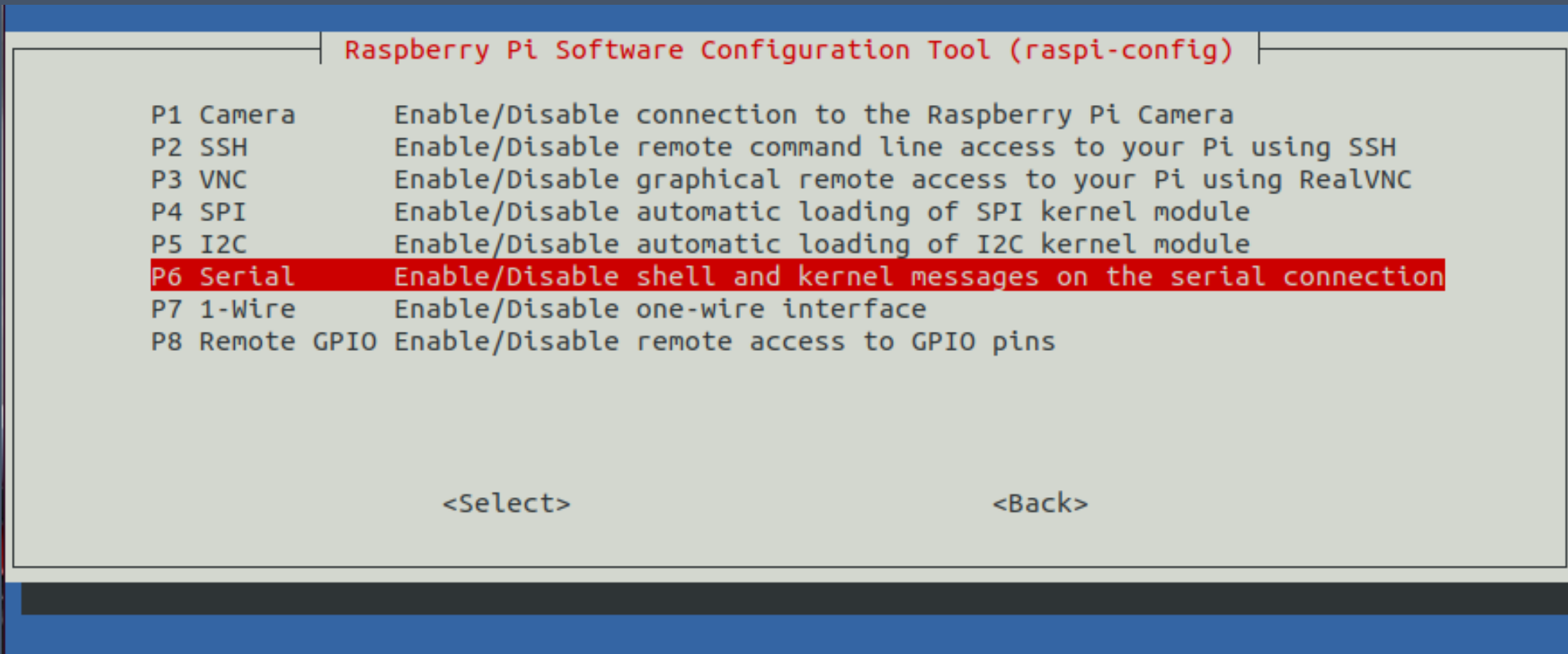
\$ sudo raspi-config

5. Interfacing Options 선택



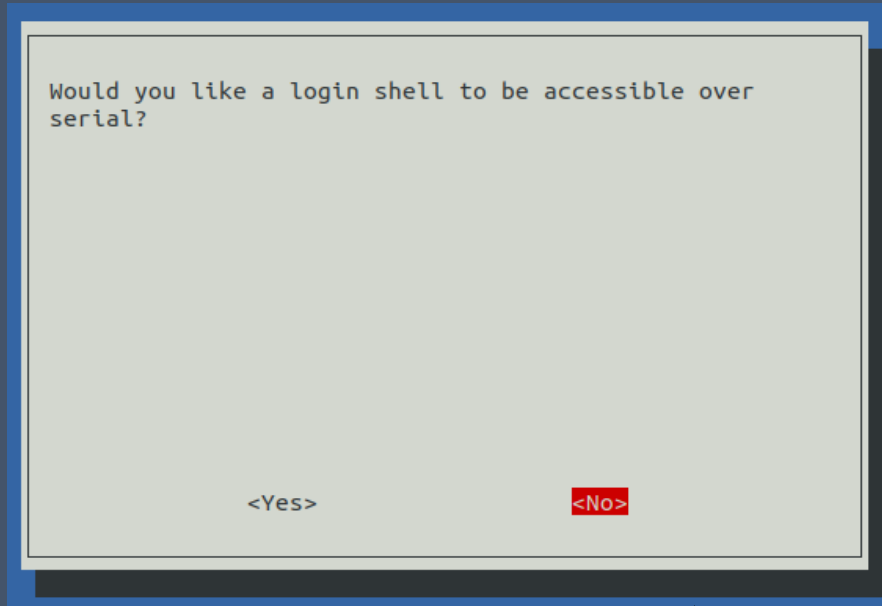
## 5. CAT.M1 실습 (RPI3 Raspberry Pi OS install)

P6 Serial 선택

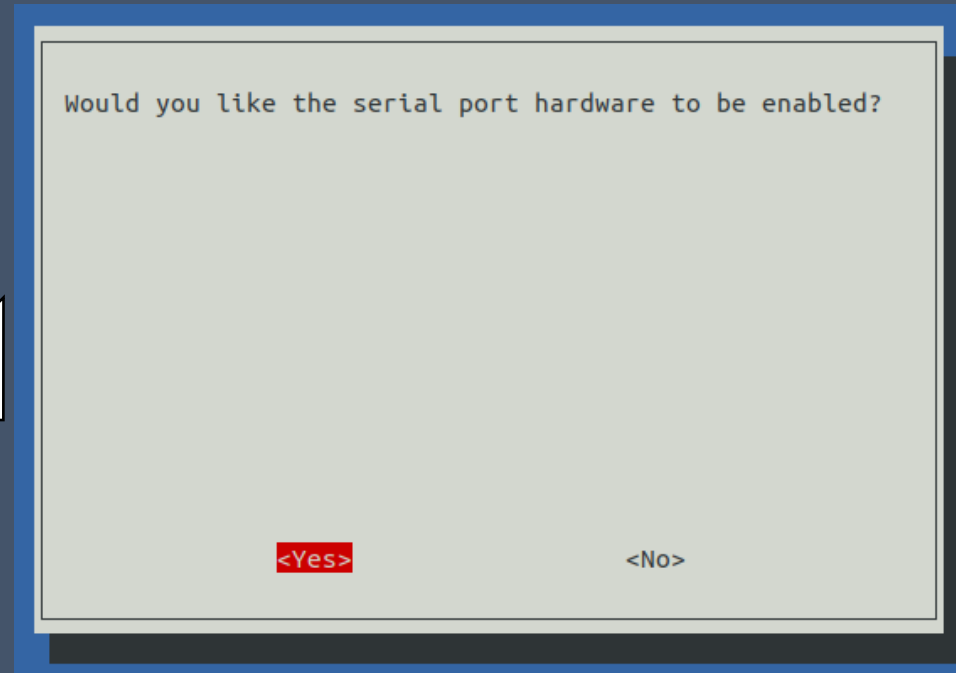


## 5. CAT.M1 실습 (RPI3 Raspberry Pi OS install)

No 선택



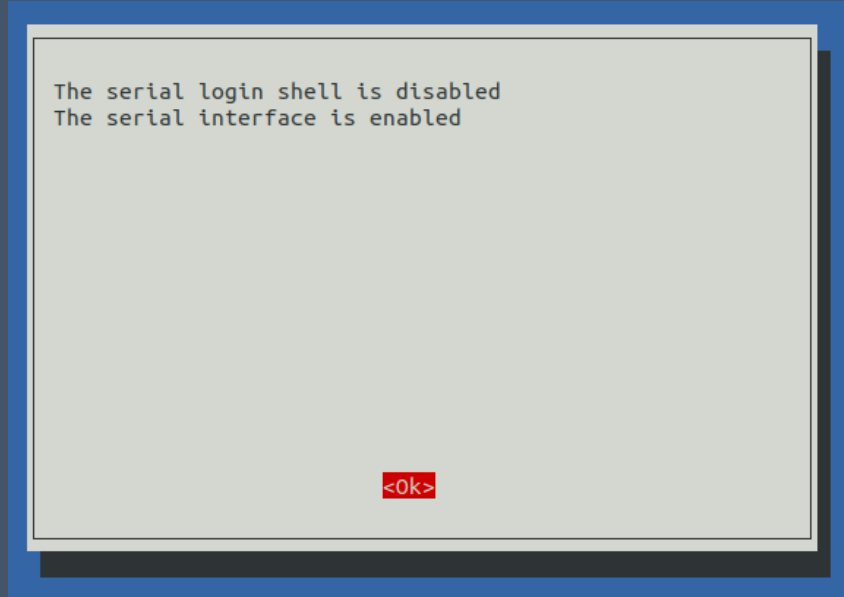
Yes 선택



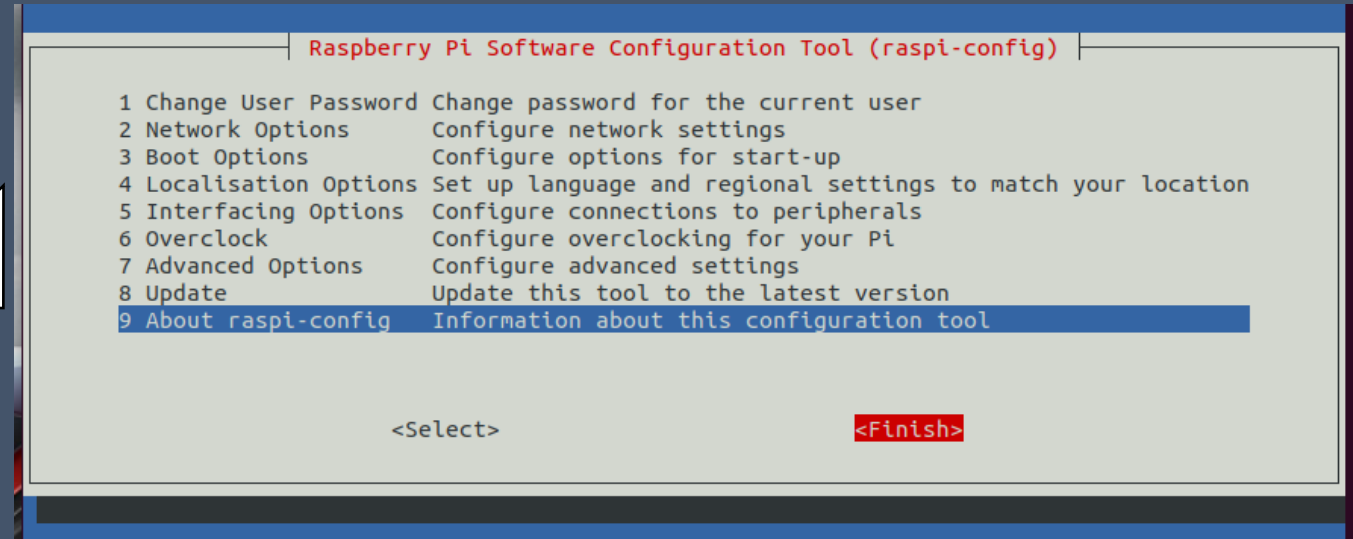


## 5. CAT.M1 실습 (RPI3 Raspberry Pi OS install)

OK 선택



Finish 선택

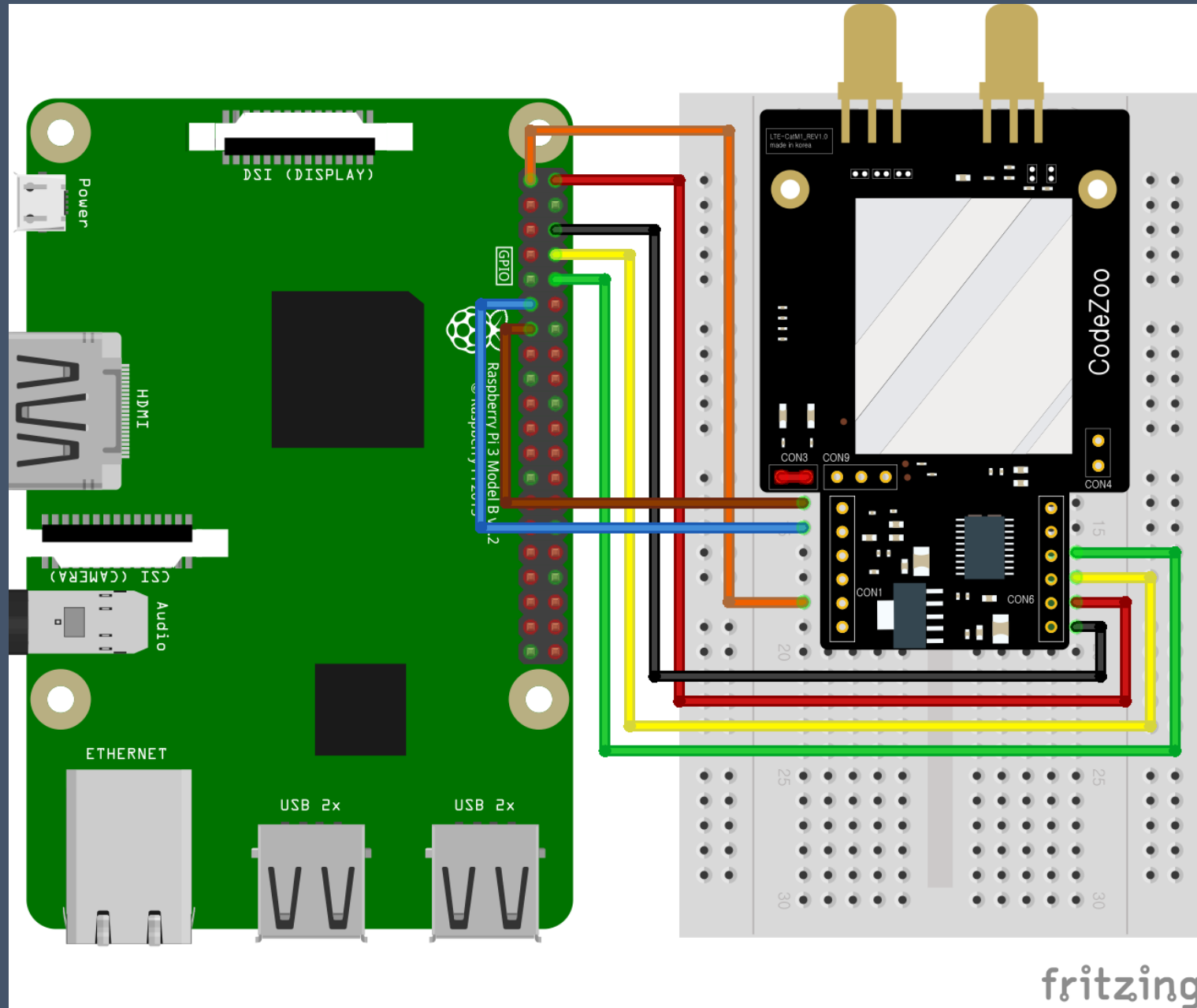


## 5. CAT.M1 실습 (RPI3 Raspberry Pi OS install)

라즈베리파이 다시 부팅 합니다  
부팅후 "/dev/ttyS0" 파일이 생성 됩니다.


```
pi@raspberrypi:~ $  
pi@raspberrypi:~ $ ls /dev/ttyS0  
/dev/ttyS0  
pi@raspberrypi:~ $
```

## 5. CAT.M1 실습




## 5. CAT.M1 실습 (다운로드)

[https://github.com/codezoo-ltd/CAT.M1\\_RaspberryPi](https://github.com/codezoo-ltd/CAT.M1_RaspberryPi)






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 **codezoo-ltd** Update README.md ...

129d1f1 28 minutes ago 6 commits

 CZCATM1	indent error & Hex Encoding error Fix	2 hours ago
 LICENSE	Initial commit	6 months ago
 README.md	Update README.md	28 minutes ago
 catm1Test.py	Test Complete version 1.0	5 months ago
 socketTest.py	Test Complete version 1.0	5 months ago

README.md



# CAT.M1\_RaspberryPi

---

LTE CAT.M1 BG96 RaspberryPi Open Source (with Python)

## 5. CAT.M1 실습 (다운로드)

codezoo-ltd / CAT.M1\_RaspberryPi

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codezoo-ltd	Update README.md	...
📁 CZCATM1	indent error & Hex Encoding error Fix	
📄 LICENSE	Initial commit	
📄 README.md	Update README.md	
📄 catm1Test.py	Test Complete version 1.0	
📄 socketTest.py	Test Complete version 1.0	

Clone with HTTPS ⓘ [Use SSH](#)


Use Git or checkout with SVN using the web URL.

[https://github.com/codezoo-ltd/CAT.M1\\_](https://github.com/codezoo-ltd/CAT.M1_) 

🖥 Open with GitHub Desktop

📦 Download ZIP

5 months ago

README.md 

# CAT.M1\_RaspberryPi

LTE CAT.M1 BG96 RaspberryPi Open Source (with Python)

## 5. CAT.M1 실습 (다운로드)

```
jbmater@jbmater:~/work$ git clone https://github.com/codezoo-ltd/CAT.M1_RaspberryPi.git
Cloning into 'CAT.M1_RaspberryPi'...
remote: Enumerating objects: 27, done.
remote: Counting objects: 100% (27/27), done.
remote: Compressing objects: 100% (19/19), done.
remote: Total 27 (delta 7), reused 17 (delta 5), pack-reused 0
Unpacking objects: 100% (27/27), done.
jbmater@jbmater:~/work$
```

## 5. CAT.M1 실습 (실습예제1)

```
jbmater@jbmater:~/work/CAT.M1_RaspberryPi$ ls -al
total 32
drwxr-xr-x  4 jbmater jbmater 4096  8월 18 03:24 .
drwxr-xr-x 39 jbmater jbmater 4096  8월 18 03:24 ..
-rw-r--r--  1 jbmater jbmater  529  8월 18 03:24 catm1Test.py
drwxr-xr-x  2 jbmater jbmater 4096  8월 18 03:24 CZCATM1
drwxr-xr-x  8 jbmater jbmater 4096  8월 18 03:24 .git
-rw-r--r--  1 jbmater jbmater 1064  8월 18 03:24 LICENSE
-rw-r--r--  1 jbmater jbmater  210  8월 18 03:24 README.md
-rw-r--r--  1 jbmater jbmater 1246  8월 18 03:24 socketTest.py
jbmater@jbmater:~/work/CAT.M1_RaspberryPi$ python3 catm1Test.py
```



## 5. CAT.M1 실습 (실습예제2)

```
jbmater@jbmater:~/work/CAT.M1_RaspberryPi$ ls -al
total 32
drwxr-xr-x  4 jbmater jbmater 4096 8월 18 03:24 .
drwxr-xr-x 39 jbmater jbmater 4096 8월 18 03:24 ..
-rw-r--r--  1 jbmater jbmater  529 8월 18 03:24 catm1Test.py
drwxr-xr-x  2 jbmater jbmater 4096 8월 18 03:24 CZCATM1
drwxr-xr-x  8 jbmater jbmater 4096 8월 18 03:24 .git
-rw-r--r--  1 jbmater jbmater 1064 8월 18 03:24 LICENSE
-rw-r--r--  1 jbmater jbmater  210 8월 18 03:24 README.md
-rw-r--r--  1 jbmater jbmater 1246 8월 18 03:24 socketTest.py
jbmater@jbmater:~/work/CAT.M1_RaspberryPi$ python3 socketTest.py
```

*감사합니다.*