TI DSP, MCU 및 Xilinx Zynq FPGA
프로그래밍 전문가 과정

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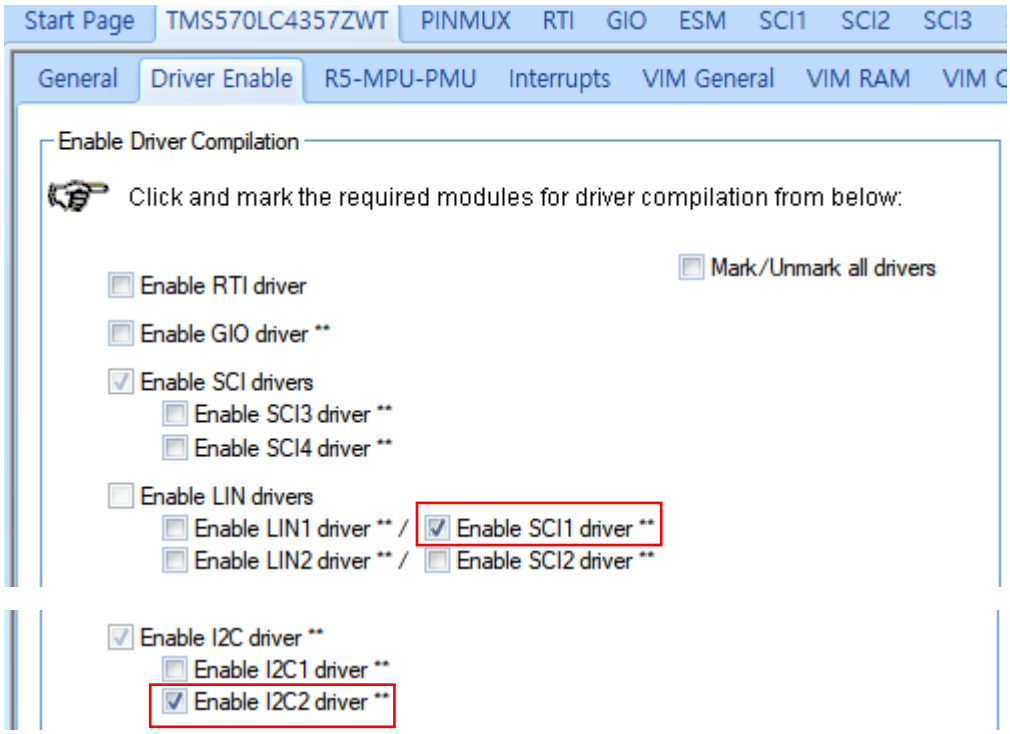
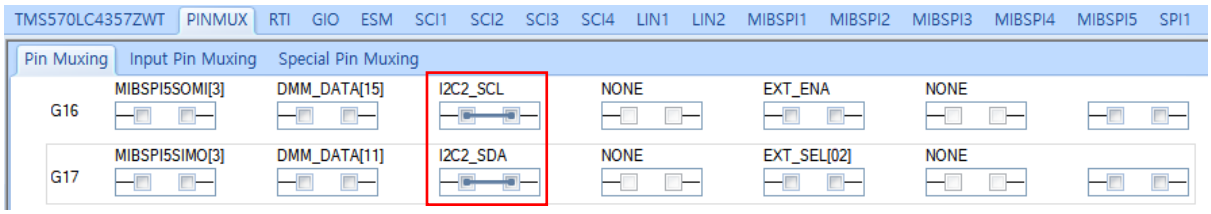
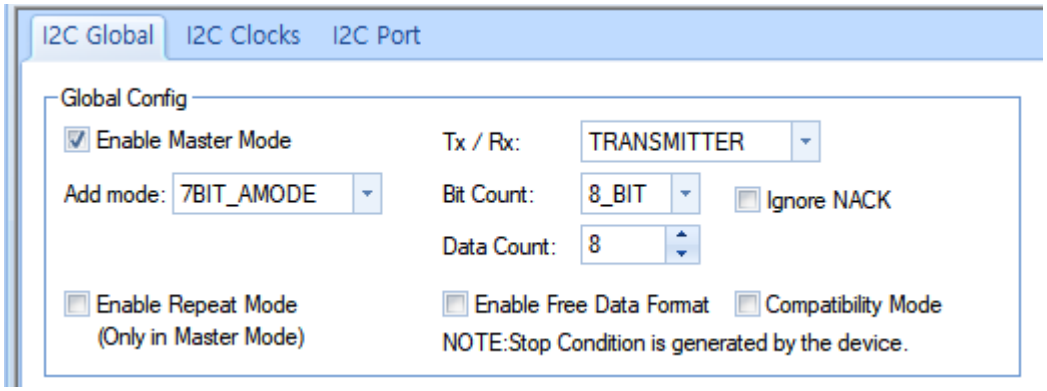
I2C_Lidar

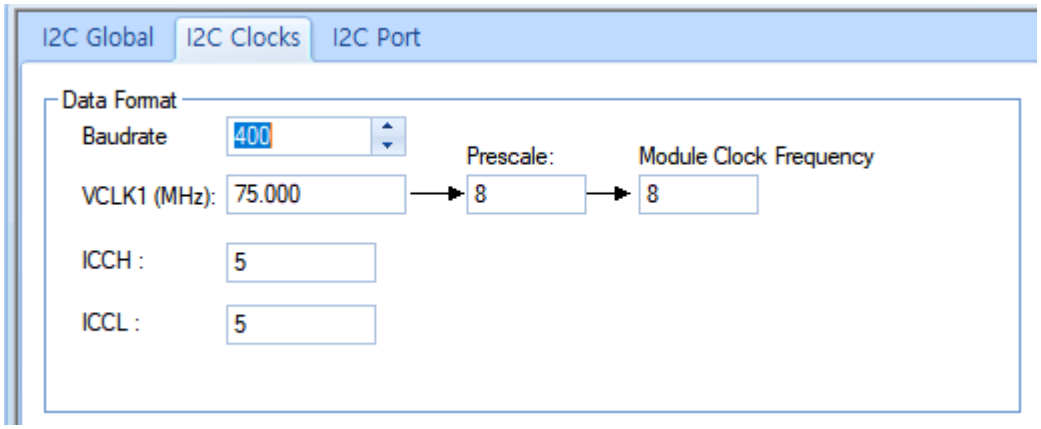
HCG 설정





I2C2


I2C Global
I2C Clocks
I2C Port
Global Config
Enable Master Mode
Tx / Rx:
TRANSMITTER
Add mode:
7BIT_AMODE
Bit Count:
8_BIT
Ignore NACK
Data Count:
8
Enable Repeat Mode
(Only in Master Mode)
Enable Free Data Format
Compatibility Mode
NOTE:Stop Condition is generated by the device.


I2C Global
I2C Clocks
I2C Port
Data Format
Baudrate
400
Prescale:
Module Clock Frequency
VCLK1 (MHz):
75.000
8
8
ICCH :
5
ICCL :
5

CCS 코드

```
#include <HL_hal_stdtypes.h>
#include <HL_i2c.h>
#include <HL_reg_sci.h>
#include <HL_sci.h>
#include <HL_sys_core.h>
#include <stdbool.h>
#include <stdio.h>
#include <string.h>

#define UART sciREG1
#define LIDAR_SLAVE_ADDR 0x62

#define ACQ_COMMAND 0x00
#define STATUS 0x01
#define SIG_COUNT_VAL 0x02
#define ACQ_CONFIG_REG 0x04
#define THRESHOLD_BYPASS 0x1C
#define READ_FROM 0x8f

#define FULL_DELAY_HIGH 0x0f

uint8 receives[2];
volatile int g_acc_flag;

uint8 bias_cnt = 0;

void sciDisplayText(sciBASE_t *sci, uint8 *text, uint32 len);
void pwmSet(void);
void wait(uint32 delay);
void Lidar_without_bias(void);
void Lidar_bias(void);
void Get_Data(void);

void Lidar_enable(void);

void wait(uint32 delay)
{
    int i;

    for (i = 0; i < delay; i++)
        ;
}

void sciDisplayText(sciBASE_t *sci, uint8 *text, uint32 len)
{
    while (len--)
    {
        while ((UART->FLR & 0x4) == 4)
            ;
        sciSendByte(UART, *text++);
    }
}

void disp_set(char *str)
{
    char txt_buf[256] = { 0 };
    unsigned int buf_len;
    sprintf(txt_buf, str);
    buf_len = strlen(txt_buf);
    sciDisplayText(sciREG1, (uint8 *) txt_buf, buf_len);
    wait(100000);
}

int main(void)
{
    char txt_buf[256] = { 0 };
    unsigned int buf_len;
    volatile int i ;
    int cnt = 1;
```

```
    uint16 ave[2] = { 0 };

    sciInit();

    disp_set("SCI Configuration Success!!\n\r\0");

    i2cInit();
    wait(10000000);

    disp_set("I2C Init Success!!\n\r\0");

    Lidar_enable();

    disp_set("Lidar Enable Success!!\n\r\0");

    wait(1000000);

    for (;;)
    {

        Get_Data();

        if (g_acc_flag) //1이 되었을 때 동작
        {
            uint16 tmp;
            tmp = receives[0] << 8; //8비트 두개를 합쳐서 2바이트로 저장
            tmp |= receives[1];

                if (cnt % 3 == 0)
                {
                    tmp = (ave[0] + ave[1]) / 2; //FIR필터

                    sprintf(txt_buf, "Distance = %d\n\r\0", tmp);
                    buf_len = strlen(txt_buf);
                    sciDisplayText(sciREG1, (uint8 *) txt_buf, buf_len);

                    i = 0;
                    cnt++;

                    g_acc_flag = 0;

                }
                else
                {

                    ave[i] = tmp; //필터를 위해 값을 저장

                    i++;
                    cnt++;

                    g_acc_flag = 0;

                }

            }
        Lidar_without_bias(); //99번은 ACQ_COMMAND에 0x03 세팅
        bias_cnt++;
        if(bias_cnt == 100){

            Lidar_bias(); //100번째에 ACQ_COMMAND에 0x04 세팅

            bias_cnt = 0;
        }
    }
    return 0;
}

void Lidar_enable(void)
{
```

```
    uint8 tmp[4] = { 0x80, 0x08, 0x00, 0x04 };

    volatile unsigned int cnt = 7;
    i2cSetSlaveAdd(i2cREG2, LIDAR_SLAVE_ADDR); //LIDAR_SLAVE_ADDR 0x62
    i2cSetDirection(i2cREG2, I2C_TRANSMITTER); //전송모드
    /* 마스터 모드에서만 사용가능 전송값*/
    i2cSetCount(i2cREG2, cnt + 1);
    i2cSetMode(i2cREG2, I2C_MASTER); //마스터모드
    i2cSetStop(i2cREG2); //안정성을 위해 스탑부터
    i2cSetStart(i2cREG2); //시작
    i2cSendByte(i2cREG2, SIG_COUNT_VAL);
    i2cSend(i2cREG2, 1, &tmp[0]); //0x80

    i2cSendByte(i2cREG2, ACQ_CONFIG_REG);
    i2cSend(i2cREG2, 1, &tmp[1]); //0x08

    i2cSendByte(i2cREG2, THRESHOLD_BYPASS);
    i2cSend(i2cREG2, 1, &tmp[2]); //0x00

    i2cSendByte(i2cREG2, ACQ_COMMAND);
    i2cSend(i2cREG2, 1, &tmp[3]); //0x04

    disp_set("Lidar tmp 1 Enable Success!!\n\r\0");

    while (i2cIsBusBusy(i2cREG2) == true)
        ; //데이터가 오고 있는지
    while (i2cIsStopDetected(i2cREG2) == 0)
        ; //데이터가 다 왔는지
    i2cClearSCD(i2cREG2); //초기화

    wait(100000);

}

void Get_Data()
{

    i2cSetSlaveAdd(i2cREG2, LIDAR_SLAVE_ADDR); //LIDAR_SLAVE_ADDR 0x62
    i2cSetDirection(i2cREG2, I2C_TRANSMITTER); //전송
    i2cSetCount(i2cREG2, 1);
    i2cSetMode(i2cREG2, I2C_MASTER); //마스터모드
    i2cSetStop(i2cREG2); //스탑부터(안정성)
    i2cSetStart(i2cREG2); //시작
    i2cSendByte(i2cREG2, READ_FROM); //0x8f

    while (i2cIsBusBusy(i2cREG2) == true)
        //데이터가 오고 있는지
        ;
    while (i2cIsStopDetected(i2cREG2) == 0)
        //데이터가 다 왔는지
        ;
    i2cClearSCD(i2cREG2); //초기화

    i2cSetDirection(i2cREG2, I2C_RECEIVER); //데이터 받음
    i2cSetCount(i2cREG2, 2);
    i2cSetMode(i2cREG2, I2C_MASTER); //마스터모드
    i2cSetStart(i2cREG2); //시작
    i2cReceive(i2cREG2, 2, (unsigned char *) receives);
    i2cSetStop(i2cREG2); //끝

    while (i2cIsBusBusy(i2cREG2) == true)
//데이터가 오고 있는지
        ;
```

```
    while (i2cIsStopDetected(i2cREG2) == 0)
//데이터가 다 왔는지
        ;
    i2cClearSCD(i2cREG2); //초기화

    g_acc_flag = 1; //다시 값을 받기 위하여
}

void Lidar_bias(void)
{
    volatile unsigned int cnt = 1;
    unsigned char data[1] = { 0x04U };
    i2cSetSlaveAdd(i2cREG2, LIDAR_SLAVE_ADDR);
    i2cSetDirection(i2cREG2, I2C_TRANSMITTER);
    i2cSetCount(i2cREG2, cnt + 1);
    i2cSetMode(i2cREG2, I2C_MASTER);
    i2cSetStop(i2cREG2);
    i2cSetStart(i2cREG2);
    i2cSendByte(i2cREG2, ACQ_COMMAND);
    i2cSend(i2cREG2, cnt, data);
    i2cSetStop(i2cREG2);

    while (i2cIsBusBusy(i2cREG2) == true)
        ;
    while (i2cIsStopDetected(i2cREG2) == 0)
        ;
    i2cClearSCD(i2cREG2);
    wait(1000000);
}

void Lidar_without_bias(void)
{
    volatile unsigned int cnt = 1;
    unsigned char data[1] = { 0x03U };
    i2cSetSlaveAdd(i2cREG2, LIDAR_SLAVE_ADDR);
    i2cSetDirection(i2cREG2, I2C_TRANSMITTER);
    i2cSetCount(i2cREG2, cnt + 1);
    i2cSetMode(i2cREG2, I2C_MASTER);
    i2cSetStop(i2cREG2);
    i2cSetStart(i2cREG2);
    i2cSendByte(i2cREG2, ACQ_COMMAND);
    i2cSend(i2cREG2, cnt, data);
    i2cSetStop(i2cREG2);

    while (i2cIsBusBusy(i2cREG2) == true)
        ;
    while (i2cIsStopDetected(i2cREG2) == 0)
        ;
    i2cClearSCD(i2cREG2);
    wait(1000000);
}
```

추가설명

Lidar 기본정보

I2C Protocol Information

This device has a 2-wire, I2C-compatible serial interface (refer to I2C-Bus Specification, Version 2.1, January 2000, available from Philips Semiconductor). It can be connected to an I2C bus as a slave device, under the control of an I2C master device. It supports standard 400 kHz data transfer mode. Support is not provided for 10-bit addressing.

The Sensor module has a 7-bit slave address with a default value of 0x62 in hexadecimal notation. The effective 8 bit I2C address is: 0xC4 write, 0xC5 read. The device will not presently respond to a general call.

LIDAR_SLAVE_ADDR : 0x62 (7bit mode)

Data Baudrate : 400kHz

데이터를 얻는 방법

The simplest method of obtaining measurement results from the I2C interface is as follows:

1 Write 0x04 to register 0x00.
2 Read register 0x01. Repeat until bit 0 (LSB) goes low.
3 Read two bytes from 0x8f (High byte 0x0f then low byte 0x10) to obtain the 16-bit measured distance in centimeters.

1. 0x00레지스터인 ACQ_COMMAND에 0x04를 세팅한다.
2. 0x8f레지스터에서 데이터를 얻어온다. (2바이트)

주의사항

Receiver Bias Correction

Address	Name	Description	Initial Value
0x00	ACQ_COMMAND	Device command	--

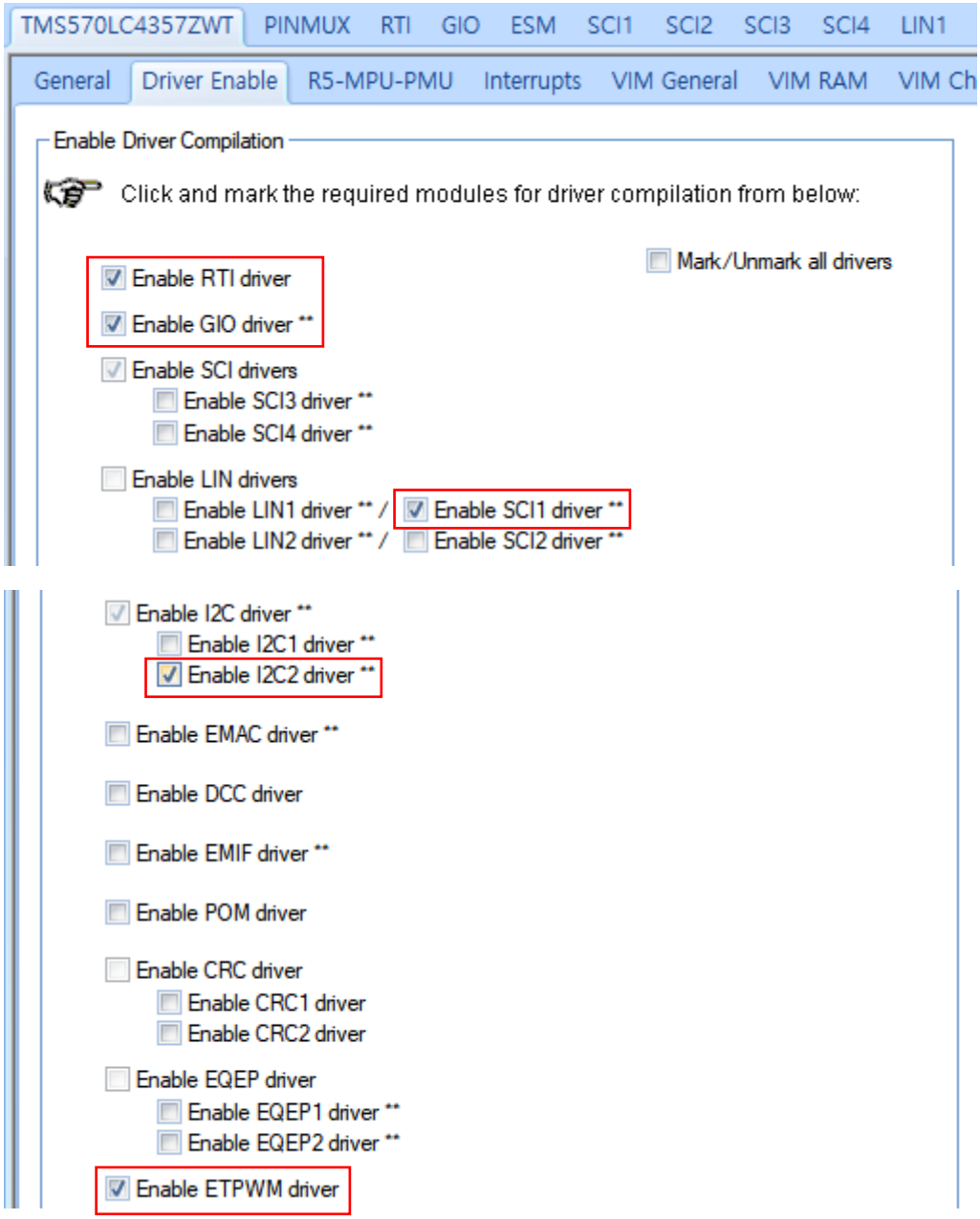
- Write 0x00: Reset device, all registers return to default values
- Write 0x03: Take distance measurement without receiver bias correction
- Write 0x04: Take distance measurement with receiver bias correction

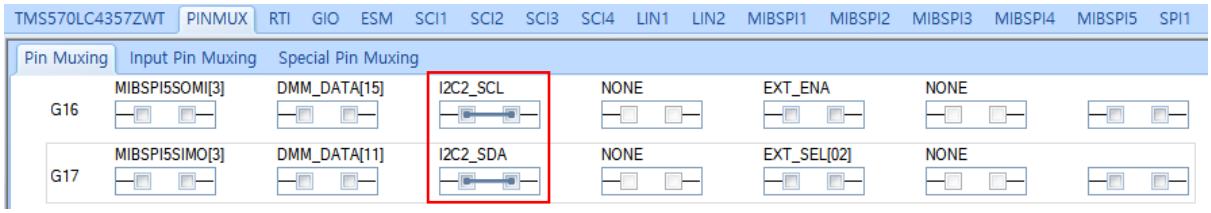
Faster distance measurements can be performed by omitting the receiver bias correction routine. Measurement accuracy and sensitivity are adversely affected if conditions change (e.g. target distance, device temperature, and optical noise). To achieve good performance at high measurement rates receiver bias correction must be performed periodically. The recommended method is to do so at the beginning of every 100 sequential measurement commands.

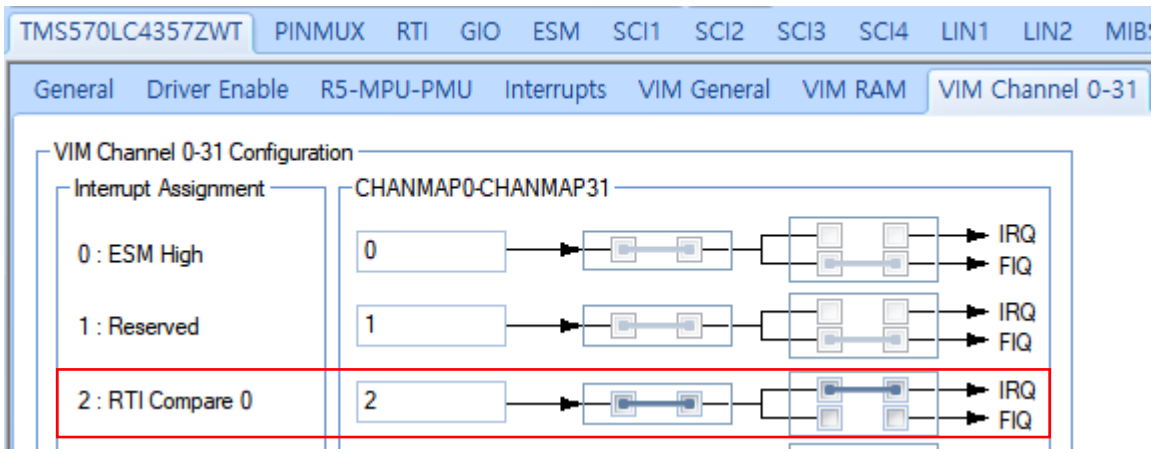
99번까지는 ACQ_COMMAND에 0x03 세팅하고, 100번째에 ACQ_COMMAND에 0x04를 세팅하는 것을 권장

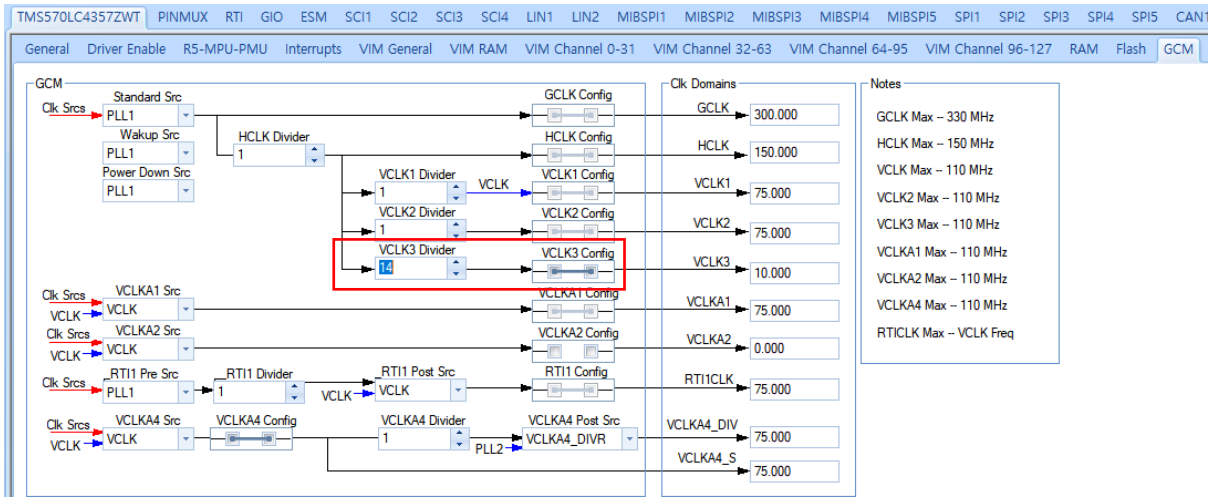
I2C – Lidar(rti 방식)

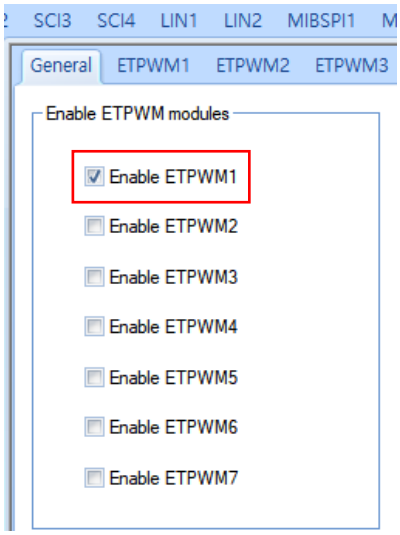
HCG 설정

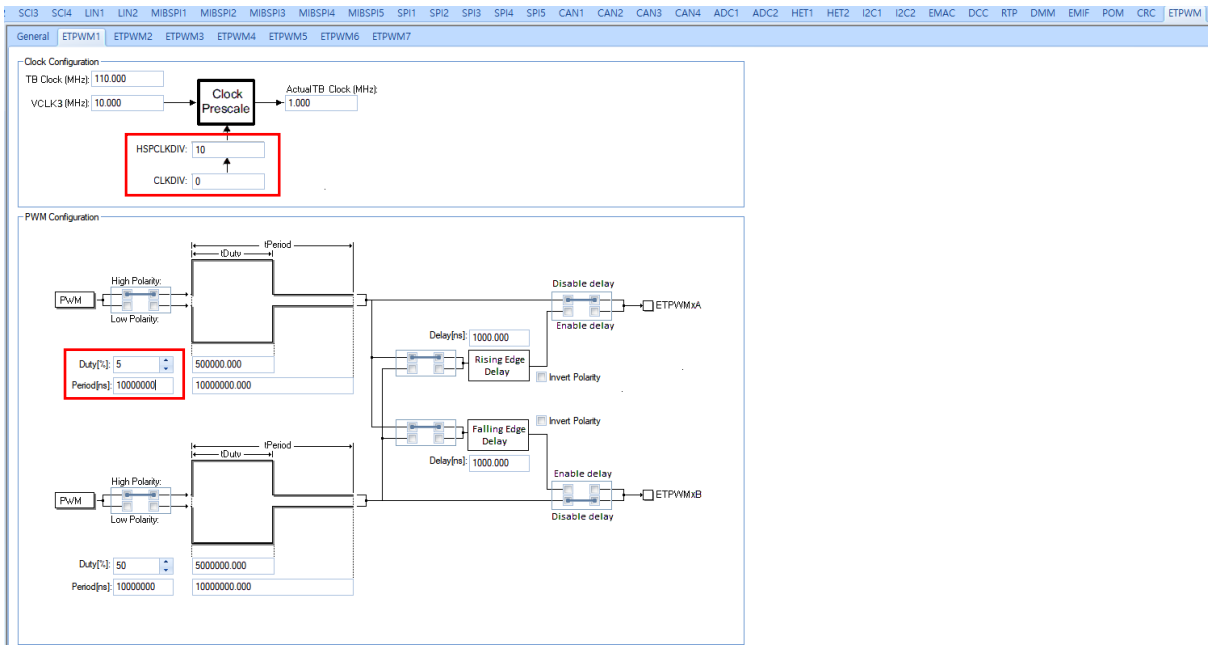



TMS570LC4357ZWT
PINMUX
RTI
GIO
ESM
SCI1
SCI2
SCI3
SCI4
LIN1
LIN2
MIBSPI1
MIBSPI2
MIBSPI3
MIBSPI4
MIBSPI5
SPI1
Pin Muxing
Input Pin Muxing
Special Pin Muxing
G16
MIBSPI5SOMI[3]
DMM_DATA[15]
I2C2_SCL
NONE
EXT_ENA
NONE
G17
MIBSPI5SIMO[3]
DMM_DATA[11]
I2C2_SDA
NONE
EXT_SEL[02]
NONE

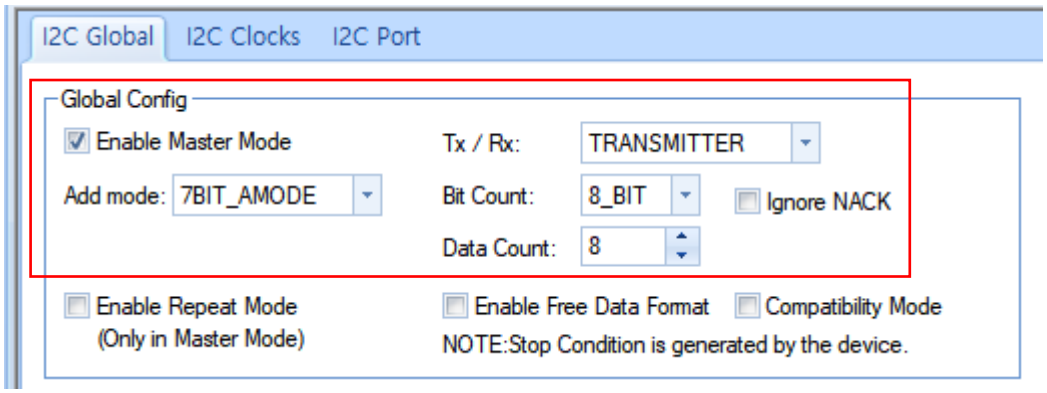

TMS570LC4357ZWT
PINMUX
RTI
GIO
ESM
SCI1
SCI2
SCI3
SCI4
LIN1
LIN2
General
Driver Enable
R5-MPU-PMU
Interrupts
VIM General
VIM RAM
VIM Channel 0-31
VIM Channel 0-31 Configuration
Interrupt Assignment
CHANMAP0-CHANMAP31
0 : ESM High
1 : Reserved
2 : RTI Compare 0
IRQ
FIQ

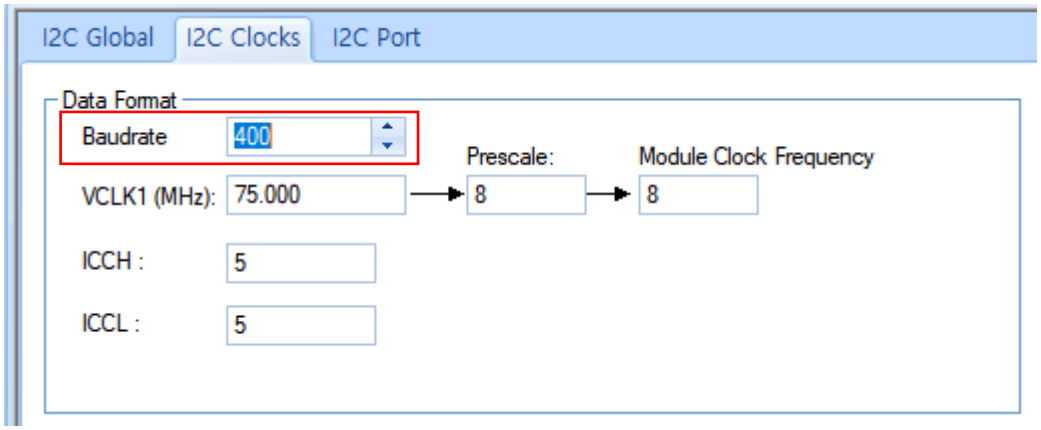

TMS570LC4357ZWT
PINMUX
RTI
GIO
ESM
SCI1
SCI2
SCI3
SCI4
LIN1
LIN2
MIBSPI1
MIBSPI2
MIBSPI3
MIBSPI4
MIBSPI5
SPI1
SPI2
SPI3
SPI4
SPI5
General
Driver Enable
R5-MPU-PMU
Interrupts
VIM General
VIM RAM
VIM Channel 0-31
VIM Channel 32-63
VIM Channel 64-95
VIM Channel 96-127
RAM
Flash
GCM
Standard Src
Wakup Src
Power Down Src
HCLK Divider
VCLK1 Divider
VCLK2 Divider
VCLK3 Divider
GCLK Config
HCLK Config
VCLK1 Config
VCLK2 Config
VCLK3 Config
VCLKA1 Src
VCLKA2 Src
RTI1 Pre Src
RTI1 Divider
RTI1 Post Src
RTI1 Config
VCLKA4 Src
VCLKA4 Config
VCLKA4 Divider
VCLKA4 Post Src
Clk Domains
GCLK
HCLK
VCLK1
VCLK2
VCLK3
VCLKA1
VCLKA2
RTI1CLK
VCLKA4_DIV
VCLKA4_S
300.000
150.000
75.000
75.000
10.000
75.000
0.000
75.000
75.000
75.000
Notes
GCLK Max -- 330 MHz
HCLK Max -- 150 MHz
VCLK Max -- 110 MHz
VCLK2 Max -- 110 MHz
VCLK3 Max -- 110 MHz
VCLKA1 Max -- 110 MHz
VCLKA2 Max -- 110 MHz
VCLKA4 Max -- 110 MHz
RTICLK Max -- VCLK Freq


SCI3
SCI4
LIN1
LIN2
MIBSPI1
General
ETPWM1
ETPWM2
ETPWM3
Enable ETPWM modules
Enable ETPWM1
Enable ETPWM2
Enable ETPWM3
Enable ETPWM4
Enable ETPWM5
Enable ETPWM6
Enable ETPWM7


SCI3 SCI4 LIN1 LIN2 MIBSPI1 MIBSPI2 MIBSPI3 MIBSPI4 MIBSPI5 SPI1 SPI2 SPI3 SPI4 SPI5 CAN1 CAN2 CAN3 CAN4 ADC1 ADC2 HET1 HET2 I2C1 I2C2 EMAC DCC RTP DMM EMIF POM CRC ETPWM
General ETPWM1 ETPWM2 ETPWM3 ETPWM4 ETPWM5 ETPWM6 ETPWM7
Clock Configuration
TB Clock (MHz): 110.000
VCLK3 (MHz): 10.000
Clock Prescale
Actual TB Clock (MHz): 1.000
HSPCLKDIV: 10
CLKDIV: 0
PWM Configuration
tPeriod
tDuty
High Polarity
PWM
Low Polarity
Duty[%]: 5
Period[ns]: 10000000
500000.000
10000000.000
Disable delay
Enable delay
ETPWMxA
Delay[ns]: 1000.000
Rising Edge Delay
Invert Polarity
Falling Edge Delay
Invert Polarity
Delay[ns]: 1000.000
Enable delay
ETPWMxB
Disable delay
Duty[%]: 50
Period[ns]: 10000000
5000000.000
10000000.000

I2C2


I2C Global
I2C Clocks
I2C Port
Global Config
Enable Master Mode
Tx / Rx:
TRANSMITTER
Add mode:
7BIT_AMODE
Bit Count:
8_BIT
Ignore NACK
Data Count:
8
Enable Repeat Mode
(Only in Master Mode)
Enable Free Data Format
Compatibility Mode
NOTE:Stop Condition is generated by the device.


I2C Global
I2C Clocks
I2C Port
Data Format
Baudrate
400
Prescale:
Module Clock Frequency
VCLK1 (MHz):
75.000
8
8
ICCH :
5
ICCL :
5

CCS 코드

```
#include <HL_etpwm.h>
#include <HL_gio.h>
#include <HL_hal_stdtypes.h>
#include <HL_i2c.h>
#include <HL_reg_etpwm.h>
#include <HL_reg_i2c.h>
#include <HL_reg_rti.h>
#include <HL_reg_sci.h>
#include <HL_rti.h>
#include <HL_sci.h>
#include <HL_sys_core.h>
#include <stdbool.h>
#include <stdio.h>
#include <string.h>

#define UART sciREG1
#define LIDAR_SLAVE_ADDR 0x62

#define ACQ_COMMAND 0x00
#define STATUS 0x01
#define SIG_COUNT_VAL 0x02
#define ACQ_CONFIG_REG 0x04
#define THRESHOLD_BYPASS 0x1C
#define READ_FROM 0x8f

#define FULL_DELAY_HIGH 0x0f

uint8 receives[2];
volatile int g_acc_flag;

void sciDisplayText(sciBASE_t *sci, uint8 *text, uint32 len);
void pwmSet(void);
void wait(uint32 delay);
void Lidar_without_bias(void);

void Lidar_enable(void);

void wait(uint32 delay)
{
    int i;

    for (i = 0; i < delay; i++)
        ;
}

void sciDisplayText(sciBASE_t *sci, uint8 *text, uint32 len)
{
    while (len--)
    {
        while ((UART->FLR & 0x4) == 4)
            ;
        sciSendByte(UART, *text++);
    }
}

void disp_set(char *str)
{
    char txt_buf[256] = { 0 };
    unsigned int buf_len;
    sprintf(txt_buf, str);
    buf_len = strlen(txt_buf);
    sciDisplayText(sciREG1, (uint8 *) txt_buf, buf_len);
    wait(100000);
}

int main(void)
{
    char txt_buf[256] = { 0 };
    unsigned int buf_len;
```

```
volatile int i ;
int cnt = 1;

uint16 ave[2] = { 0 };

sciInit();

disp_set("SCI Configuration Success!!\n\r\0");

gioInit();

disp_set("GIO Init Success!!\n\r\0");

i2cInit();
wait(10000000);

disp_set("I2C Init Success!!\n\r\0");

Lidar_enable();

disp_set("Lidar Enable Success!!\n\r\0");

rtiInit();
rtiEnableNotification(rtiREG1, rtiNOTIFICATION_COMPARE0);
_enable_IRQ_interrupt_();
rtiStartCounter(rtiREG1, rtiCOUNTER_BLOCK0);

disp_set("RTI Init Success!!\n\r\0");

etpwmInit();

disp_set("ETPWM Configuration Success!!\n\r\0");

etpwmStartTBCLK();
wait(1000000);

for (;;)
{
    if (g_acc_flag)
    {
        uint16 tmp;
        tmp = receives[0] << 8;
        tmp |= receives[1];

            if (cnt % 3 == 0)
            {
                tmp = (ave[0] + ave[1]) / 2;

                sprintf(txt_buf, "Distance = %d\n\r\0", tmp);
                buf_len = strlen(txt_buf);
                sciDisplayText(sciREG1, (uint8 *) txt_buf, buf_len);

                i = 0;
                cnt++; //4

                g_acc_flag = 0;

            }
            else
            {

                ave[i] = tmp; //0 1

                i++; //1 2
                cnt++; //2 3

                g_acc_flag = 0;

            }

        }

    Lidar_without_bias();
```

```
    }
    return 0;
}

void Lidar_enable(void)
{
    uint8 tmp[4] = { 0x80, 0x08, 0x00, 0x04 };

    volatile unsigned int cnt = 7;
    i2cSetSlaveAdd(i2cREG2, LIDAR_SLAVE_ADDR);
    i2cSetDirection(i2cREG2, I2C_TRANSMITTER);
    i2cSetCount(i2cREG2, cnt + 1);
    i2cSetMode(i2cREG2, I2C_MASTER);
    i2cSetStop(i2cREG2);
    i2cSetStart(i2cREG2);

    i2cSendByte(i2cREG2, SIG_COUNT_VAL);
    i2cSend(i2cREG2, 1, &tmp[0]); //0x80

    i2cSendByte(i2cREG2, ACQ_CONFIG_REG);
    i2cSend(i2cREG2, 1, &tmp[1]); //0x08

    i2cSendByte(i2cREG2, THRESHOLD_BYPASS);
    i2cSend(i2cREG2, 1, &tmp[2]); //0x00

    i2cSendByte(i2cREG2, ACQ_COMMAND);
    i2cSend(i2cREG2, 1, &tmp[3]); //0x04

    disp_set("Lidar tmp 1 Enable Success!!\n\r\0");

    while (i2cIsBusBusy(i2cREG2) == true)
        ;
    while (i2cIsStopDetected(i2cREG2) == 0)
        ;
    i2cClearSCD(i2cREG2);

    wait(100000);

}

void rtiNotification(rtiBASE_t *rtiREG, uint32 notification)
{

    i2cSetSlaveAdd(i2cREG2, LIDAR_SLAVE_ADDR);
    i2cSetDirection(i2cREG2, I2C_TRANSMITTER);
    i2cSetCount(i2cREG2, 1);
    i2cSetMode(i2cREG2, I2C_MASTER);
    i2cSetStop(i2cREG2);
    i2cSetStart(i2cREG2);
    i2cSendByte(i2cREG2, READ_FROM);

    while (i2cIsBusBusy(i2cREG2) == true)
        ;
    while (i2cIsStopDetected(i2cREG2) == 0)
        ;
    i2cClearSCD(i2cREG2);

    i2cSetDirection(i2cREG2, I2C_RECEIVER);
    i2cSetCount(i2cREG2, 2);
    i2cSetMode(i2cREG2, I2C_MASTER);
    i2cSetStart(i2cREG2);
    i2cReceive(i2cREG2, 2, (unsigned char *) receives);
    i2cSetStop(i2cREG2);

    while (i2cIsBusBusy(i2cREG2) == true)
        ;
    while (i2cIsStopDetected(i2cREG2) == 0)
        ;
    i2cClearSCD(i2cREG2);

    g_acc_flag = 1;
}
```

```
void Lidar_without_bias(void)
{
    volatile unsigned int cnt = 1;
    unsigned char data[1] = { 0x03U };
    i2cSetSlaveAdd(i2cREG2, LIDAR_SLAVE_ADDR);
    i2cSetDirection(i2cREG2, I2C_TRANSMITTER);
    i2cSetCount(i2cREG2, cnt + 1);
    i2cSetMode(i2cREG2, I2C_MASTER);
    i2cSetStop(i2cREG2);
    i2cSetStart(i2cREG2);
    i2cSendByte(i2cREG2, ACQ_COMMAND);
    i2cSend(i2cREG2, cnt, data);
    i2cSetStop(i2cREG2);

    while (i2cIsBusBusy(i2cREG2) == true)
        ;
    while (i2cIsStopDetected(i2cREG2) == 0)
        ;
    i2cClearSCD(i2cREG2);
    wait(1000000);
}
```