

The Engine of Korea

공감과 소통, 참여와 협력의 양 날개를 펼쳐 미래로 날아가는

한양대 ERICA



한양대학교
HANYANG UNIVERSITY

2ch DC Motor Driver Doc V3.2

AIRO Lab



첨단지능로봇연구실

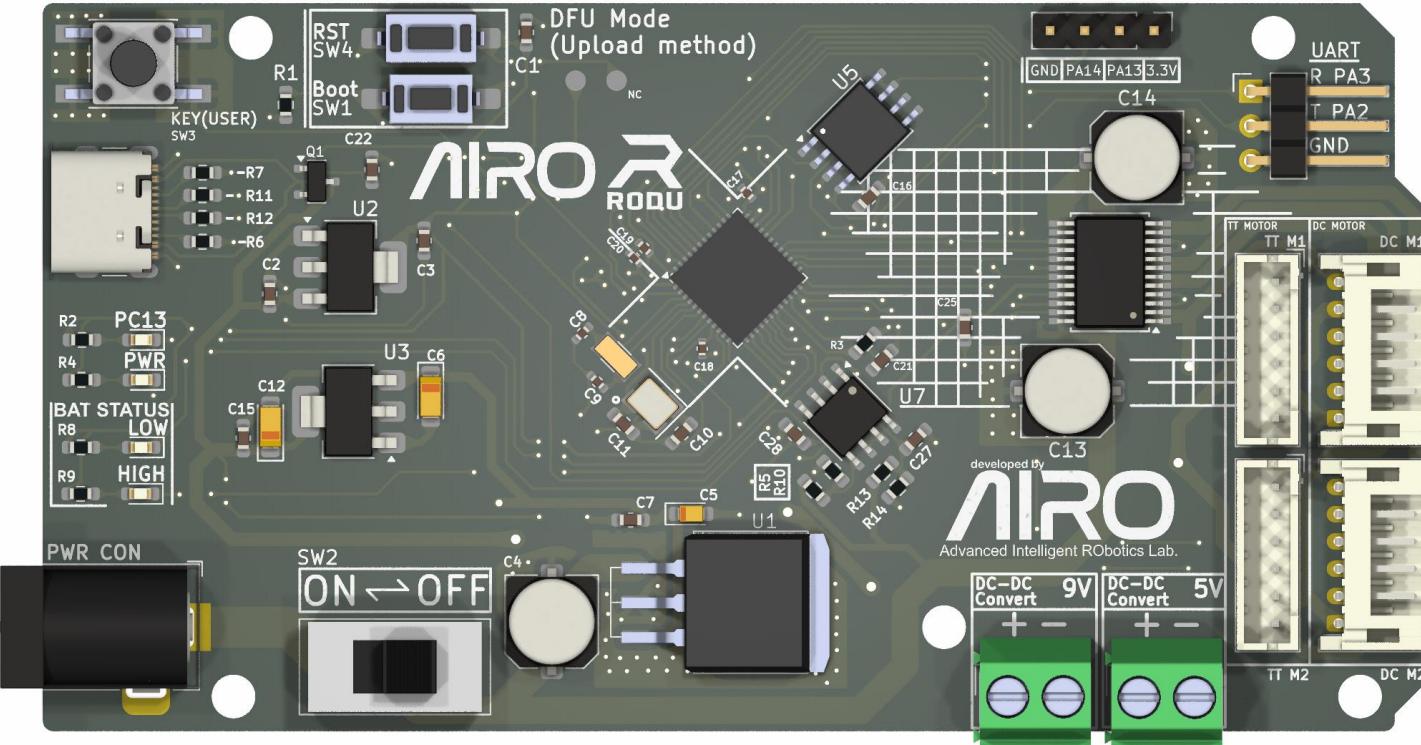
Advanced Intelligent Robotics Lab.



AIRO

Advanced Intelligence RobOt Lab.

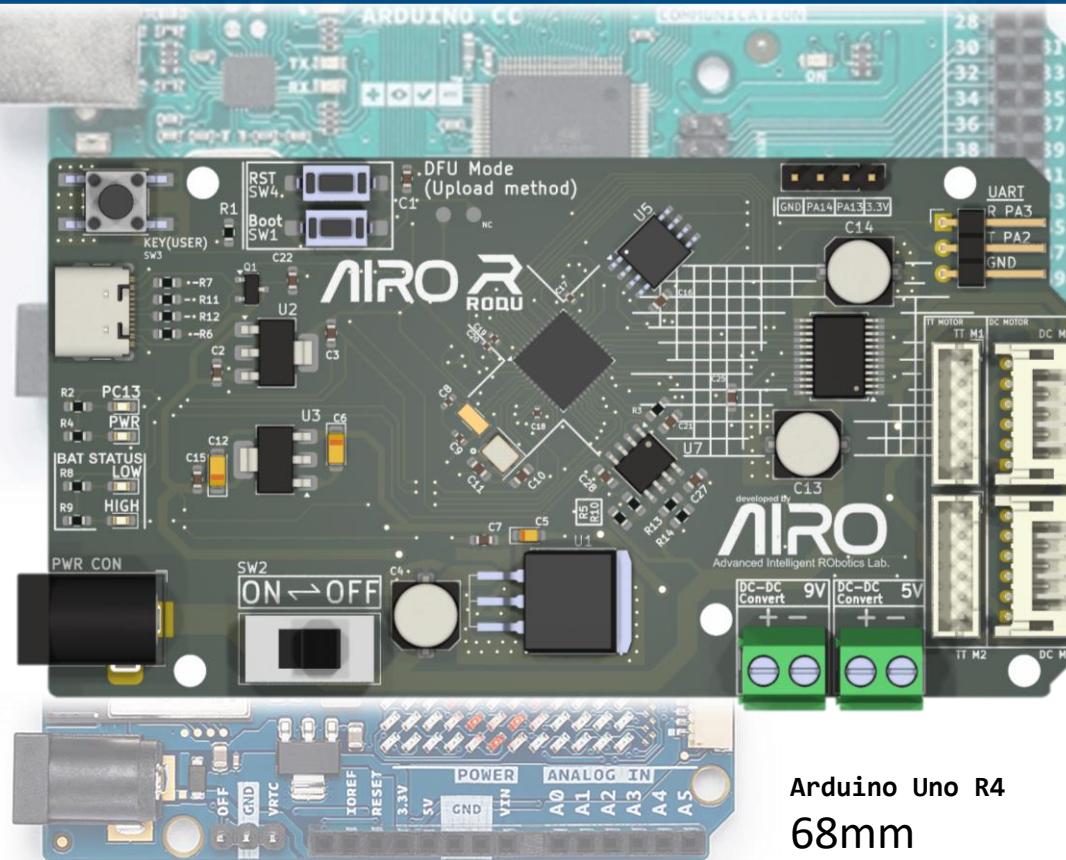
Technical Details



❖ Electrical Spec.

- MCU : STM32F411
 - Core : ARM® Cortex®-M4 CPU
- Motor Driver : TB6612FNG
- # of Motor Channel : 2
- Operating Voltage : DC 9 ~ 12V

Technical Details



Arduino Mega R3
101.52mm

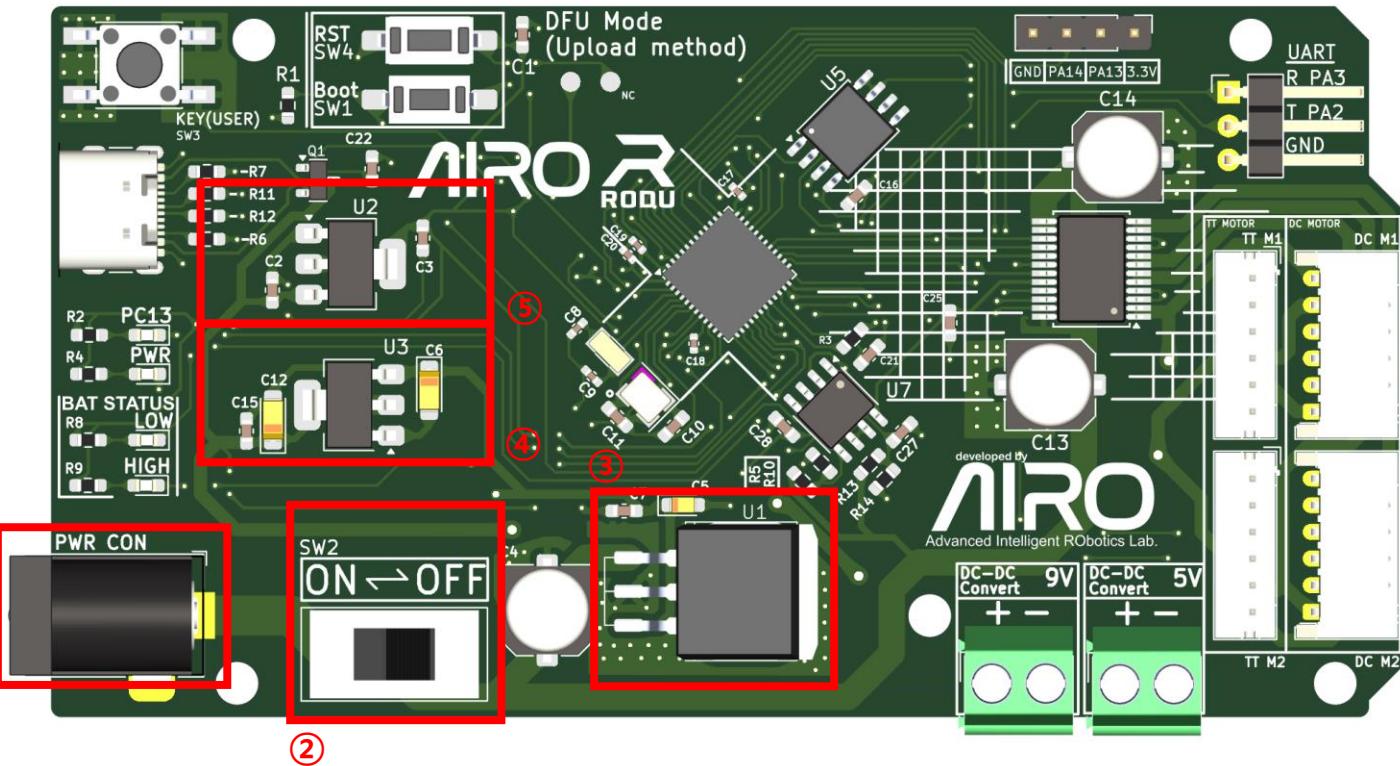
AIRO Lab DC Motor Driver
& Controller V3.2
101.52mm

Arduino Uno R4
68mm

Size Comparison

- Same hardware size as Arduino Mega

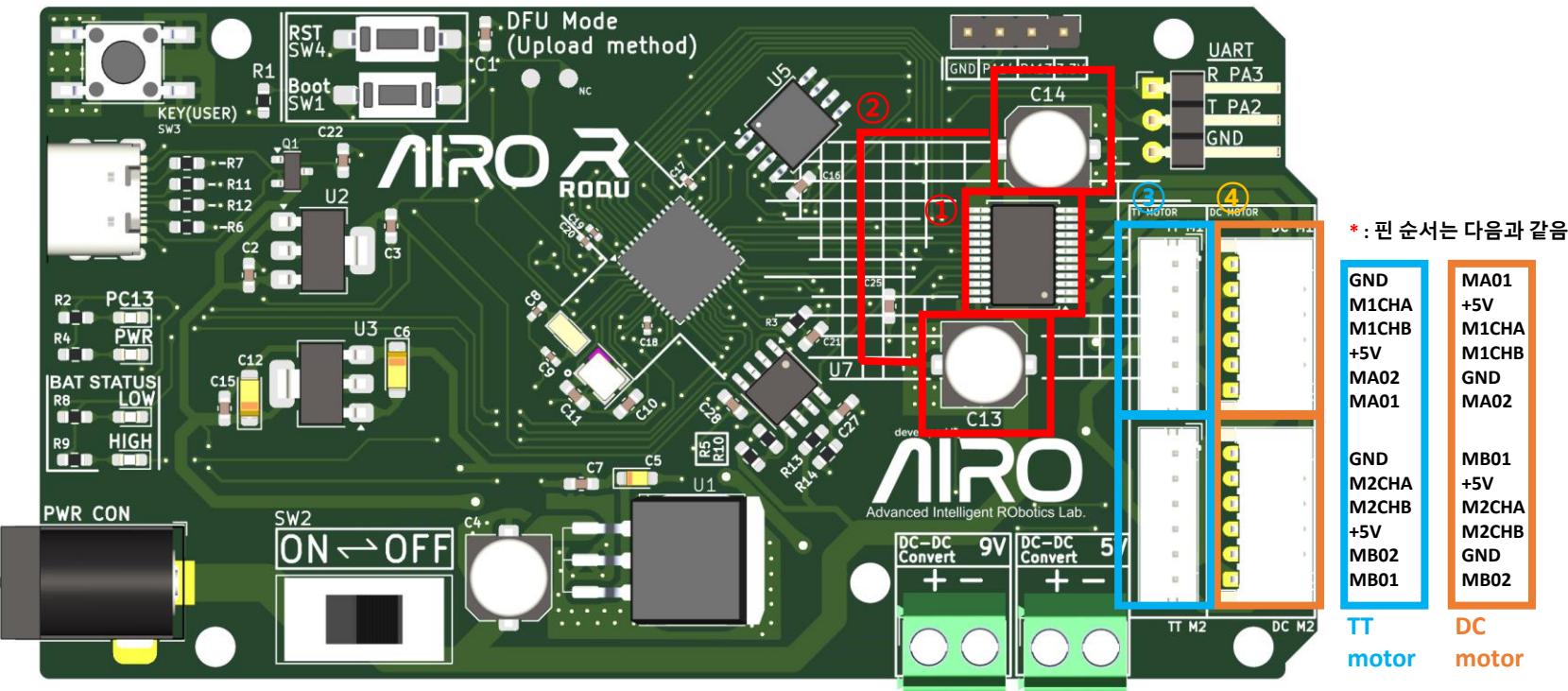
Technical Details



❖ Power

- ① Barrel Jack Socket – 3셀 배터리를 통한 전원 입력 포트(인가전압 : 9.6V ~ 12.6V)
- ② SPDT Switch – 마스터 전원 스위치, 배터리 전압 ON/OFF 제어
- ③ 9V Buck Converter – 입력된 배터리 전압(12V)을 9V의 일정한 출력으로 조절 (12V to 9V)
- ④ 5V Buck Converter – 9V 전압을 통해 모터 및 기타 소자에서 사용하는 5V 생성 (9V to 5V)
- ⑤ 3.3V Buck Converter – 5V 전압을 통해 MCU 및 기타 소자에서 사용하는 3.3V 생성 (5V to 3.3V)

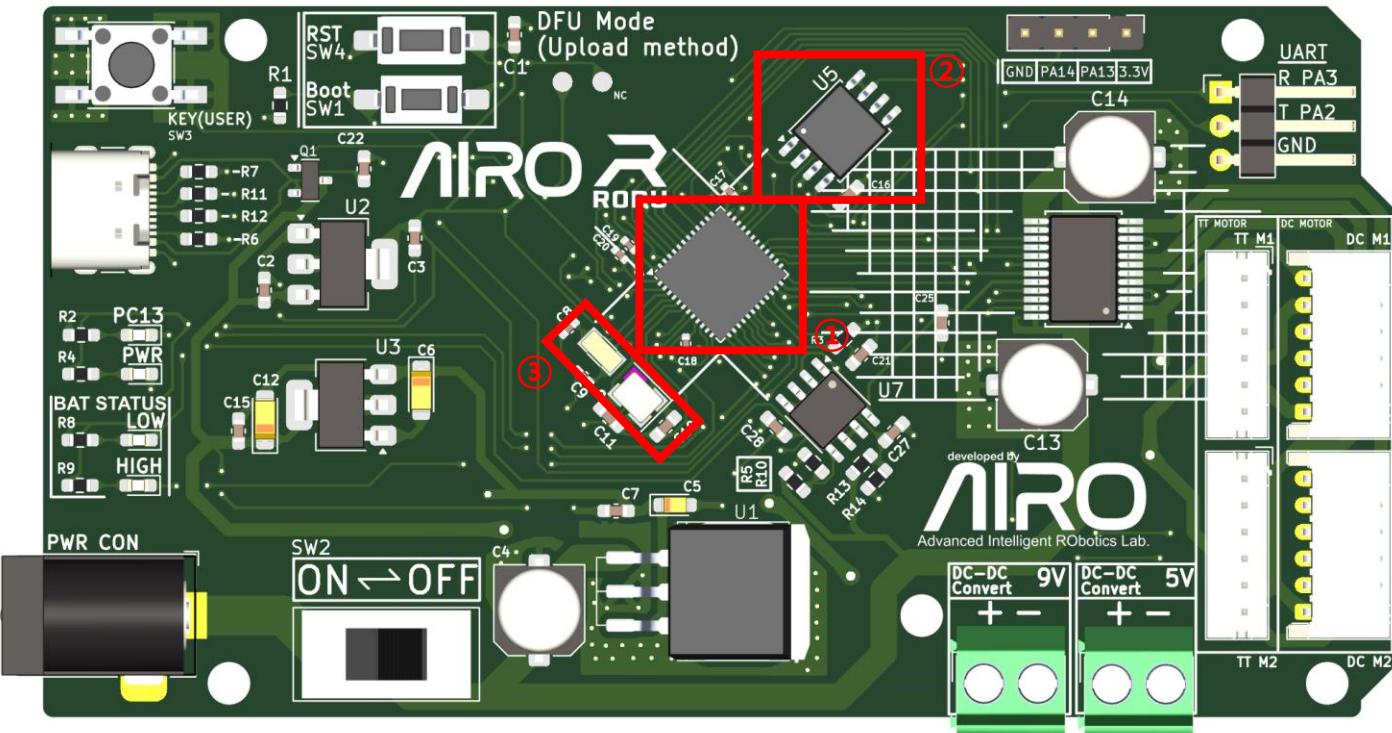
Technical Details



❖ Motor Drive

- ① TB6612FNG – 2ch Motor Driver
- ② Capacitor – 고전력 순간 사용시 전력량 보조 공급용 커패시터
- ③ TT Motor Connector – 모터 연결용 커넥터 (TT 엔코더 모터)
- ④ DC Motor Connector – 모터 연결용 커넥터 (DC 엔코더 모터)

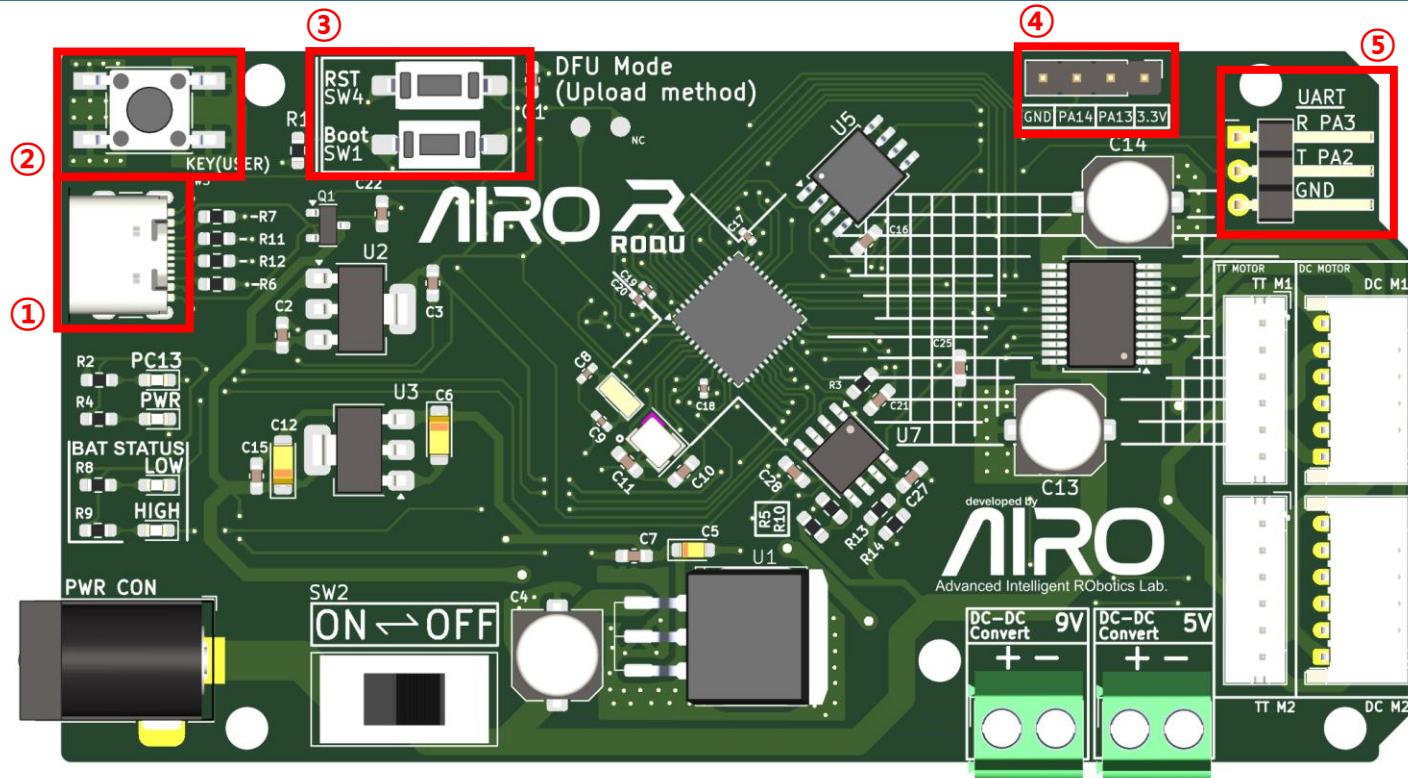
Technical Details



❖ Controller (MCU)

- ① STM32F411CCU – 고속 연산이 가능한 ARM Cortex-M4 기반의 프로세서
- ② W25Q32JVSSIQ – NVRAM, 32Mb 메모리 크기를 갖고 있는 Flash Memory
- ③ Crystal – 높은 정확도의 데이터 처리 및 안정성 제공

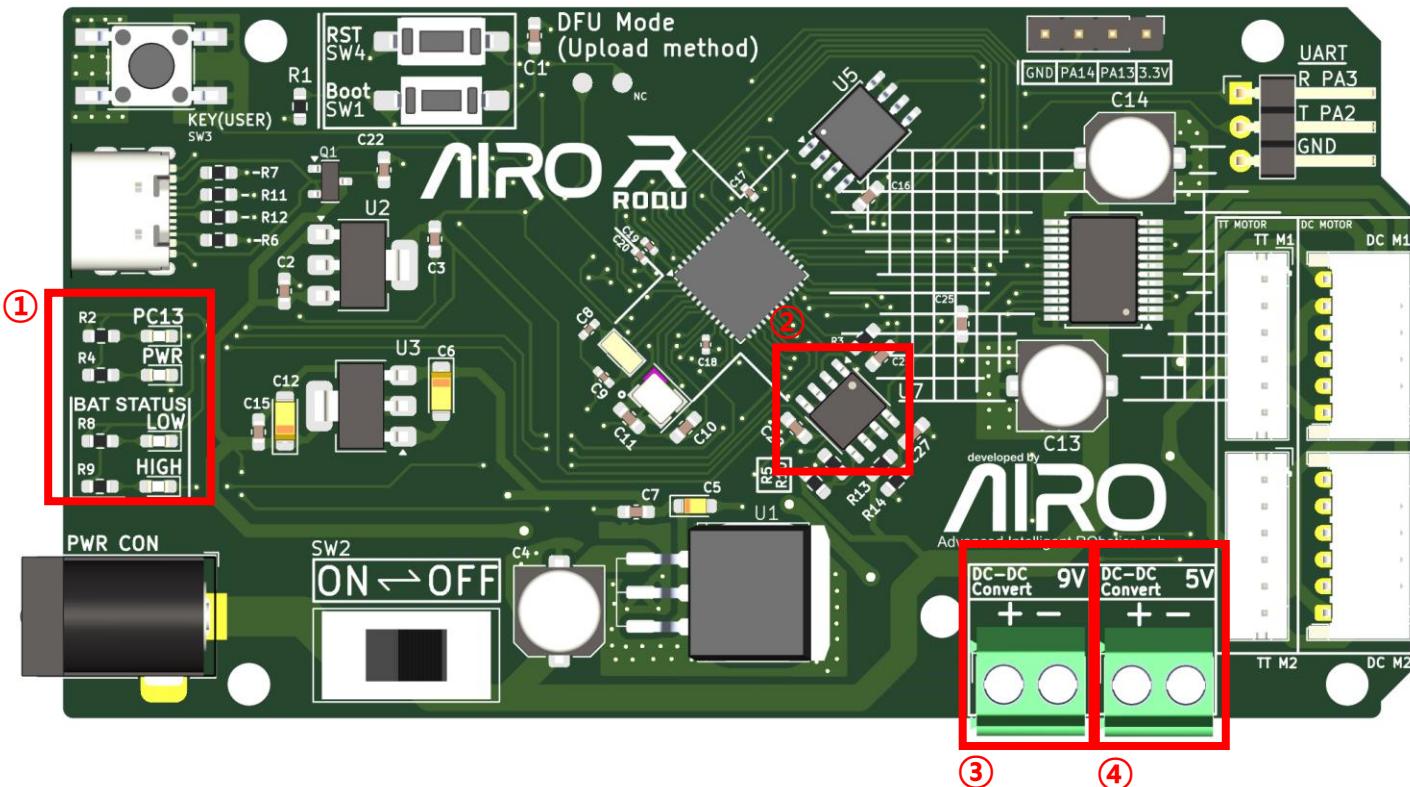
Technical Details



❖ Interface

- ① USB type C – 시리얼 COM 포트용 USB
- ② Key(User) button – 사용자 커스텀이 가능한 버튼
- ③ Boot mode button – BOOTLOADER 모드 진입 버튼 (RST, Boot)
- ④ JTAG – STLink 연결 디버깅용 포트
- ⑤ UART – 외부 MCU 연결을 위한 UART 채널 (PA3: RX / PA2: TX)

Technical Details



❖ 기타

- ① LED – 보드 PWR 및 배터리 전원 상태 표시용 LED
- ② OP-Amp – 절연회로 구성용 IC
- ③ 9V 제공 커넥터 – 보드(AIRO DRIVER)에서 제공하는 9V 전압 사용을 위한 Screw Terminal (Connector)
- ④ 5V 제공 커넥터 – 보드(AIRO DRIVER)에서 제공하는 5V 전압 사용을 위한 Screw Terminal (Connector)

Technical Details

STM32F411CCU - Specification

System		ART Accelerator™	Connectivity
Power supply	1.2V internal regulator	Arm® Cortex®-M4 CPU 100 MHz	3x I²C
POR/PDR/PVD/BOR	Xtal oscillators 32 kHz + 4 ~ 26 MHz	Floating point unit (FPU)	3x USART
Internal RC oscillators 32 kHz + 16 MHz	Nested vector interrupt controller (NVIC)	LIN, smartcard, IrDA, Modem control	5x SPI or 5x I²S (2x I²S with full duplex)
PLL	JTAG/SW debug	SDIO	USB 2.0 OTG FS
Clock control	Embedded trace macrocell (ETM)		
RTC/AWU	Memory protection unit (MPU)		
2x watchdogs (independent + window)	AHB-Lite bus matrix		
36/50/81 I/Os	APB bus		
Cyclic redundancy check (CRC)	16-channel DMA with Batch acquisition mode (BAM)		
96-bit unique ID	256-Kbyte Flash memory		
Voltage scaling	128-Kbyte SRAM		
	80-byte backup data		
Analog		Control	
		1x 12-bit ADC 2.4 MSPS 16 channels / 0.41 µs	5x 16-bit timer
		Temperature sensor	1x 16-bit motor control PWM synchronized AC timer
			2x 32-bit timer

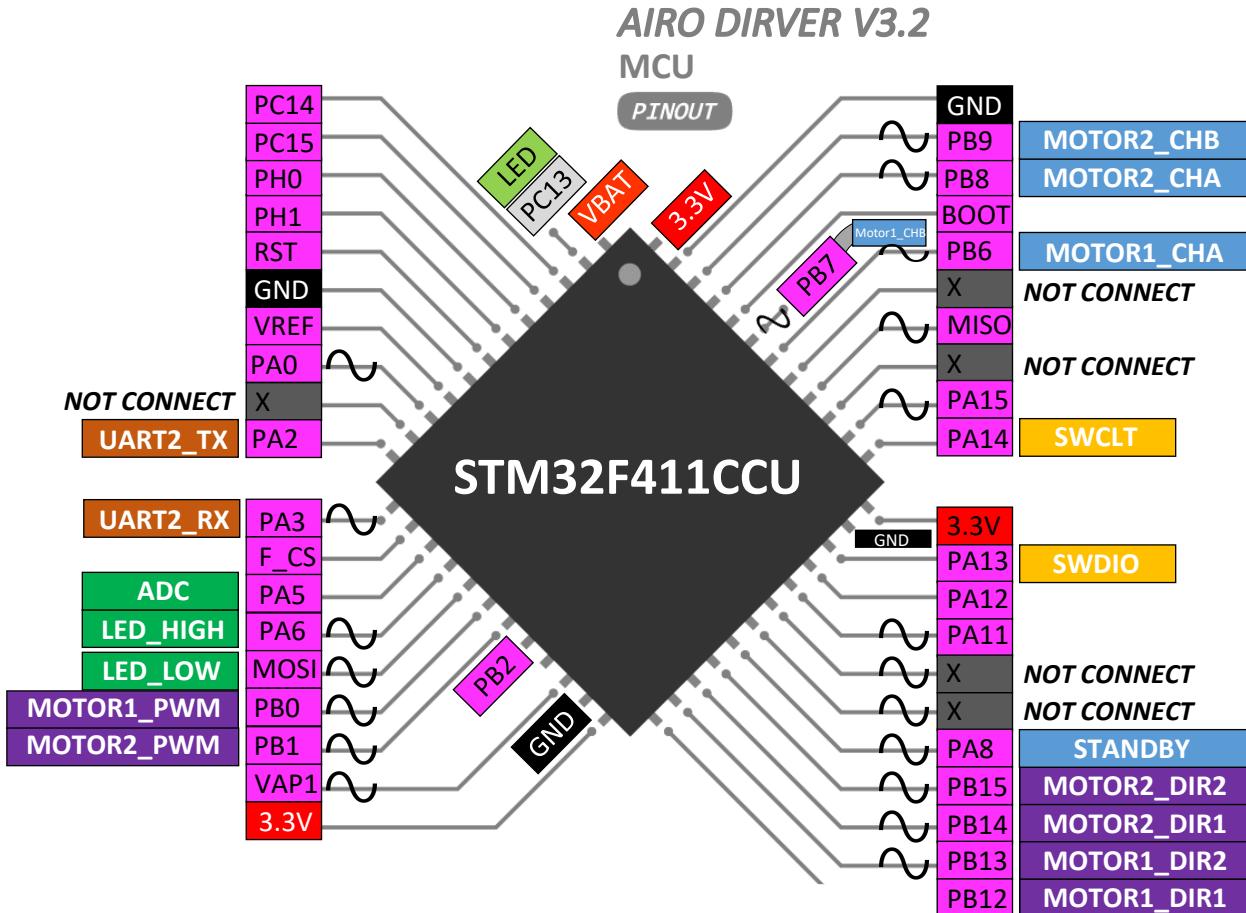
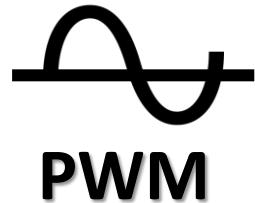


❖ STM32F411

- ① ARM Cortex-M4 코어 기반의 고성능 칩셋
 - 100MHz의 클럭 속도와 FPU(Floating Point Unit)으로 고속 연산 및 실시간 제어 가능
- ② 저전력 모드 제공
 - 낮은 소비 전력으로 구동 가능
- ③ 고급 임베디드 시스템 개발
 - STM32CubeMX 개발 툴 등을 이용하여 하드웨어 제어와 관련된 복잡한 시스템 구현 가능
- ④ 저렴한 가격
 - 스펙 대비 상대적으로 저렴한 가격으로 타 고성능 임베디드 애플리케이션 대비 동급 성능 구현

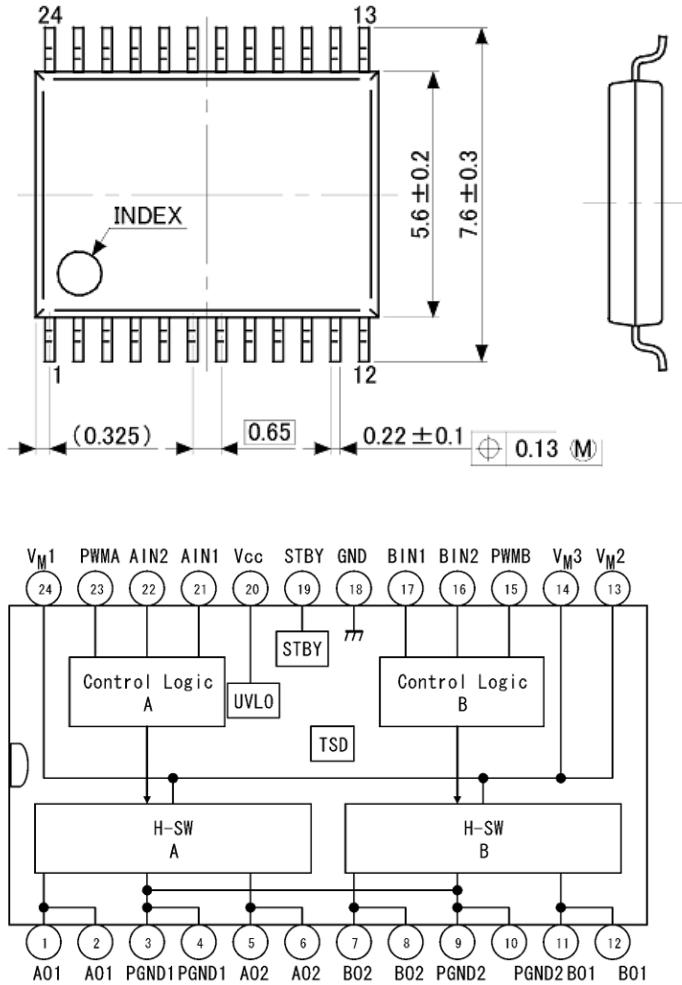
Technical Details

- STM32F411CCU & AIRO DRIVER - Pinout



Technical Details

• TB6612FNG



Pin Functions

No.	Pin Name	I/O	Function
1	AO1	O	ch A output 1
2	AO1	—	Power GND 1
3	PGND1	—	
4	PGND1	—	
5	AO2	O	ch A output 2
6	AO2	—	
7	BO2	O	ch B output 2
8	BO2	—	
9	PGND2	—	Power GND 2
10	PGND2	—	
11	BO1	O	ch B output 1
12	BO1	—	
13	VM2	—	Motor supply
14	VM3	—	
15	PWMB	I	ch B PWM input/200 kΩ pull-down at internal
16	BIN2	I	ch B input 2/200 kΩ pull-down at internal
17	BIN1	I	ch B input 1/200 kΩ pull-down at internal
18	GND	—	Small signal GND
19	STBY	I	"L" = standby/200 kΩ pull-down at internal
20	Vcc	—	Small signal supply
21	AIN1	I	ch A input 1/200 kΩ pull-down at internal
22	AIN2	I	ch A input 2/200 kΩ pull-down at internal
23	PWMA	I	ch A PWM input/200 kΩ pull-down at internal
24	VM1	—	Motor supply

Technical Details

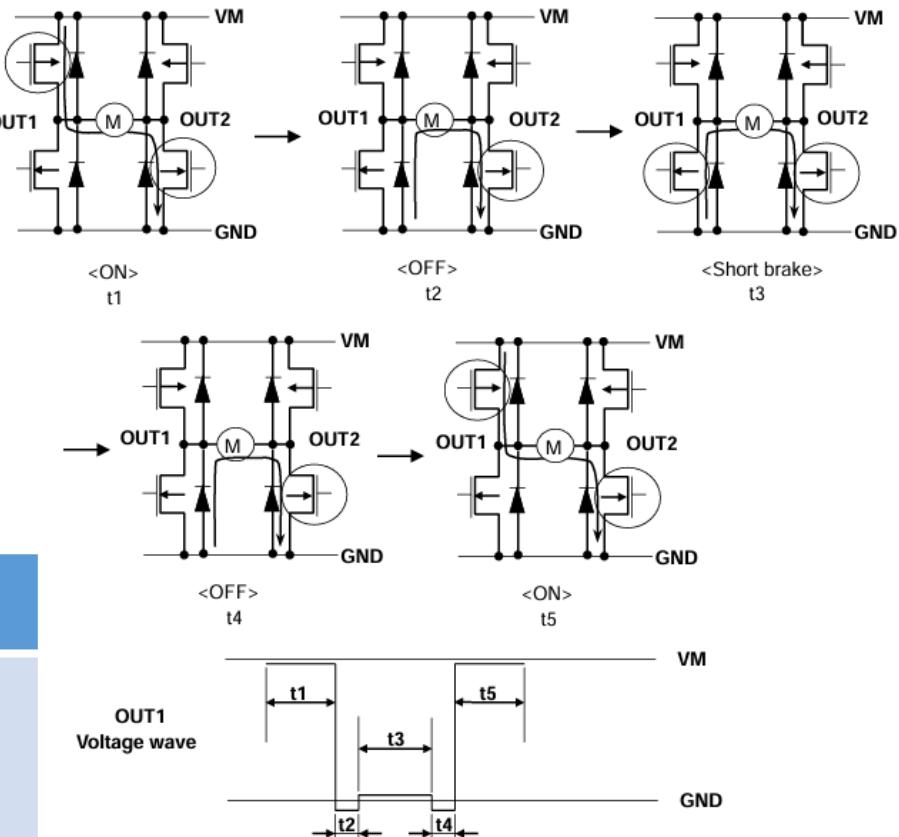
• TB6612FNG

Input				Output		
IN1	IN2	PWM	STBY	OUT1	OUT2	Mode
H	H	H/L	H	L	L	Short brake
L	H	H	H	L	H	CCW
		L	H	L	L	Short brake
H	L	H	H	H	L	CW
		L	H	L	L	Short brake
L	L	H	H	OFF (High impedance)		Stop
H/L	H/L	H/L	L	OFF (High impedance)		Standby

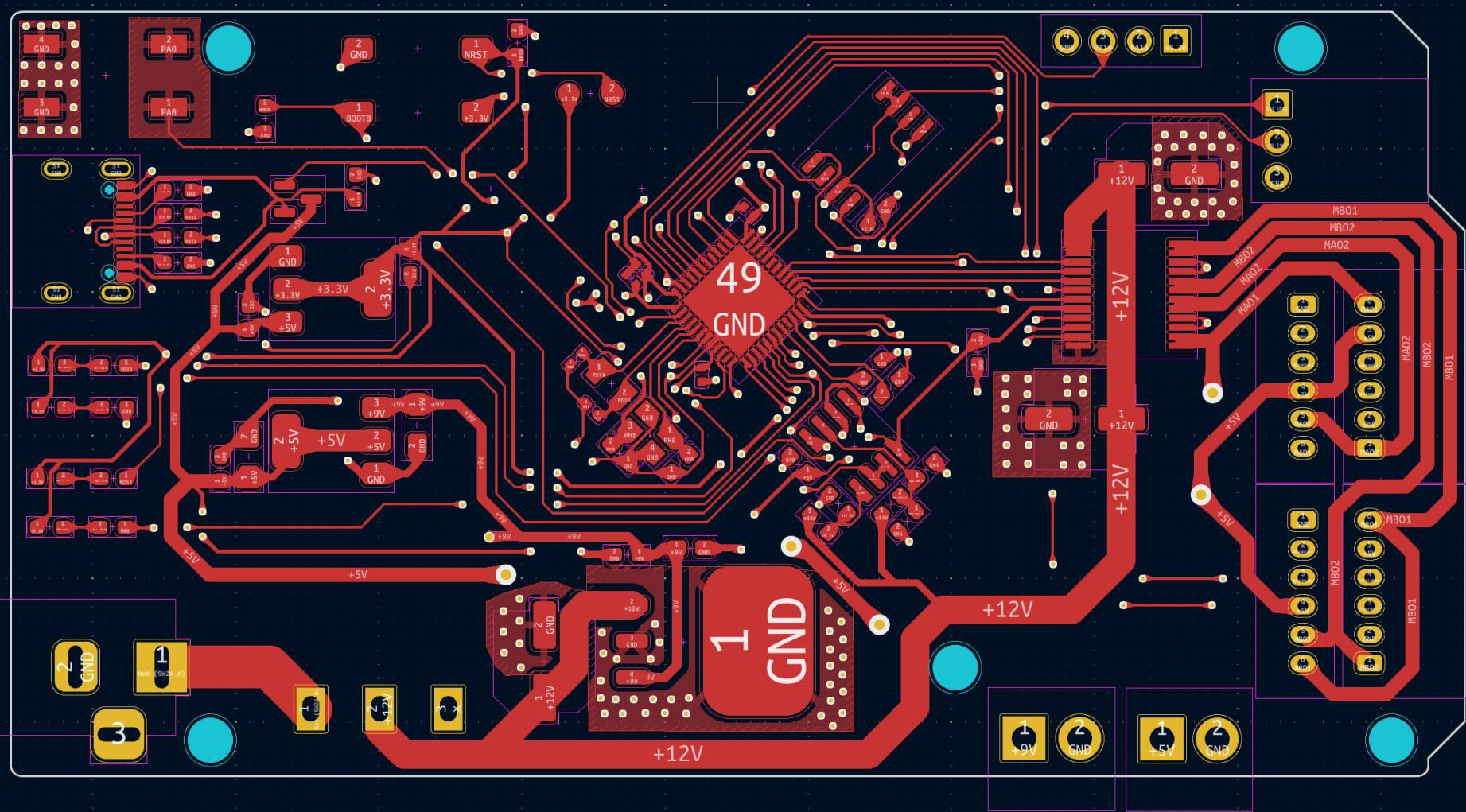
PIN	dirPin1	dirPin2	pwmPin	STBY
Motor1	PB12	PB13	PB0	PA8
Motor2	PB14	PB15	PB1	

H-SW Operating Description

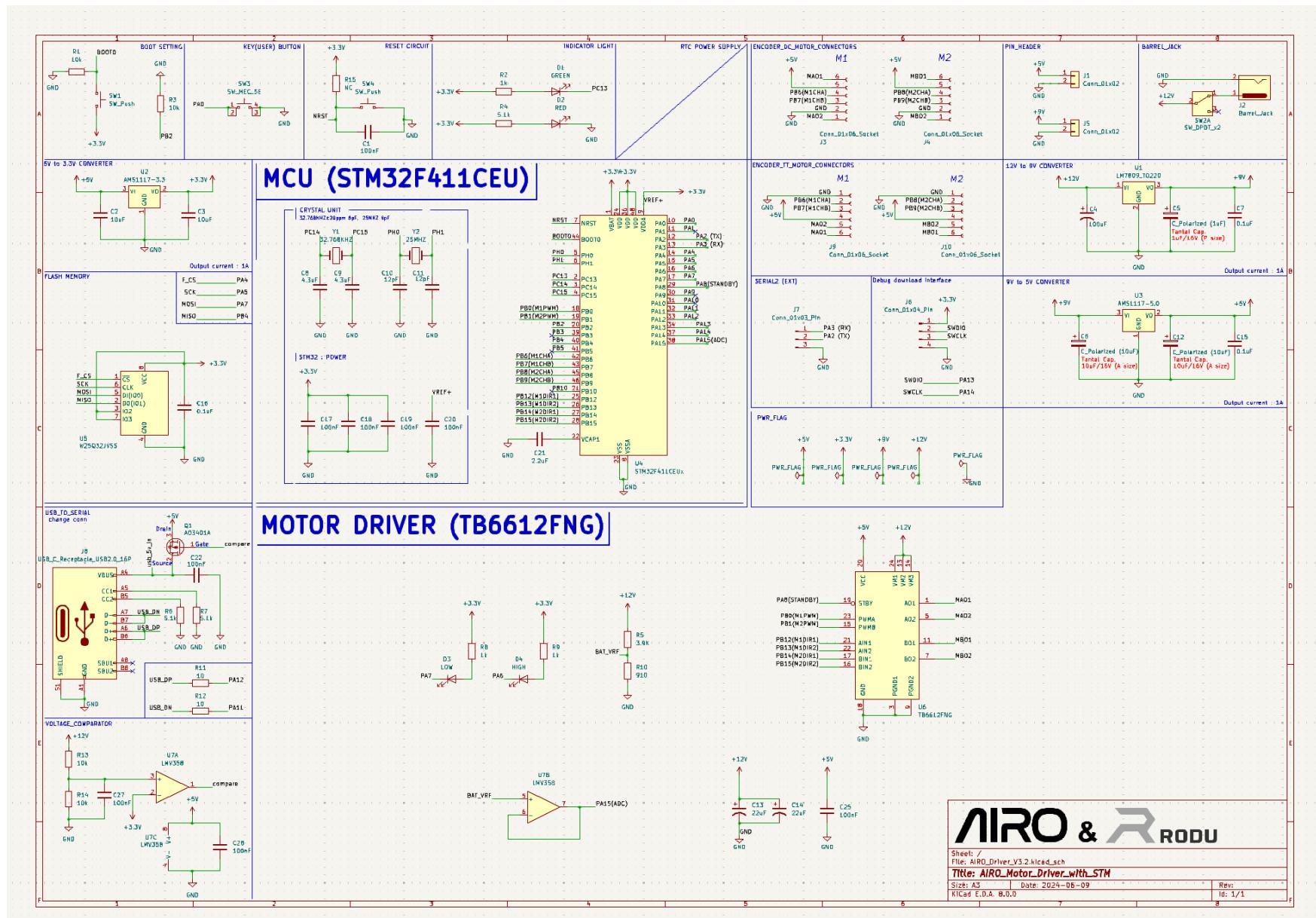
- To prevent penetrating current, dead time t2 and t4 is provided in switching to each mode in the IC.



PCB Artwork



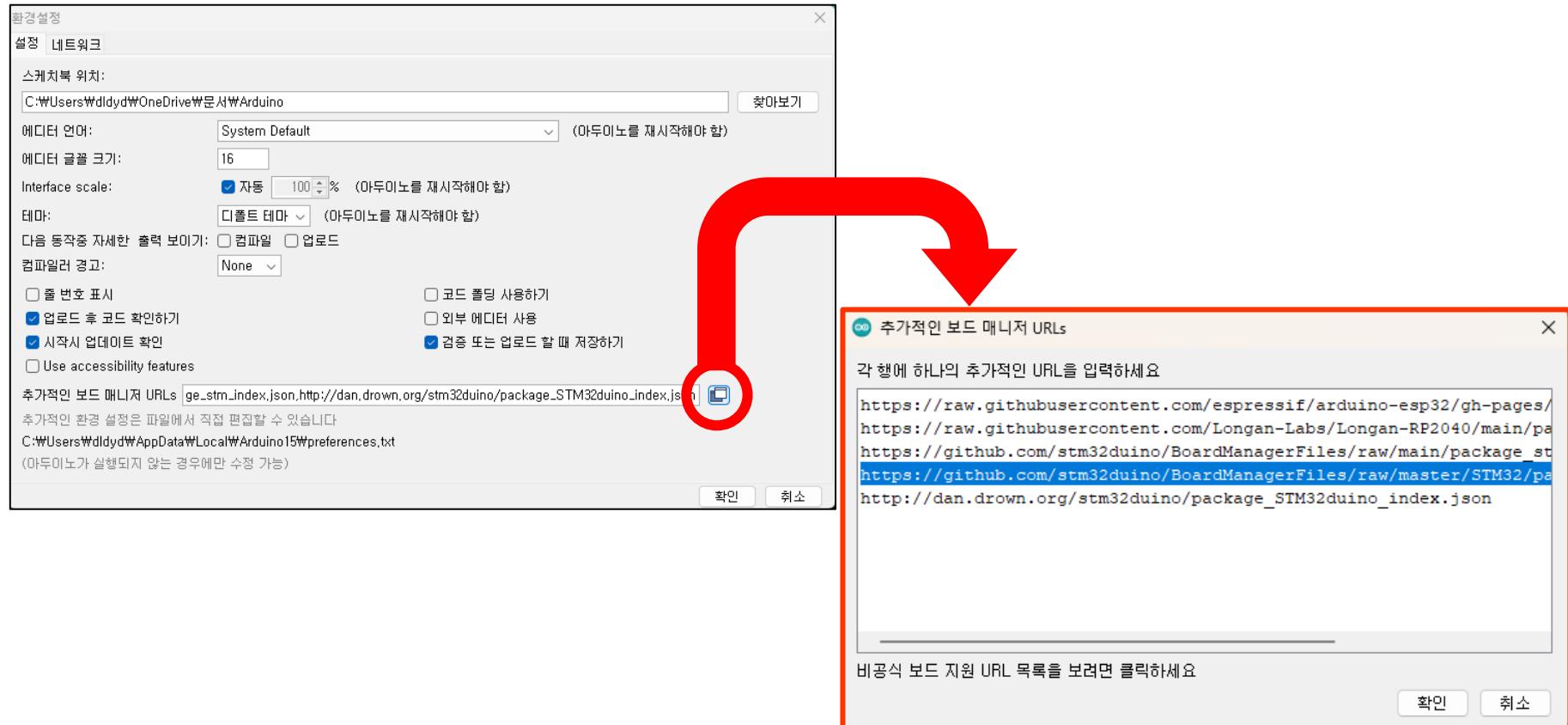
Schematic



Arduino Configuration

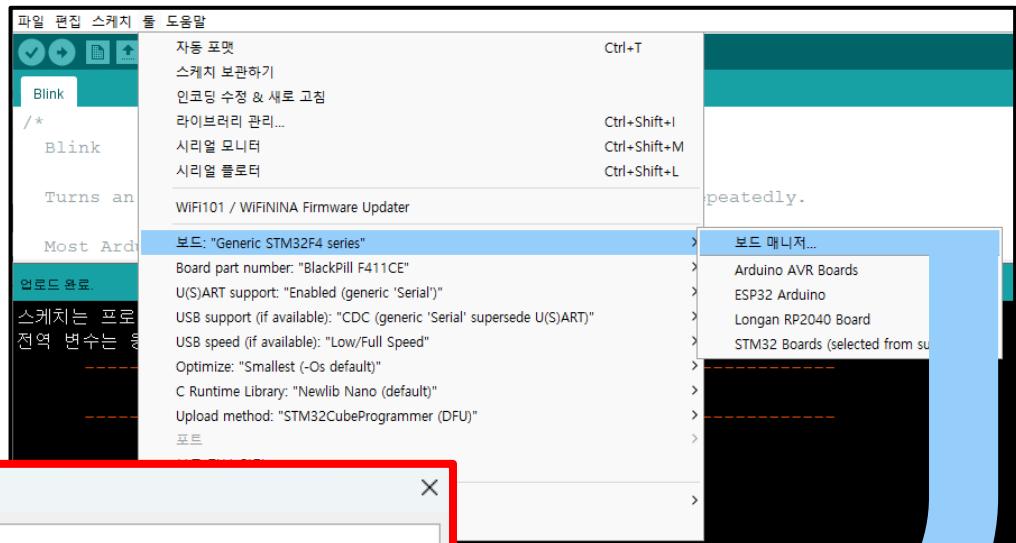
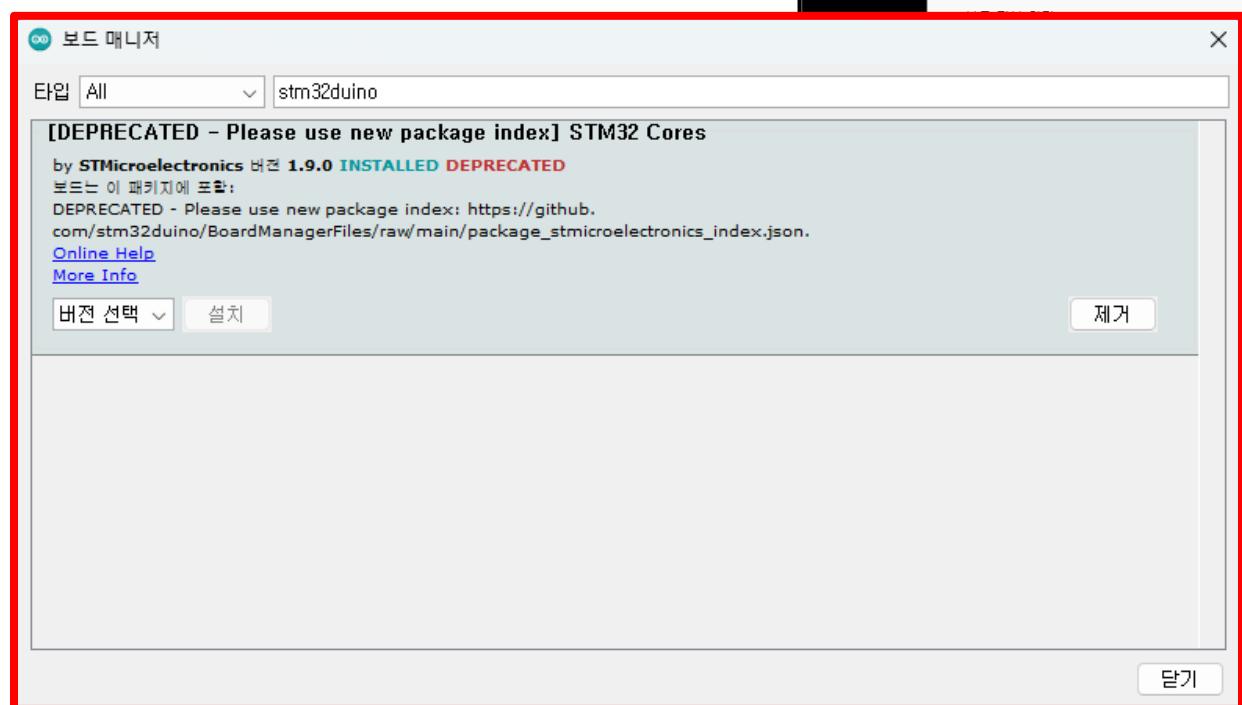
Board Manager 설치

- https://github.com/stm32duino/BoardManagerFiles/raw/master/STM32/package_stm_index.json



Arduino Configuration

보드매니저



Arduino Configuration

STM32Cube Programmer 다운로드

The screenshot shows the product page for STM32CubeProg. At the top, there's a navigation bar with links for Careers, Sample & buy, Support & community, and language options (Japanese, Chinese, English). Below the navigation is a main menu with Products, Tools & software, Applications, Solutions, and STM32 Developer Zone. A search bar and user account icons are also present. The breadcrumb navigation shows the path: Development tools > Software Development Tools > STM32 Software Development Tools > STM32 Programmers > STM32CubeProg. The main content area features the product name "STM32CubeProg ACTIVE" and a sub-headline "STM32CubeProgrammer software for all STM32". There are two prominent buttons: "Get Software" and "Download databrief". Below these are tabs for Overview, Documentation, and Tools & Software. The "Overview" tab is selected. Under the "Description" section, it says: "STM32CubeProgrammer (STM32CubeProg) is an all-in-one multi-OS software tool for programming STM32 products." To the right, there's a large image of the STM32CubeProgrammer logo and some descriptive text about its features: "It provides an easy-to-use and efficient environment for reading, writing and verifying device memory through both the debug interface (JTAG and SWD) and the bootloader interface (UART, USB DFU, I²C, SPI, and CAN). STM32CubeProgrammer offers a wide range of features to program STM32 internal memories (such as Flash, RAM, and OTP) as well as external memories. STM32CubeProgrammer also allows option programming and upload, programming content verification, and programming automation through scripting." The bottom of the page has a footer with links for Description, All features, Circuit Diagram, Get Software, Featured Products, Featured Videos, and Recommended for you.

Arduino Configuration

STM32Cube Programmer 다운로드

Get Software

Part Number	General Description	Latest version	Download	All versions
+ STM32CubePrg-Lin	STM32CubeProgrammer software for Linux	2.16.0	Get latest	Select version
+ STM32CubePrg-Mac	STM32CubeProgrammer software for Mac	2.16.0	Get latest	Select version
+ STM32CubePrg-W32	STM32CubeProgrammer software for Win32	2.16.0	Get latest	Select version
+ STM32CubePrg-W64	STM32CubeProgrammer software for Win64	2.16.0	Get latest	Select version



2.16.0 

2.15.0 

2.14.0 

최신버전이 아닌 Select Version → 2.15.0으로 받을 것!!!!
2.15.0 이후 버전은 테스트 X

Arduino Configuration

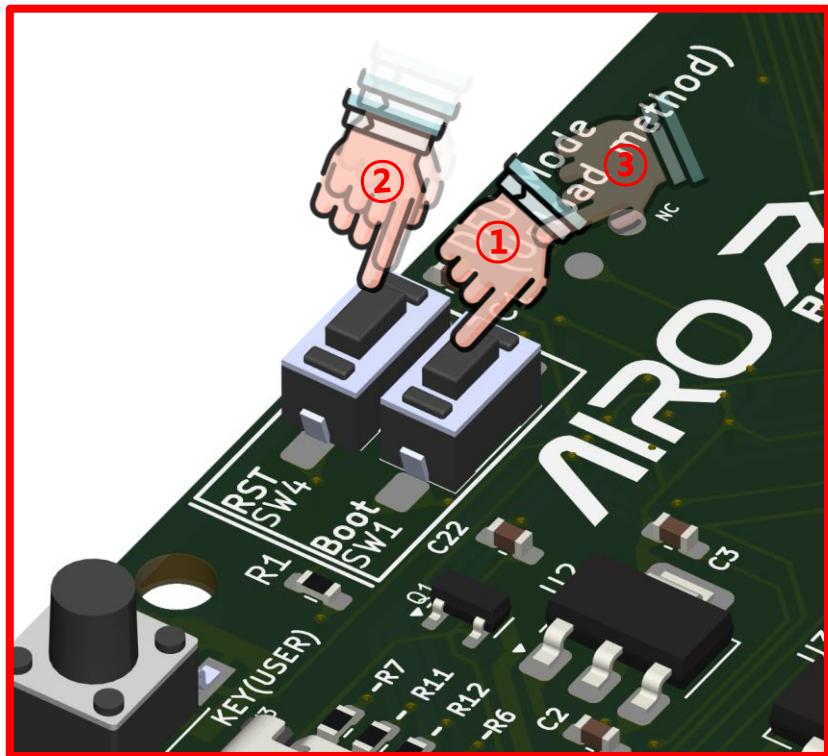
• DFU 모드 진입 방법 (STM32 BOOTLOADER)

- BOOT 누른 상태에서 RST를 눌렀다 뗀 후, BOOT를 뗈다.

① BOOT 버튼 유지 ② ③

코드 업로드를 위한

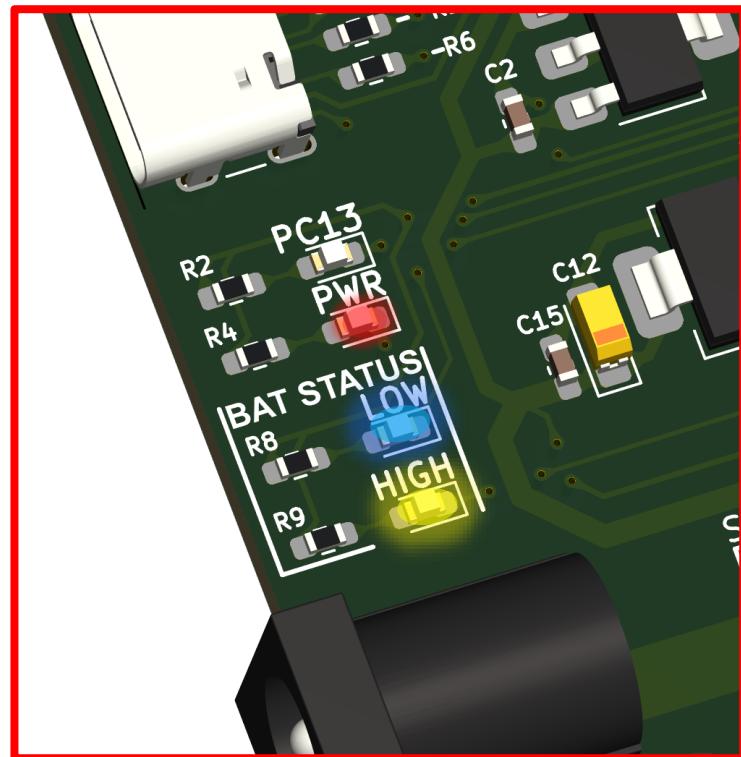
**STM32
BootLoader 진입**



Arduino Configuration

• DFU 모드 진입 상태 확인 (STM32 BOOTLOADER)

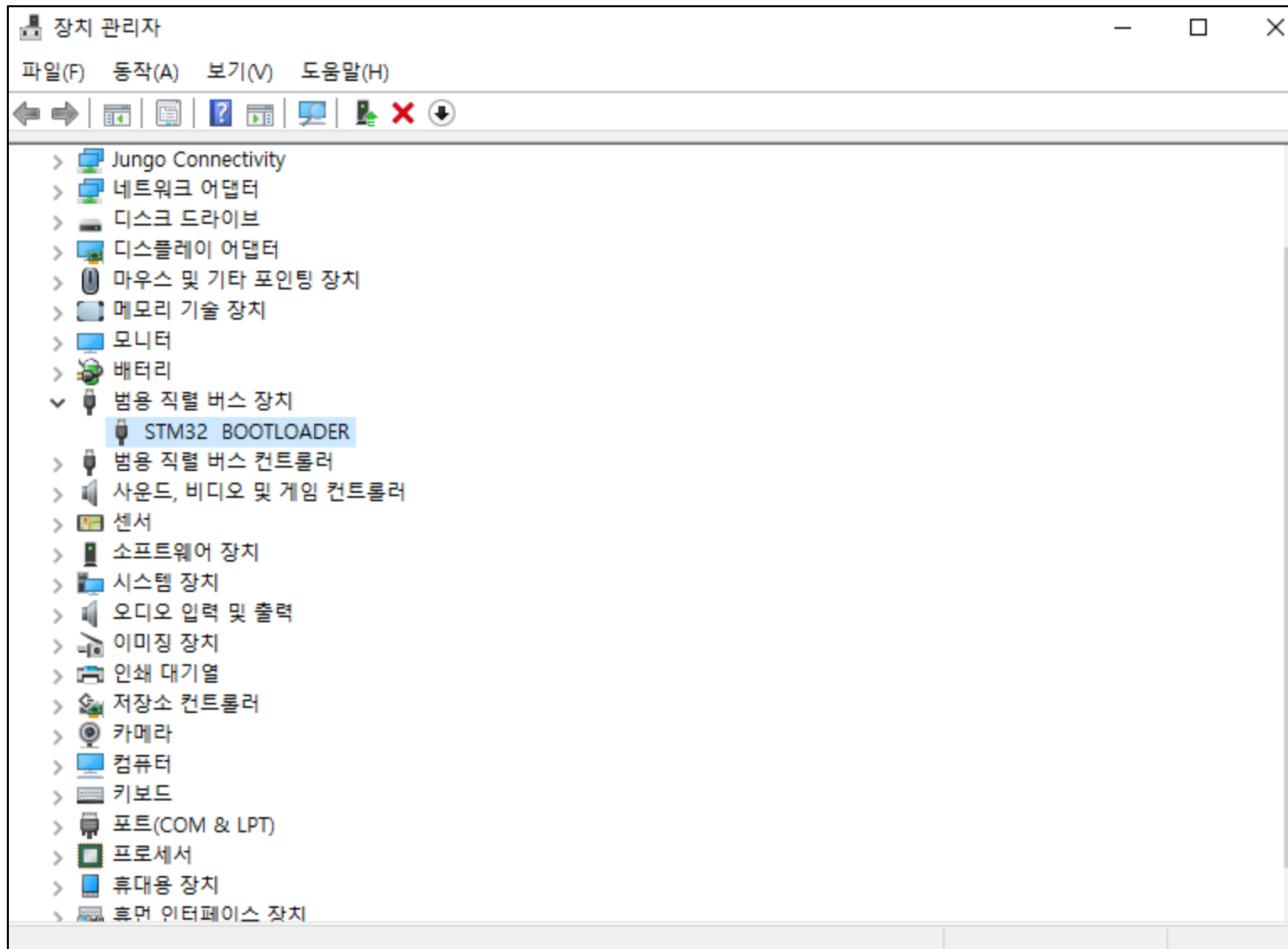
- BootLoader에 진입하게 되면 LOW(파랑), HIGH(노랑)에 동시에 LED가 들어오게 됨



Arduino Configuration

• DFU 모드 진입 상태 확인 (STM32 BOOTLOADER)

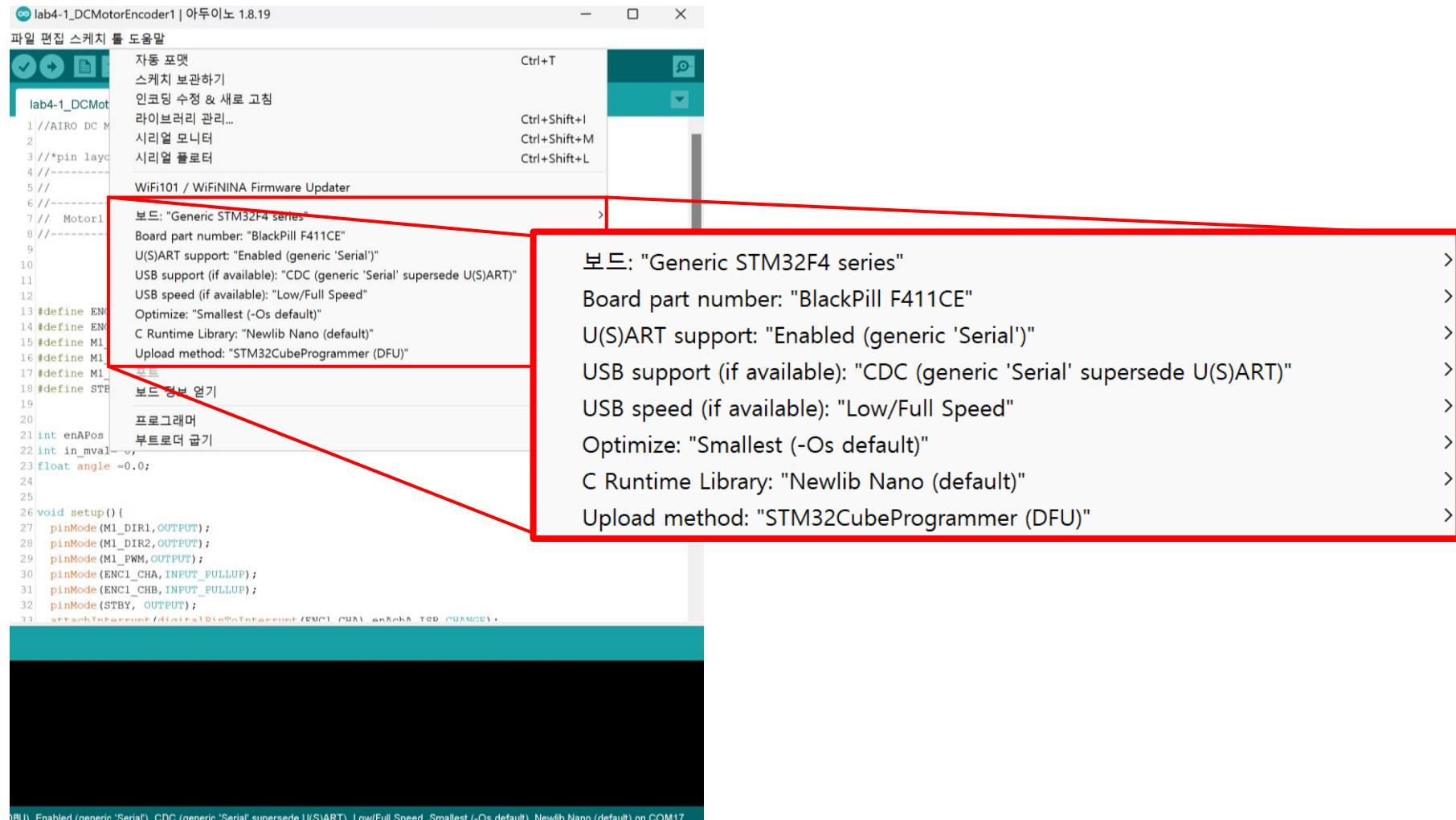
- 장치 관리자에서 STM32 BOOTLOADER 확인 가능



Arduino Configuration

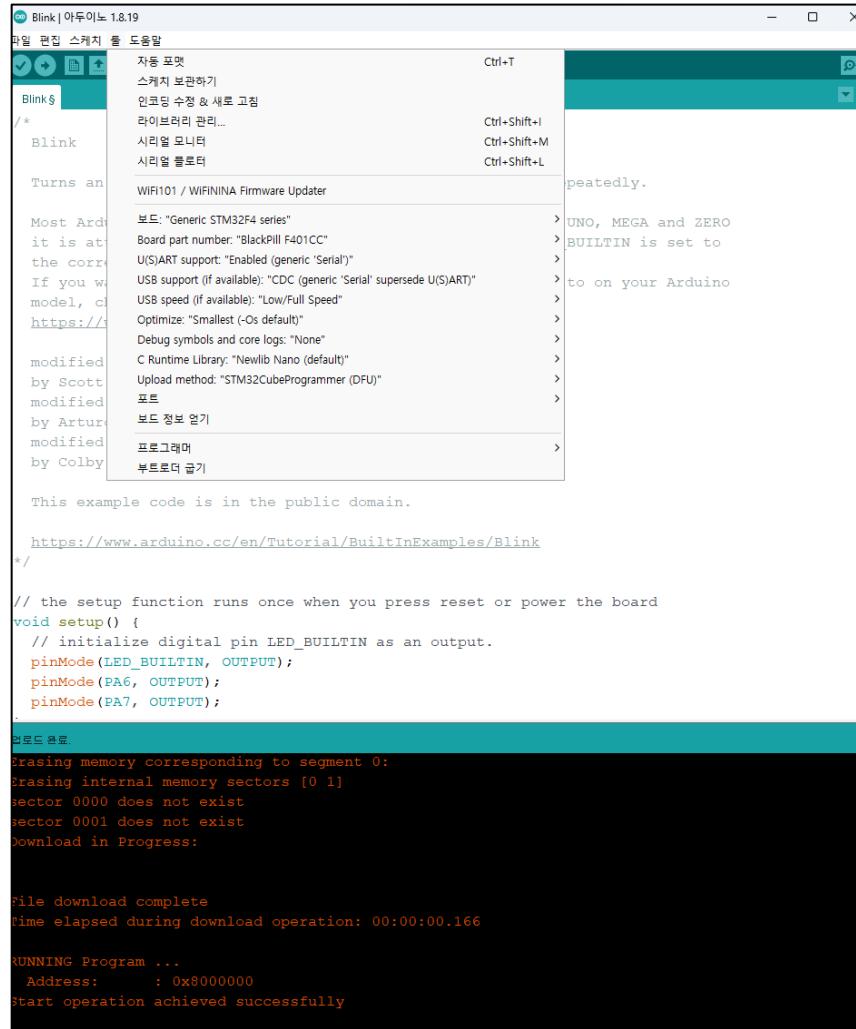
● AIRO DRIVER V3.2 (STM32) 툴 설정

- 스케치 업로드 전 툴 설정 확인



Arduino Configuration

- USB C를 사용해 업로드 하는 경우 (맨 처음)
 - COM 포트 안잡히는게 정상



Blink | 아두이노 1.8.19

파일 편집 스케치 툴 도움말

스케치 보관하기

인코딩 수정 & 새로 고침

라이브리리 관리...

시리얼 모니터

시리얼 플로터

Turns an LED on and off.

Most Arduino boards support USB serial. If you want to use a different model, click here.

<https://www.arduino.cc/en/Tutorial/BuiltInExamples/Blink>

```
/*
 * This example code is in the public domain.
 */

void setup() {
    // initialize digital pin LED_BUILTIN as an output.
    pinMode(LED_BUILTIN, OUTPUT);
    pinMode(PA6, OUTPUT);
    pinMode(PA7, OUTPUT);
}

void loop() {
    digitalWrite(LED_BUILTIN, HIGH); // Turn the LED on (HIGH is the voltage level)
    delay(1000); // Wait for a second
    digitalWrite(LED_BUILTIN, LOW); // Turn the LED off by making the voltage LOW
    delay(1000); // Wait for a second
}
```

Uploading to: WiFi101 / WiFiNINA Firmware Updater

보드: "General STM32F4 series"

Board part number: "BlackPill F401CC"

U(S)ART support: "Enabled (generic 'Serial')"

USB support (if available): "CDC (generic 'Serial' supersedes U(S)ART)"

USB speed (if available): "Low/Full Speed"

Optimize: "Smallest (-Os default)"

Debug symbols and core logs: "None"

C Runtime Library: "Newlib Nano (default)"

Upload method: "STM32CubeProgrammer (DFU)"

포트

보드 정보 열기

프로그래머

부트로더 굽기

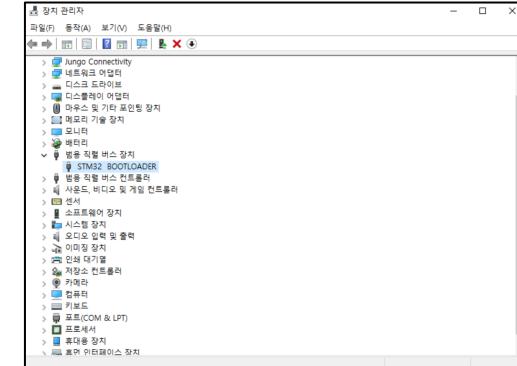
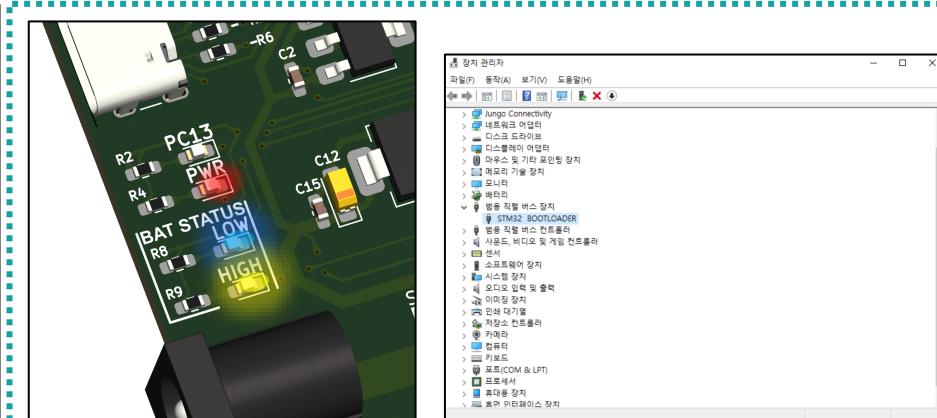
Example code is in the public domain.

<https://www.arduino.cc/en/Tutorial/BuiltInExamples/Blink>

Erasing memory corresponding to segment 0:
 Erasing internal memory sectors [0 1]
 sector 0000 does not exist
 sector 0001 does not exist
 Download in Progress:

File download complete
 Time elapsed during download operation: 00:00:00.166

RUNNING Program ...
 Address: : 0x8000000
 Start operation achieved successfully



보드에 LOW & HIGH에 LED가 들어오거나
 또는 장치 관리자에 BOOTLOADER가 잡히는 상태라면
 포트가 안잡히는 상황에서도 업로드 가능!!

(업로드 이후 정상적으로 포트 잡히는거 확인 가능!!)

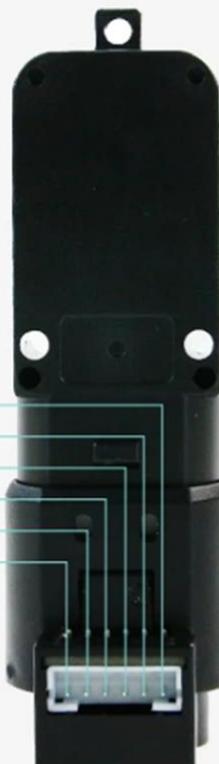
모터 사용 시 주의사항

● 모터를 사용시 주의 사항

- TT 모터 또는 DC 모터를 올바른 커넥터에 꽂아야함

TT motor Pin map

- 01 Encoder ground wire
- 02 Encoder output A phase
- 03 Encoder output B phase
- 04 Encoder power supply
- 05 Motor line+
- 06 Motor line-



DC motor Pin map



M-:Motor power line“-”

GND: Sensor signal line“-”

A: Sensor signal line A phase

B: Sensor signal B phase

VCC: Sensor positive 5V

M+: Motor power line“+”

Serial2의 사용

• HardwareSerial에 정의 필요

- Serial2(RX, TX)

```
HardwareSerial Serial2(PA3, PA2);

void setup() {
    Serial.begin(115200);
    Serial2.begin(115200);
}

void loop() {
    Serial2.println("gg");
    if(Serial2.available())
    {
        Serial.println(Serial2.read());
    }
    delay(500);
}
```

AIRO DC MOTOR DRIVER & CONTROLLER

AIRO DC MOTOR DRIVER & CONTROLLER - DEVELOPMENT HISTORY (2024 H2)

- 1st generation : [BluePill\(External\)](#), DC Motor Use Support, Provide motor supply power
- 2st generation : BlackPill(External), DC Motor Use Support, Provide motor supply power
- **3st generation : STM32F411CCU(Internal), DC Motor & TT Motor Use Support, Provides a variety of external power sources**



AIRO DC MOTOR DRIVER
& CONTROLLER V1



AIRO DC MOTOR DRIVER
& CONTROLLER V2



AIRO DC MOTOR DRIVER
& CONTROLLER V3

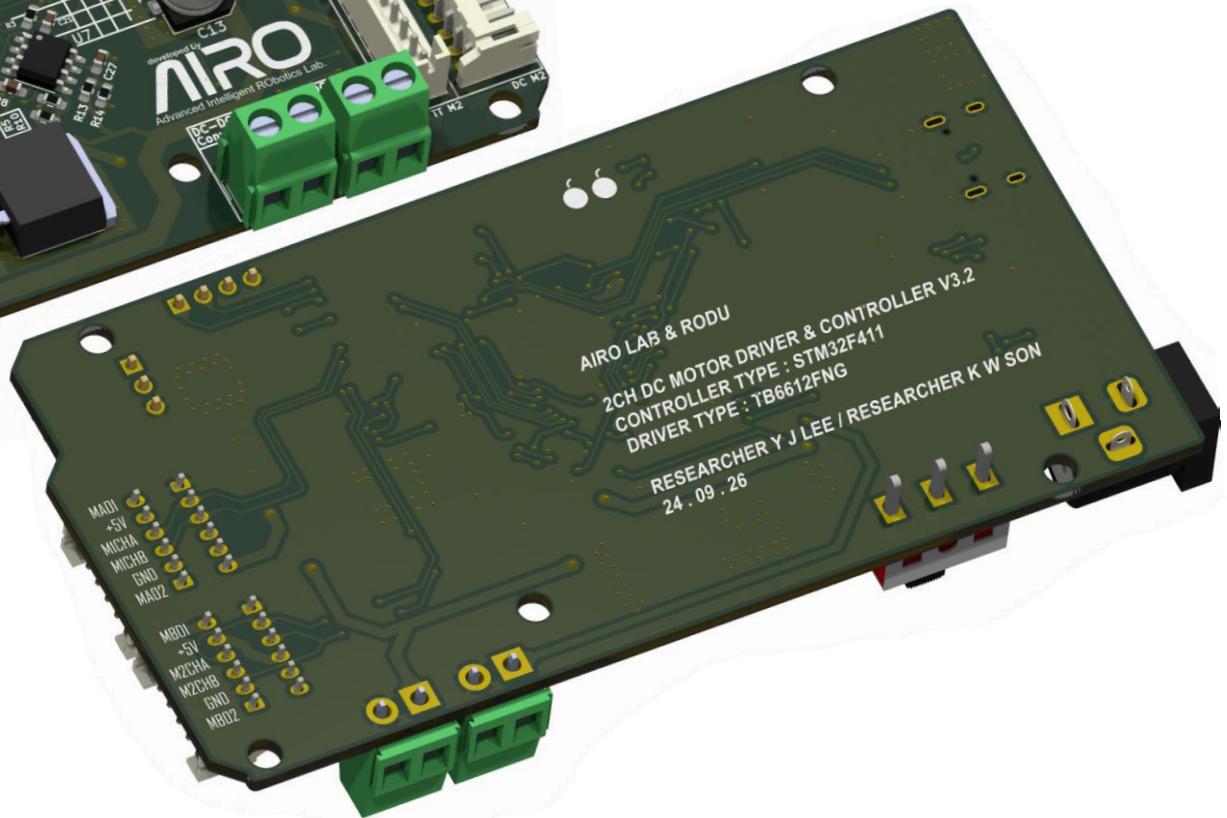
AIRO DC MOTOR DRIVER & CONTROLLER V3.2

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한양대 ERICA

AIRO LAB & RODU

2CH DC MOTOR DRIVER & CONTROLLER V3.2
CONTROLLER TYPE : STM32F411
DRIVER TYPE : TB6612FNG

RESEARCHER_Lee Yongjae / RESEARCHER_Son Kunwoo
24.09.26



AIRO

Advanced Intelligence Robotic Lab.