SAMSUNG Research

서울 IoT 센터

이산화탄소 값을 추출하여 클라우드로 보내기

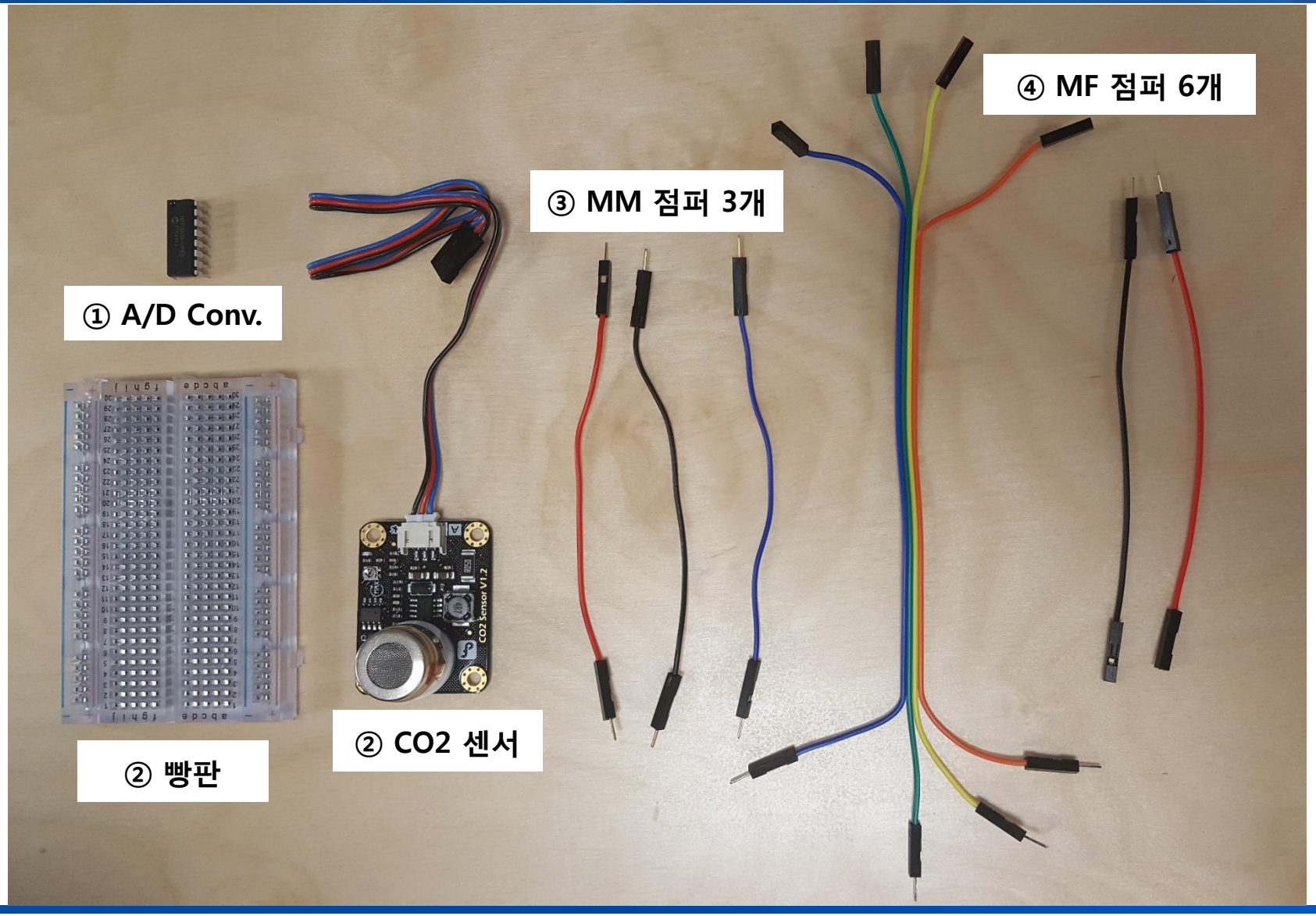
Aug. 23, 2018

Shape the Future with Innovation and Intelligence

Source Code

https://download.tizen.online/siot_co2_edu.zip

준비물



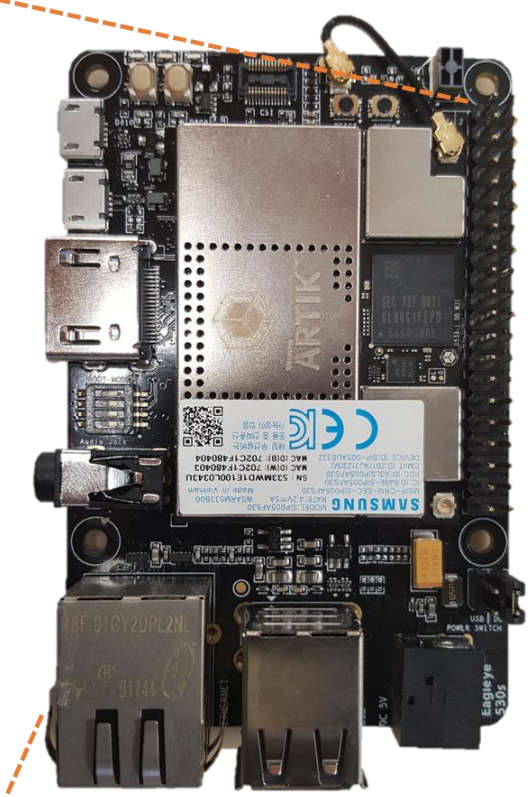
Analog CO2 Sensor

SEN0159 Specification https://www.dfrobot.com/wiki/index.php/CO2_Sensor_SKU:SEN0159

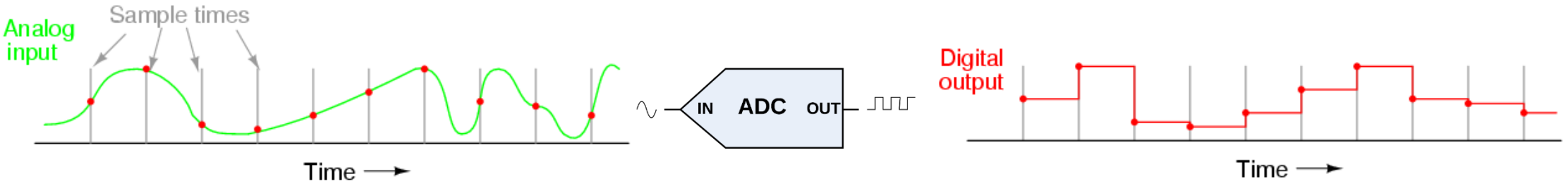
- Operating voltage:5V
- The output voltage of the module falls as the concentration of the CO2 increases
- Interface: **Analog**
- Size:32x42mm

GND
VCC
Analog signal output

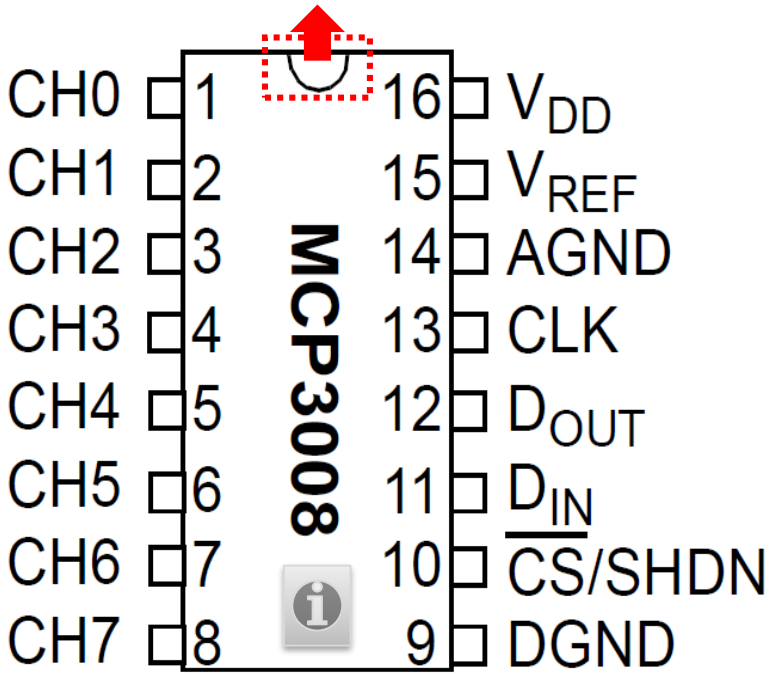
3.3V	1	2	5V
I2C_SDA	3	4	5V
I2C_SCL	5	6	GND
AGPIO0	7	8	UART_TX
GND	9	10	UART_RX
GPIO0	11	12	I2SBLK1
GPIO1	13	14	GND
PWM2	15	16	GPIO2
3.3V	17	18	GPIO3
SPI_MOSI	19	20	GND
SPI_MISO	21	14	PWM0
SPI_CLK	23	24	SPI_CS
GND	25	26	GPIO4
NC	27	28	NC
GPIO9	29	30	GND
GPIO6	31	32	GPIO7
GPIO8	33	34	GND
I2SLRCLK1	35	36	ADC0
ADC1	37	38	I2SDIN1
GND	39	40	I2SDOUT1



Analog to Digital Converter



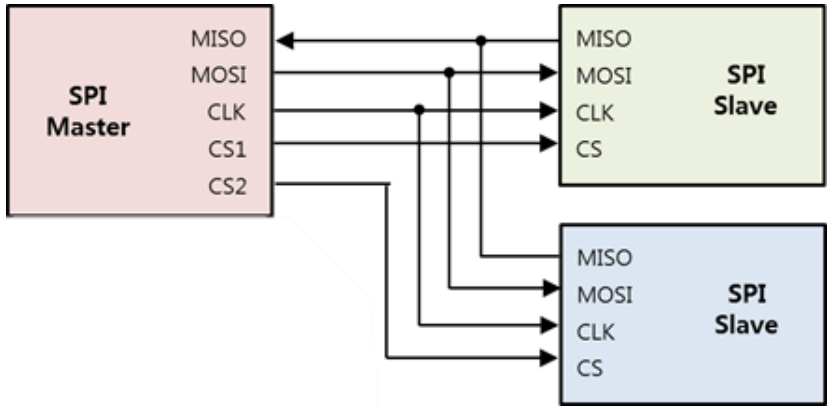
- **MCP3008 Features**
  - 10-bit resolution (0 ~ 1023)
  - 8 input channels
  - **SPI serial interface**
  - Single supply operation: 2.7V - 5.5V



SPI (Serial Peripheral Interface)

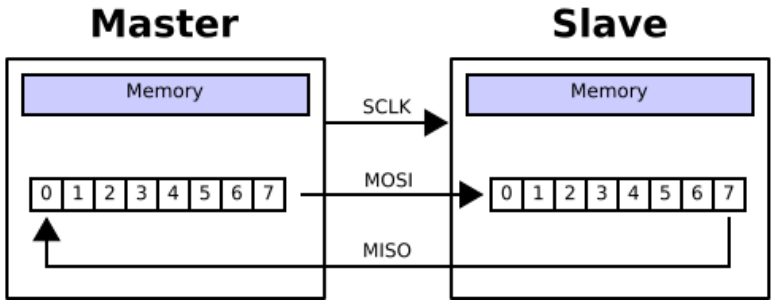
Interface (4 wire)

- CLK: Serial Clock (output from master)
- MOSI: Master Output Slave Input (Slave - D_{IN})
- MISO: Master Input Slave Output(Slave - D_{OUT})
- CS: Chip Select (aka, Slave Select)

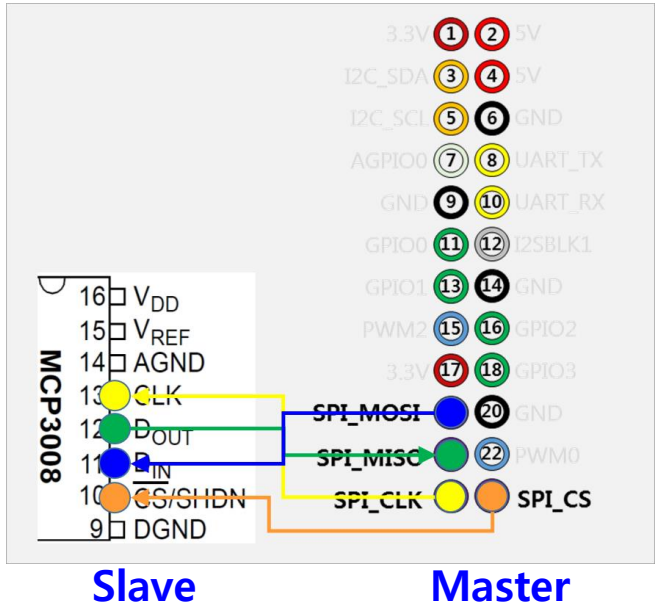


Operation

- 2개의 shift register를 이용해서 circular buffer로 동작
  - 한번에 1 bit씩 주고 받음



※ https://en.wikipedia.org/wiki/Serial_Peripheral_Interface_Bus



SPI (Serial Peripheral Interface) on Tizen

Peripheral I/O SPI API

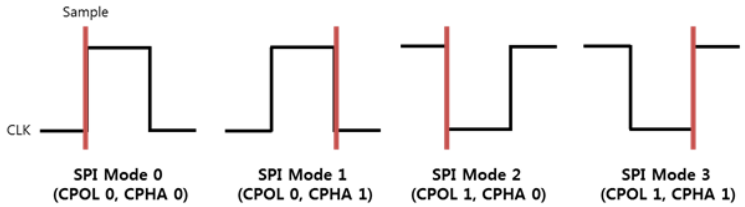
/* Open & Close interface */ ← 보드 정보 필요

int peripheral_spi_open(int **bus**, int **cs**, peripheral_spi_h *spi);

int peripheral_spi_close(peripheral_spi_h spi);

Table: ARTIK 530

Pin name				Bus (parameter1)	Chip Select (parameter 2)
SPI0_MOSI	SPI0_MISO	SPI0_CLK	SPI0_CS	2	0



/* Setup interface */ ← MCP3008 정보 필요

int peripheral_spi_set_mode(peripheral_spi_h spi, peripheral_spi_mode_e **mode**);

int peripheral_spi_set_bit_order(peripheral_spi_h spi, peripheral_spi_bit_order_e **bit_order**);

int peripheral_spi_set_bits_per_word(peripheral_spi_h spi, uint8_t **bits**);

int peripheral_spi_set_frequency(peripheral_spi_h spi, uint32_t **freq_hz**);

/* Transfer data */ ← MCP3008 정보 필요

int peripheral_spi_transfer(peripheral_spi_h spi, uint8_t *txdata, uint8_t *rxdata, uint32_t **length**);

SPI (Serial Peripheral Interface)

실습

Sample code

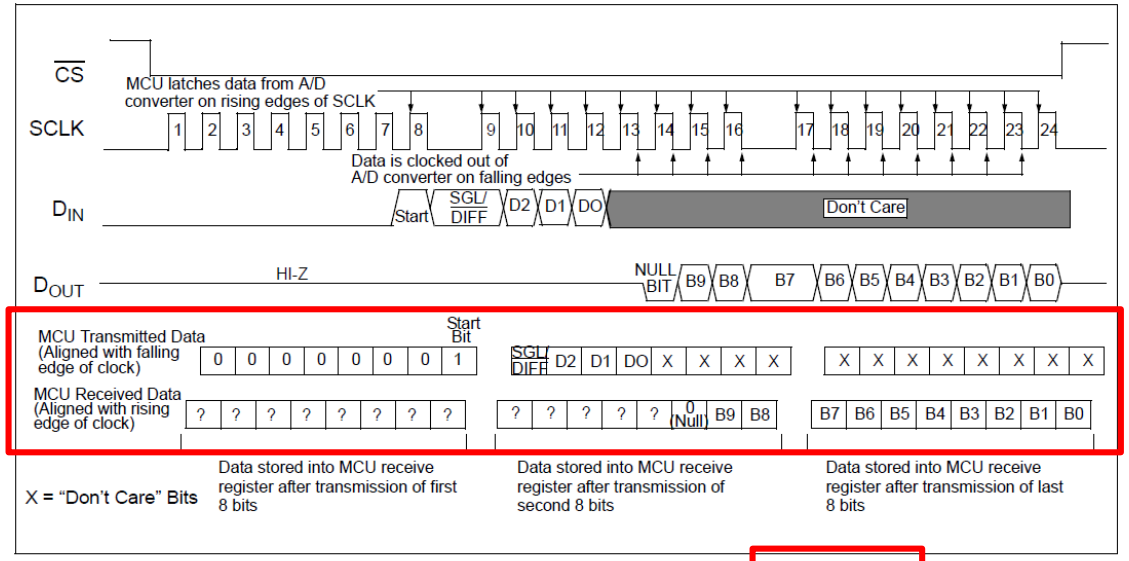
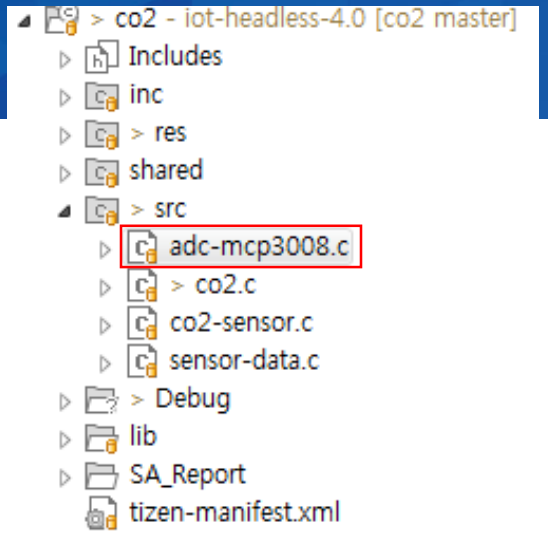


FIGURE 6-1: SPI Communication with the MCP3004/3008 using 8-bit segments (Mode 0,0: SCLK idles low).

1. 8bit짜리 데이터(word) 3개
2. most significant bit first




```
int adc_mcp3008_init(void)
{
  ……
  peripheral_spi_set_mode(MCP3008_H, PERIPHERAL_SPI_MODE_X);
  peripheral_spi_set_bit_order(MCP3008_H,
        PERIPHERAL_SPI_BIT_ORDER_XXX);
  peripheral_spi_set_bits_per_word(MCP3008_H, X);
  peripheral_spi_set_frequency(MCP3008_H, MCP3008_SPEED);
  ……
}
```

SPI (Serial Peripheral Interface)

Sample code

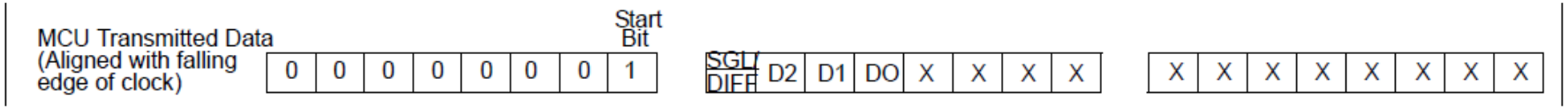


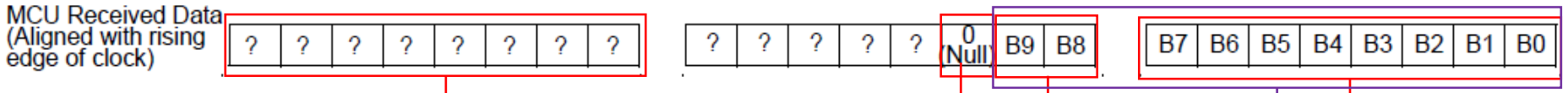
TABLE 5-2: CONFIGURE BITS FOR THE MCP3008

Control Bit Selections				Input Configuration	Channel Selection
Single /Diff	D2	D1	D0		
1	0	0	0	single-ended	CH0
1	0	0	1	single-ended	CH1
1	0	1	0	single-ended	CH2
1	0	1	1	single-ended	CH3
1	1	0	0	single-ended	CH4
1	1	0	1	single-ended	CH5
1	1	1	0	single-ended	CH6
1	1	1	1	single-ended	CH7

```
int adc_mcp3008_read(int ch_num, unsigned int *out_value)
{
        unsigned char rx[3] = {0, };
        unsigned char tx[3] = {0, };
        ......

        tx[0] = MCP3008_TX_WORD1; /*  0x01     (0b00000001) */
        switch (ch_num) {
        case 0:
                tx[1] = MCP3008_TX_CH0; /* 0x80    (0b10000000) */
                break;
        case 1:
                tx[1] = MCP3008_TX_CH1;
                break;
         ........
        }
        tx[2] = MCP3008_TX_WORD3; /* 0x00      (0b00000000) */

        peripheral_spi_transfer(MCP3008_H, tx, rx, 3);
}
```

SPI (Serial Peripheral Interface)

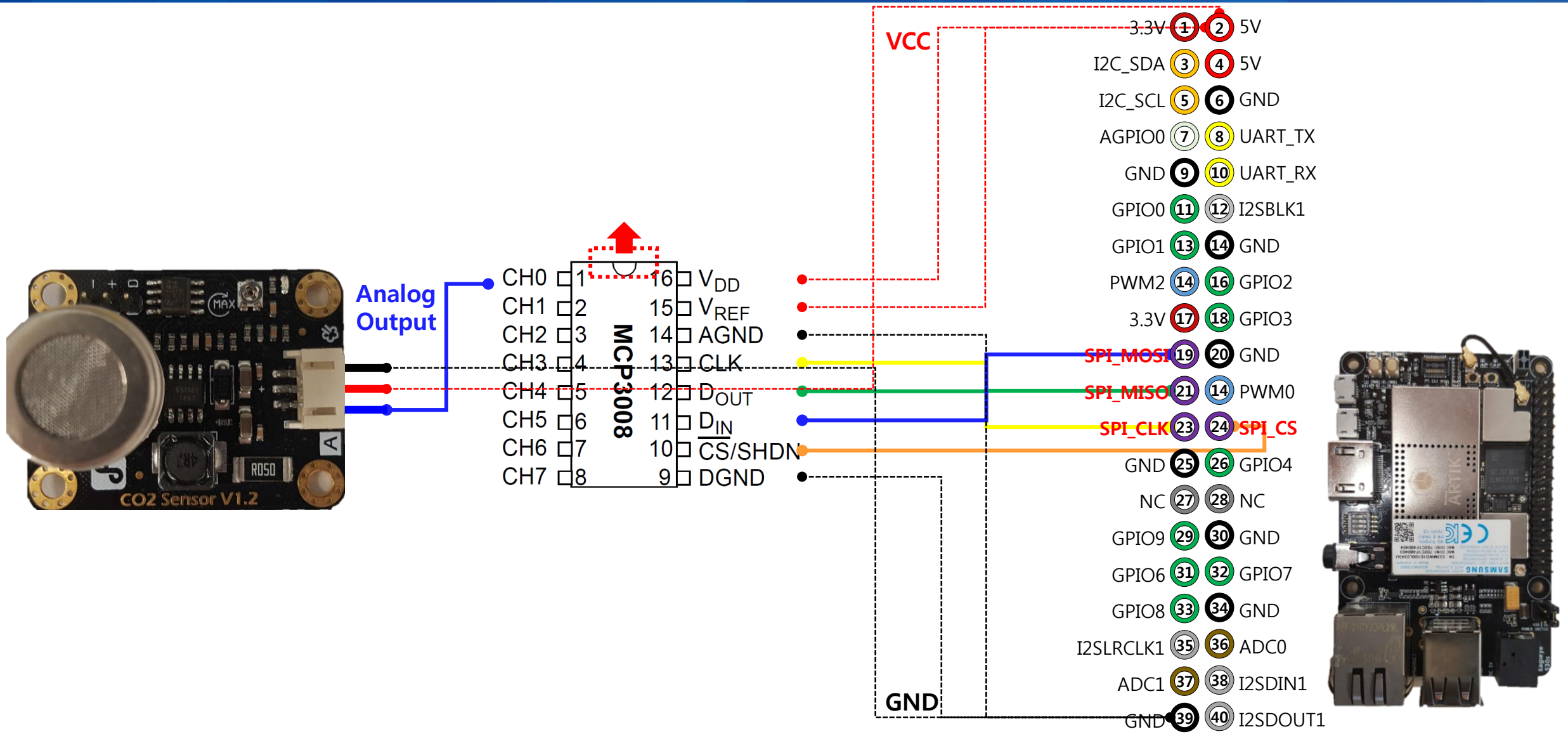
Sample code




```
int adc_mcp3008_read(int ch_num, unsigned int *out_value)
{
        unsigned char rx[3] = {0, };
        ......
        peripheral_spi_transfer(MCP3008_H, tx, rx, 3);
        rx_w1 = rx[0] & MCP3008_RX_WORD1_MASK; /* 0x00 (0b00000000) */
        retv_if(rx_w1 != 0, -1);

        rx_w2_nb = rx[1] & MCP3008_RX_WORD2_NULL_BIT_MASK; /* 0x04 (0b0000010) */
        retv_if(rx_w2_nb != 0, -1); /* 두번째 데이터의 null bit 체크 */

        rx_w2 = rx[1] & MCP3008_RX_WORD2_MASK; /* 0x03 (0b00000011) */
         /* 두번째 데이터의 2 bit 사용 */
        rx_w3 = rx[2] & MCP3008_RX_WORD3_MASK; /* 0xFF (0b11111111 ) */
         /* 세번째 데이터의 8 bit 사용 */
        result = ((rx_w2 << 8) | (rx_w3)) & UINT10_VALIDATION_MASK;  /* 0x3FF */
         /* 10 bit 결과 생성 */
        *out_value = result;
        return 0;
}
```

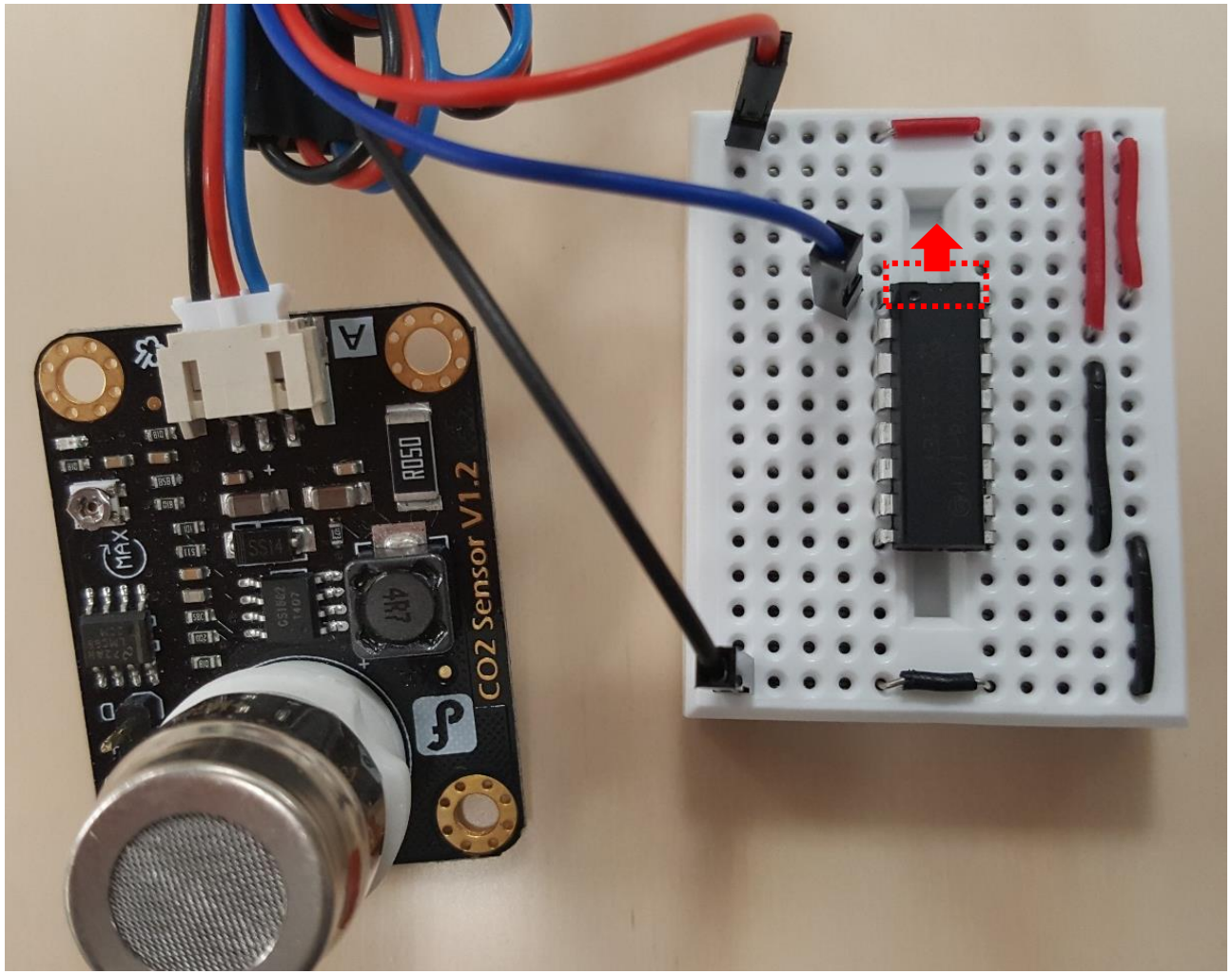
Pause

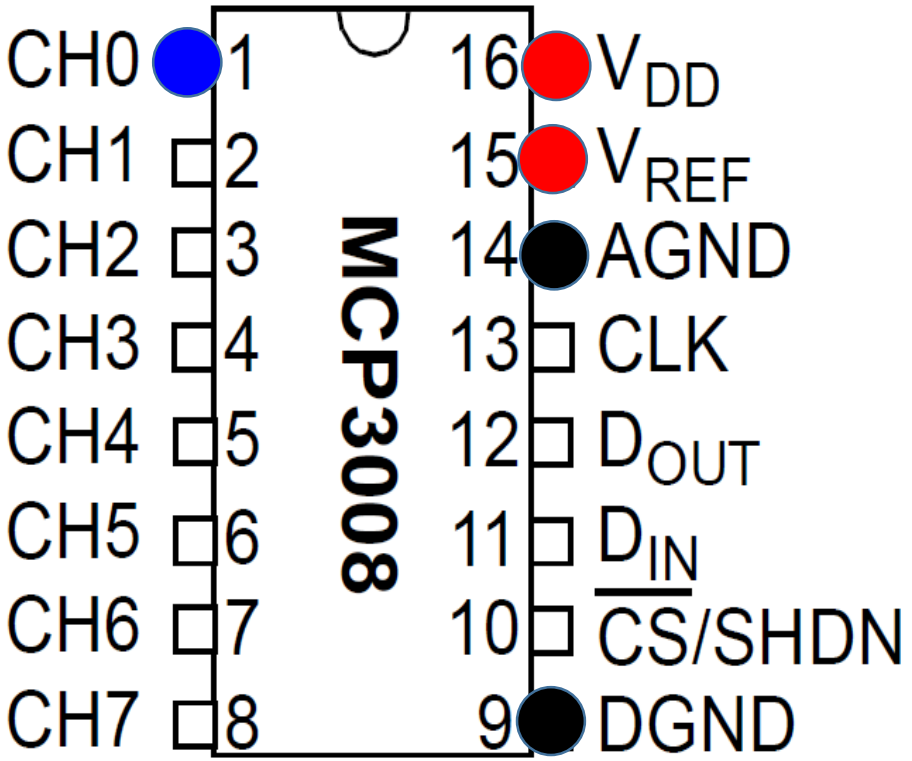
How to connect analog CO2 sensor



연결 순서 (사진)

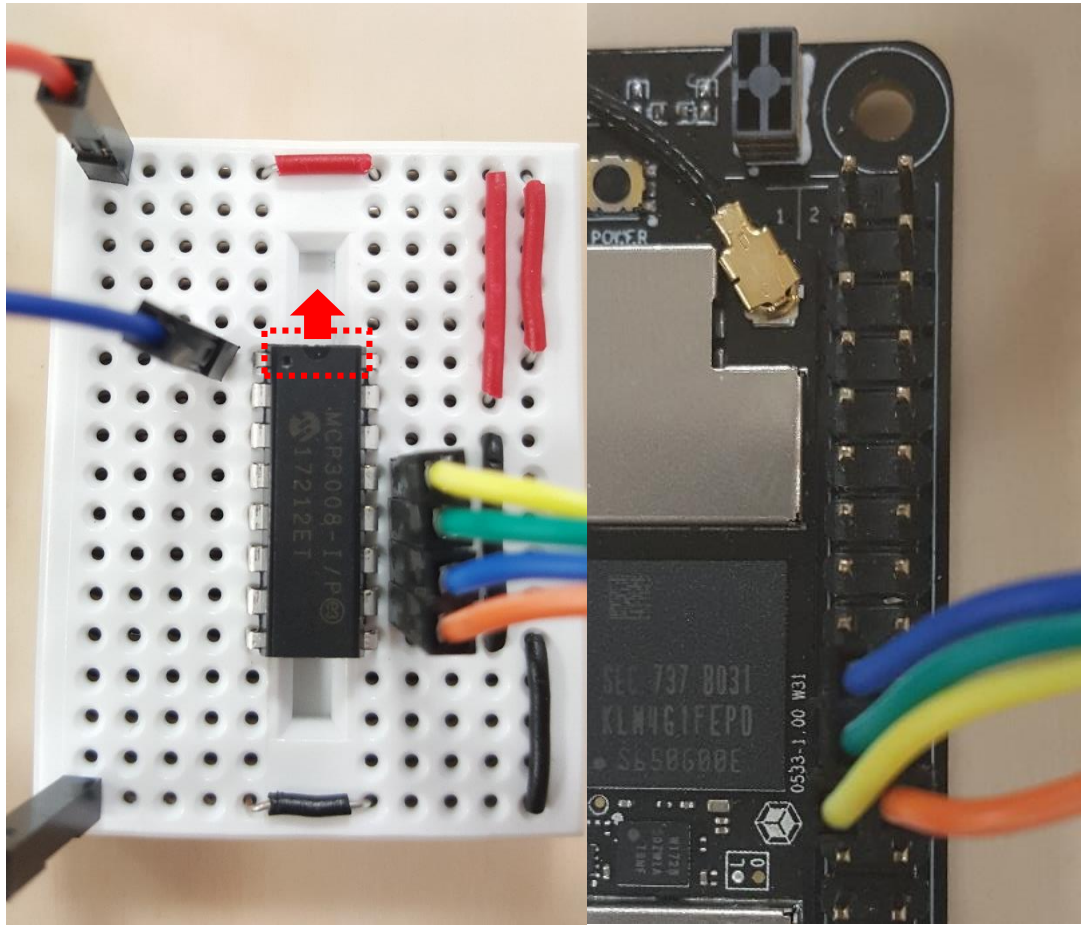
① CO2 ←→ ADC 및 VCC, GND 연결

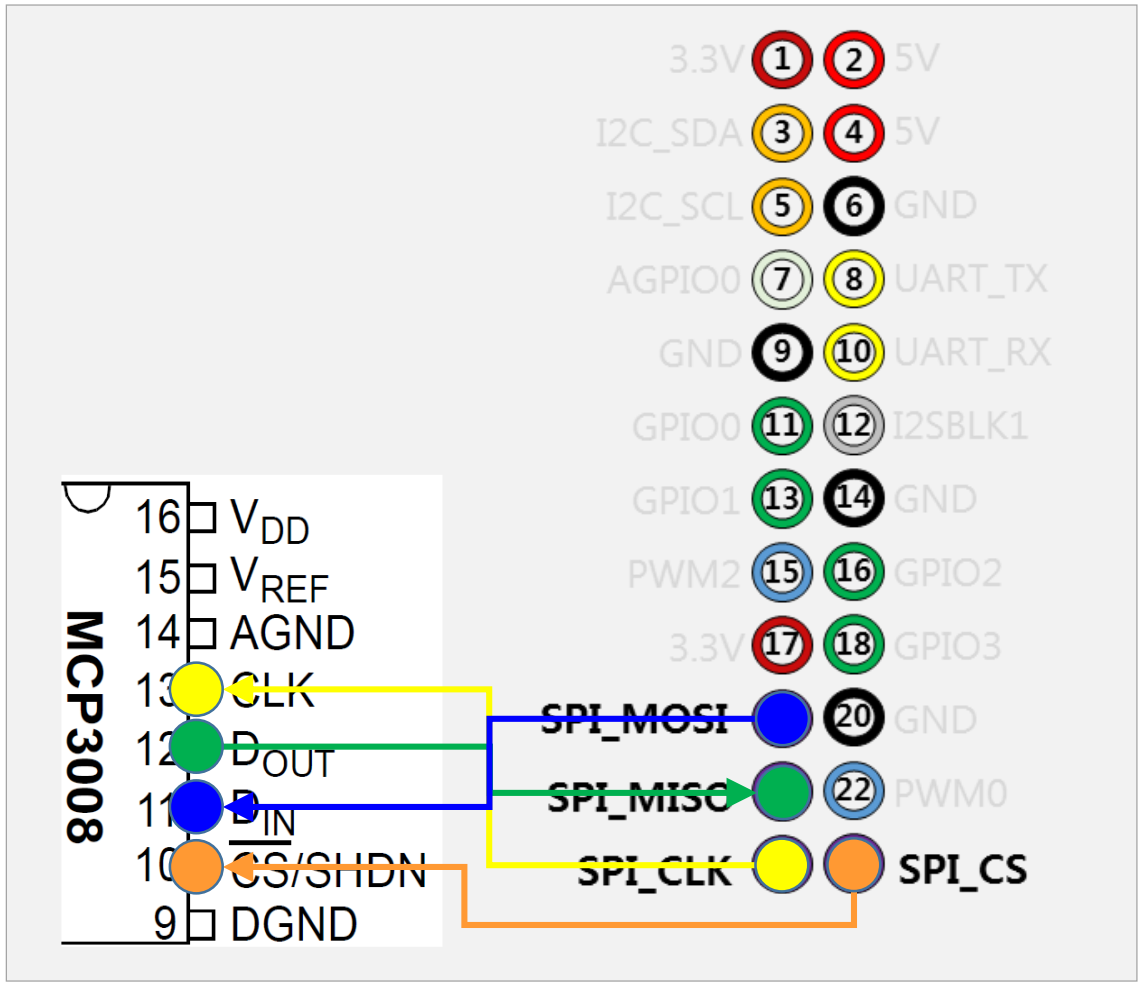




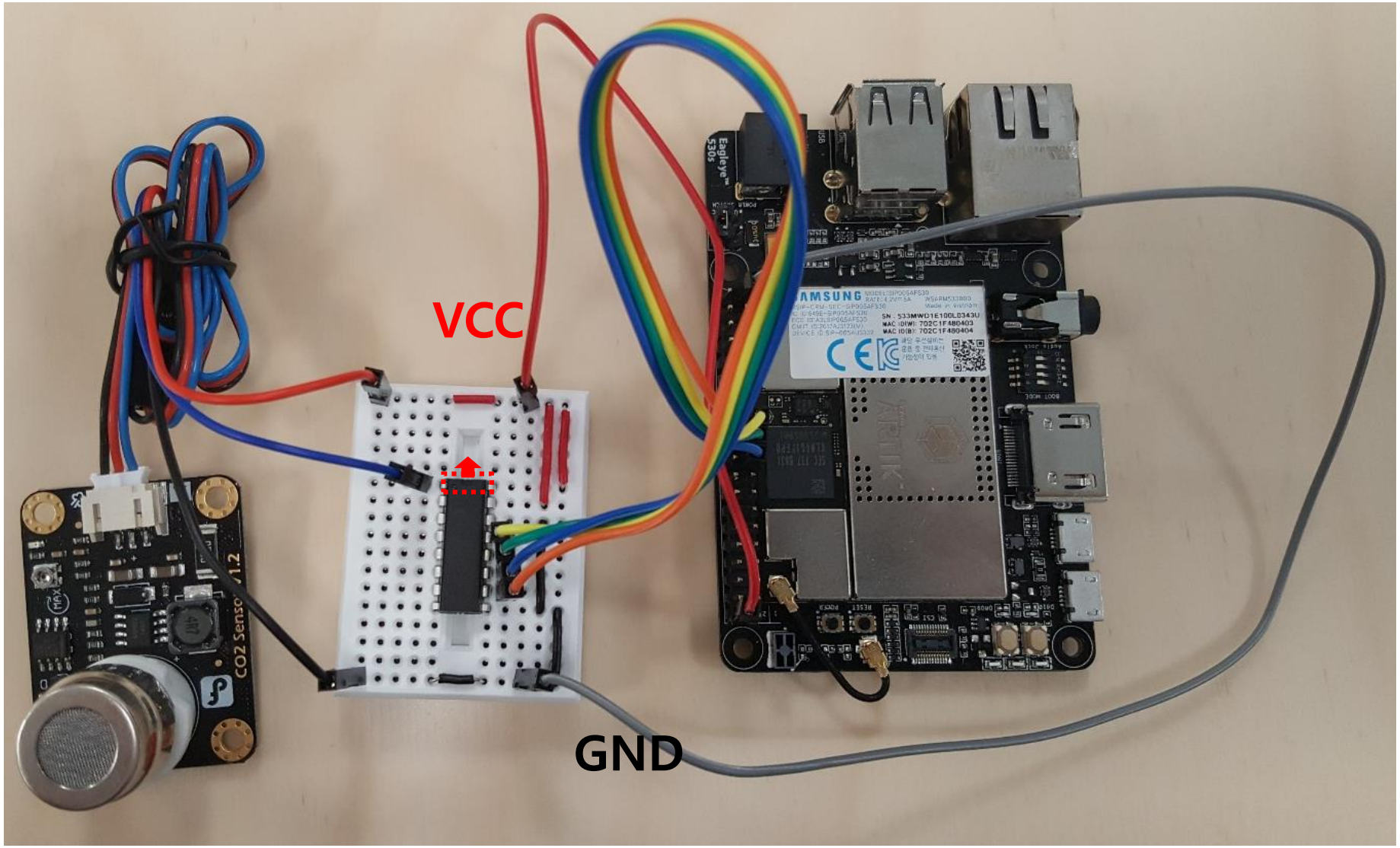
연결 순서 (사진)

② ADC ←→ Eagleye 530s





연결모습(사진)



Sample Application 작성 (without SmartThings)

실습

APP 작성

```
static void gathering_start(void *data)
{
   app_data *ad = data;
   ……
   if (ad->getter_co2)
     ecore_timer_del(ad->getter_co2);

   ad->getter_co2 =
     ecore_timer_add(SENSOR_GATHER_INTERVAL, __get_co2,
ad);

   return;
}
```

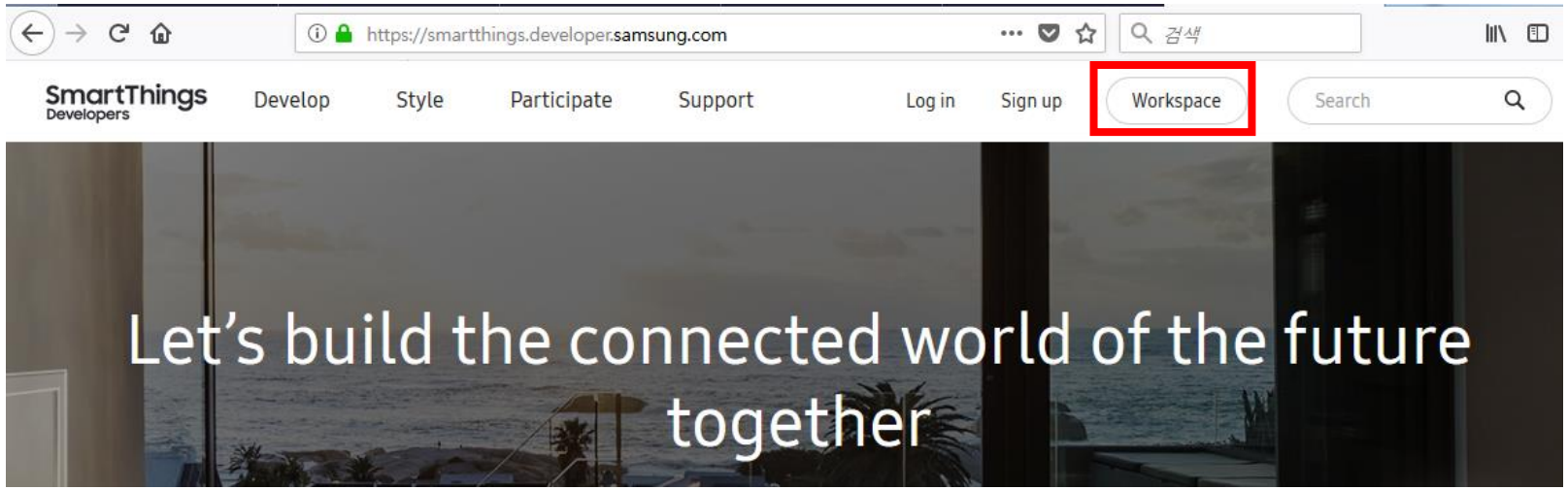
```
static Eina_Bool __get_co2(void *data)
{
     int ret = 0;
     unsigned int value = 0;
     static unsigned int sum = 0;
     static unsigned int count = 0;

     app_data *ad = data;
     ……
     ret = co2_sensor_read(CH_CO2, &value);
     count++;
     sum += value;

     if (count == TOTAL_COUNT) {
       unsigned int avg = 0;
       avg = sum/TOTAL_COUNT;

       _D("co2 avg value - %u", avg);
       sensor_data_set_uint(ad->co2_data, avg);
       ……
       count = 0;
       sum = 0;
     }
     return ECORE_CALLBACK_RENEW;
}
```

Sample Application 작성 (with SmartThings)

실습

Smart Things Device 생성

- https://smartthings.developer.samsung.com → https://devworkspace.developer.samsung.com

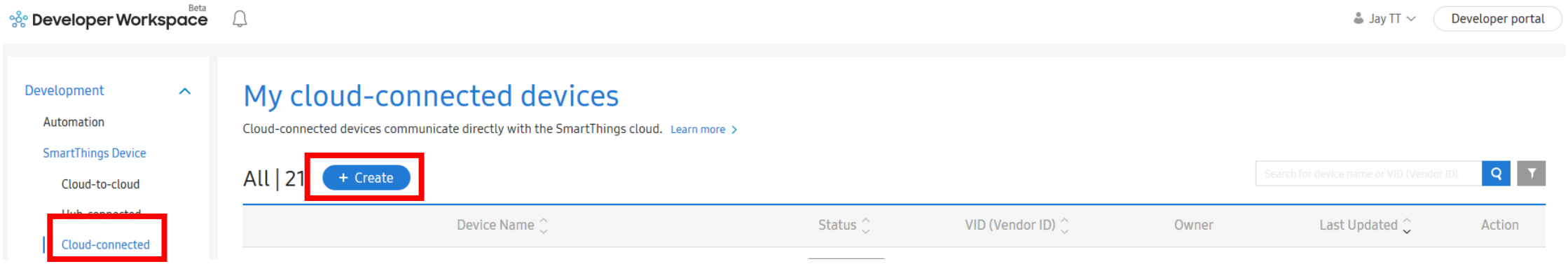


Sample Application 작성 (with SmartThings)

실습

Smart Things Device 생성

- Cloud connected 선택

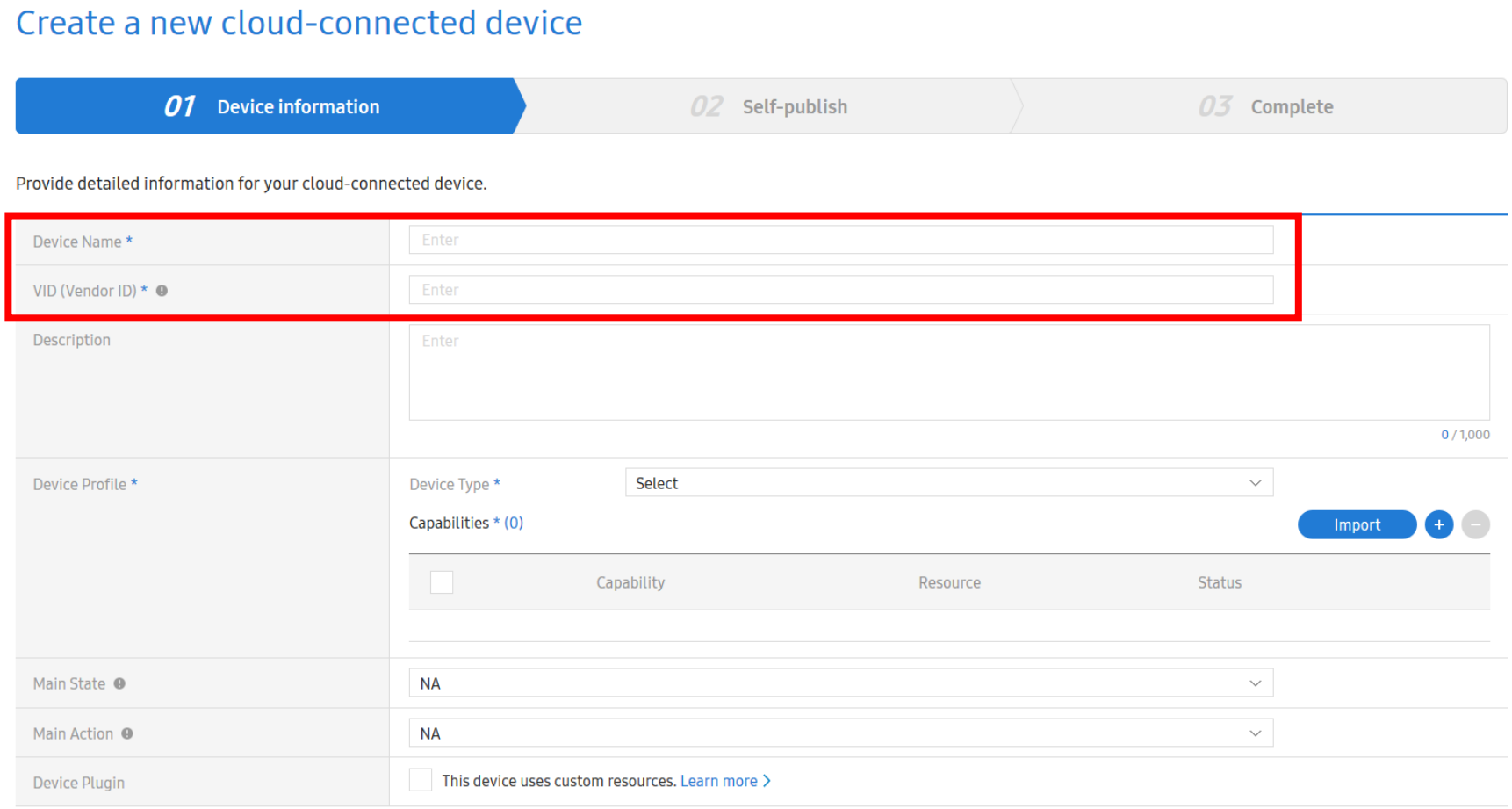


Sample Application 작성 (with SmartThings)

실습

Smart Things Device 생성

- Device 정보 입력



Sample Application 작성 (with SmartThings)

실습

Smart Things Device 생성

- Capabilities 선택

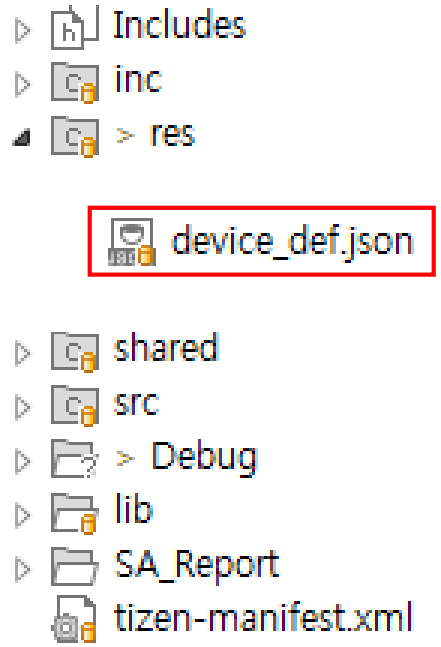
Sample Application 작성 (with SmartThings)

실습

Application 코드 수정

- device_def.json 수정

```
{
  "device": [
    {
      "specification": {
        "device": {
          "deviceName": "Your_Device_Name",
        },
        "platform": {
          "manufacturerName": "MNID",
          "vendorId": "Your_Vender_Name"
        }
      },
……
"configuration": {
    "easySetup": {
      "connectivity": {
        "type": 1,
        "softAP": {
          "setupId": "999",
}
```



Devworkspace에서 생성한 Device정보와 동일하게 수정

https://developer.tizen.org/development/iot-preview/iot-apis/things-sdk-api/device-definition

Sample Application 작성

Things SDK API 복습

int **st_things_set_configuration_prefix_path**(const char* ro_path, const char* rw_path);

int **st_things_initialize**(const char *json_path, bool *easysetup_complete);

int **st_things_register_request_cb**(st_things_get_request_cb get_cb, st_things_set_request_cb set_cb);

int **st_things_register_things_status_change_cb**(st_things_status_change_cb status_cb);

int st_things_register_user_confirm_cb(st_things_user_confirm_cb confirm_cb);

int st_things_register_reset_cb(st_things_reset_confirm_cb confirm_cb, st_things_reset_result_cb result_cb);

int **st_things_start**(void);

int **st_things_notify_observers**(const char *resource_uri);

int **st_things_stop**(void);

int **st_things_deinitialize**(void);

Pause

Sample Application 작성

APP 작성

```
static Eina_Bool __get_co2(void *data)
{
   unsigned int value = 0;
   static unsigned int sum = 0;
   static unsigned int count = 0;
   app_data *ad = data;
   ……
   ret = read_sensor(&value);

   count++;
   sum += value;

   if (count == SENSOR_GATHER_COUNT) {
      unsigned int avg = 0;
      avg = sum/SENSOR_GATHER_COUNT;

      _D("co2 avg value - %u", avg);

      sensor_data_set_uint(ad->co2_data, avg);

#ifdef USE_ST_SDK
      st_things_notify_observers(SENSOR_URI_CO2);
#endif
      ……
}
```

```
23      "resources": {
24        "single": [
25          {
26            "uri": "/capability/airQualitySensor/main/0",
```

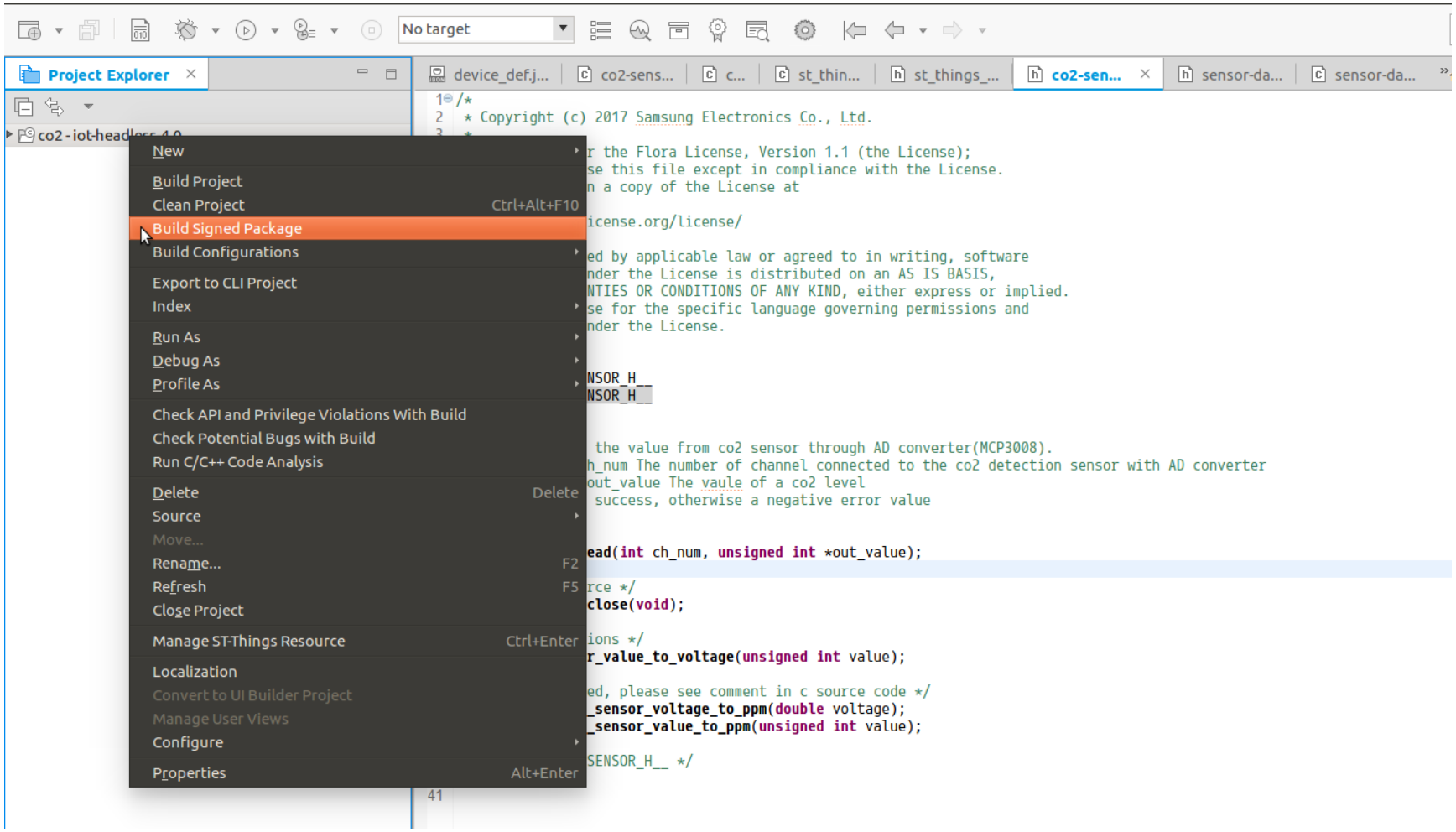
```
static bool handle_get_request(st_things_get_request_message_s* req_msg,
st_things_representation_s* resp_rep)
{
   _D("resource_uri [%s]", req_msg->resource_uri);
   retv_if(!g_ad, false);

   if (0 == strcmp(req_msg->resource_uri, SENSOR_URI_CO2)) {
      _D("query : %s, property: %s", req_msg->query, req_msg->property_key);

      if (req_msg->has_property_key(req_msg, SENSOR_KEY_CO2)) {
         unsigned int value = 0;
         sensor_data_get_uint(g_ad->co2_data, &value);
         resp_rep->set_int_value(resp_rep, SENSOR_KEY_CO2, value);
      }
      ……

      return true;
   }
   _E("not supported uri");
    return false;
```

```
43      "properties": [
44        {
45          "key": "airQuality",
46          "type": 2,
47          "mandatory": true,
48          "rw": 1
49        },
```

Sample Application 작성 (with SmartThings)

실습

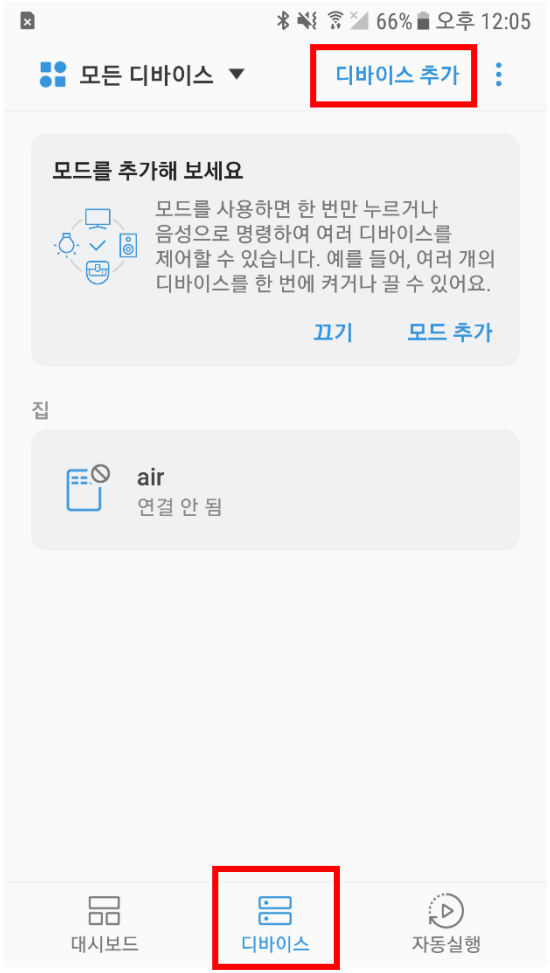
Build Signed Package

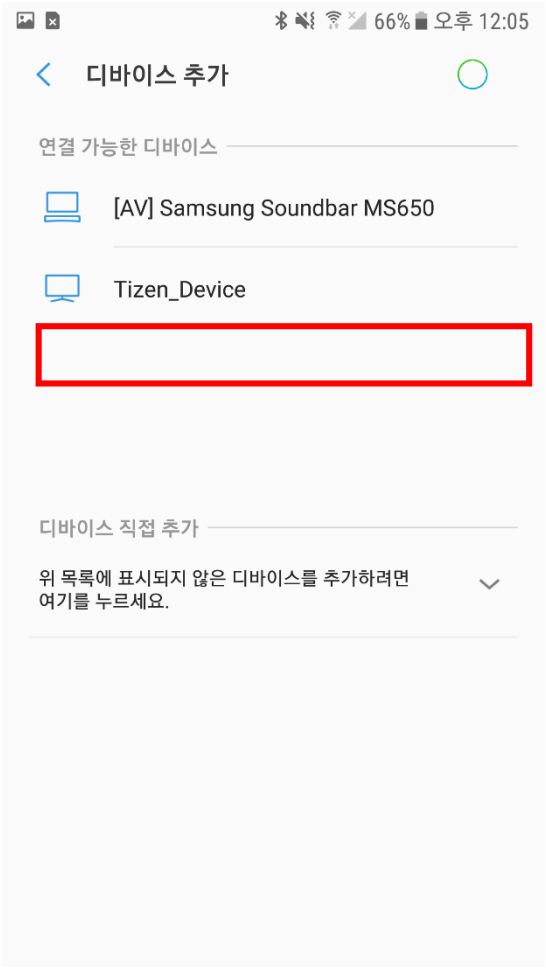


Smart things App에서 데이터 확인하기

실습

Smart things APP에서 장치 추가하기





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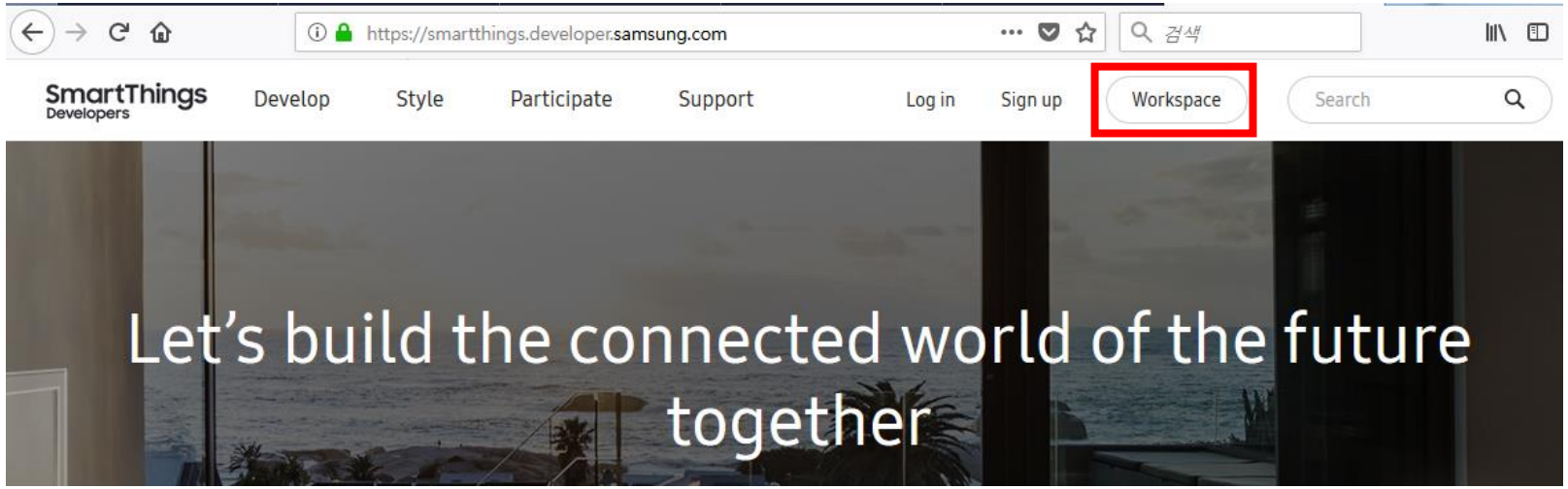
Smart things App에서 데이터 확인하기

- 뭐가 문제지?

Virtual Device 생성하기

개발자 Workspace로 이동

- 실제 단말 application 개발 전 기본 동작 확인 가능
- https://smartthings.developer.samsung.com → https://devworkspace.developer.samsung.com

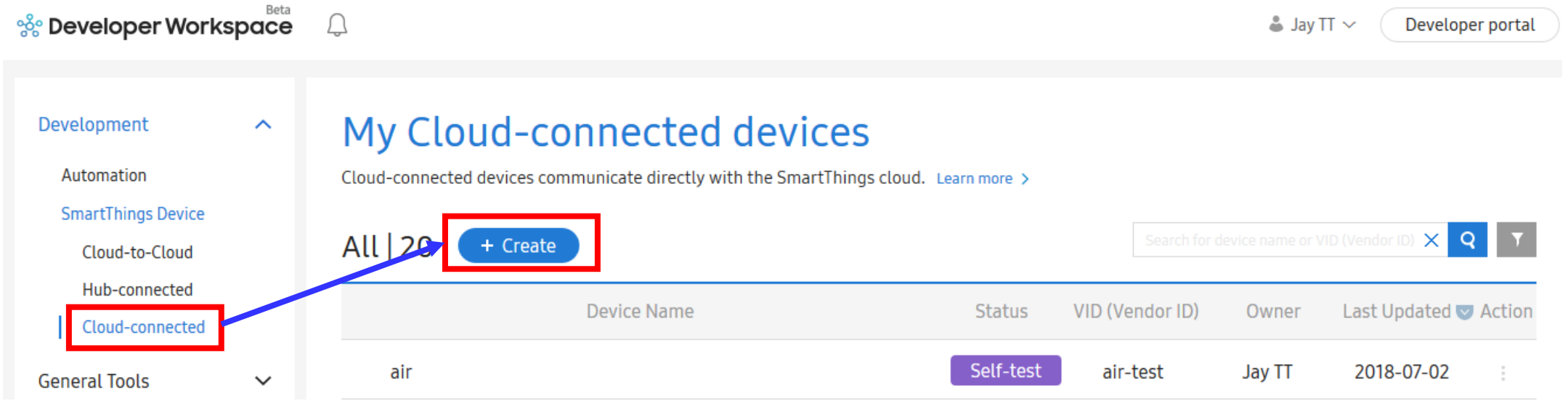


Virtual Device 생성하기

실습

Virtual Device용 profile 생성

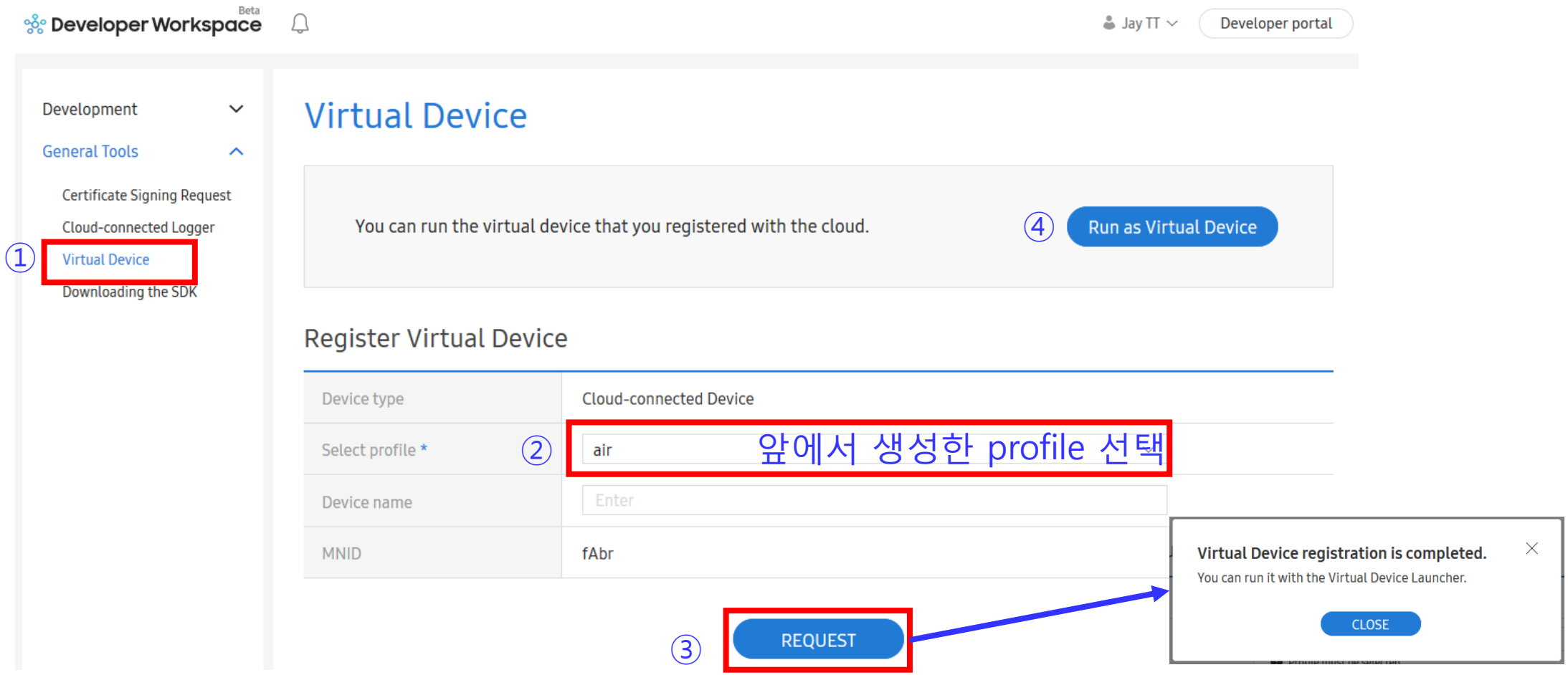
- Cloud-connected 디바이스 profile 생성



Virtual Device 생성하기

실습

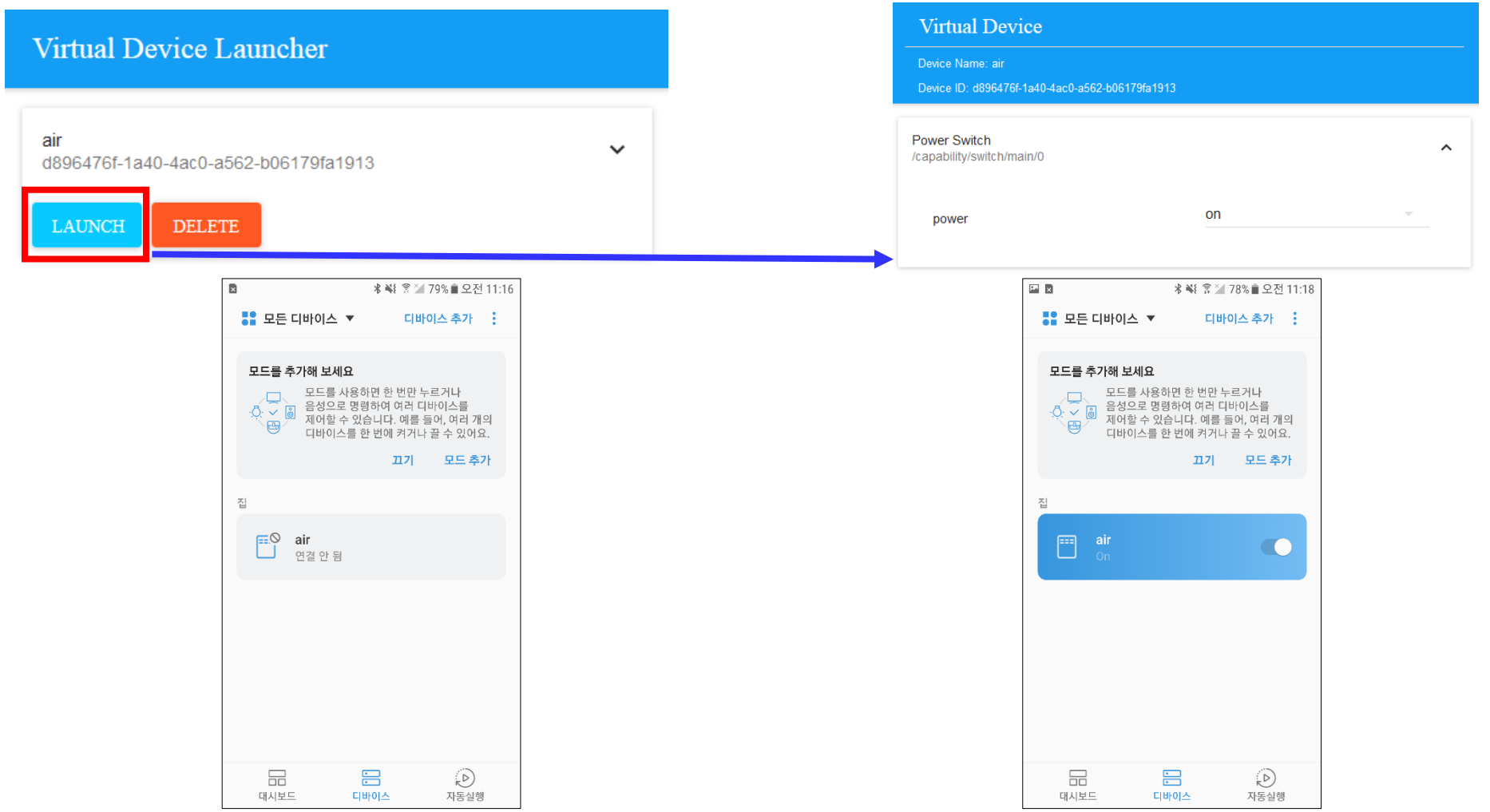
Virtual Device 생성



Virtual Device 생성하기

실습

Virtual Device 실행



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Thank you

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