RT-Thread Nano Porting

Example Code Introduction for 32-bit NuMicro® Family

Document Information

Application	This example, based on the GPIO_OutputInput demo in BSP, shows how to port RT-Thread Nano and create 2 threads.
BSP Version	M251_M252_M254_M256_M258_Series_BSP_CMSIS_V3.02.006
Hardware	NuMaker-M252SD V1.2

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1. Overview

This example, based on the GPIO_OutputInput demo in BSP, shows how to port RT-Thread Nano and create 2 threads. Thread 1 can control LED flashing every 500 ms through GPIO. Thread 2 alternately prints the words "Hello" and "World" every 1000 ms through UART.

1.1 Principle

RT-Thread Nano is a refined hard real-time kernel designed for systems with limited memory resources. It includes functions such as thread management, inter-thread synchronization and communication, clock management, interrupt management, and memory management, which make RT-Thread Nano ideal for embedded systems requiring high-performance real-time control. It supports a variety of CPU architectures, including Arm Cortex M0/M23/M3/M4/M7 and RISC-V, and requires minimal memory resources, with a minimum of 3 KB Flash and 1.2 KB RAM.

This example is based on the M252SD2AE microcontroller, which includes 64 KB Flash and 12 KB RAM, and shows how to port the RT-Thread Nano and create 2 threads.

1.2 Demo Result

After the sample code is compiled and programmed, the LED (PB14) flashes every 500 ms, as shown in Figure 1-1.

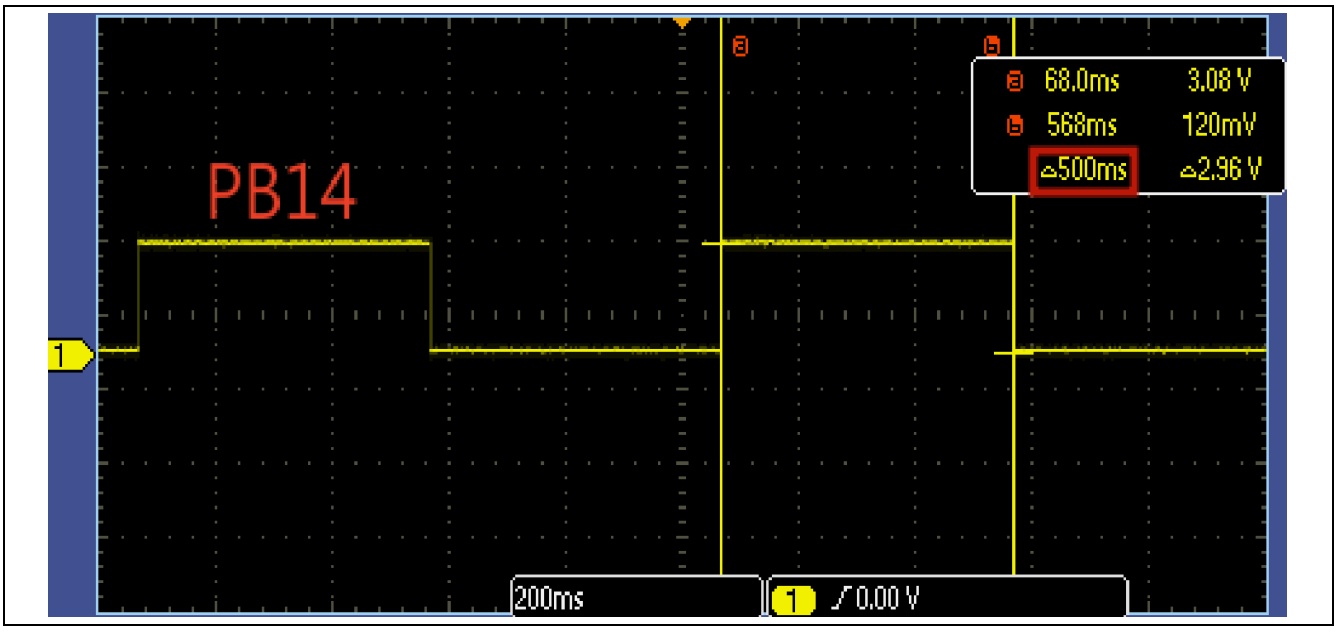


Figure 1-1 Compilation and Programming Results

The message printed by the serial port is shown in Figure 1-2.

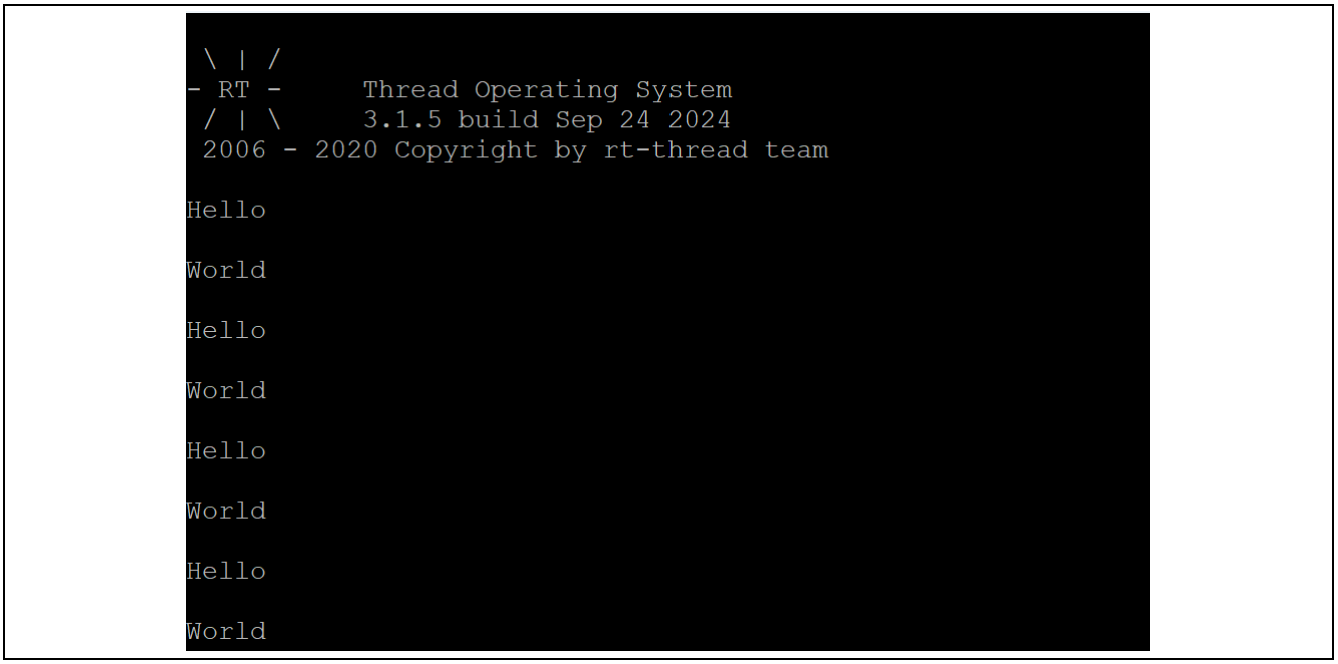


Figure 1-2 Serial Port Prints a Message

2. Code Description

2.1 Download RT-Thread Nano Source Code

Click the link below to download the RT-Thread Nano source code on the official website.

https://www.rt-thread.org/document/site/#/rt-thread-version/rt-thread-nano/an0038-nano-introduction

The source code is extracted as follows.

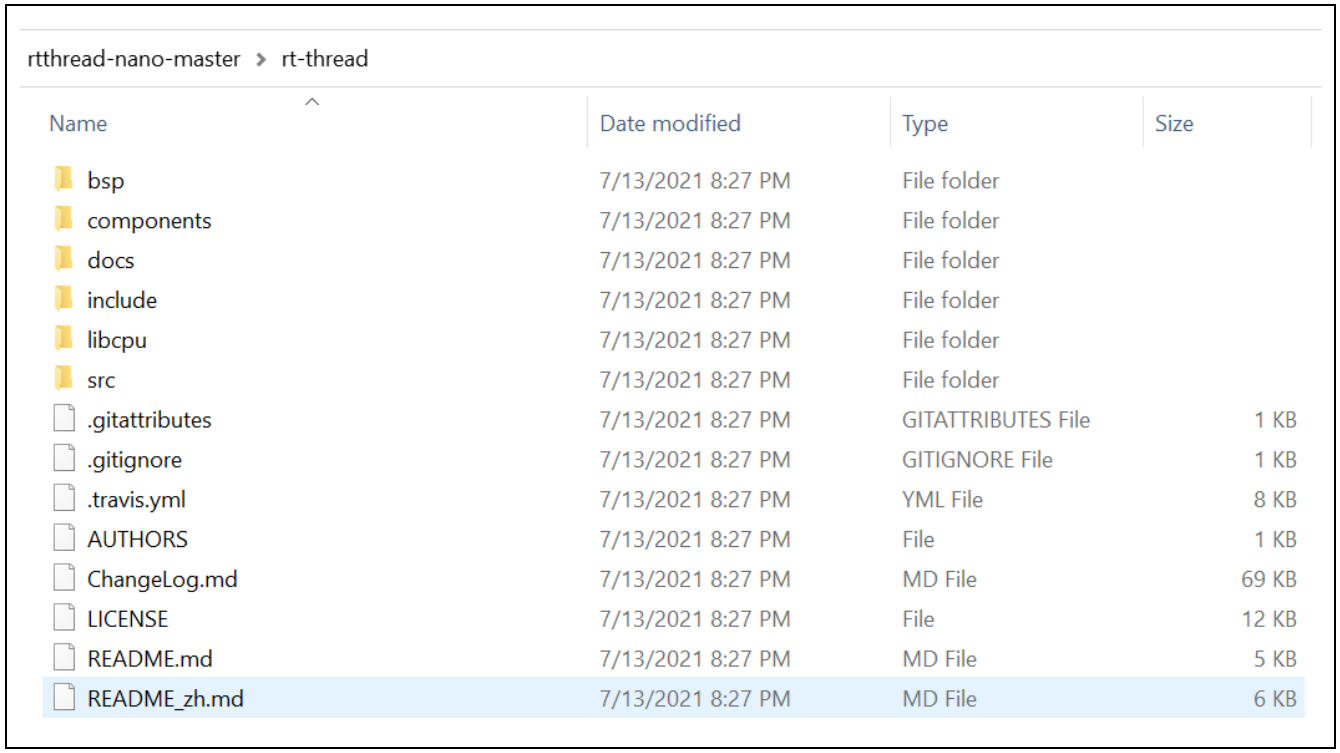


Figure 2-1 rt-thread File Structure

2.2 Copy rt-thread File to BSP Path

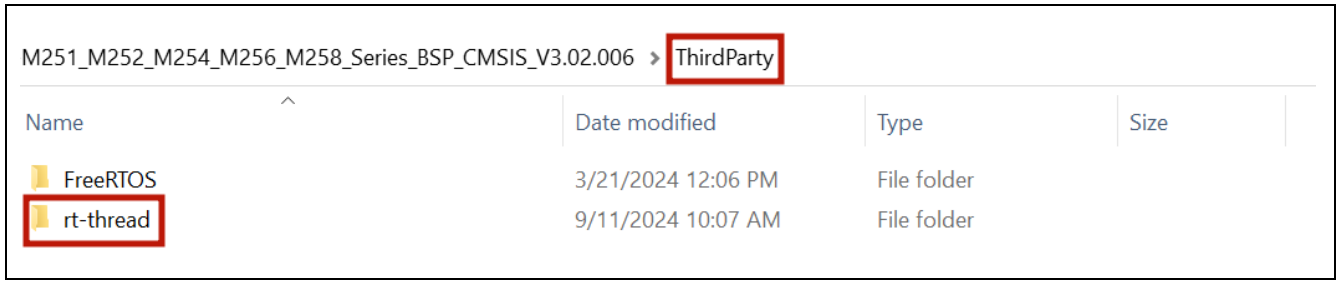


Figure 2-2 rt-thread Path

2.3 Create a New "rt-thread" Group

Create a new "rt-thread" group in the project and add the associated source code files.

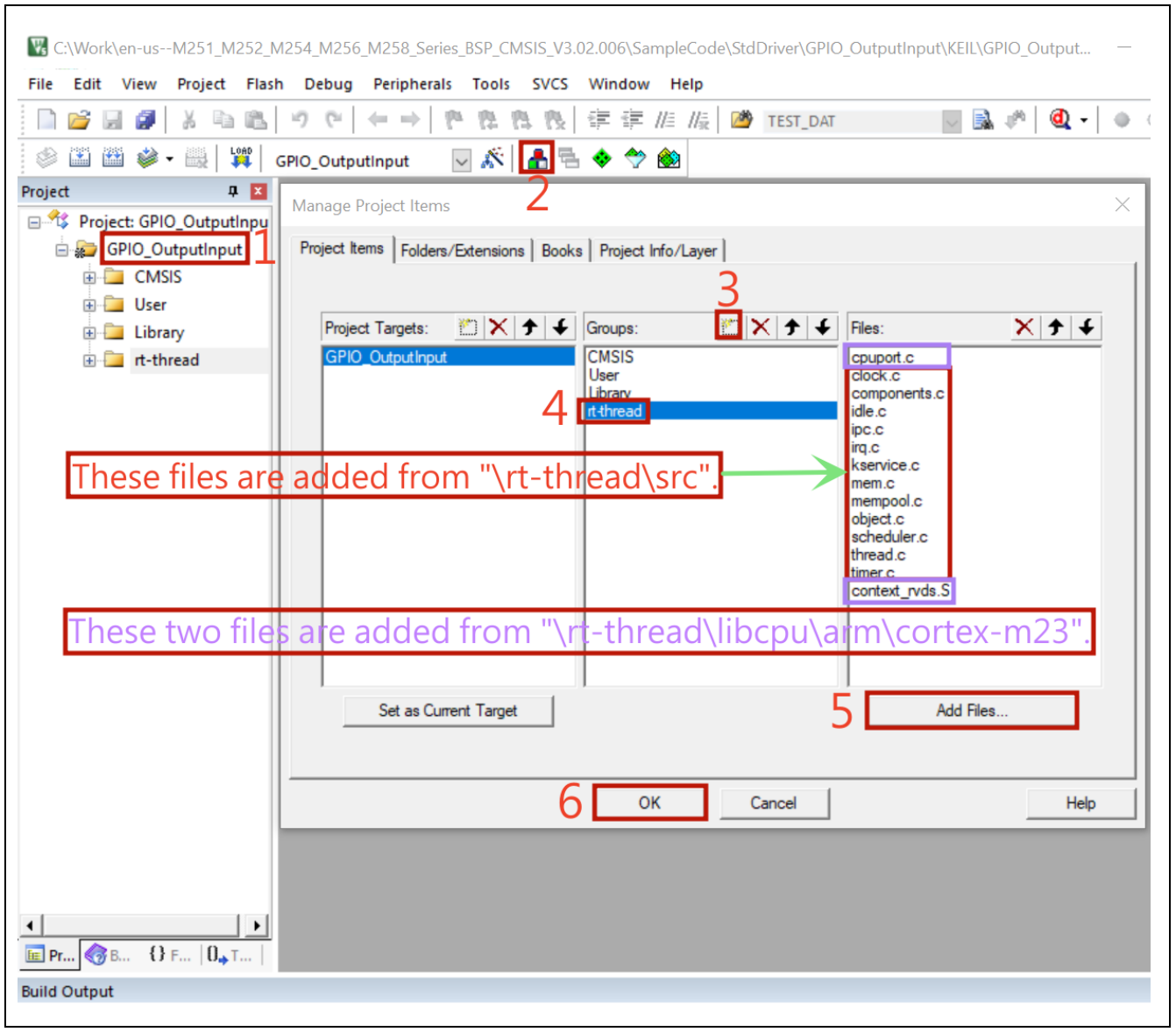


Figure 2-3 Create a New "rt-thread" Group and Add Source Code Files

2.4 Copy *Board.c* and *rtconfig.h* Files

Copy the *Board.c* and *rtconfig.h* files from the "\rt-thread\bsp_template\" path to the "\GPIO_OutputInput\" path, then add them to the "User" group.

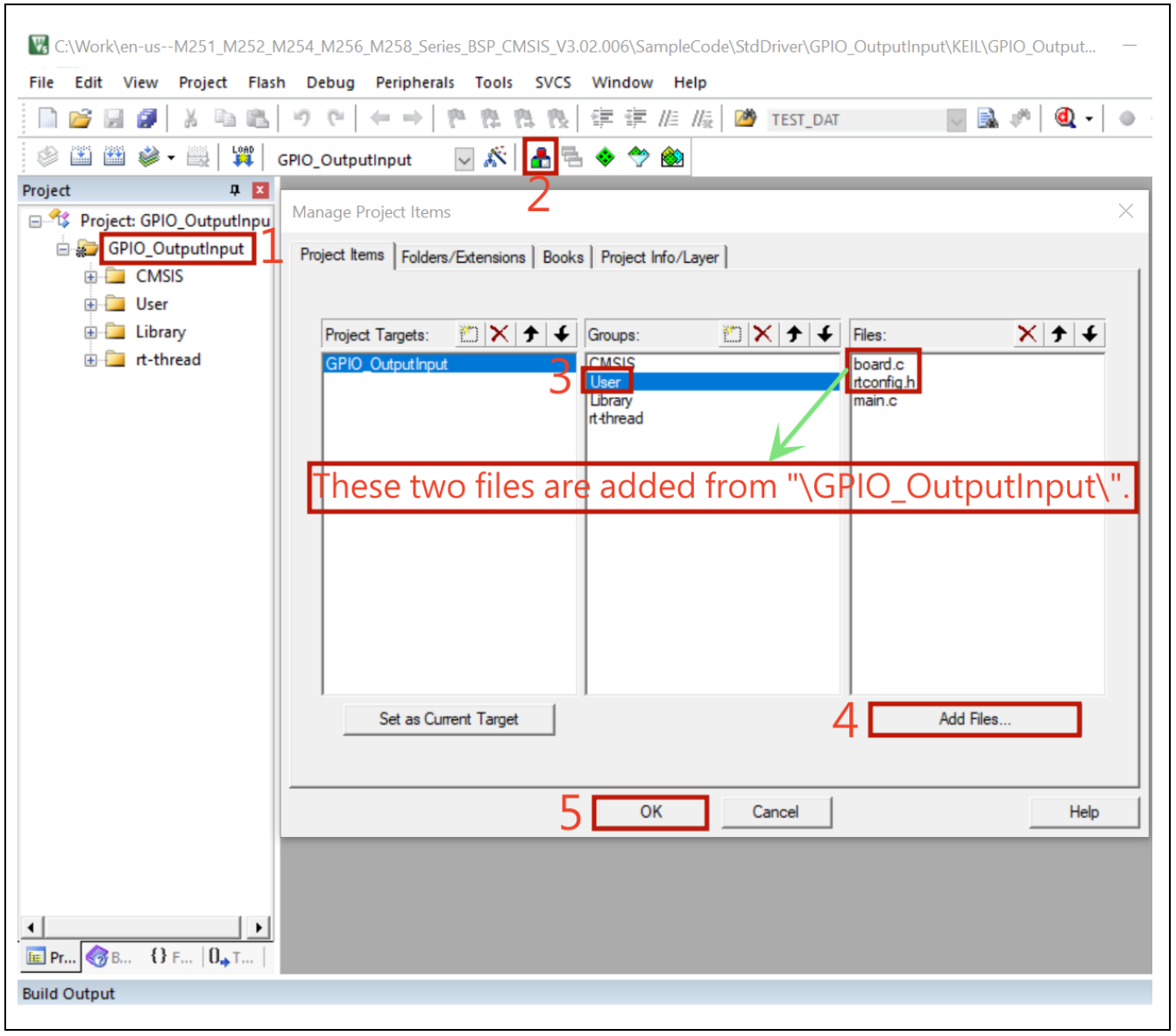


Figure 2-4 Add Files to the "User" Group

2.5 Modify "Include Paths"

Add rt-thread file include path in project options.

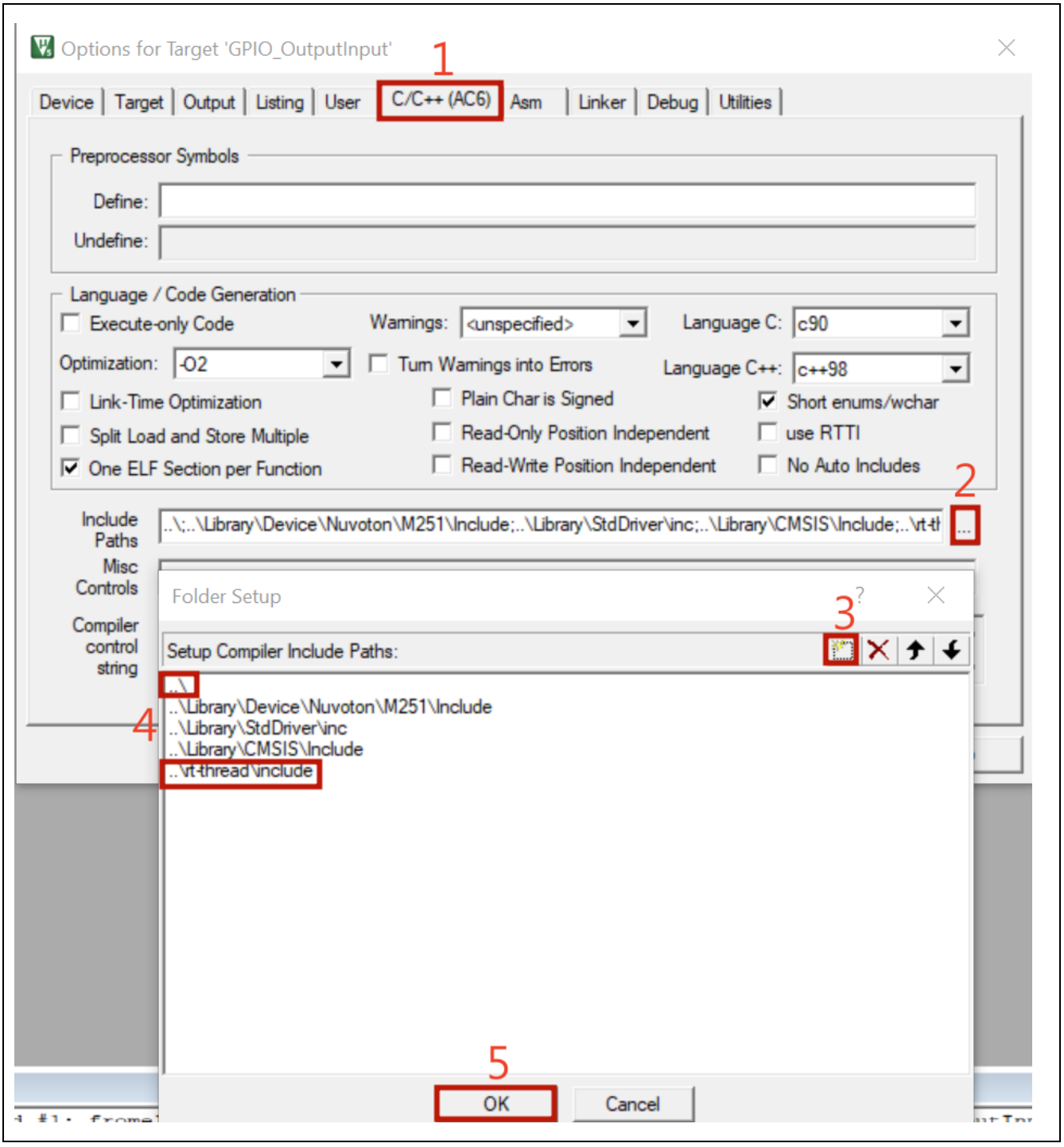


Figure 2-5 Add the rt-thread File Include Paths

2.6 Modify *board.c* File

Include header files *NuMicro.h* and *stdio.h*.

```
#include <rthw.h>
#include <rtthread.h>
#include <stdio.h>
#include "NuMicro.h"
```

Because the maximum SRAM size of the target chip is 12 KB, it is necessary to modify "# define RT_HEAP_SIZE (15 * 1024) " to "# define RT_HEAP_SIZE (4 * 1024) ".

```
/*
 * Please modify RT_HEAP_SIZE if you enable RT_USING_HEAP
 * the RT_HEAP_SIZE max value = (sram size - ZI size), 1024 means 1024 bytes
 */
#define RT_HEAP_SIZE (4*1024)
```

The original array variable and functions are redefined as follows to avoid non-word-aligned risks.

```
static rt_uint32_t rt_heap[RT_HEAP_SIZE/sizeof(rt_uint32_t)];

RT_WEAK void *rt_heap_begin_get(void)
{
    return (void *)rt_heap;
}

RT_WEAK void *rt_heap_end_get(void)
{
    return (void *)((rt_uint32_t)rt_heap + sizeof(rt_heap));
}
```

Add the SysTick_Handler function under the rt_os_tick_callback function.

```
   void SysTick_Handler(void)
   {
    rt_os_tick_callback();
   }
```

In the rt_hw_board_init function, comment the first line, then add SYS_Init, SystemCoreClockUpdate, and SysTick_Config functions.

```
    //#error "TODO 1: OS Tick Configuration."
    /*
     * TODO 1: OS Tick Configuration
     * Enable the hardware timer and call the rt_os_tick_callback function
     * periodically with the frequency RT_TICK_PER_SECOND.
     */
    /* System Init */
    SYS_UnlockReg();
    SYS_Init();
    SYS_LockReg();

    /* System Clock Update */
    SystemCoreClockUpdate();

    /* System Tick Configuration */
    SysTick_Config(SystemCoreClock / RT_TICK_PER_SECOND);
```

Copy the SYS_Init function from the *main.c* file to the *board.c* file.

In the uart_init function, comment the first line, then add the UART reset function and the baud rate setting function.

```
static int uart_init(void)
{
    //#error "TODO 2: Enable the hardware uart and config baudrate."
    /* Reset UART module */
    SYS_ResetModule(UART0_RST);

    /* Configure UART0 and set UART0 baud rate */
    UART_Open(UART0, 115200);

    return 0;
}
```

In the rt_hw_console_output function, comment the first line and then write the printf function.

```
void rt_hw_console_output(const char *str)
{
    //#error "TODO 3: Output the string 'str' through the uart."
    printf("%s", str);
}
```

2.7 Modify *main.c* File

Include header file *rtthread.h*.

```
    #include "stdio.h"
    #include "NuMicro.h"
    #include <rtthread.h>
```

Define all thread-related variables.

```
    static struct rt_thread blink_thread;
    static char blink_thread_stack[256];
    static struct rt_thread print_thread;
    static char print_thread_stack[256];
```

Thread 1 function design.

```
    void blink_thread_entry(void *parameter)
    {
        while (1)
        {
            PB14 = 1;
            rt_thread_mdelay(500);
            PB14 = 0;
            rt_thread_mdelay(500);
        }
    }
```

Thread 2 function design.

```
    void print_thread_entry(void *parameter)
    {
        while (1)
        {
            rt_kprintf("\nHello\n");
            rt_thread_mdelay(1000);
            rt_kprintf("\nWorld\n");
```

```
            rt_thread_mdelay(1000);
        }
    }
```

Delete the SYS_Init and UART0_Init functions.

Re-write the main function.

```
int main(void)
{
    rt_err_t ret;

    /* Configure PB.14 as Output mode */
    GPIO_SetMode(PB, BIT14, GPIO_MODE_OUTPUT);

    /* Create thread 1 */
    ret = rt_thread_init(&blink_thread,
                         "led blink",
                         blink_thread_entry,
                         RT_NULL,
                         &blink_thread_stack[0],
                         sizeof(blink_thread_stack),
                         RT_THREAD_PRIORITY_MAX-2,
                         20);

    if (ret == RT_EOK)
    {
        /* After the thread 1 is created successfully, start the thread 1 */
        rt_thread_startup(&blink_thread);
    }

    /* Create thread 2*/
    ret = rt_thread_init(&print_thread,
                         "print info",
                         print_thread_entry,
                         RT_NULL,
                         &print_thread_stack[0],
                         sizeof(print_thread_stack),
                         RT_THREAD_PRIORITY_MAX-3,
                         20);

    if (ret == RT_EOK)
    {
        /* After the thread 2 is created successfully, start the thread 2 */
        rt_thread_startup(&print_thread);
    }

    return 0;
}
```

2.8 Modify *rtconfig.h* File

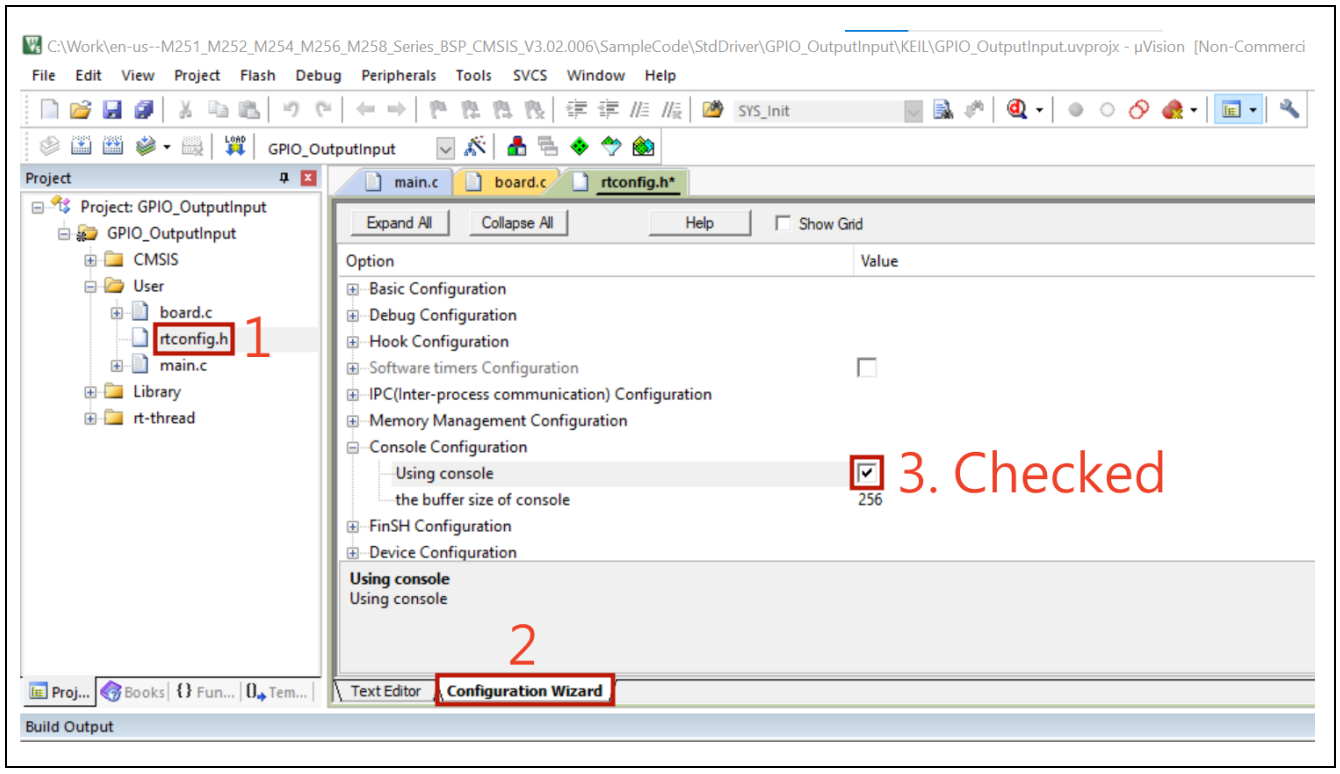
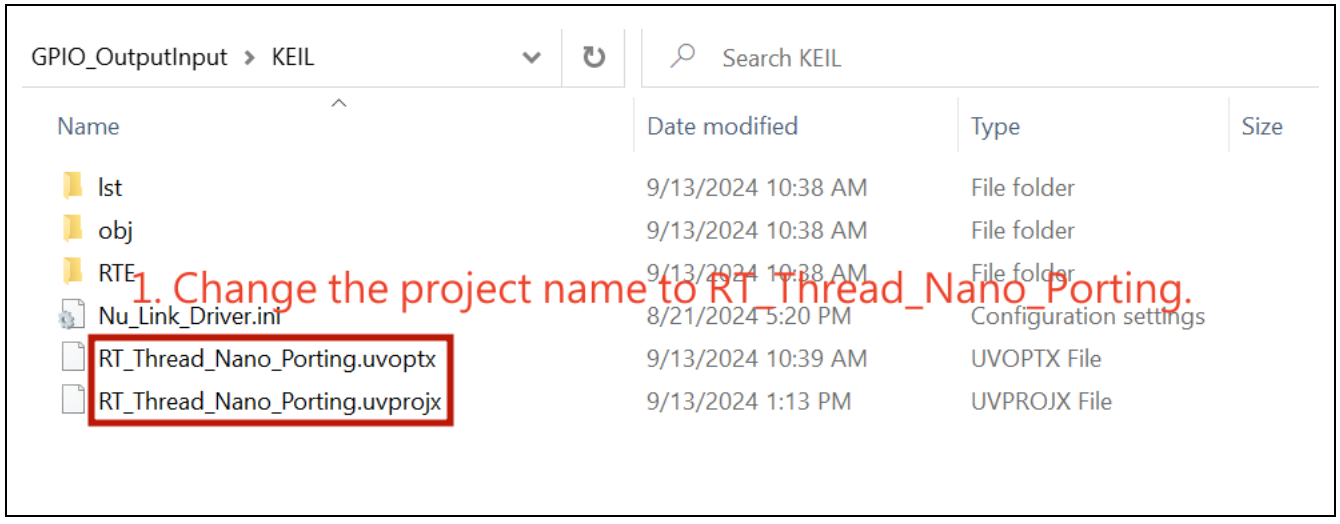


Figure 2-6 Configure "console"

2.9 Modify Project Name

Modify the project name to "RT_Thread_Nano_Porting".



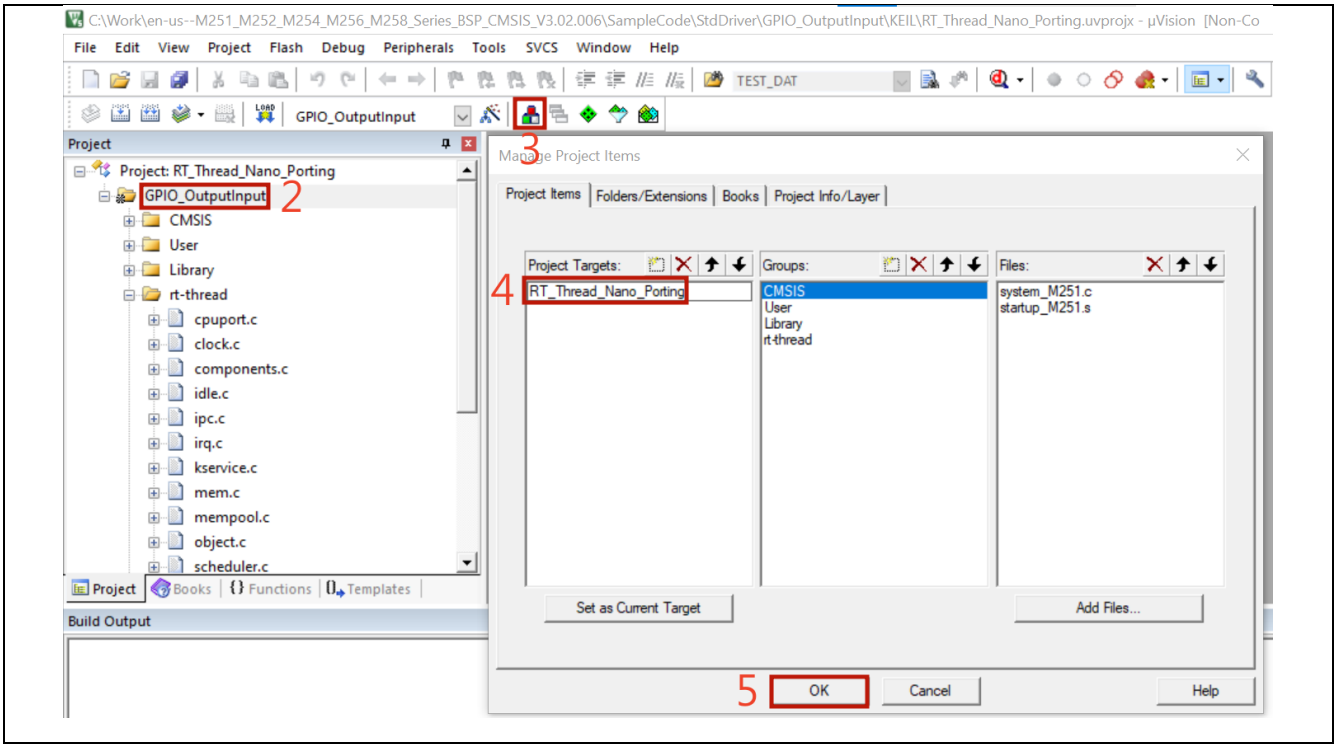


Figure 2-7 Modify Project Name to "RT_Thread_Nano_Porting"

2.10 Modify Related File Name

Modify the file names accordingly and delete unnecessary files.

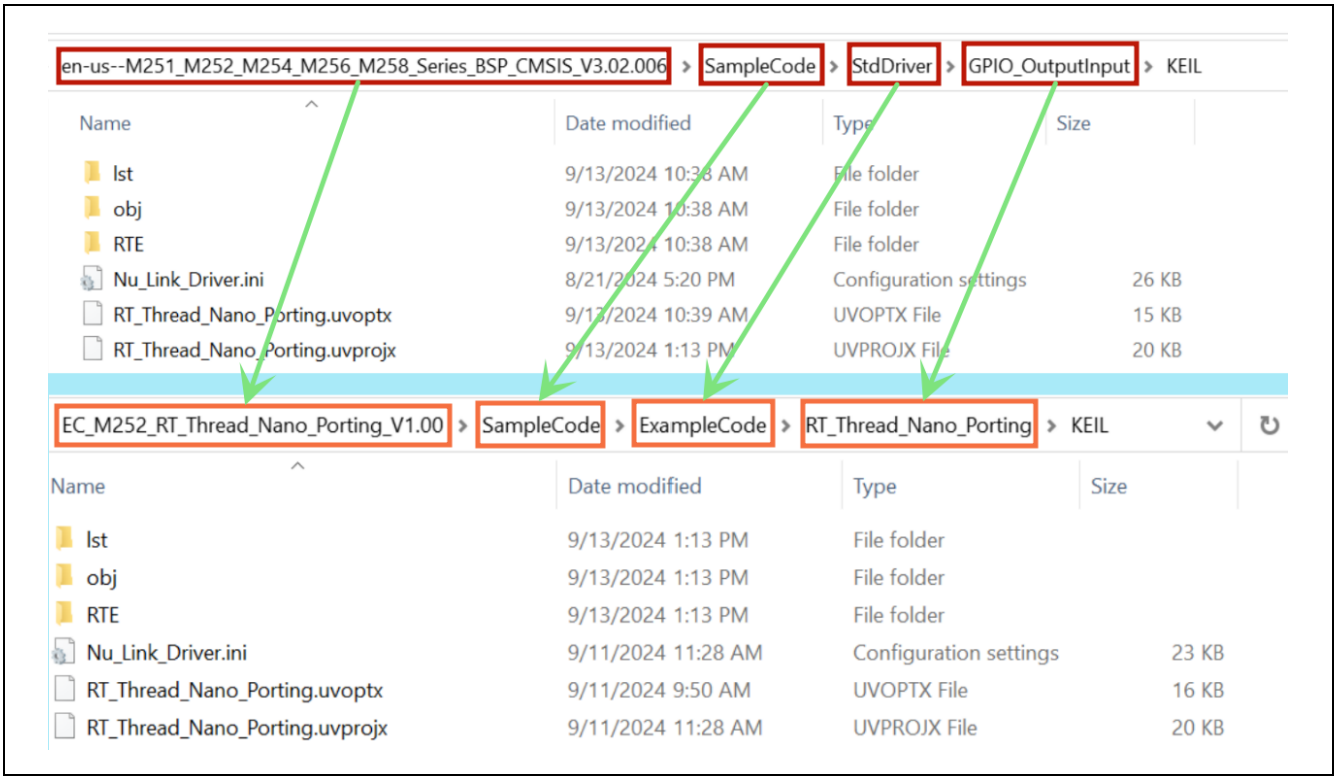


Figure 2-8 Modify the Name of Each File

3. Software and Hardware Requirements

3.1 Software Requirements

- BSP version
  - M251_M252_M254_M256_M258_Series_BSP_CMSIS_V3.02.006
- IDE version
  - Keil uVersion 5.36

3.2 Hardware Requirements

- Circuit components
  - NuMaker-M252SD V1.2
- Pin Connect
  - You need to enable the USB-to-serial port function by setting the DIP switch on the Nu-Link2-Me.

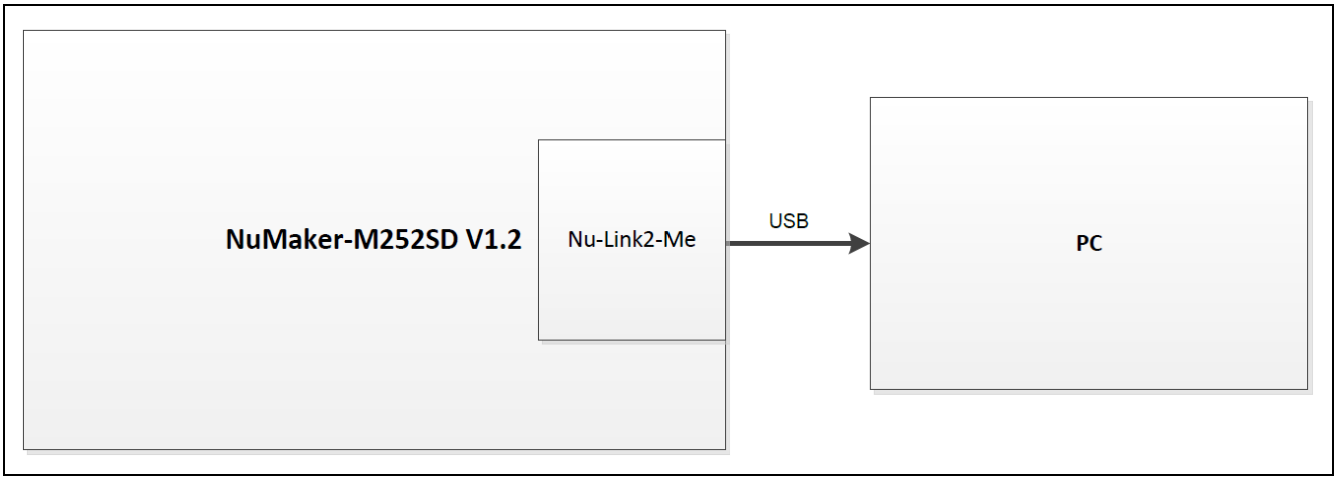


Figure 3-1 Pin Connect

4. Directory Information

EC_M252_RT_Thread_Nano_Porting_V1.00	
Library	Sample code header and source files
CMSIS	Cortex® Microcontroller Software Interface Standard (CMSIS) by Arm® Corp.
Device	CMSIS compliant device header file
StdDriver	All peripheral driver header and source files
ThirdParty	
rt-thread	Source file of RT-Thread Nano code
SampleCode	
ExampleCode	
Project	Source file of example code

Figure 4-1 Directory Structure

5. Example Code Execution

1. Browse the sample code folder as described in the Directory Information section and double-click *RT_Thread_Nano_Porting.uvprojx*.
2. Enter Keil compile mode.
   - Build
   - Download
   - Start/Stop debug session
3. Enter debug mode.
   - Run

6. Revision History

Date	Revision	Description
2024.10.08	1.00	Initial version.

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