MS51 SPI 實現 ARGB LED 呼吸燈燈效

NuMicro® 8 位系列微控制器範例代碼介紹

文件資訊

應用簡述	本範例代碼使用MS51 SPI 來模擬ARGB LED 的時序並實現呼吸燈燈效
BSP 版本	MS51 Series BSP V1.00.003
開發平台	NuMaker-MS51PC Ver1.0

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1 概述

此範例代碼使用MS51 系列的SPI 來模擬ARGB LED 的時序，演示ARGB LED 呼吸燈效果。此範例代碼使用一組timer 來定時更新ARGB LED 呼吸燈的亮度及一組SPI 來模擬ARGB LED 的時序。

1.1 原理

1.1.1 ARGB LED 資料傳輸時間(TH+TL=1.25 us ± 600 ns)

ARGB LED 時序圖如圖 1-1至圖 1-3所示。邏輯'0'定義為高準位0.4 us ± 150 ns 與低準位0.85 us ± 150 ns; 邏輯'1'定義為高準位0.8 us ± 150 ns 與低準位0.45 us ± 150 ns; 邏輯重置定義為大於50 us的低準位。

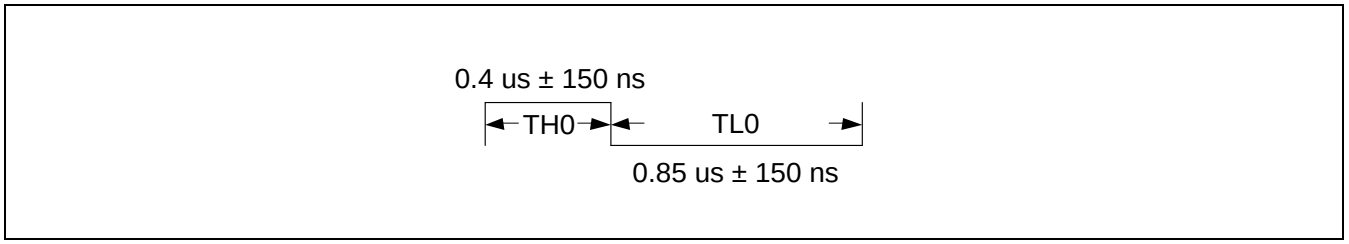

圖 1-1 邏輯'0'

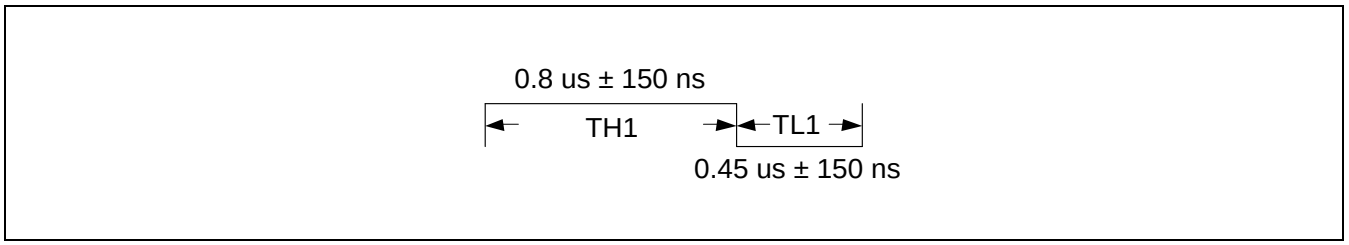

圖 1-2 邏輯'1'

圖 1-3 重置

1.1.2 SPI 時鐘頻率

程式中設定系統時鐘HIRC 為24 MHz 以及SPI 時鐘除頻值為8，由此可計算出SPI 時鐘速率為

3 MHz，這代表一個SPI 時鐘為 0.333 us。換句話說，邏輯'0' 映射為SPI 位元樣式為'1000'，如圖 1-4所示; 邏輯'1' 映射為SPI 位元樣式為'1110'，亦即3 個位元組的RGB 資料格式可轉化成12 個位元組的SPI 資料格式。

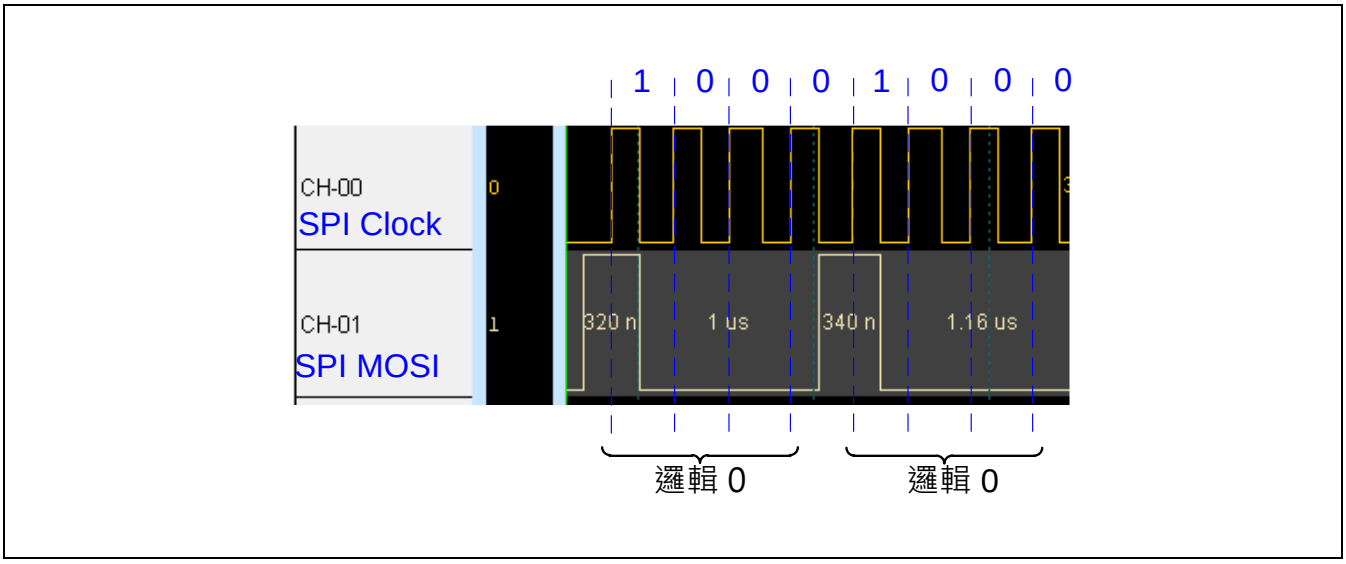

圖 1-4 邏輯'0' 映射為 SPI 位元樣式

1.2 執行結果

執行結果如圖 1-5所示。

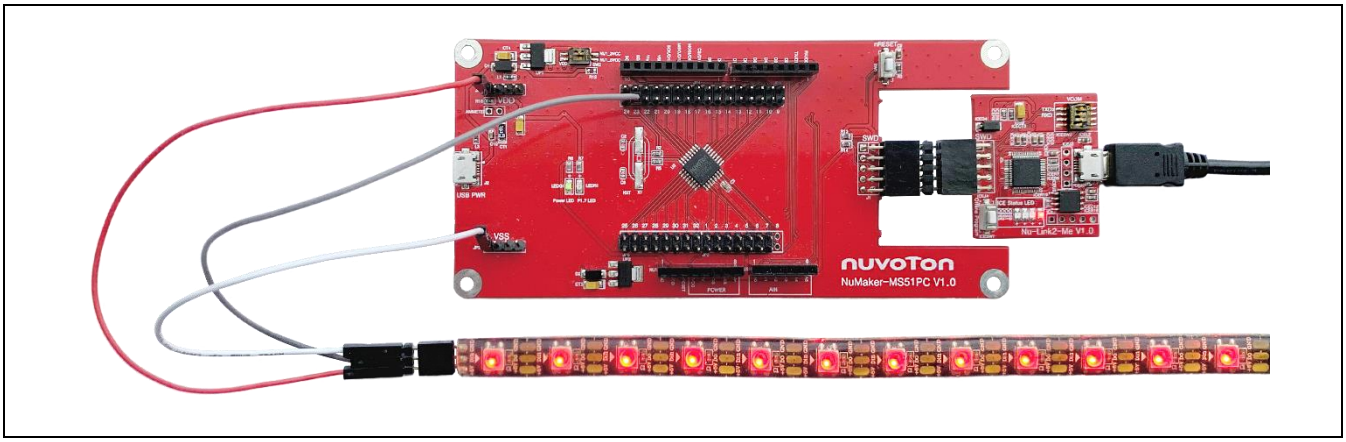

圖 1-5 執行結果

2 代碼介紹

代碼工作流程如下：

1. main.c 中初始化 MS51 相關外設，包含 HIRC、SPI、與 Timer 3

2. 在 while 迴圈中呼叫 Breathing_TOPDOWN()來計算出相對應的 ARGB LED 亮度

3. 使用 SPI_Send() 來模擬 ARGB LED 時序

```
void main (void)
{
    /* Set HIRC = 24 MHz */
    MODIFY_HIRC(HIRC_24);

    P00 = 1;
    P00_INPUT_MODE;
    ENABLE_P00_PULLDOWN;

    /* Set SPI configure */
    SPI_Init();

    /* Enable Timer3 to add time counter */
    Timer3_1ms_initial();

    /* Init LED to all disable */
    Disable_TOPDOWN();
    SPI_Send();

    while(1)
    {

        /* Control LED */
        if (!spi_finish_flag)
        {
            Breathing_TOPDOWN();
            SPI_Send();
        }
    }
}
```

當 Breathing_TOPDOWN()被呼叫時，會定時更新 ARGB LED 亮度。計數器與亮度變化的關係如表 2-1 所示。

```
void Breathing_TOPDOWN(void)
{
    unsigned char TempR, TempG, TempB;
    unsigned long TempCal;

    /* Calculate brightness */
    TempCal = *(BreathingBright + (HDIV_Mod(HDIV_Div(TOPDOWNTimeCounter,
(BreathingRate[TOPDOWNSpeed]) * 8), BreathingArraySize)));
```

```
    TempCal = HDIV_Div((TempCal * TOPDOWNBrightness), 100);

    /* Calculate color and set transfer data */
    TempR = HDIV_Div((TOPDOWNRGBColor[0] * TempCal), 100);
    TempG = HDIV_Div((TOPDOWNRGBColor[1] * TempCal), 100);
    TempB = HDIV_Div((TOPDOWNRGBColor[2] * TempCal), 100);
    Set_TOPDOWN_RGB(TempR, TempG, TempB);

    /* Reset TOPDOWNTimeCounter */
    if(HDIV_Div(TOPDOWNTimeCounter, BreathingRate[TOPDOWNSpeed] * 8 * BreathingArraySize))
    {
        TOPDOWNTimeCounter -= BreathingRate[TOPDOWNSpeed] * 8 * BreathingArraySize;
    }
}
```

TOPDOWNTimeCounter	TempCal	TempR	TempG	TempB
0	0	0	0	0
…	…	…	…	…
48	0	0	0	0
…	…	…	…	…
96	1	2	0	0
…	…	…	…	…
144	2	5	0	0
…	…	…	…	…

表 2-1 計數器與亮度變化的關係表

3 軟體與硬體需求

- **軟體需求**
  - BSP 版本
    - MS51 Series BSP V1.00.003
  - IDE 版本
    - Keil uVersion 5.26
- **硬體需求**
  - 電路元件
    - NuMaker-MS51PC Ver1.0
    - ARGB LED
  - 示意圖

使用 SPI MOSI 腳位來模擬 ARGB LED 時序圖。

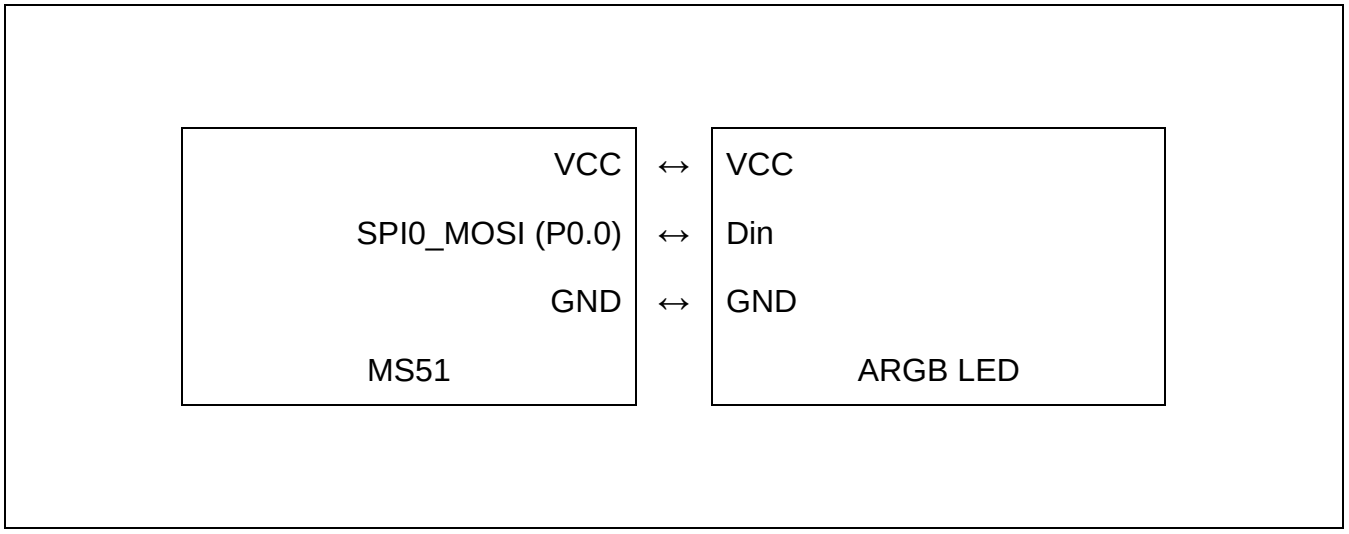

圖 3-1 示意圖

註：ARGB LED 工作電壓為 5V，故 NuMaker-MS51PC 開發板為 ARGB LED 供電電壓必須更換為 5V。可以改變 Nu-Link2-Me 上的 ICEJPR1(MCUVCC)電阻使其輸出 5V 電壓，如圖 3-2 所示。

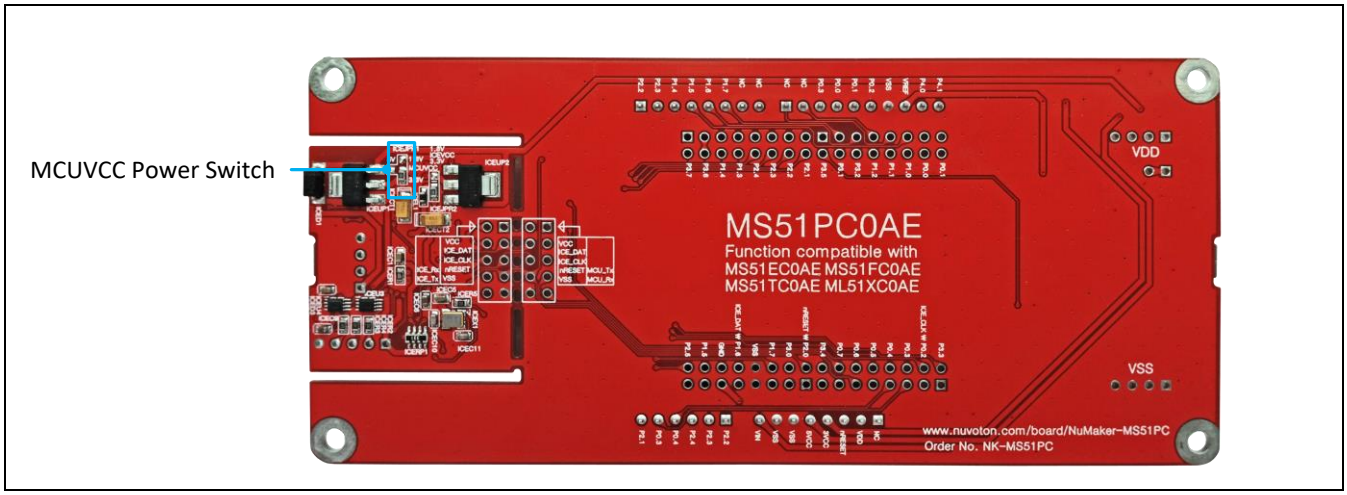

圖 3-2 Nu-Link2-Me 5V 電源供應

4 目錄資訊

目錄資訊如圖 4-1所示。

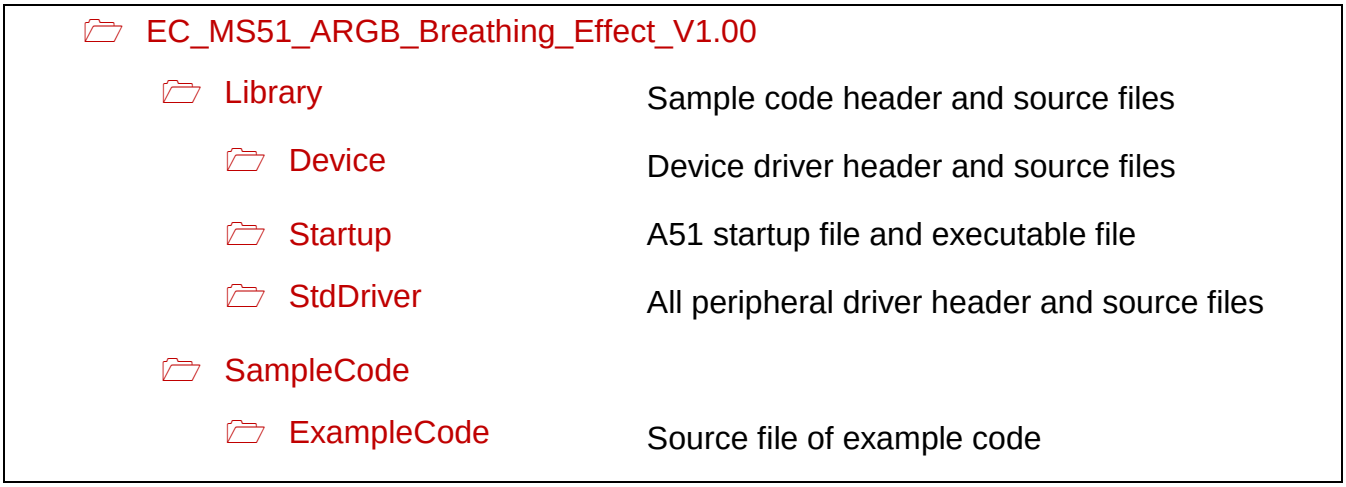

圖 4-1 目錄資訊

5 範例程式執行

1. 根據目錄資訊章節進入 ExampleCode 路徑中的 KEIL 資料夾，雙擊 *MS51_ARGB_Breathing_Effect.uvproj*。
2. 進入編譯模式介面
   a. 編譯
   b. 下載代碼至記憶體
   c. 進入 / 離開除錯模式
3. 進入除錯模式介面
   a. 執行代碼

6 修訂紀錄

Date	Revision	Description
2021.07.29	1.00	1. 初始發布.

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