모바일 센서 공학 : 실습

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Arduino Basic Structure

```
void setup() {
        // Do initialization : Executed only once
        // 초기화 루틴: setup() 함수, 최초 1회만 실행
}

void loop() {
        // Loop : Continuously executed
        // 반복 루틴: loop() 함수, setup 이후 무한반복
}
```

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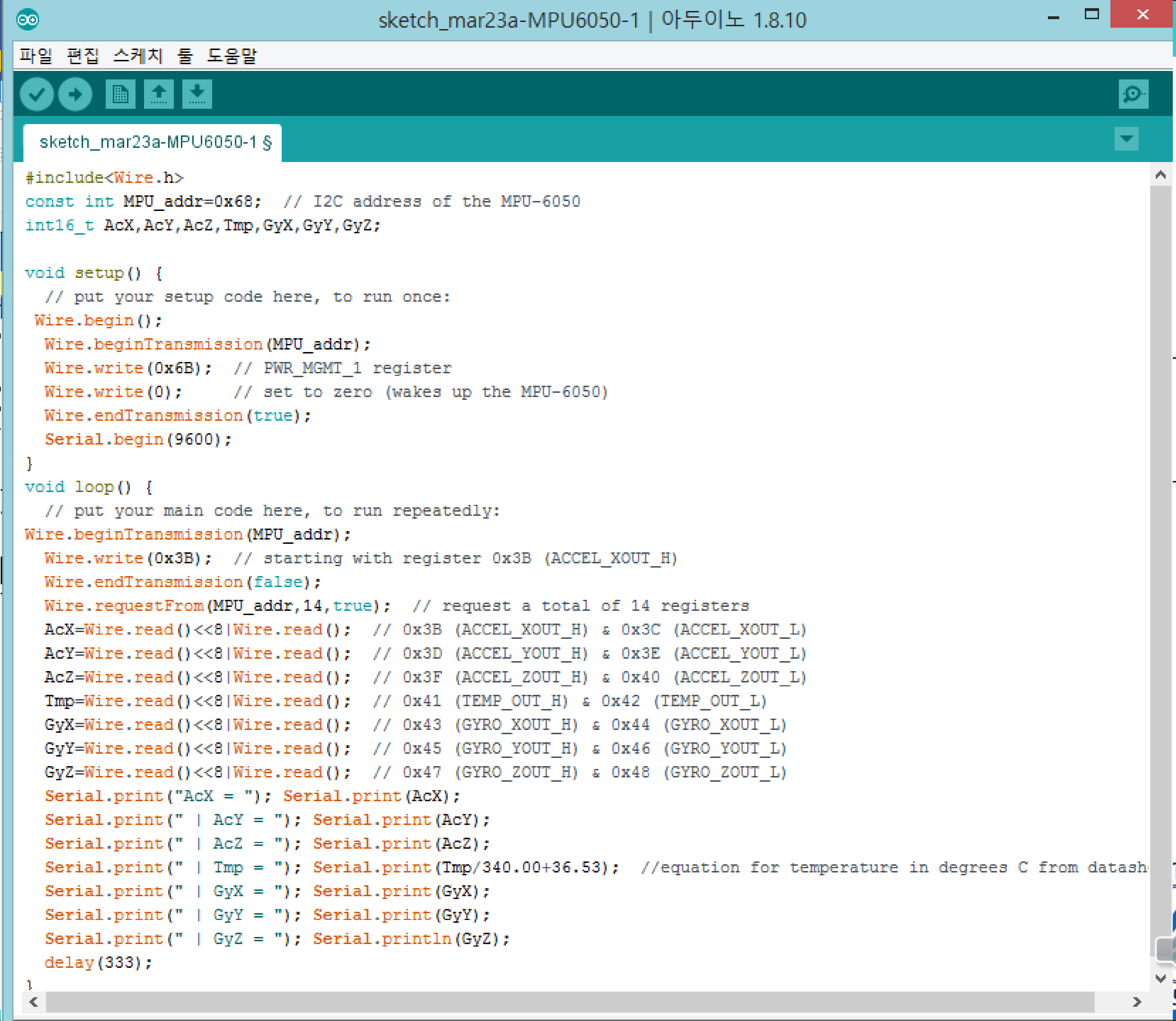
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sketch_mar23a-MPU6050-1 §

```
#include<Wire.h>
const int MPU_addr=0x68;  // I2C address of the MPU-6050
int16_t AcX,AcY,AcZ,Tmp,GyX,GyY,GyZ;

void setup() {
  // put your setup code here, to run once:
 Wire.begin();
  Wire.beginTransmission(MPU_addr);
  Wire.write(0x6B);  // PWR_MGMT_1 register
  Wire.write(0);     // set to zero (wakes up the MPU-6050)
  Wire.endTransmission(true);
  Serial.begin(9600);
}
void loop() {
  // put your main code here, to run repeatedly:
Wire.beginTransmission(MPU_addr);
  Wire.write(0x3B);  // starting with register 0x3B (ACCEL_XOUT_H)
  Wire.endTransmission(false);
  Wire.requestFrom(MPU_addr,14,true);  // request a total of 14 registers
  AcX=Wire.read()<<8|Wire.read();  // 0x3B (ACCEL_XOUT_H) & 0x3C (ACCEL_XOUT_L)
  AcY=Wire.read()<<8|Wire.read();  // 0x3D (ACCEL_YOUT_H) & 0x3E (ACCEL_YOUT_L)
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  Tmp=Wire.read()<<8|Wire.read();  // 0x41 (TEMP_OUT_H) & 0x42 (TEMP_OUT_L)
  GyX=Wire.read()<<8|Wire.read();  // 0x43 (GYRO_XOUT_H) & 0x44 (GYRO_XOUT_L)
  GyY=Wire.read()<<8|Wire.read();  // 0x45 (GYRO_YOUT_H) & 0x46 (GYRO_YOUT_L)
  GyZ=Wire.read()<<8|Wire.read();  // 0x47 (GYRO_ZOUT_H) & 0x48 (GYRO_ZOUT_L)
  Serial.print("AcX = "); Serial.print(AcX);
  Serial.print(" | AcY = "); Serial.print(AcY);
  Serial.print(" | AcZ = "); Serial.print(AcZ);
  Serial.print(" | Tmp = "); Serial.print(Tmp/340.00+36.53);  //equation for temperature in degrees C from datash
  Serial.print(" | GyX = "); Serial.print(GyX);
  Serial.print(" | GyY = "); Serial.print(GyY);
  Serial.print(" | GyZ = "); Serial.println(GyZ);
  delay(333);
}
```
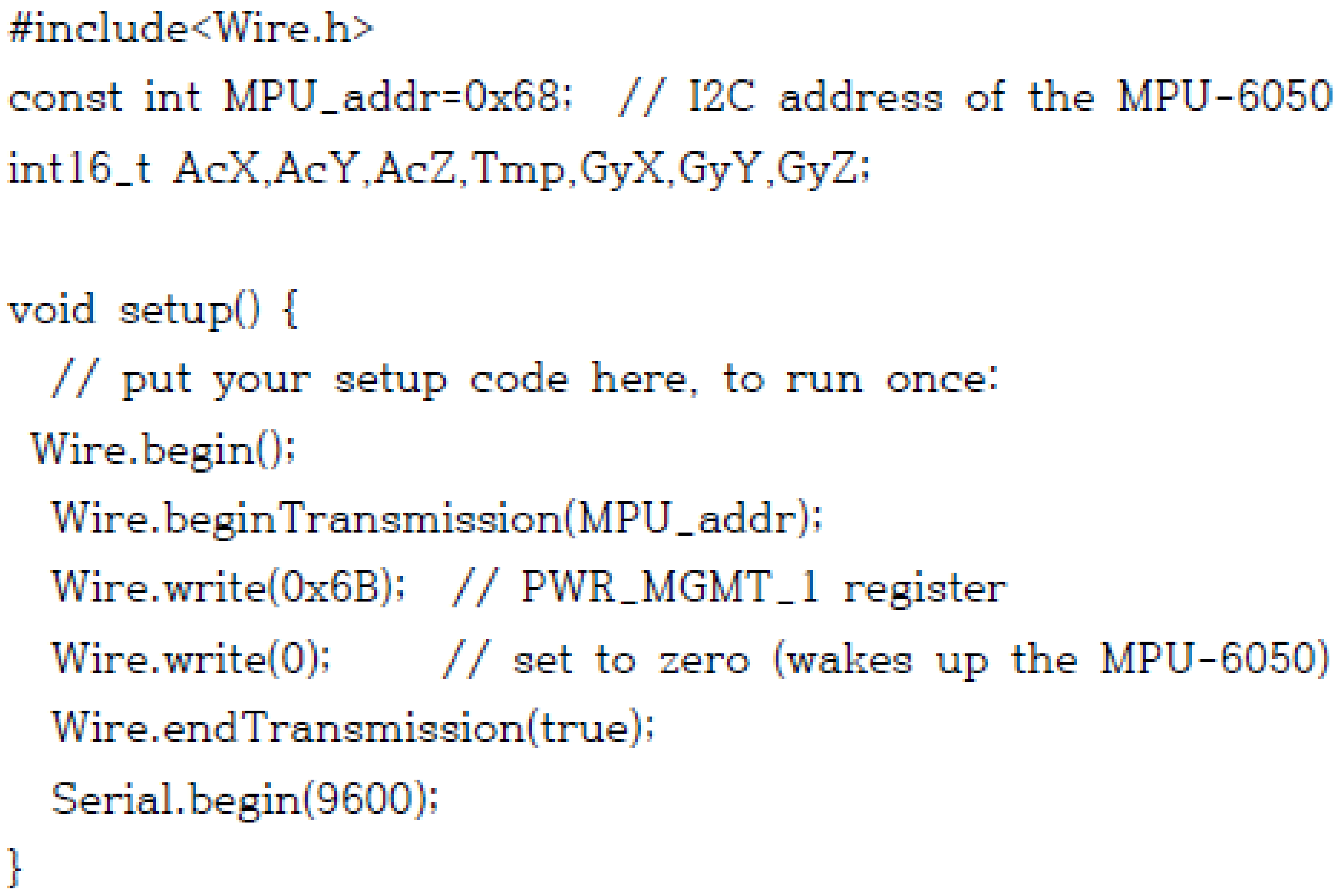

실습 1 : 프로그램 MPU6050-Arduino



```
#include<Wire.h>
const int MPU_addr=0x68;  // I2C address of the MPU-6050
int16_t AcX,AcY,AcZ,Tmp,GyX,GyY,GyZ;

void setup() {
  // put your setup code here, to run once:
 Wire.begin();
  Wire.beginTransmission(MPU_addr);
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  Wire.write(0);     // set to zero (wakes up the MPU-6050)
  Wire.endTransmission(true);
  Serial.begin(9600);
}
```
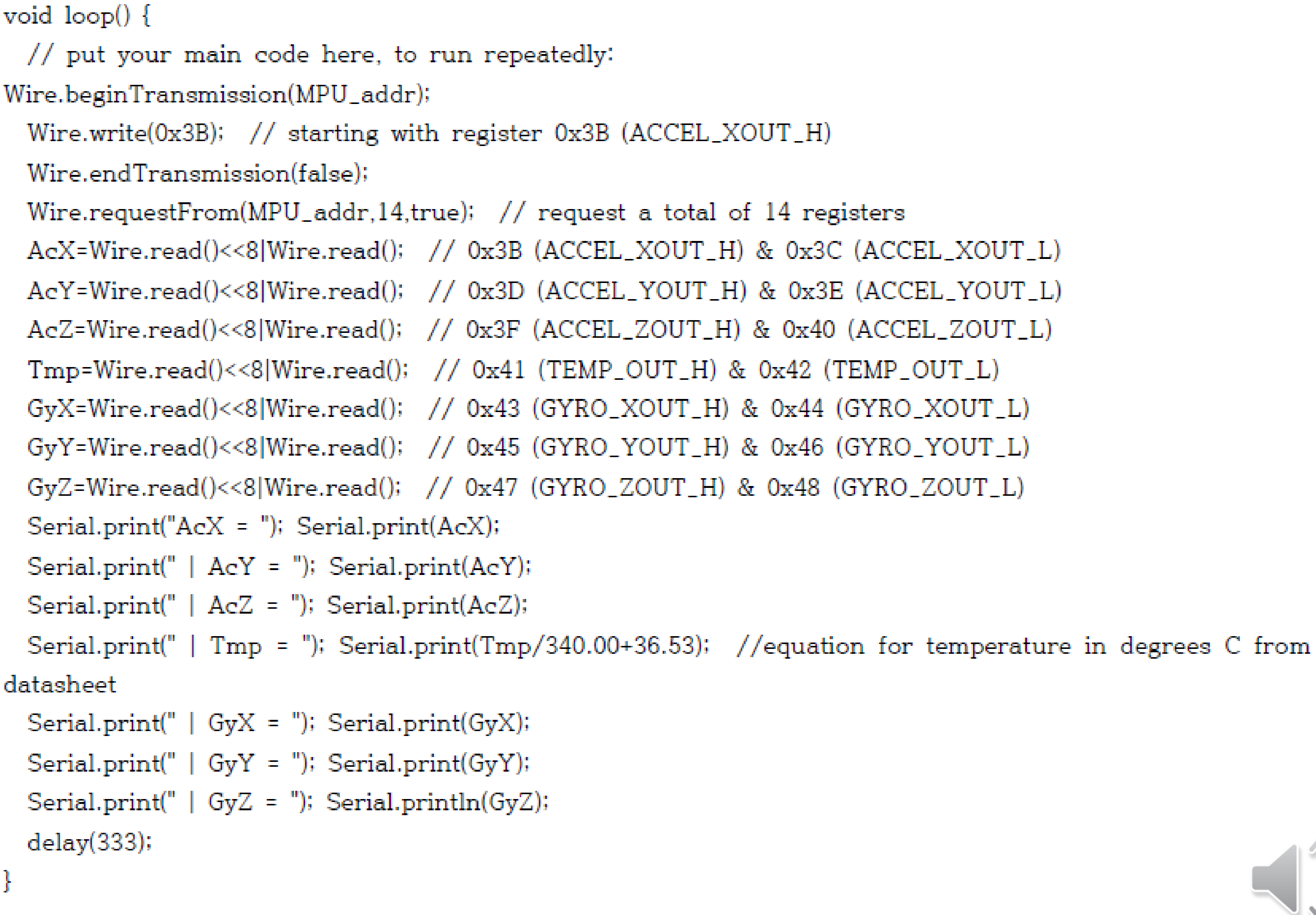

실습 1 : 프로그램 MPU6050-Arduino



```
void loop() {
  // put your main code here, to run repeatedly:
Wire.beginTransmission(MPU_addr);
  Wire.write(0x3B);  // starting with register 0x3B (ACCEL_XOUT_H)
  Wire.endTransmission(false);
  Wire.requestFrom(MPU_addr,14,true);  // request a total of 14 registers
  AcX=Wire.read()<<8|Wire.read();  // 0x3B (ACCEL_XOUT_H) & 0x3C (ACCEL_XOUT_L)
  AcY=Wire.read()<<8|Wire.read();  // 0x3D (ACCEL_YOUT_H) & 0x3E (ACCEL_YOUT_L)
  AcZ=Wire.read()<<8|Wire.read();  // 0x3F (ACCEL_ZOUT_H) & 0x40 (ACCEL_ZOUT_L)
  Tmp=Wire.read()<<8|Wire.read();  // 0x41 (TEMP_OUT_H) & 0x42 (TEMP_OUT_L)
  GyX=Wire.read()<<8|Wire.read();  // 0x43 (GYRO_XOUT_H) & 0x44 (GYRO_XOUT_L)
  GyY=Wire.read()<<8|Wire.read();  // 0x45 (GYRO_YOUT_H) & 0x46 (GYRO_YOUT_L)
  GyZ=Wire.read()<<8|Wire.read();  // 0x47 (GYRO_ZOUT_H) & 0x48 (GYRO_ZOUT_L)
  Serial.print("AcX = "); Serial.print(AcX);
  Serial.print(" | AcY = "); Serial.print(AcY);
  Serial.print(" | AcZ = "); Serial.print(AcZ);
  Serial.print(" | Tmp = "); Serial.print(Tmp/340.00+36.53);  //equation for temperature in degrees C from datasheet
  Serial.print(" | GyX = "); Serial.print(GyX);
  Serial.print(" | GyY = "); Serial.print(GyY);
  Serial.print(" | GyZ = "); Serial.println(GyZ);
  delay(333);
}
```

실습 1 : 프로그램 MPU6050-Arduino

- Wire.begin(address)

I2C 통신 초기화

Address : 슬레이브모드 주소

- Wire.beginTransmission(address)

마스터에서 전송을 시작하기위해 슬레이브주소지정

- Wire.write(Address or data)

전송할 데이터를 버퍼에 쓰는 것.

- Wire.endTransmission(True or False)

버퍼데이터를 전송,

False 이면 계속하여 전송가능. True 이면 전송종료.

Wire Library : **Wire.requestFrom()**

- Used by the master to request bytes from a slave device.
- **Syntax**

  Wire.requestFrom(address, quantity)
  Wire.requestFrom(address, quantity, stop)
- **Parameters**

  address: the 7-bit address of the device to request bytes from

  quantity: the number of bytes to request
- stop : boolean. true will send a stop message after the request, releasing the bus. false will continually send a restart after the request, keeping the connection active.
- **Returns**

  byte : the number of bytes returned from the slave device

Wire Library : **Wire.read()**

- **Description**

Reads a byte that was transmitted from a slave device to a master after a call to requestFrom() or was transmitted from a master to a slave. read() inherits from the Stream utility class.

- **Syntax**

  Wire.read()

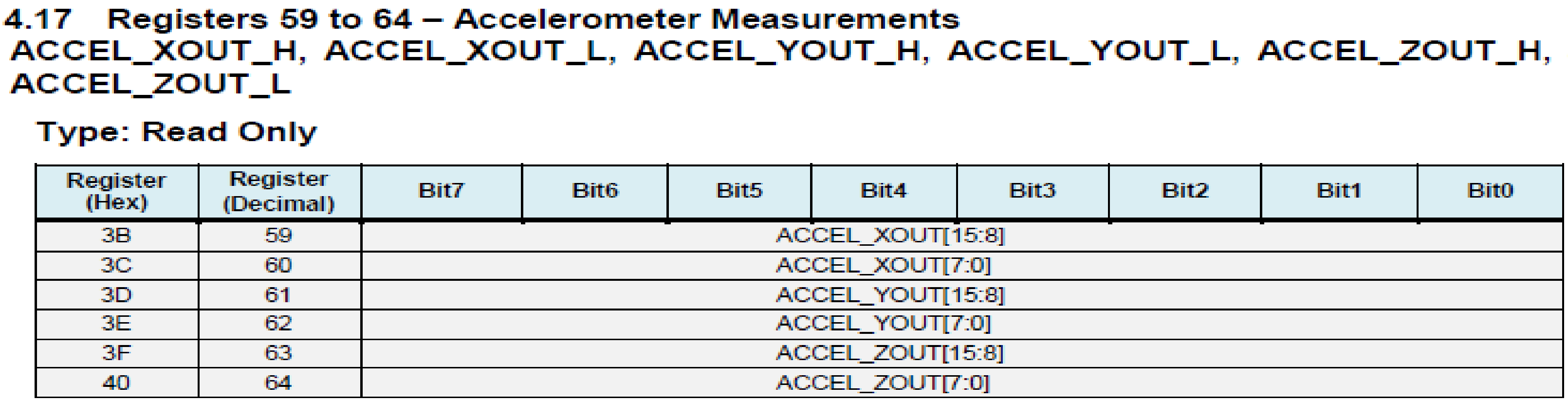
- **Parameters**

  none

- **Returns**

  The next byte received

MPU6050 Data Registers

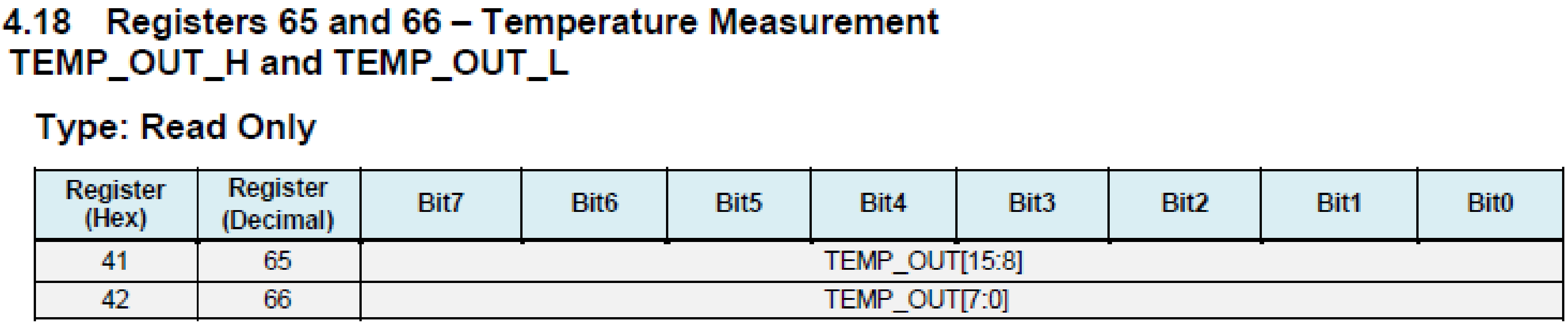


4.17 Registers 59 to 64 – Accelerometer Measurements

ACCEL_XOUT_H, ACCEL_XOUT_L, ACCEL_YOUT_H, ACCEL_YOUT_L, ACCEL_ZOUT_H, and ACCEL_ZOUT_L

Type: Read Only

Register (Hex)	Register (Decimal)	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
3B	59	ACCEL_XOUT[15:8]							
3C	60	ACCEL_XOUT[7:0]							
3D	61	ACCEL_YOUT[15:8]							
3E	62	ACCEL_YOUT[7:0]							
3F	63	ACCEL_ZOUT[15:8]							
40	64	ACCEL_ZOUT[7:0]							

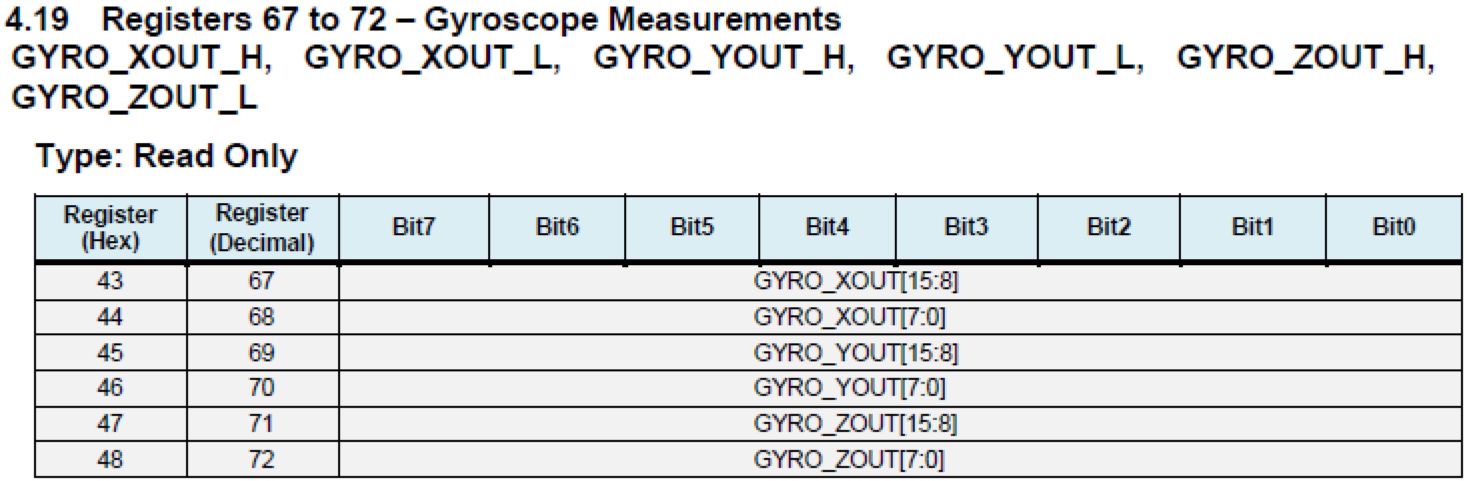


4.18 Registers 65 and 66 – Temperature Measurement

TEMP_OUT_H and TEMP_OUT_L

Type: Read Only

Register (Hex)	Register (Decimal)	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
41	65	TEMP_OUT[15:8]							
42	66	TEMP_OUT[7:0]							



4.19 Registers 67 to 72 – Gyroscope Measurements

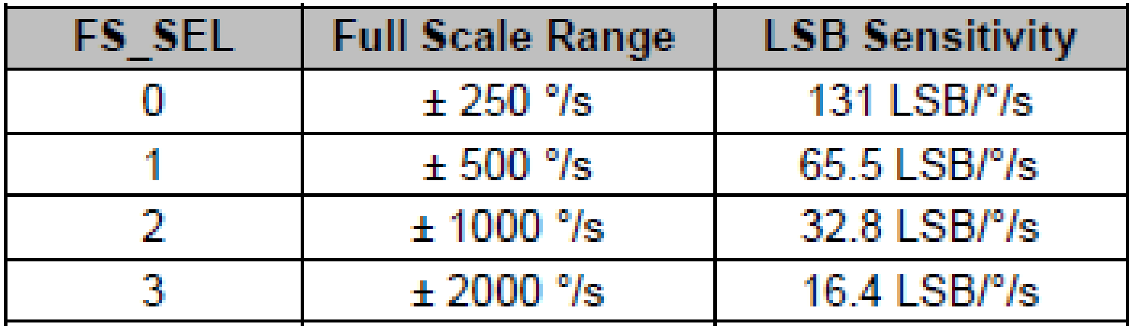
GYRO_XOUT_H, GYRO_XOUT_L, GYRO_YOUT_H, GYRO_YOUT_L, GYRO_ZOUT_H, and GYRO_ZOUT_L

Type: Read Only

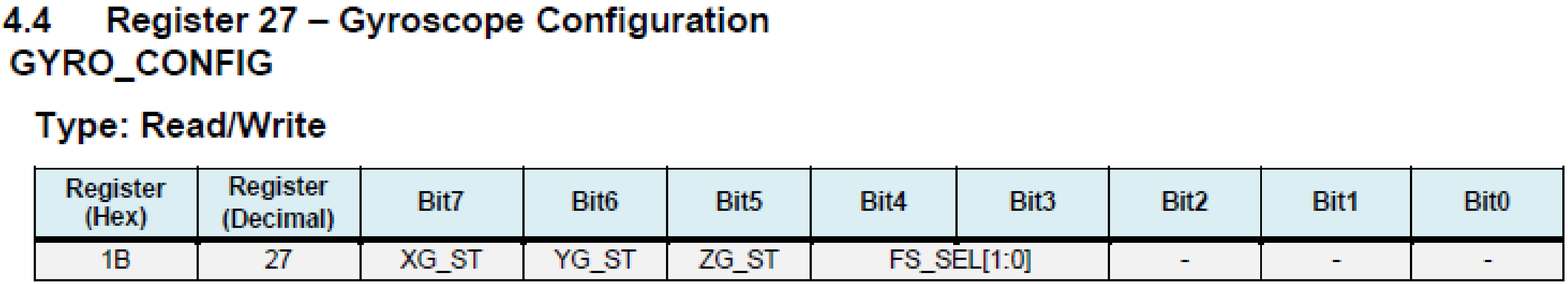
Register (Hex)	Register (Decimal)	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
43	67	GYRO_XOUT[15:8]							
44	68	GYRO_XOUT[7:0]							
45	69	GYRO_YOUT[15:8]							
46	70	GYRO_YOUT[7:0]							
47	71	GYRO_ZOUT[15:8]							
48	72	GYRO_ZOUT[7:0]							

MPU6050 Data Registers

- Gyroscope Scale



FS_SEL	Full Scale Range	LSB Sensitivity
0	± 250 °/s	131 LSB/°/s
1	± 500 °/s	65.5 LSB/°/s
2	± 1000 °/s	32.8 LSB/°/s
3	± 2000 °/s	16.4 LSB/°/s



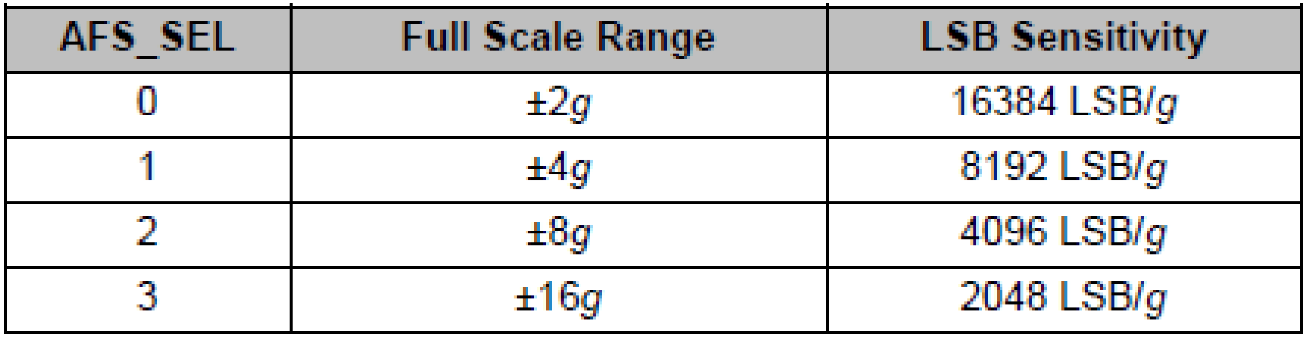
4.4 Register 27 – Gyroscope Configuration GYRO_CONFIG

Type: Read/Write

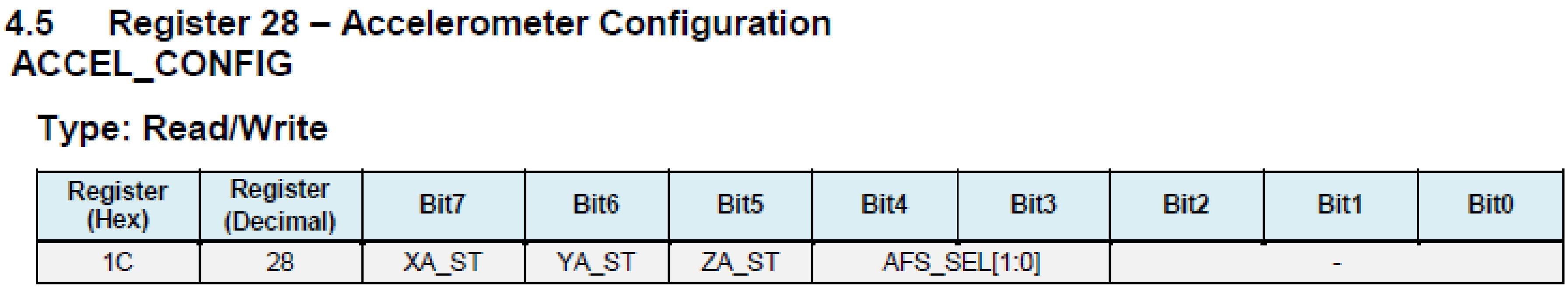
Register (Hex)	Register (Decimal)	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
1B	27	XG_ST	YG_ST	ZG_ST	FS_SEL[1:0]		-	-	-

MPU6050 Data Registers

- Accelerometer Scale



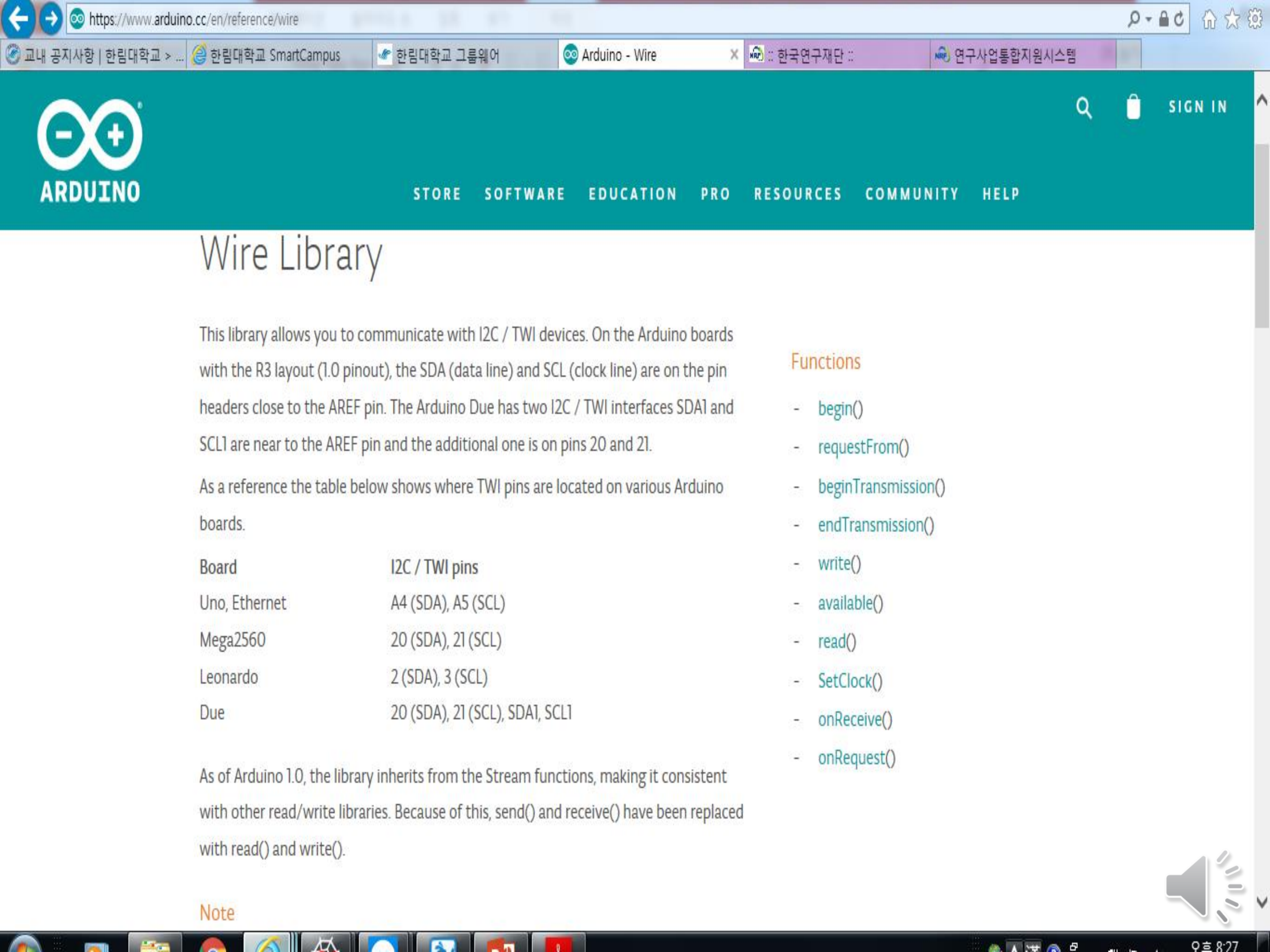
AFS_SEL	Full Scale Range	LSB Sensitivity
0	±2*g*	16384 LSB/*g*
1	±4*g*	8192 LSB/*g*
2	±8*g*	4096 LSB/*g*
3	±16*g*	2048 LSB/*g*



4.5 Register 28 – Accelerometer Configuration ACCEL_CONFIG

Type: Read/Write

Register (Hex)	Register (Decimal)	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
1C	28	XA_ST	YA_ST	ZA_ST	AFS_SEL[1:0]		-		



Wire Library

This library allows you to communicate with I2C / TWI devices. On the Arduino boards with the R3 layout (1.0 pinout), the SDA (data line) and SCL (clock line) are on the pin headers close to the AREF pin. The Arduino Due has two I2C / TWI interfaces SDA1 and SCL1 are near to the AREF pin and the additional one is on pins 20 and 21.

As a reference the table below shows where TWI pins are located on various Arduino boards.

Board	I2C / TWI pins
Uno, Ethernet	A4 (SDA), A5 (SCL)
Mega2560	20 (SDA), 21 (SCL)
Leonardo	2 (SDA), 3 (SCL)
Due	20 (SDA), 21 (SCL), SDA1, SCL1

As of Arduino 1.0, the library inherits from the Stream functions, making it consistent with other read/write libraries. Because of this, send() and receive() have been replaced with read() and write().

Functions

- begin()
- requestFrom()
- beginTransmission()
- endTransmission()
- write()
- available()
- read()
- SetClock()
- onReceive()
- onRequest()

Note

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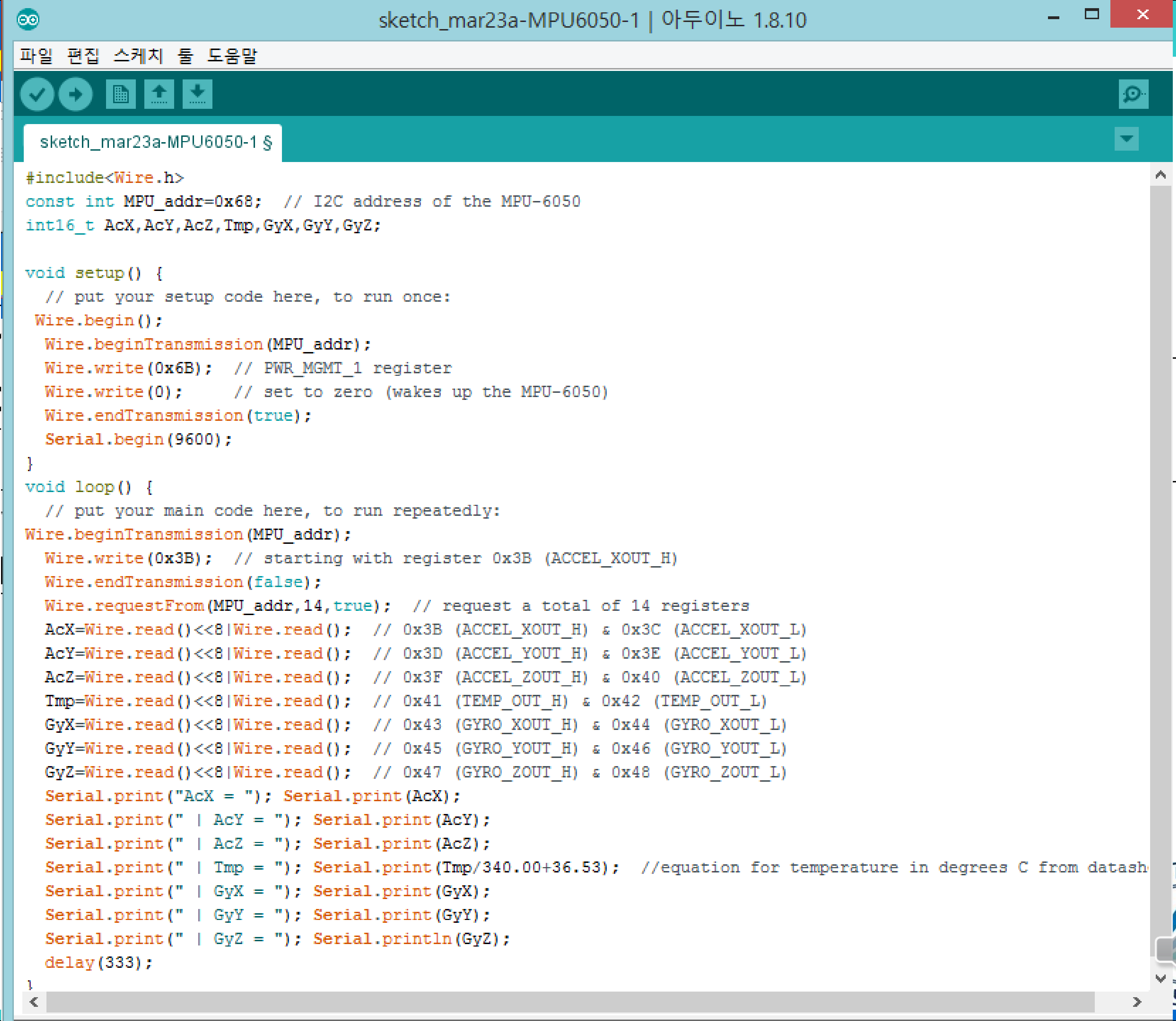
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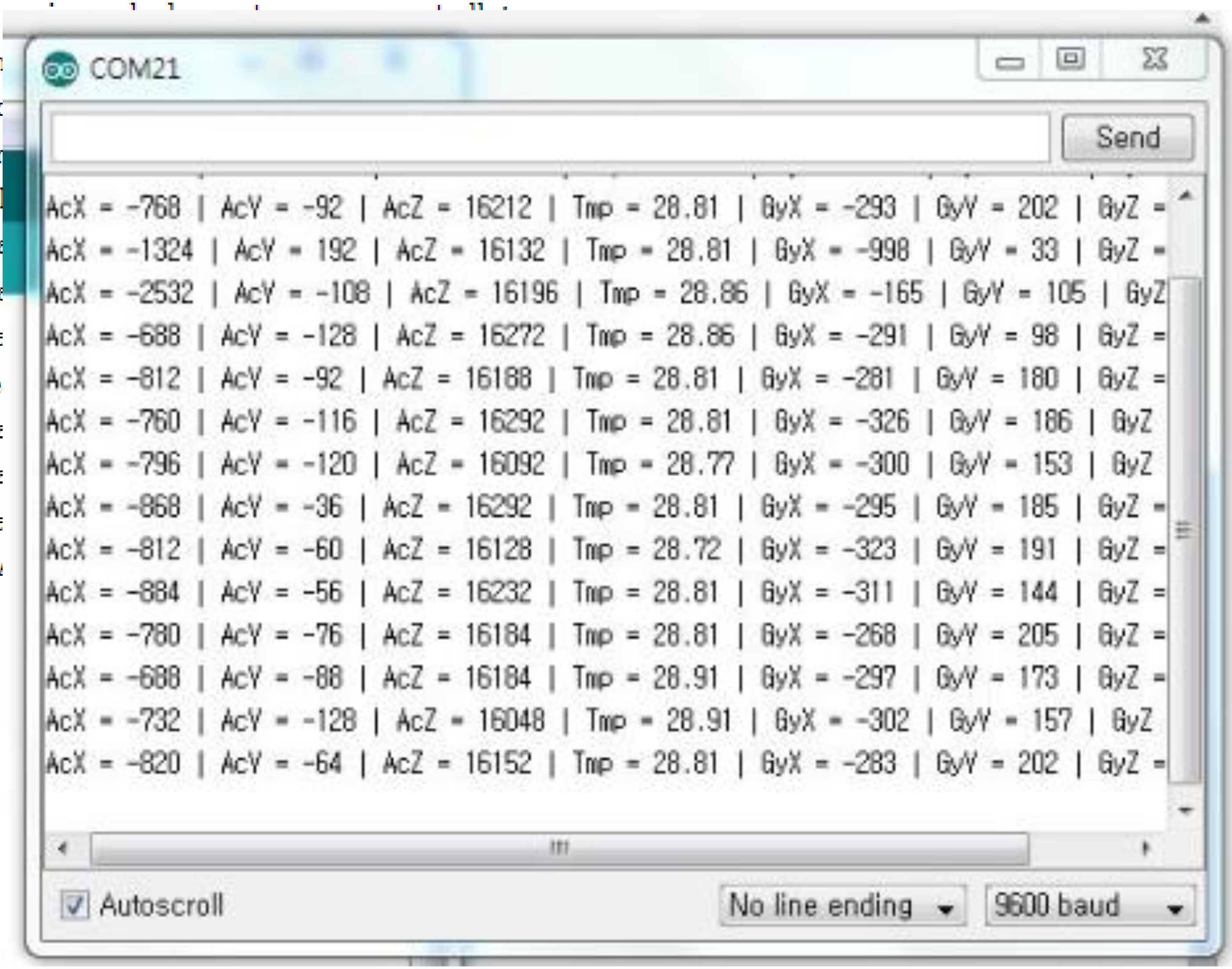
```
#include<Wire.h>
const int MPU_addr=0x68;  // I2C address of the MPU-6050
int16_t AcX,AcY,AcZ,Tmp,GyX,GyY,GyZ;

void setup() {
  // put your setup code here, to run once:
 Wire.begin();
  Wire.beginTransmission(MPU_addr);
  Wire.write(0x6B);  // PWR_MGMT_1 register
  Wire.write(0);     // set to zero (wakes up the MPU-6050)
  Wire.endTransmission(true);
  Serial.begin(9600);
}
void loop() {
  // put your main code here, to run repeatedly:
Wire.beginTransmission(MPU_addr);
  Wire.write(0x3B);  // starting with register 0x3B (ACCEL_XOUT_H)
  Wire.endTransmission(false);
  Wire.requestFrom(MPU_addr,14,true);  // request a total of 14 registers
  AcX=Wire.read()<<8|Wire.read();  // 0x3B (ACCEL_XOUT_H) & 0x3C (ACCEL_XOUT_L)
  AcY=Wire.read()<<8|Wire.read();  // 0x3D (ACCEL_YOUT_H) & 0x3E (ACCEL_YOUT_L)
  AcZ=Wire.read()<<8|Wire.read();  // 0x3F (ACCEL_ZOUT_H) & 0x40 (ACCEL_ZOUT_L)
  Tmp=Wire.read()<<8|Wire.read();  // 0x41 (TEMP_OUT_H) & 0x42 (TEMP_OUT_L)
  GyX=Wire.read()<<8|Wire.read();  // 0x43 (GYRO_XOUT_H) & 0x44 (GYRO_XOUT_L)
  GyY=Wire.read()<<8|Wire.read();  // 0x45 (GYRO_YOUT_H) & 0x46 (GYRO_YOUT_L)
  GyZ=Wire.read()<<8|Wire.read();  // 0x47 (GYRO_ZOUT_H) & 0x48 (GYRO_ZOUT_L)
  Serial.print("AcX = "); Serial.print(AcX);
  Serial.print(" | AcY = "); Serial.print(AcY);
  Serial.print(" | AcZ = "); Serial.print(AcZ);
  Serial.print(" | Tmp = "); Serial.print(Tmp/340.00+36.53);  //equation for temperature in degrees C from datash
  Serial.print(" | GyX = "); Serial.print(GyX);
  Serial.print(" | GyY = "); Serial.print(GyY);
  Serial.print(" | GyZ = "); Serial.println(GyZ);
  delay(333);
}
```

실습 1 : 프로그램 MPU6050-Arduino

```
void loop() {
  // put your
Wire.beginTran
  Wire.write(0x
  Wire.endTran
  Wire.requestI
  AcX=Wire.rea
  AcY=Wire.rea
  AcZ=Wire.rea
  Tmp=Wire.re
  GyX=Wire.rea
  GyY=Wire.rea
  GyZ=Wire.rea
  Serial.print("A
  Serial.print("
  Serial.print("
  Serial.print("                                                             from
datasheet
  Serial.print("
  Serial.print("
  Serial.print("
  delay(333);
}
```



```
AcX = -768 | AcY = -92 | AcZ = 16212 | Tmp = 28.81 | GyX = -293 | GyY = 202 | GyZ =
AcX = -1324 | AcY = 192 | AcZ = 16132 | Tmp = 28.81 | GyX = -998 | GyY = 33 | GyZ =
AcX = -2532 | AcY = -108 | AcZ = 16196 | Tmp = 28.86 | GyX = -165 | GyY = 105 | GyZ
AcX = -688 | AcY = -128 | AcZ = 16272 | Tmp = 28.86 | GyX = -291 | GyY = 98 | GyZ =
AcX = -812 | AcY = -92 | AcZ = 16188 | Tmp = 28.81 | GyX = -281 | GyY = 180 | GyZ =
AcX = -760 | AcY = -116 | AcZ = 16292 | Tmp = 28.81 | GyX = -326 | GyY = 186 | GyZ
AcX = -796 | AcY = -120 | AcZ = 16092 | Tmp = 28.77 | GyX = -300 | GyY = 153 | GyZ
AcX = -868 | AcY = -36 | AcZ = 16292 | Tmp = 28.81 | GyX = -295 | GyY = 185 | GyZ =
AcX = -812 | AcY = -60 | AcZ = 16128 | Tmp = 28.72 | GyX = -323 | GyY = 191 | GyZ =
AcX = -884 | AcY = -56 | AcZ = 16232 | Tmp = 28.81 | GyX = -311 | GyY = 144 | GyZ =
AcX = -780 | AcY = -76 | AcZ = 16184 | Tmp = 28.81 | GyX = -268 | GyY = 205 | GyZ =
AcX = -688 | AcY = -88 | AcZ = 16184 | Tmp = 28.91 | GyX = -297 | GyY = 173 | GyZ =
AcX = -732 | AcY = -128 | AcZ = 16048 | Tmp = 28.91 | GyX = -302 | GyY = 157 | GyZ
AcX = -820 | AcY = -64 | AcZ = 16152 | Tmp = 28.81 | GyX = -283 | GyY = 202 | GyZ =
```

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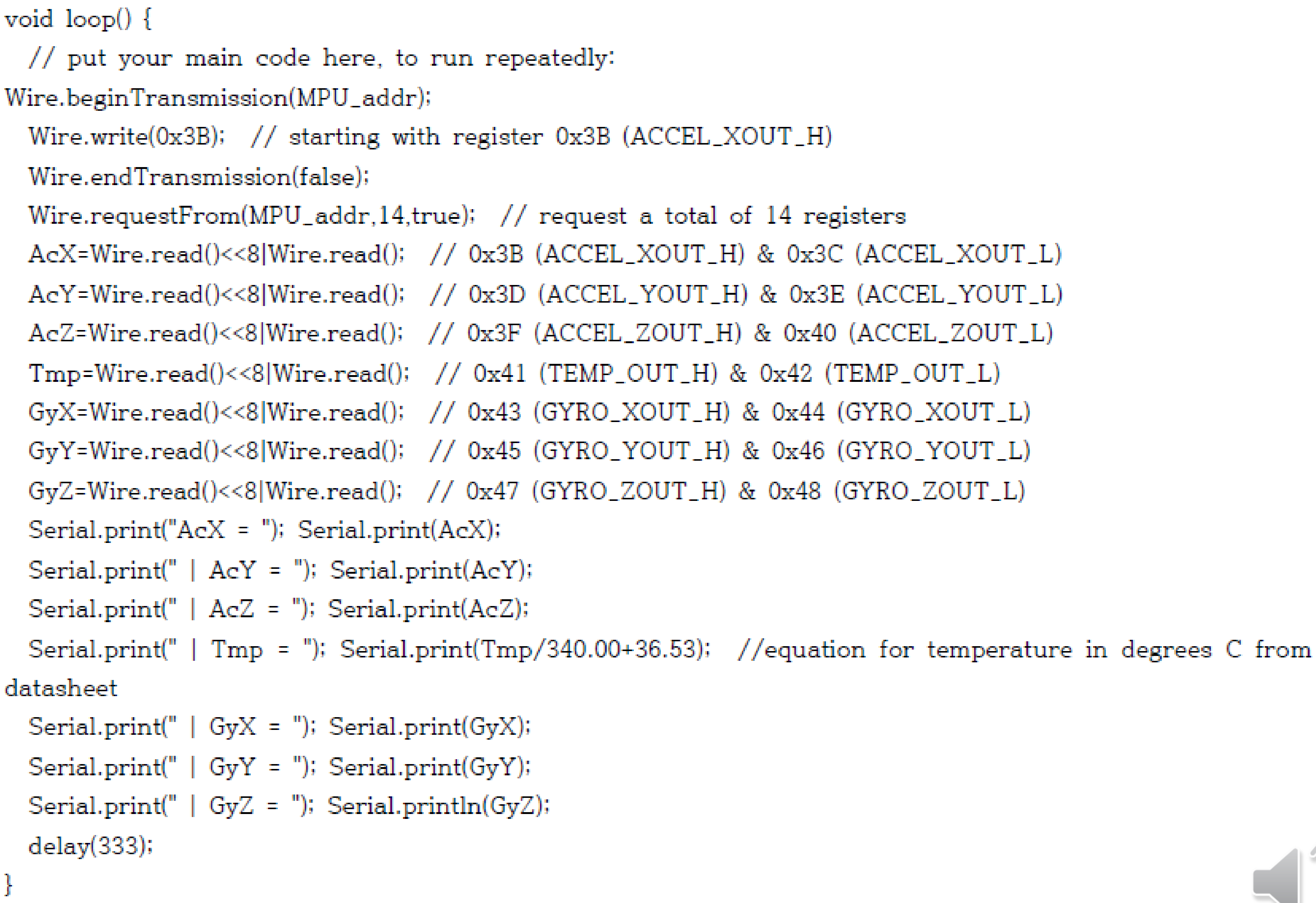

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