# 控制SPI介面的LCD顯示屏– ILI9341

NuMicro® 32 位系列微控制器範例代碼介紹

## 文件資訊

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|---|---|
| 代碼簡述 | 本範例代碼基於NUC126平台，透過SPI介面控制Ili9341的LCD螢幕 |
| BSP 版本 | NUC126_Series_BSP_CMSIS_v3.00.004 |
| 開發平台 | NuTiny-NUC126 |

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# 1 功能介紹

## 1.1 簡介

本範例代碼使用NUC126平台，透過SPI介面實現ILI9341 LCD Panel的控制。ILI9341是一顆LCD顯示屏的控制IC，目前市面上多做成模組販售，使用者需要了解如何控制ILI9341以驅動LCD顯示屏。ILI9341的詳細規格與指令參數請至其官方網站下載Datasheet，以了解詳細操作內容。

# 2 代碼介紹

## 2.1 初始化 PWM 模組

本函數初始化PWM模組以進行LCD螢幕亮度的調節。PWM的頻率為1 kHz，佔空比為50%。

```
/*---------------------------------------------------------------------------------------------------------*/
/* Function                                                                                                */
/*---------------------------------------------------------------------------------------------------------*/
static void _InitPWMModule(void)
{
    /* Using PWM1 channel 5 (PC14) for tunning back light brightness */
    SYS->GPC_MFPH &= ~(SYS_GPC_MFPH_PC14MFP_Msk);
    SYS->GPC_MFPH |= SYS_GPC_MFPH_PC14MFP_PWM1_CH5;

    /* Select and enable module clock */
    CLK_EnableModuleClock(PWM1_MODULE);
    CLK_SetModuleClock(PWM1_MODULE, CLK_CLKSEL1_PWM1SEL_PCLK1, NULL);

    /* Reset PWM1 module */
    SYS_ResetModule(PWM1_RST);

    /* PWM1 channel 5 frequency is 1000Hz, duty 50%, */
    PWM_ConfigOutputChannel(PWM1, 5, 1000, 50);

    /* Enable output of PWM1 channel 5 */
    PWM_EnableOutput(PWM1, PWM_CH_5_MASK);

    /* Start PWM counter */
    PWM_Start(PWM1, PWM_CH_5_MASK);
}
```

## 2.2 初始化 SPI 模組

初始化SPI模組以驅動LCD螢幕。SPI設定為Master模式、8 bit資料寬度，並運作在24 MHz的速度下。

```
static void _InitSPIModule(void)
{
    /* Using SPI1 for displaying the LCD */
    /* Switch the multi-function pin to SPI */
    SYS->GPD_MFPH &= ~(SYS_GPD_MFPH_PD13MFP_Msk | SYS_GPD_MFPH_PD14MFP_Msk |
SYS_GPD_MFPH_PD15MFP_Msk);
    SYS->GPD_MFPH |= (SYS_GPD_MFPH_PD13MFP_SPI1_MOSI | SYS_GPD_MFPH_PD14MFP_SPI1_MISO |
SYS_GPD_MFPH_PD15MFP_SPI1_CLK);


    /* Select and enable module clock */
    CLK_EnableModuleClock(SPI1_MODULE);
    CLK_SetModuleClock(SPI1_MODULE, CLK_CLKSEL2_SPI1SEL_PLL, 0);


    /* SPI open on master mode, mode 0, 8bit data width and operate on 24M Hz */
    SPI_Open(SPI_LCD_PORT, SPI_MASTER, SPI_MODE_0, 8, 24000000);


    /* Disable auto SS function */
    SPI_DisableAutoSS(SPI_LCD_PORT);


    /* Enable SPI */
    SPI_ENABLE(SPI_LCD_PORT);


}
```

## 2.3 初始化 LCD 螢幕所需的 MCU 硬體

此函數初始化了SPI與PWM模組，並設定PC14為GPIO的輸出模式以作為螢幕背光的開關。

```
static void _InitMCUHWforLCD(void)
{
    /* Initial SPI Module for LCD display */
    _InitSPIModule();

    /* Initial PWM for backlight brightness control */
    _InitPWMModule();

    /* Set PC14 to output mode for LCD backlight on/off switch */
    GPIO_SetMode(PC, BIT14, GPIO_MODE_OUTPUT);
}
```

## 2.4 初始化 MuMaker 開發板的硬體

初始化MCU硬體以及驅動IC ILI9341。詳細的ILI9341暫存器內容請參考ILI9341的Datasheet。

```
void Drv_NuMaker_HWInit(void)
{
    /* Initial NuMaker Hardware */
    /* Initial MCU Hardware */
    _InitMCUHWforLCD();

    /* Initial ILI9341 LCD Panel Hardware */
    Drv_ILI9341_LCD_Init();
}
```

## 2.5 Main 函數

Main函數中，將會做系統初始化、MCU硬體初始化以及ILI9341 (螢幕驅動IC) 的初始化。初始化後，while迴圈將會顯示黃、綠、紅三種顏色，並以每200 ms的速度進行切換。

```
int32_t main(void)
{
    uint32_t i = 0;
    /* Initial MCU System */
    SYS_Init();
    /* Initial NuMaker Hardware */
    Drv_NuMaker_HWInit();
```

```
    while (1)
    {
        /* Display color yellow */
        for (i = 0; i < (LCD_Resolution_X * LCD_Resolution_Y * 2); i++)
        {
            LCD_Set_Color(Yellow);
        }

        CLK_SysTickDelay(200000);

        /* Display color Green */
        for (i = 0; i < (LCD_Resolution_X * LCD_Resolution_Y * 2); i++)
        {
            LCD_Set_Color(Green);
        }

        CLK_SysTickDelay(200000);

        /* Display color Red */
        for (i = 0; i < (LCD_Resolution_X * LCD_Resolution_Y * 2); i++)
        {
            LCD_Set_Color(Red);
        }

        CLK_SysTickDelay(200000);
    }
}
```

# 3 軟體與硬體環境

- **軟體環境**
  - BSP 版本
    - NUC126_Series_BSP_CMSIS_v3.00.004
  - IDE 版本
    - Keil uVersion 5.26
- **硬體環境**
  - 電路元件
    - NuTiny-NUC126 * 1
    - 牛橋 Nu-Bridge * 1
    - Ili9341 LCD Panel

■ 接線圖

1. 將NuTiny-NUC126的UART_RX0(PD.0)、UART_TX0(PD.1)連接至Nu-Bridge，打印訊息。設置終端機的COM Port與Baudrate，COM Port的編號可在裝置管理員中找到「NuBridge Virtual Com Port (COMX)」，Baudrate設置為115200。

2. 將ILI9341依照以下連接方式，與NUC126連接。

| Nu-Bridge | | |
|---|---|---|
| UART RX | ↔ | UART_TX (PB.1) |
| UART TX | ↔ | UART_RX (PB.0) |
| GND | | GND |

| ILI9341 | | NUC126 |
|---|---|---|
| LEDK1~K4 | ↔ | PC.14 |
| LEDA | ↔ | 3VCC(3.3V) |
| 3VCC | ↔ | 3VCC(3.3V) |
| GND | ↔ | GND |
| LCM_SPI_MISO | ↔ | PD.14 |
| LCM_SPI_MOSI | ↔ | PD.13 |
| LCM_SPI_SS | ↔ | PD.12 |
| LCM_DC | ↔ | PD.6 |
| LCM_SPI_CLK | ↔ | PD.15 |
| LCM_RESET | ↔ | RESET |

# 4 目錄資訊

- EC_NUC126_SPI_LCD_Ili9341_Readme_EN_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
  - SampleCode
    - ExampleCode — Source file of example code

# 5 如何執行範例程式

1. 根據目錄資訊章節進入 EC_NUC126_SPI_LCD_Ili9341_Readme_EN_V1.00 \SampleCode\ExampleCode\NUC126_SPI_LCD_ILI9341，雙擊路徑中 SPI_LCD_Ili9341.uvproj 開啟專案。
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 |
|---|---|---|
| Nov. 20, 2019 | 1.00 | 1. 初版 |

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