TI DSP, MCU 및 Xilinx Zynq FPGA 프로그래밍 전문가 과정

- MPU9250 -

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MPU9250

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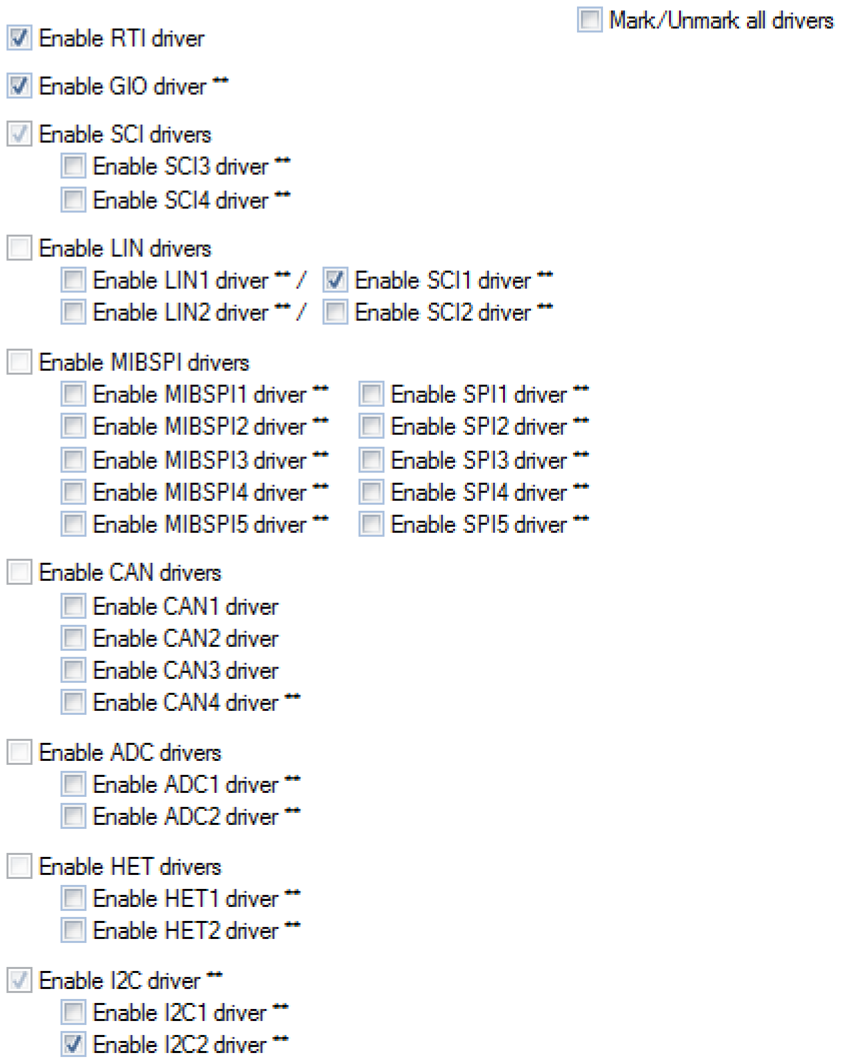
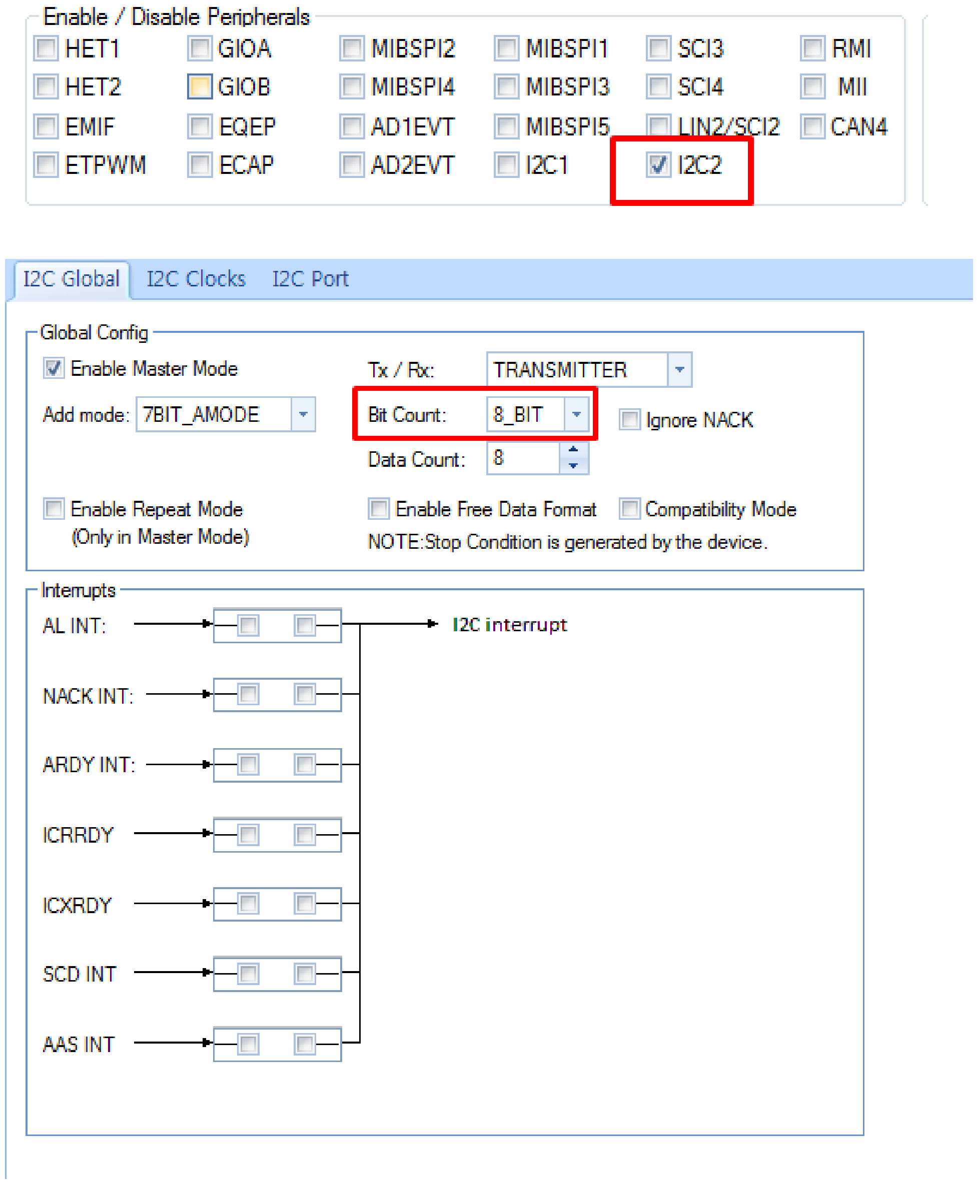
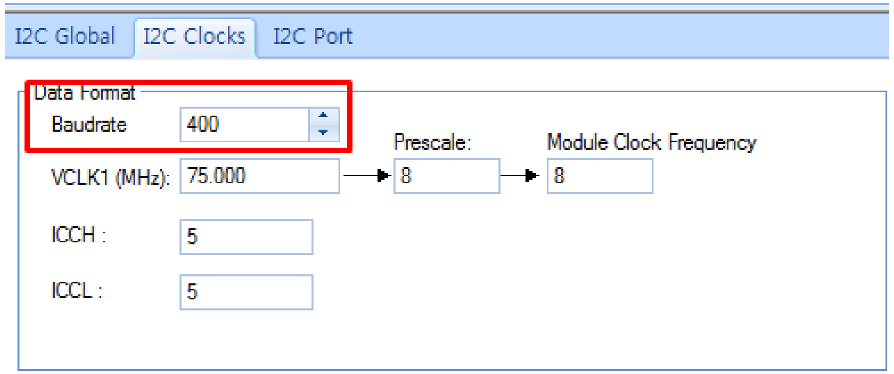
ps. MPU9250 datasheet, zip파일의 추가된 코드와 MPU9250.h를 참고하여 꼭 같이 보세요.

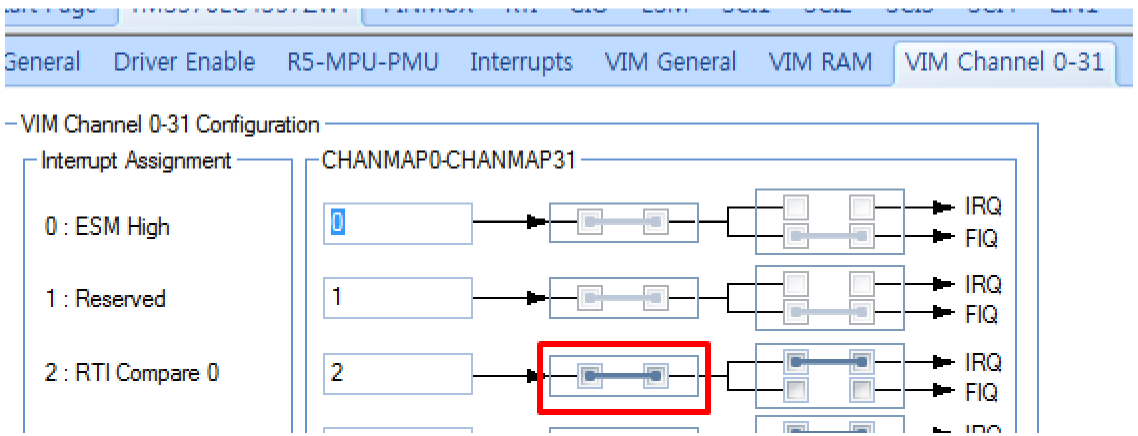
1. HALCOGEN 설정





1. HALCOGEN 설정





2. CODE

```
uint8 c = readByte(MPU9250_ADDRESS, WHO_AM_I_MPU9250); // MPU9250 인식이 되어 제대로 값이 읽어져 오면 0x71이 읽힘.
    sprintf(txt_buf, "I AM = %x\n\r\0", c
            );

    buf_len = strlen(txt_buf);
    sciDisplayText(sciREG1, (uint8 *) txt_buf, buf_len);
if (c == 0x71)
{
    calibrateMPU9250(gyroBias, accelBias); // gyro, acc 평균값 셋팅을 위한 함수
    disp_set("MPU9250 calibration Success!!!!!!\n\r\0");

    initMPU9250(); // MPU9250 초기화
    disp_set("MPU9250 Init Success!!!!!!\n\r\0");

    initAK8963(magCalibration); // 지자기 초기화
    disp_set("MPU9250 AK8963 Init Success!!!!!!\n\r\0");

    get_offset_value(); // gyro 값을 1000번을 읽어 평균값을 구하는 함수
    disp_set("gyro_offset_setting Success!!\n\r\0");
```

2. CODE

```
void getGres() {
  switch (Gscale)
  {
    // Possible gyro scales (and their register bit settings) are:
    // 250 DPS (00), 500 DPS (01), 1000 DPS (10), and 2000 DPS  (11).
    // Here's a bit of an algorith to calculate DPS/(ADC tick) based on that 2-bit value:
  case GFS_250DPS:
    gRes = 250.0/32768.0;
    break;
  case GFS_500DPS:
    gRes = 500.0/32768.0;
    break;
  case GFS_1000DPS:
    gRes = 1000.0/32768.0;
    break;
  case GFS_2000DPS:
    gRes = 2000.0/32768.0;
    break;
  }
}
```

```
void getMres() {
  switch (Mscale)
  {
    // Possible magnetometer scales (and their register bit settings) are:
    // 14 bit resolution (0) and 16 bit resolution (1)
  case MFS_14BITS:
    mRes = 10.0 * 4219.0/ 8190.0; // Proper scale to return milliGauss
    break;
  case MFS_16BITS:
    mRes = 10.0 * 4219.0/ 32760.0; // Proper scale to return milliGauss
    break;
  }
}
```

```
void getAres(void) {
  switch (Ascale)
  {
    // Possible accelerometer scales (and their register bit settings) are:
    // 2 Gs (00), 4 Gs (01), 8 Gs (10), and 16 Gs  (11).
    // Here's a bit of an algorith to calculate DPS/(ADC tick) based on that 2-bit value:
  case AFS_2G:
    aRes = 2.0/32768.0;
    break;
  case AFS_4G:
    aRes = 4.0/32768.0;
    break;
  case AFS_8G:
    aRes = 8.0/32768.0;
    break;
  case AFS_16G:
    aRes = 16.0/32768.0;
    break;
  }
}
```

1. 원하는 스케일링 값을 확인한다.

2. 다음 ppt를 본다.

2. CODE

*MPU9250.h   *HL_sys_main.c

```c
#define AHRS true         // set to false for basic data read
#define SerialDebug true  // set to true to get Serial output for debugging


enum Ascale {
  AFS_2G = 0,
  AFS_4G,
  AFS_8G,
  AFS_16G
};

enum Gscale {
  GFS_250DPS = 0,
  GFS_500DPS,
  GFS_1000DPS,
  GFS_2000DPS
};

enum Mscale {
  MFS_14BITS = 0, // 0.6 mG per LSB
  MFS_16BITS      // 0.15 mG per LSB
};

uint8 Gscale = GFS_500DPS;
uint8 Ascale = AFS_2G;
uint8 Mscale = MFS_16BITS; // Choose either 14-bit or 16-bit magnetometer resolution
uint8 Mmode = 0x02;        // 2 for 8 Hz, 6 for 100 Hz continuous magnetometer data read
```

1. 위에서 설정한 스펙을 확인 후, 스케일링하는 부분으로 3번째 박스 부분에서 enum 부분의 원하는 값으로 선택해야 합니다. 주의!!

2. CODE

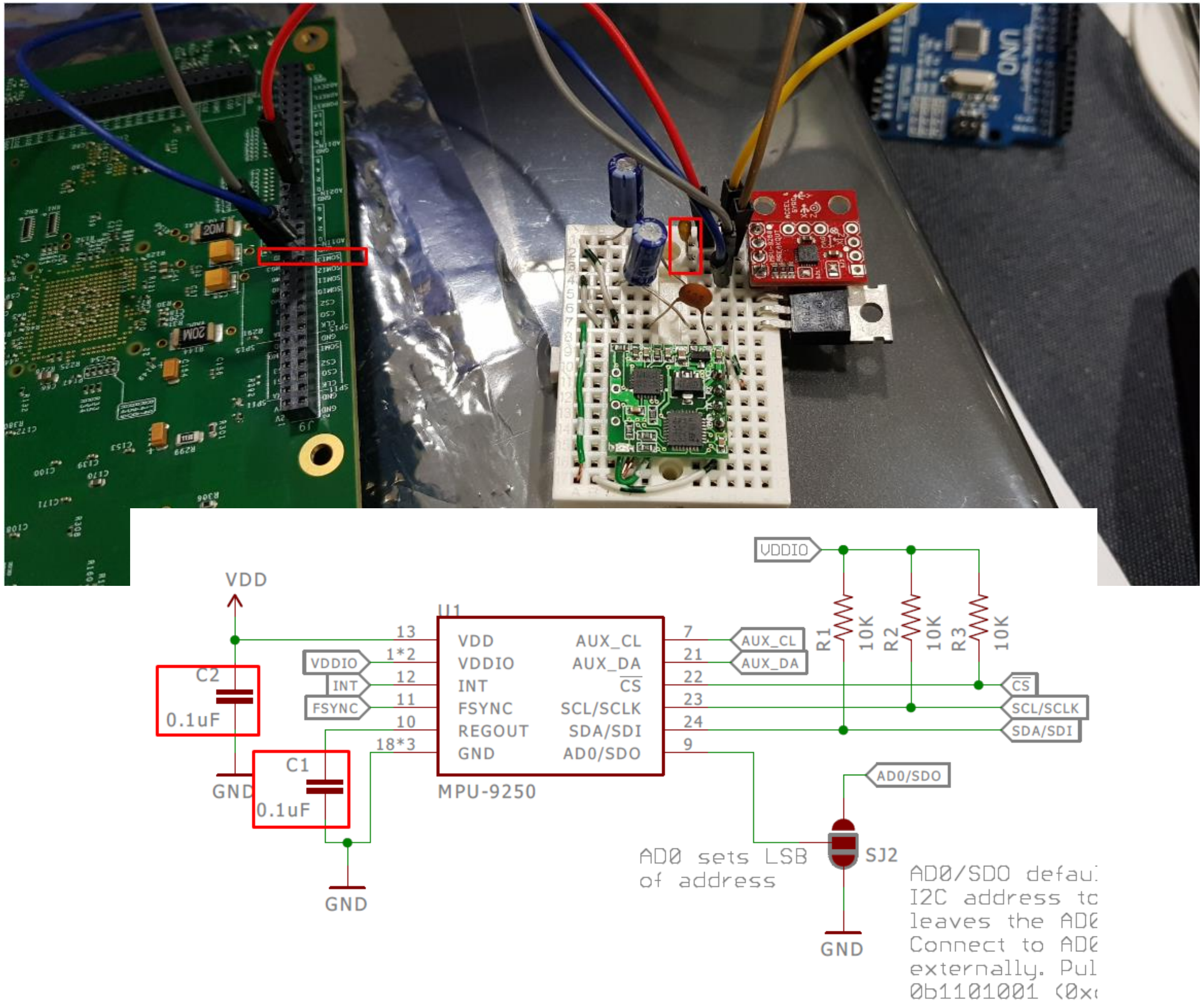
```
            /*보고 싶은 영역의 주석을 풀어 값이 잘 나오는지 확인을 해보면 됨.*/
            /*가속도 mg로 표현하기 때문에 1000을 곱한 것임. 즉 1g임*/
//            sprintf(txt_buf, "acc_x = %f \t acc_y = %f \t acc_z = %f \n\r\0",
//                    1000 * ax   , 1000 * ay   , 1000 * az );
//
//            buf_len = strlen(txt_buf);
//            sciDisplayText(sciREG1, (uint8 *) txt_buf, buf_len);
//            wait(3000000);

            /*각속도*/
//            sprintf(txt_buf, "GYRO_x = %d \t GYRO_y = %d \t GYRO_z = %d \n\r\0",
//                       ((int)gx)   , ((int)gy)   , ((int)gz) );
//
//            buf_len = strlen(txt_buf);
//            sciDisplayText(sciREG1, (uint8 *) txt_buf, buf_len);
//            wait(1000000);

            /*지자기*/
//            sprintf(txt_buf, "MAG_x = %f \t MAG_y = %f \t MAG_z = %f \n\r\0",
//                    mx   , my   , mz );
//
//            buf_len = strlen(txt_buf);
//            sciDisplayText(sciREG1, (uint8 *) txt_buf, buf_len);
//            wait(1000000);
```

1. 주석을 풀어 본인이 보기 원하는 부분을 보면 됩니다.

3. SIMULATION



1. I2C에 핀 연결을 왼쪽의 사진처럼 해줍니다.
2. MPU9250에서 제공해주는 데이터 시트처럼 다이오드를 연결해주면 전압의 안정효과를 볼 수 있습니다.

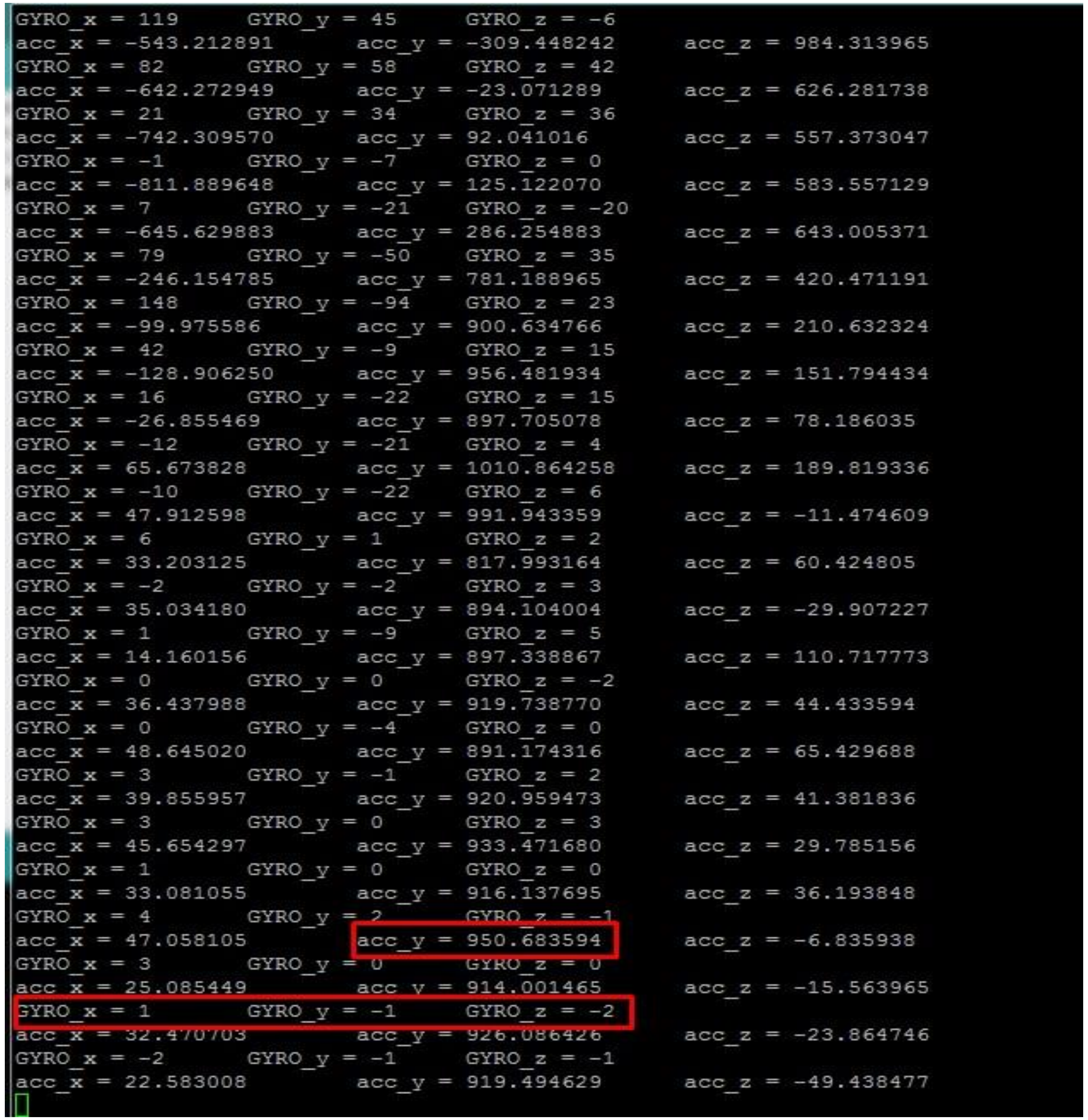
3. SIMULATION

```
SCI Configuration Success!!
GIO Init Success!!
I2C Init Success!!
I AM = 71
MPU9250 calibration Success!!!!!!
MPU9250 Init Success!!!!!!
MPU9250 AK8963 Init Success!!!!!!
gyro_offset_setting Success!!
RTI Init Success!!
acc_x = -0.488281        acc_y = 3.845215        acc_z = 996.032715
GYRO_x = 0       GYRO_y = 0      GYRO_z = 0
acc_x = 0.610352         acc_y = 6.591797        acc_z = 999.877930
GYRO_x = 0       GYRO_y = 0      GYRO_z = 0
acc_x = 1.098633         acc_y = 3.601074        acc_z = 993.286133
GYRO_x = 0       GYRO_y = 0      GYRO_z = 0
acc_x = -0.671387        acc_y = 4.333496        acc_z = 997.985840
GYRO_x = 0       GYRO_y = 0      GYRO_z = 0
acc_x = 1.159668         acc_y = 5.554199        acc_z = 999.633789
GYRO_x = 0       GYRO_y = 0      GYRO_z = 0
acc_x = -0.671387        acc_y = 4.455566        acc_z = 994.567871
GYRO_x = 0       GYRO_y = 0      GYRO_z = 0
acc_x = 0.427246         acc_y = 5.981445        acc_z = 994.262695
GYRO_x = 0       GYRO_y = 0      GYRO_z = 0
acc_x = 2.319336         acc_y = 7.385254        acc_z = 994.873047
GYRO_x = 0       GYRO_y = 0      GYRO_z = 0
acc_x = -0.915527        acc_y = 6.408691        acc_z = 1001.098633
GYRO_x = 0       GYRO_y = 0      GYRO_z = 0

acc_x = 3.234863         acc_y = 5.859375        acc_z = 992.431641
GYRO_x = 0       GYRO_y = 0      GYRO_z = 0
acc_x = 2.502441         acc_y = 7.751465        acc_z = 992.614746
GYRO_x = 0       GYRO_y = 0      GYRO_z = 0
acc_x = 4.150391         acc_y = 5.737305        acc_z = 998.413086
GYRO_x = 0       GYRO_y = 0      GYRO_z = 0
acc_x = 2.624512         acc_y = 3.906250        acc_z = 994.873047
GYRO_x = 0       GYRO_y = 0      GYRO_z = 0
acc_x = 2.685547         acc_y = 3.540039        acc_z =
```

1. 가속도가 z방향으로 1000mg 거의 1g가 잘 나오는 것을 확인할 수 있습니다.

3. SIMULATION



```
GYRO_x = 119      GYRO_y = 45      GYRO_z = -6
acc_x = -543.212891      acc_y = -309.448242      acc_z = 984.313965
GYRO_x = 82      GYRO_y = 58      GYRO_z = 42
acc_x = -642.272949      acc_y = -23.071289      acc_z = 626.281738
GYRO_x = 21      GYRO_y = 34      GYRO_z = 36
acc_x = -742.309570      acc_y = 92.041016      acc_z = 557.373047
GYRO_x = -1      GYRO_y = -7      GYRO_z = 0
acc_x = -811.889648      acc_y = 125.122070      acc_z = 583.557129
GYRO_x = 7      GYRO_y = -21      GYRO_z = -20
acc_x = -645.629883      acc_y = 286.254883      acc_z = 643.005371
GYRO_x = 79      GYRO_y = -50      GYRO_z = 35
acc_x = -246.154785      acc_y = 781.188965      acc_z = 420.471191
GYRO_x = 148      GYRO_y = -94      GYRO_z = 23
acc_x = -99.975586      acc_y = 900.634766      acc_z = 210.632324
GYRO_x = 42      GYRO_y = -9      GYRO_z = 15
acc_x = -128.906250      acc_y = 956.481934      acc_z = 151.794434
GYRO_x = 16      GYRO_y = -22      GYRO_z = 15
acc_x = -26.855469      acc_y = 897.705078      acc_z = 78.186035
GYRO_x = -12      GYRO_y = -21      GYRO_z = 4
acc_x = 65.673828      acc_y = 1010.864258      acc_z = 189.819336
GYRO_x = -10      GYRO_y = -22      GYRO_z = 6
acc_x = 47.912598      acc_y = 991.943359      acc_z = -11.474609
GYRO_x = 6      GYRO_y = 1      GYRO_z = 2
acc_x = 33.203125      acc_y = 817.993164      acc_z = 60.424805
GYRO_x = -2      GYRO_y = -2      GYRO_z = 3
acc_x = 35.034180      acc_y = 894.104004      acc_z = -29.907227
GYRO_x = 1      GYRO_y = -9      GYRO_z = 5
acc_x = 14.160156      acc_y = 897.338867      acc_z = 110.717773
GYRO_x = 0      GYRO_y = 0      GYRO_z = -2
acc_x = 36.437988      acc_y = 919.738770      acc_z = 44.433594
GYRO_x = 0      GYRO_y = -4      GYRO_z = 0
acc_x = 48.645020      acc_y = 891.174316      acc_z = 65.429688
GYRO_x = 3      GYRO_y = -1      GYRO_z = 2
acc_x = 39.855957      acc_y = 920.959473      acc_z = 41.381836
GYRO_x = 3      GYRO_y = 0      GYRO_z = 3
acc_x = 45.654297      acc_y = 933.471680      acc_z = 29.785156
GYRO_x = 1      GYRO_y = 0      GYRO_z = 0
acc_x = 33.081055      acc_y = 916.137695      acc_z = 36.193848
GYRO_x = 4      GYRO_y = 2      GYRO_z = -1
acc_x = 47.058105      acc_y = 950.683594      acc_z = -6.835938
GYRO_x = 3      GYRO_y = 0      GYRO_z = 0
acc_x = 25.085449      acc_y = 914.001465      acc_z = -15.563965
GYRO_x = 1      GYRO_y = -1      GYRO_z = -2
acc_x = 32.470703      acc_y = 926.086426      acc_z = -23.864746
GYRO_x = -2      GYRO_y = -1      GYRO_z = -1
acc_x = 22.583008      acc_y = 919.494629      acc_z = -49.438477
```

1. 가속도가 y방향으로도 잘 나오는 것을 확인할 수 있습니다.

2. 자이로값도 설정한 범위 내에서 잘 변화하는 것을 보이며, 움직임이 없을 시 x,y,z 모두 0을 확인 할 수 있습니다.

3. SIMULATION

```
roll = 1          pitch = 1
roll = 0          pitch = 1
roll = 1          pitch = 1
roll = 1          pitch = 1
roll = 1          pitch = 1
roll = 1          pitch = 1
roll = 1          pitch = 1
roll = 1          pitch = 1
roll = 1          pitch = 1
roll = 1          pitch = 1
roll = 1          pitch = 1
roll = 1          pitch = 1
roll = 1          pitch = 1
roll = 1          pitch = 1
roll = 1          pitch = 1
roll = 1          pitch = 1
roll = 1          pitch = 1
roll = 1          pitch = 1
roll = 1          pitch = 1
roll = 1          pitch = 1
roll = 1          pitch = 1
roll = 1          pitch = 1
roll = 1          pitch = 1
roll = 0          pitch = 1
roll = 1          pitch = 1
roll = 0          pitch = 1
roll = 1          pitch = 1
roll = 1          pitch = 1
roll = 0          pitch = 1
roll = 0          pitch = 0
roll = 0          pitch = 1
roll = 1          pitch = 1
roll = 0          pitch = 1
roll = 0          pitch = 1
roll = 1          pitch = 1
roll = 1          pitch = 1
roll = 1          pitch = 1
roll = 1          pitch = 1
roll = 1          pitch = 1
roll = 1          pitch = 1
roll = 0          pitch = 1
roll = 1          pitch = 1
roll = 1          pitch = 1
```

```
roll = 0          pitch = -1
roll = -1         pitch = 1
roll = -1         pitch = -1
roll = -1         pitch = -6
roll = 0          pitch = -11
roll = -1         pitch = -9
roll = 0          pitch = -14
roll = -2         pitch = -16
roll = -1         pitch = -16
roll = 0          pitch = -20
roll = -1         pitch = -19
roll = 0          pitch = -25
roll = -1         pitch = -24
roll = 0          pitch = -25
roll = 0          pitch = -25
roll = 0          pitch = -25
roll = 0          pitch = -26
roll = 0          pitch = -26
roll = 0          pitch = -27
roll = 0          pitch = -31
roll = -1         pitch = -25
roll = 0          pitch = -29
roll = 0          pitch = -31
roll = 0          pitch = -33
roll = 0          pitch = -32
roll = 0          pitch = -31
roll = 0          pitch = -32
roll = 0          pitch = -34
roll = 0          pitch = -31
roll = 0          pitch = -32
roll = 0          pitch = -32
roll = 0          pitch = -32
roll = 0          pitch = -32
roll = 0          pitch = -32
roll = 0          pitch = -32
roll = 0          pitch = -32
roll = -1         pitch = -31
roll = 0          pitch = -32
roll = -1         pitch = -32
roll = 0          pitch = -32
roll = -1         pitch = -31
roll = 0          pitch = -32
roll = 0          pitch = -33
roll = -1         pitch = -35
roll = 0          pitch = -36
roll = 0          pitch = -34
```

```
roll = 29         pitch = -1
roll = 40         pitch = -1
roll = 45         pitch = -6
roll = 69         pitch = 4
roll = 69         pitch = 2
roll = 66         pitch = 5
roll = 64         pitch = 8
roll = 69         pitch = 0
roll = 70         pitch = 10
roll = 76         pitch = 9
roll = 78         pitch = 8
roll = 83         pitch = 0
roll = 80         pitch = 0
roll = 82         pitch = 3
roll = 82         pitch = 0
roll = 82         pitch = 2
roll = 85         pitch = 4
roll = 77         pitch = 6
roll = 84         pitch = 3
roll = 80         pitch = -9
roll = 77         pitch = 4
roll = 79         pitch = 7
roll = 78         pitch = 7
roll = 85         pitch = 1
roll = 78         pitch = 4
roll = 81         pitch = 3
roll = 79         pitch = 4
roll = 80         pitch = 0
roll = 80         pitch = 1
roll = 81         pitch = 1
roll = 80         pitch = 3
roll = 80         pitch = 2
roll = 80         pitch = 1
roll = 82         pitch = 3
roll = 80         pitch = 2
roll = 81         pitch = 0
roll = 80         pitch = 2
roll = 81         pitch = 1
roll = 79         pitch = 2
roll = 80         pitch = 1
roll = 81         pitch = 2
roll = 81         pitch = 2
roll = 79         pitch = 2
roll = 80         pitch = 1
```

1. Roll과 pitch값인, 즉 각도가 매우 잘 측정되고 있습니다.