CPE403 – Advanced Embedded Systems

Design Assignment 5

DO NOT REMOVE THIS PAGE DURING SUBMISSION:

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Github Repository link (root): https://github.com/MeralAbuJaser/Advanced-Embedded-Systems

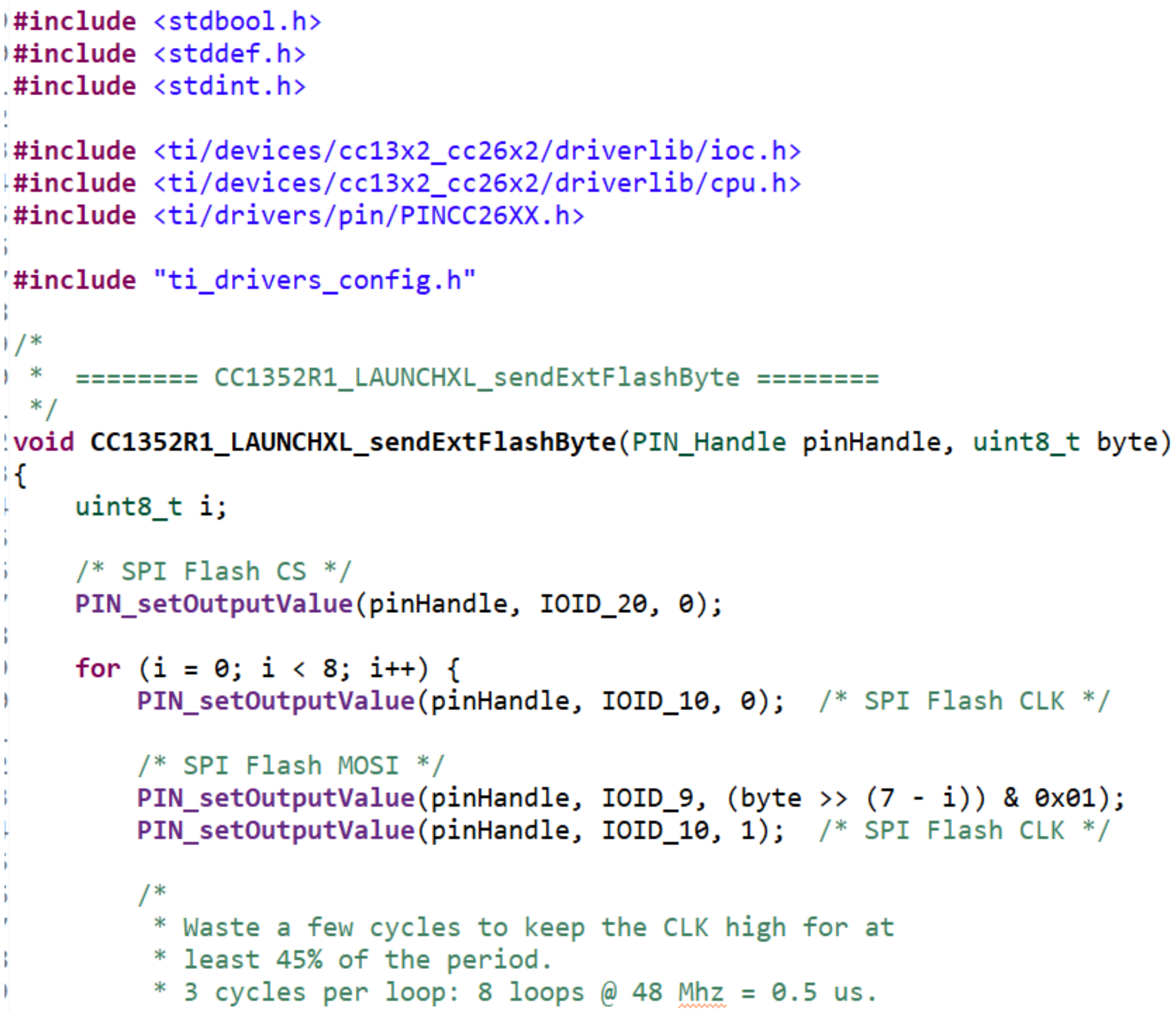
Youtube Playlist link (root): I didn't upload a video since I was unable to work with only 1 launchpad ☹

Follow the submission guideline to be awarded points for this Assignment.

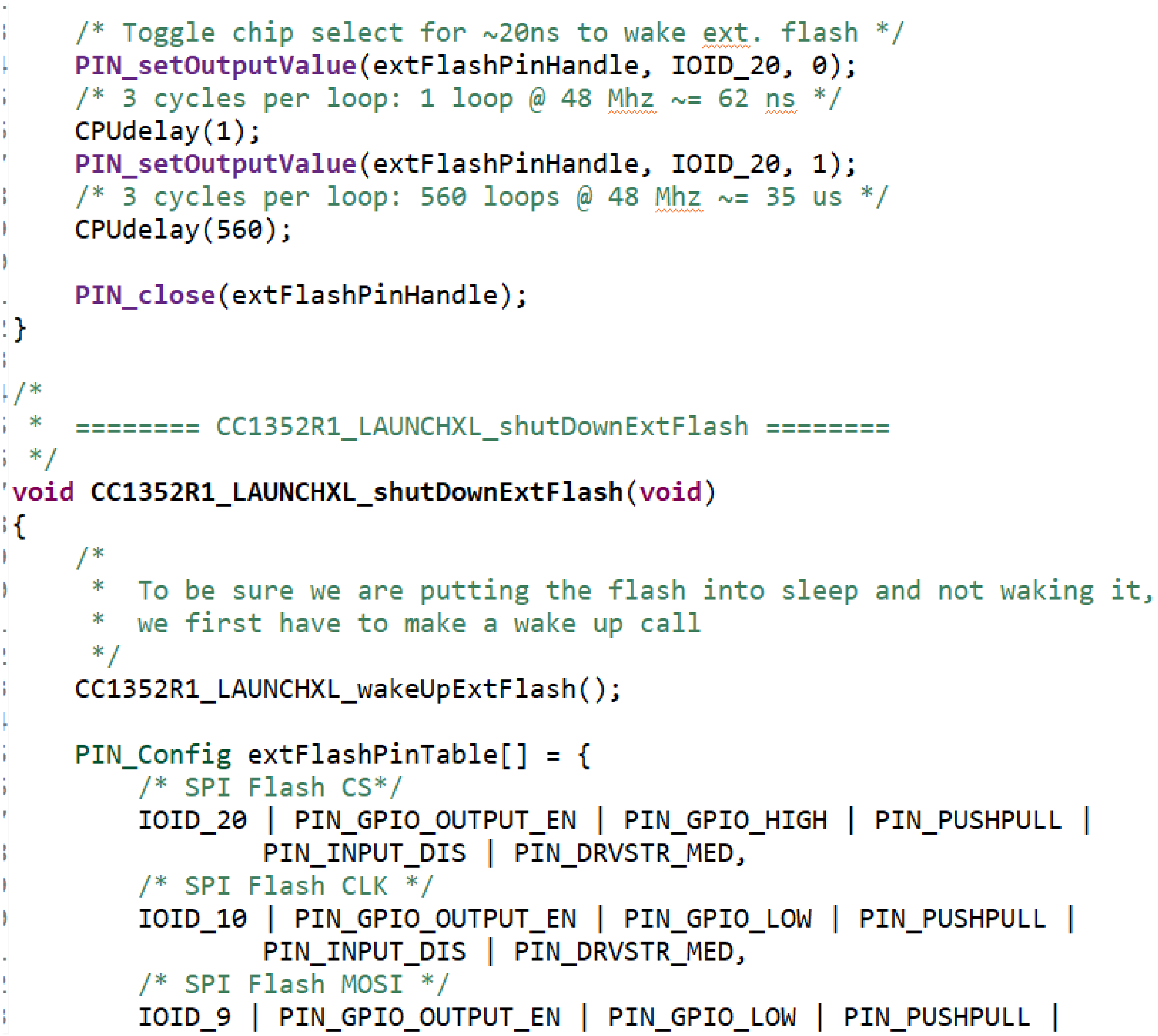
Submit the following for all Assignments:

1. In the document, for each task submit the modified or included code (from the base code) with highlights and justifications of the modifications. Also include the comments. If no base code is provided, submit the base code for the first task only.
2. Create a private Github repository with a random name (no CPE/403, Lastname, Firstname). Place all labs under the root folder TIVAC, sub-folder named Assignment1, with one document and one video link file for each lab, place modified c files named as asng_taskxx.c.
3. If multiple c files or other libraries are used, create a folder asng1_t01 and place these files inside the folder.
4. The folder should have a) Word document (see template), b) source code file(s) with startup_ccs.c and other include files, c) text file with youtube video links (see template).
5. Submit the doc file in canvas before the due date. The root folder of the github assignment directory should have the documentation and the text file with youtube video links.
6. Organize your youtube videos as playlist under the name "cpe403". The playlist should have the video sequence arranged as submission or due dates.
7. Only submit pdf documents. Do not forget to upload this document in the github repository and in the canvas submission portal.

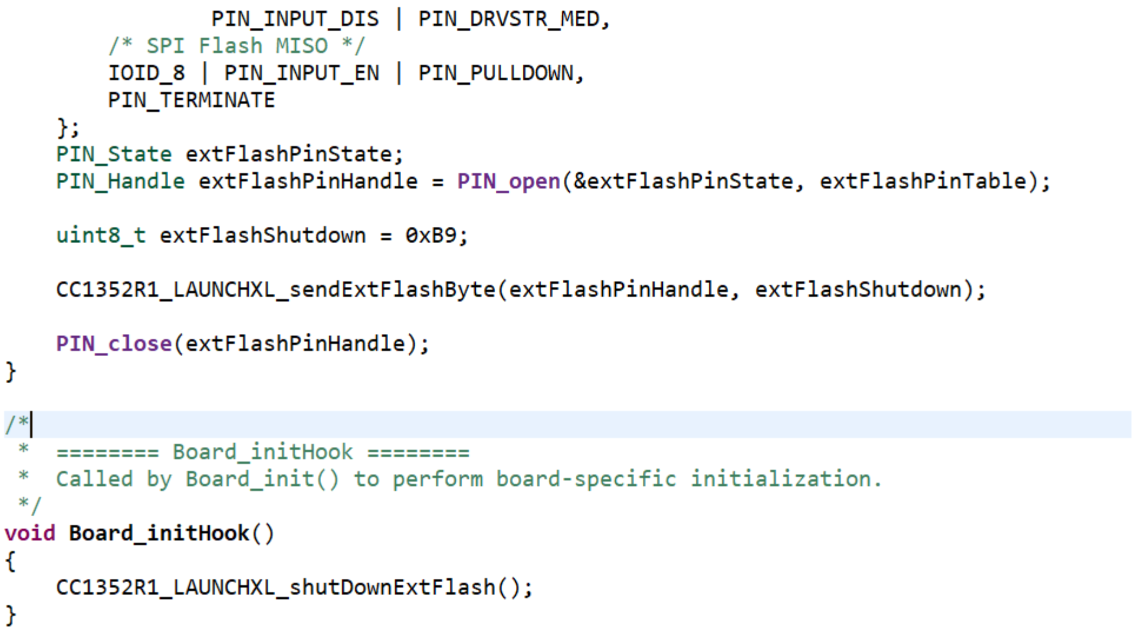
1.



```
#include <stdbool.h>
#include <stddef.h>
#include <stdint.h>

#include <ti/devices/cc13x2_cc26x2/driverlib/ioc.h>
#include <ti/devices/cc13x2_cc26x2/driverlib/cpu.h>
#include <ti/drivers/pin/PINCC26XX.h>

#include "ti_drivers_config.h"

/*
 *  ======== CC1352R1_LAUNCHXL_sendExtFlashByte ========
 */
void CC1352R1_LAUNCHXL_sendExtFlashByte(PIN_Handle pinHandle, uint8_t byte)
{
    uint8_t i;

    /* SPI Flash CS */
    PIN_setOutputValue(pinHandle, IOID_20, 0);

    for (i = 0; i < 8; i++) {
        PIN_setOutputValue(pinHandle, IOID_10, 0);  /* SPI Flash CLK */

        /* SPI Flash MOSI */
        PIN_setOutputValue(pinHandle, IOID_9, (byte >> (7 - i)) & 0x01);
        PIN_setOutputValue(pinHandle, IOID_10, 1);  /* SPI Flash CLK */

        /*
         * Waste a few cycles to keep the CLK high for at
         * least 45% of the period.
         * 3 cycles per loop: 8 loops @ 48 Mhz = 0.5 us.
        CPUdelay(8);
    }

    PIN_setOutputValue(pinHandle, IOID_10, 0);  /* CLK */
    PIN_setOutputValue(pinHandle, IOID_20, 1);  /* CS */

    /*
     * Keep CS high at least 40 us
     * 3 cycles per loop: 700 loops @ 48 Mhz ~= 44 us
     */
    CPUdelay(700);
}

/*
 *  ======== CC1352R1_LAUNCHXL_wakeUpExtFlash ========
 */
void CC1352R1_LAUNCHXL_wakeUpExtFlash(void)
{
    PIN_Config extFlashPinTable[] = {
        /* SPI Flash CS */
        IOID_20 | PIN_GPIO_OUTPUT_EN | PIN_GPIO_HIGH | PIN_PUSHPULL |
                PIN_INPUT_DIS | PIN_DRVSTR_MED,
        PIN_TERMINATE
    };
    PIN_State extFlashPinState;
    PIN_Handle extFlashPinHandle = PIN_open(&extFlashPinState, extFlashPinTable);

    /*
     *  To wake up we need to toggle the chip select at
     *  least 20 ns and ten wait at least 35 us.
     */
```



```
    /* Toggle chip select for ~20ns to wake ext. flash */
    PIN_setOutputValue(extFlashPinHandle, IOID_20, 0);
    /* 3 cycles per loop: 1 loop @ 48 Mhz ~= 62 ns */
    CPUdelay(1);
    PIN_setOutputValue(extFlashPinHandle, IOID_20, 1);
    /* 3 cycles per loop: 560 loops @ 48 Mhz ~= 35 us */
    CPUdelay(560);

    PIN_close(extFlashPinHandle);
}

/*
 *  ======== CC1352R1_LAUNCHXL_shutDownExtFlash ========
 */
void CC1352R1_LAUNCHXL_shutDownExtFlash(void)
{
    /*
     *  To be sure we are putting the flash into sleep and not waking it,
     *  we first have to make a wake up call
     */
    CC1352R1_LAUNCHXL_wakeUpExtFlash();

    PIN_Config extFlashPinTable[] = {
        /* SPI Flash CS*/
        IOID_20 | PIN_GPIO_OUTPUT_EN | PIN_GPIO_HIGH | PIN_PUSHPULL |
                PIN_INPUT_DIS | PIN_DRVSTR_MED,
        /* SPI Flash CLK */
        IOID_10 | PIN_GPIO_OUTPUT_EN | PIN_GPIO_LOW | PIN_PUSHPULL |
                PIN_INPUT_DIS | PIN_DRVSTR_MED,
        /* SPI Flash MOSI */
        IOID_9 | PIN_GPIO_OUTPUT_EN | PIN_GPIO_LOW | PIN_PUSHPULL |
```



```
                PIN_INPUT_DIS | PIN_DRVSTR_MED,
        /* SPI Flash MISO */
        IOID_8 | PIN_INPUT_EN | PIN_PULLDOWN,
        PIN_TERMINATE
    };
    PIN_State extFlashPinState;
    PIN_Handle extFlashPinHandle = PIN_open(&extFlashPinState, extFlashPinTable);

    uint8_t extFlashShutdown = 0xB9;

    CC1352R1_LAUNCHXL_sendExtFlashByte(extFlashPinHandle, extFlashShutdown);

    PIN_close(extFlashPinHandle);
}

/*
 *  ======== Board_initHook ========
 *  Called by Board_init() to perform board-specific initialization.
 */
void Board_initHook()
{
    CC1352R1_LAUNCHXL_shutDownExtFlash();
}
```

I tried using the below code with the collector to get the reading of the temperature, humidity and light but it wont work without having 2 launchpads. I was supposed to meet with my friend so we can use our launchpads together but unfortunate she was out of state.

```
#include <xdc/std.h>
#include <xdc/runtime/Error.h>
#include <xdc/runtime/System.h>
#include <ti/sysbios/BIOS.h>
#include <ti/sysbios/knl/Task.h>
#include <ioc.h>
#include "sys_ctrl.h"
#include "ti_drivers_config.h"
#include <inc/hw_ccfg.h>
#include <inc/hw_ccfg_simple_struct.h>
/* Header files required for the temporary idle task function */
#include <ti/drivers/Power.h>
#include <ti/drivers/power/PowerCC26XX.h>
#include <aon_rtc.h>
#include <prcm.h>
#if (defined(FEATURE_BLE_OAD) || defined(FEATURE_NATIVE_OAD)) && !defined(OAD_ONCHIP)
#include <ti/drivers/SPI.h>
#endif
#if defined(FEATURE_BLE_OAD)
    #include "ble_oad/oad_switch.h"
#endif
/* Header files required to enable instruction fetch cache */
#include <vims.h>
#include <hw_memmap.h>
#include <ti/sysbios/hal/Hwi.h>
#include "cpu.h"
#ifdef NV_RESTORE
#include "macconfig.h"
#ifdef ONE_PAGE_NV
#include "nvocop.h"
#else
#include "nvocmp.h"
#endif
#endif
#include <string.h>
#ifdef OSAL_PORT2TIRTOS
#include "macTask.h"
#else
#include "api_mac.h"
#include "icall.h"
#endif
#include "ssf.h"
#include "sensor.h"
#ifndef USE_DEFAULT_USER_CFG
#include "mac_user_config.h"
#ifndef CUI_DISABLE
#include "cui.h"
#endif
#ifdef USE_ITM_DBG
#include "itm.h"
#endif
```

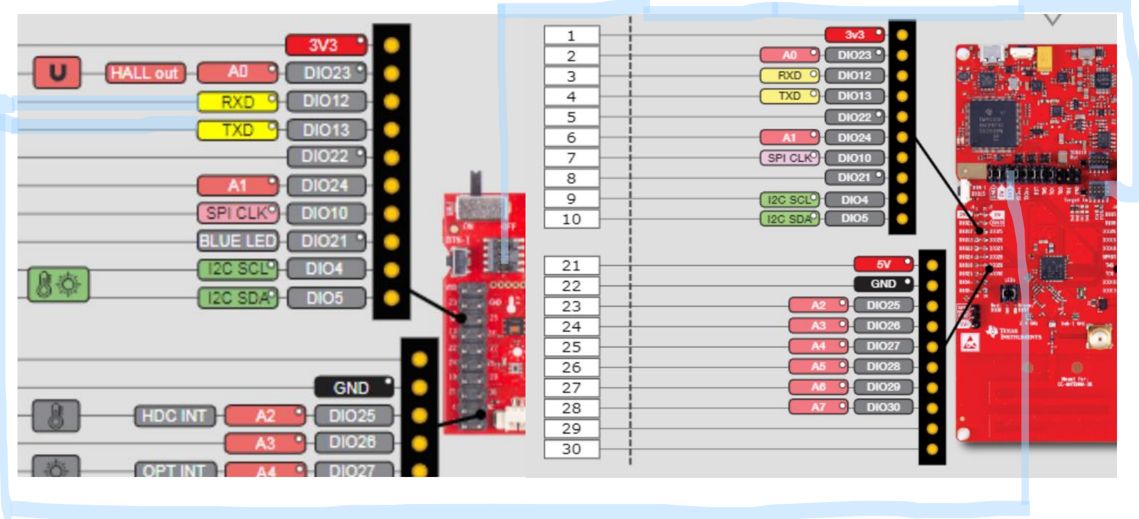
```
macUserCfg_t macUser0Cfg[] = MAC_USER_CFG;
#endif /* USE_DEFAULT_USER_CFG */
/* Assert Reasons */
#define MAIN_ASSERT_MAC          3
#define MAIN_ASSERT_HWI_TIRTOS   4
#define MAX_ASSERT_TOGGLE_COUNT  500000
#define RFC_MODE_BLE                 PRCM_RFCMODESEL_CURR_MODE1
#define RFC_MODE_IEEE                PRCM_RFCMODESEL_CURR_MODE2
#define RFC_MODE_ANT                 PRCM_RFCMODESEL_CURR_MODE4
#define RFC_MODE_EVERYTHING_BUT_ANT  PRCM_RFCMODESEL_CURR_MODE5
#define RFC_MODE_EVERYTHING          PRCM_RFCMODESEL_CURR_MODE6
/* Extended Address offset in FCFG (LSB..MSB) */
#define EXTADDR_OFFSET 0x2F0
#define APP_TASK_PRIORITY   1
#if defined(DeviceFamily_CC13X2) || (DeviceFamily_CC26X2)
#define APP_TASK_STACK_SIZE 2048
#else
#define APP_TASK_STACK_SIZE 900
#endif
#define SET_RFC_MODE(mode) HWREG( PRCM_BASE + PRCM_O_RFCMODESEL ) = (mode)
/******************************************************************************
 External Variables
 *****************************************************************************/
extern ApiMac_sAddrExt_t ApiMac_extAddr;
/******************************************************************************
 Global Variables
 *****************************************************************************/
Task_Struct appTask;        /* not static so you can see in ROV */
static uint8_t appTaskStack[APP_TASK_STACK_SIZE];

#ifdef OSAL_PORT2TIRTOS
static uint8_t _macTaskId;
#endif
/*
 When assert happens, this field will be filled with the reason:
       MAIN_ASSERT_HWI_TIRTOS or MAIN_ASSERT_MAC
 */
uint8 Main_assertReason = 0;

#ifdef NV_RESTORE
mac_Config_t Main_user1Cfg = { 0 };
#endif

static const uint8_t dummyExtAddr[] =
    { 0xFF, 0xFF, 0xFF, 0xFF, 0xFF, 0xFF, 0xFF, 0xFF };

extern void Board_init(void);

#ifdef NV_RESTORE
#ifdef ONE_PAGE_NV

/* NVOCOP load API pointers */
static void NVOCOP_loadApiPtrs(NVINTF_nvFuncts_t *pfn)
{
    // Load caller's structure with pointers to the NV API functions
    pfn->initNV      = &NVOCOP_initNV;
    pfn->compactNV   = &NVOCOP_compactNV;
    pfn->createItem  = NULL;
    pfn->deleteItem  = &NVOCOP_deleteItem;
    pfn->readItem    = &NVOCOP_readItem;
    pfn->writeItem   = &NVOCOP_writeItem;
    pfn->writeItemEx = NULL;
    pfn->getItemLen  = NULL;
}
#endif
#endif
```

```
static inline void CCFGRead_IEEE_MAC(ApiMac_sAddrExt_t addr)
{
    uint32_t macAddr = (( HWREG(
            CCFG_BASE + CCFG_O_IEEE_MAC_0 ) &
            CCFG_IEEE_MAC_0_ADDR_M ) >>
            CCFG_IEEE_MAC_0_ADDR_S );
    memcpy(addr, (uint8_t *)&macAddr, (APIMAC_SADDR_EXT_LEN / 2));

    macAddr = (( HWREG(
            CCFG_BASE + CCFG_O_IEEE_MAC_1 ) &
            CCFG_IEEE_MAC_1_ADDR_M ) >>
            CCFG_IEEE_MAC_1_ADDR_S );
    memcpy(addr + (APIMAC_SADDR_EXT_LEN / 2), (uint8_t *)&macAddr,
           (APIMAC_SADDR_EXT_LEN / 2));
}

/*!
 * @brief       Fill in your own assert function.
 *
 * @param       assertReason - reason: MAIN_ASSERT_HWI_TIRTOS or
 *                                     MAIN_ASSERT_MAC
 */
void Main_assertHandler(uint8_t assertReason)
{
    Main_assertReason = assertReason;

#if defined(RESET_ASSERT)
    Ssf_assertInd(assertReason);

    /* Pull the plug and start over */
    SysCtrlSystemReset();
#else
    Hwi_disable();
    while(1)
    {
        /* Put you code here to do something if in assert */
    }
#endif
}
Void appTaskFxn(UArg a0, UArg a1)
{
    /* The following code encapsulated in TI_154STACK_FPGA flag is used for
     * internal FPGA evaluation of the 15.4 Stack and should not be used with
     * TI hardware platforms. */
#ifdef TI_154STACK_FPGA
    /* FPGA build disables POWER constraints */
    Power_setConstraint(PowerCC26XX_IDLE_PD_DISALLOW);
    Power_setConstraint(PowerCC26XX_SB_DISALLOW);

    IOCPortConfigureSet(IOID_20, IOC_PORT_RFC_GPO0, IOC_STD_OUTPUT);
    IOCPortConfigureSet(IOID_18, IOC_PORT_RFC_GPI0, IOC_STD_INPUT);
    // configure RF Core SMI Command Link
    IOCPortConfigureSet(IOID_22, IOC_IOCFG0_PORT_ID_RFC_SMI_CL_OUT, IOC_STD_OUTPUT);
    IOCPortConfigureSet(IOID_21, IOC_IOCFG0_PORT_ID_RFC_SMI_CL_IN, IOC_STD_INPUT);
#endif

#ifndef OSAL_PORT2TIRTOS
    /* Initialize ICall module */
    ICall_init();
#endif
    /* Copy the extended address from the CCFG area */
    CCFGRead_IEEE_MAC(ApiMac_extAddr);

    /* Check to see if the CCFG IEEE is valid */
    if(memcmp(ApiMac_extAddr, dummyExtAddr, APIMAC_SADDR_EXT_LEN) == 0)
    {
        /* No, it isn't valid.  Get the Primary IEEE Address */
        memcpy(ApiMac_extAddr, (uint8_t *)(FCFG1_BASE + EXTADDR_OFFSET),
               (APIMAC_SADDR_EXT_LEN));
    }
```

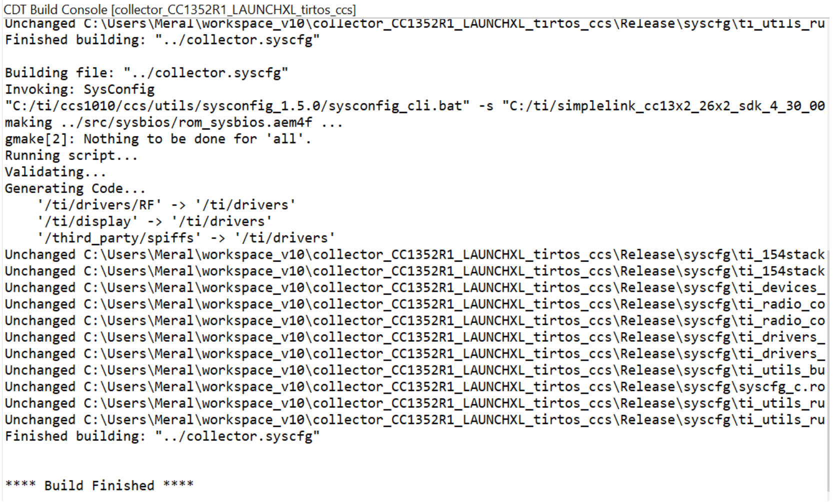
```c
#ifdef NV_RESTORE
    /* Setup the NV driver */
#ifdef ONE_PAGE_NV
    NVOCOP_loadApiPtrs(&Main_user1Cfg.nvFps);
#else
    NVOCMP_loadApiPtrs(&Main_user1Cfg.nvFps);
#endif

    if(Main_user1Cfg.nvFps.initNV)
    {
        Main_user1Cfg.nvFps.initNV( NULL);
    }
#endif

    /* Initialize the application */
#ifdef OSAL_PORT2TIRTOS
    Sensor_init(_macTaskId);
#else
    ICall_createRemoteTasks();

    /* Initialize the application */
    Sensor_init();
#endif

    /* Kick off application - Forever loop */
    while(1)
    {
        Sensor_process();
    }
}
xdc_Void Main_excHandler(UInt *excStack, UInt lr)
{
    /* User defined function */
    Main_assertHandler(MAIN_ASSERT_HWI_TIRTOS);
}
void assertHandler(void){
    /* User defined function */
    Main_assertHandler(MAIN_ASSERT_MAC);
}
int main(void){
    Task_Params taskParams;

#ifndef USE_DEFAULT_USER_CFG
    macUser0Cfg[0].pAssertFP = assertHandler;
#endif
    Board_init();
#if defined(FEATURE_BLE_OAD) && !defined(OAD_IMG_A)
    if(!PIN_getInputValue(CONFIG_PIN_BTN1)){
        OAD_markSwitch();
    }
#endif /* FEATURE_BLE_OAD */
#if (defined(FEATURE_BLE_OAD) || defined(FEATURE_NATIVE_OAD)) && !defined(OAD_ONCHIP)
    SPI_init();
#endif
#if !defined(POWER_MEAS) && !defined(CUI_DISABLE)
    CUI_params_t cuiParams;
    CUI_paramsInit(&cuiParams);
    CUI_init(&cuiParams);
#endif
#ifdef OSAL_PORT2TIRTOS
    _macTaskId = macTaskInit(macUser0Cfg);
#endif

    /* Configure task. */
    Task_Params_init(&taskParams);
    taskParams.stack = appTaskStack;
    taskParams.stackSize = APP_TASK_STACK_SIZE;
    taskParams.priority = APP_TASK_PRIORITY;
    Task_construct(&appTask, appTaskFxn, &taskParams, NULL);
```

```
#ifdef USE_ITM_DBG
    ITM_config itm_config =
    {
      48000000,
      ITM_6000000
    };
    ITM_initModule(itm_config);
    ITM_enableModule();
#endif /* USE_ITM_DBG */

    BIOS_start(); /* enable interrupts and start SYS/BIOS */

    return (0);
}
```

2. Block diagram and/or Schematics showing the components, pins used, and interface.

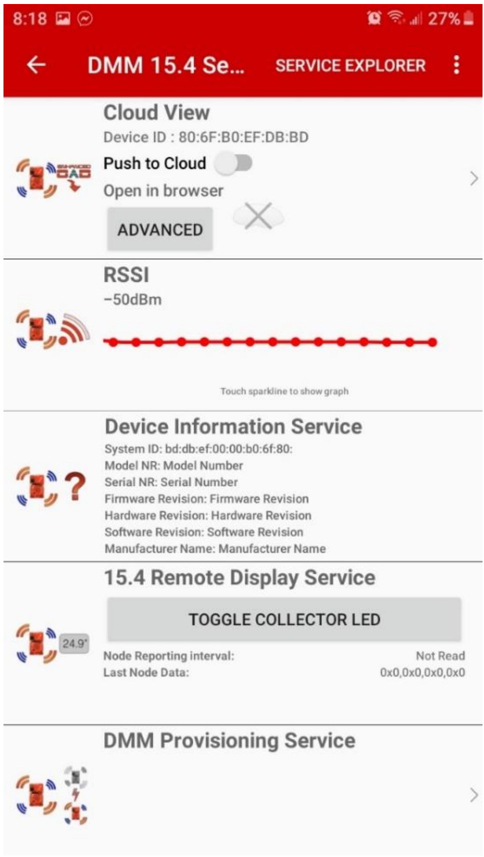


3. Screenshots of the IDE, physical setup, debugging process - Provide screenshot of successful compilation, screenshots of registers, variables, graphs, etc.



CDT Build Console [collector_CC1352R1_LAUNCHXL_tirtos_ccs]

```
Unchanged C:\Users\Meral\workspace_v10\collector_CC1352R1_LAUNCHXL_tirtos_ccs\Release\syscfg\ti_utils_ru
Finished building: "../collector.syscfg"

Building file: "../collector.syscfg"
Invoking: SysConfig
"C:/ti/ccs1010/ccs/utils/sysconfig_1.5.0/sysconfig_cli.bat" -s "C:/ti/simplelink_cc13x2_26x2_sdk_4_30_00
making ../src/sysbios/rom_sysbios.aem4f ...
gmake[2]: Nothing to be done for 'all'.
Running script...
Validating...
Generating Code...
    '/ti/drivers/RF' -> '/ti/drivers'
    '/ti/display' -> '/ti/drivers'
    '/third_party/spiffs' -> '/ti/drivers'
Unchanged C:\Users\Meral\workspace_v10\collector_CC1352R1_LAUNCHXL_tirtos_ccs\Release\syscfg\ti_154stack
Unchanged C:\Users\Meral\workspace_v10\collector_CC1352R1_LAUNCHXL_tirtos_ccs\Release\syscfg\ti_154stack
Unchanged C:\Users\Meral\workspace_v10\collector_CC1352R1_LAUNCHXL_tirtos_ccs\Release\syscfg\ti_devices_
Unchanged C:\Users\Meral\workspace_v10\collector_CC1352R1_LAUNCHXL_tirtos_ccs\Release\syscfg\ti_radio_co
Unchanged C:\Users\Meral\workspace_v10\collector_CC1352R1_LAUNCHXL_tirtos_ccs\Release\syscfg\ti_radio_co
Unchanged C:\Users\Meral\workspace_v10\collector_CC1352R1_LAUNCHXL_tirtos_ccs\Release\syscfg\ti_drivers_
Unchanged C:\Users\Meral\workspace_v10\collector_CC1352R1_LAUNCHXL_tirtos_ccs\Release\syscfg\ti_drivers_
Unchanged C:\Users\Meral\workspace_v10\collector_CC1352R1_LAUNCHXL_tirtos_ccs\Release\syscfg\ti_utils_bu
Unchanged C:\Users\Meral\workspace_v10\collector_CC1352R1_LAUNCHXL_tirtos_ccs\Release\syscfg\syscfg_c.ro
Unchanged C:\Users\Meral\workspace_v10\collector_CC1352R1_LAUNCHXL_tirtos_ccs\Release\syscfg\ti_utils_ru
Unchanged C:\Users\Meral\workspace_v10\collector_CC1352R1_LAUNCHXL_tirtos_ccs\Release\syscfg\ti_utils_ru
Finished building: "../collector.syscfg"


**** Build Finished ****
```



Cloud View

Device ID : 80:6F:B0:EF:DB:BD

Push to Cloud

Open in browser

ADVANCED

RSSI

−50dBm

Touch sparkline to show graph

Device Information Service

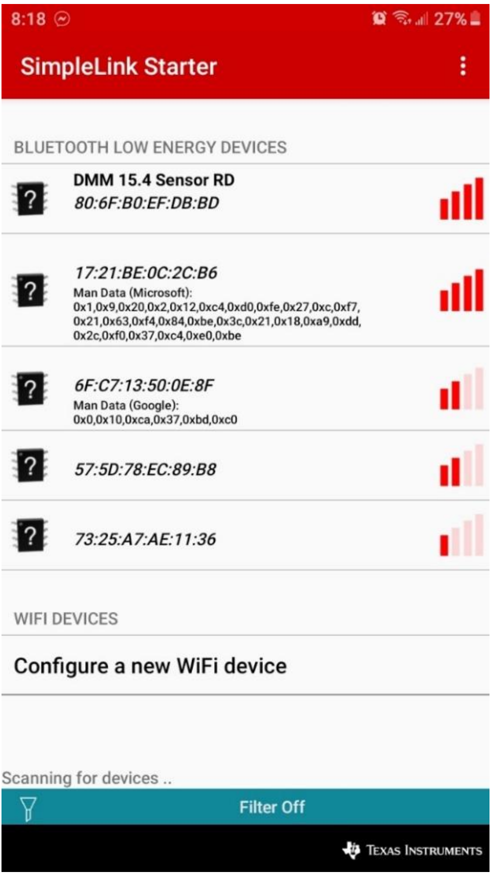
System ID: bd:db:ef:00:00:b0:6f:80:
Model NR: Model Number
Serial NR: Serial Number
Firmware Revision: Firmware Revision
Hardware Revision: Hardware Revision
Software Revision: Software Revision
Manufacturer Name: Manufacturer Name

15.4 Remote Display Service

TOGGLE COLLECTOR LED

Node Reporting interval: Not Read
Last Node Data: 0x0,0x0,0x0,0x0

DMM Provisioning Service



BLUETOOTH LOW ENERGY DEVICES

DMM 15.4 Sensor RD
80:6F:B0:EF:DB:BD

17:21:BE:0C:2C:B6
Man Data (Microsoft):
0x1,0x9,0x20,0x2,0x12,0xc4,0xd0,0xfe,0x27,0xc,0xf7,
0x21,0x63,0xf4,0x84,0xbe,0x3c,0x21,0x18,0xa9,0xdd,
0x2c,0xf0,0x37,0xc4,0xe0,0xbe

6F:C7:13:50:0E:8F
Man Data (Google):
0x0,0x10,0xca,0x37,0xbd,0xc0

57:5D:78:EC:89:B8

73:25:A7:AE:11:36

WIFI DEVICES

Configure a new WiFi device

Scanning for devices ..

I was able to connect the senser tag but was unable to connect/join the launchpad. And I don’t have an ftdi and was not able to buy one online ☹

4. Declaration

I understand the Student Academic Misconduct Policy - http://studentconduct.unlv.edu/misconduct/policy.html

“This assignment submission is my own, original work”.

Meral Abu-Jaser