M258 LCD 面板腳位的負載和短路的檢測

NuMicro® 32 位系列微控制器範例程式碼介紹

文件資訊

應用簡述	本範例代碼利用 Charge pump timeout 來推算出當下 LCD 整體負載值，再以這個 timeout 值當作掃描檢測每根 LCD pin 是否異常的基準。
BSP 版本	M251/M252/M254/M256/M258 Series CMSIS BSP V3.01.002
開發平台	NuMaker-M258KE Ver1.1

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1 概述

本範例代碼為”LCD_Loading_And_Short_Circuit_Detection”，主要是利用當下 Charge pump timeout 的最大時間，推論出當下 LCD 整體驅動的負載大小。再以這個 Charge pump timeout 的時間，當作掃描每根 Segment Pin 和 Common Pin 的 timeout 時間，用來測試當下 LCD 驅動的負載是否有異常、和檢驗是否有短路的現象。

1.1 原理

本範例主要使用 Charge pump timeout 的功能當作檢驗負載工具，檢測 Segment Pin 和 Common Pin 是否有異常現象。首先會一直不斷嘗試測試，直到尋找到最大的 Charge pump timeout 時間，也就是 LCD 當下驅動電壓的最小升壓時間。以這個 timeout 當作 LCD 整體驅動的負載大小的基準值，再以這個基準當作測試值，有了這測試值就可以掃描所有 Segment Pin 和 Common Pin 是否有負載異常，不過為了方便測試本範例有定義”USING_TEST_CPT_THRD”閥值，這閥值是量測數個正常 LCD 所得到的平均值。

首先將所有 Segment Pin 輸出先關閉。之後，一根一根開啟掃描檢測，確認是否有 Charge pump timeout 發生。若有，表示這個 Segment Pin 的驅動負載有異常，它的線路可能已經短路。反之，則表示目前 LCD 驅動負載是正常的，代表所有 Segment Pin 的輸出線路都是正常的。同理，Common Pin 掃描檢測的方式跟 Segment Pin 是一樣的方式。

由於本範例目前只提供簡易的異常檢測方式，故只有支援 Segment Pin 和 Common Pin 一根異常的錯誤檢查，若要繼續掃描檢測，需要將當下的異常現象移除後，再重覆上述的檢查方式。使用者可以嘗試調整 LCD charge pump 電壓準值、不同的傳送 Pulse type、不同外接 pull low 電阻(10K~100K 歐姆以上)等等。會因為不一樣設定，而導致有不一樣的 Charge pump timeout 值，也就代表著 LCD 驅動負載大小在變化，這些變化可以讓使用者作為找出更準確檢測方式的依據。

1.2 執行結果

將 ”LCD_Loading_And_Short_Circuit_Detection ”的專案程式燒入到 NuMaker-M258KE Ver1.1 板子，並確認所有硬體周邊是否有如圖 3-1 所示的示意圖配置。進入 Keil 專案 Debug 模式開啟 Semihost 功能，打開 Serial Window 功能列印測試訊息，並按提示發送對應的字元。

抓取當下 LCD charge pump timeout 值的測試資訊，如圖 1-1 所示:

```
LCD configurations:
 * Clock source is LIRC
 * 8 COM, 40 SEG and 1/4 Bias
 * Driving waveform is Type-A
 * Target frame rate is 64Hz

Working frame rate is 64Hz on Type-A.

 * Trigger the charge pump timeout threshold is 0x3
 * ------------------------------------------
 * [1]: Get the current charge pump timeout value(using active pulse)
 * [2]: Scan all segment pins for short circuit detection
 * [3]: Scan all common pins for short circuit detection
 Fail disable all pin & test again
 If work normaly, turn segment/common pin by pin
Test Item = 1




Get max charge pump time value = 0x3
If the test data is large, it is recommended to reduce it by 25%.
Suggest -50 percent is 0x2
Suggest -25 percent is 0x3
```

圖 1-1 抓取當下 LCD charge pump timeout 值執行結果，以及列印資訊

LCD Segment 5 Pin 外接 pull low 電阻的測試資訊如圖 1- 2 所示:

```
CPU @ 48000000 Hz
+----------------------------------------+
|    LCD Loading Detector Example Code   |
+----------------------------------------+

LCD configurations:
 * Clock source is LIRC
 * 8 COM, 40 SEG and 1/4 Bias
 * Driving waveform is Type-A
 * Target frame rate is 64Hz

Working frame rate is 64Hz on Type-A.

 * Trigger the charge pump timeout threshold is 0x3
 * ----------------------------------------
 * [1]: Get the current charge pump timeout value(using active pulse)
 * [2]: Scan all segment pins for short circuit detection
 * [3]: Scan all common pins for short circuit detection
 Fail disable all pin & test again
 If work normaly, turn segment/common pin by pin
Test Item = 2
 * Scan all segment pins and check for short circuits
 * LCD segment pin status is abnormal, and check again
 * One by one detect LCD segment pin!
 * Enable LCD SEG0 - OK
 * Enable LCD SEG1 - OK
 * Enable LCD SEG2 - OK
 * Enable LCD SEG3 - OK
 * Enable LCD SEG4 - OK
 * Enable LCD SEG5 - Short circuit detected!
```

圖 1- 2 Segment 5 Pin 外接 pull low 電阻執行結果，以及列印資訊

LCD Common 1 Pin 外接 pull low 電阻的測試資訊如圖 1- 3 所示:

```
LCD configurations:
 * Clock source is LIRC
 * 8 COM, 40 SEG and 1/4 Bias
 * Driving waveform is Type-A
 * Target frame rate is 64Hz

Working frame rate is 64Hz on Type-A.

 * Trigger the charge pump timeout threshold is 0x3
 * ------------------------------------------
 * [1]: Get the current charge pump timeout value(using active pulse)
 * [2]: Scan all segment pins for short circuit detection
 * [3]: Scan all common pins for short circuit detection
 Fail disable all pin & test again
 If work normaly, turn segment/common pin by pin
Test Item = 3
 * Scan all common pins and check for short circuits
 * LCD common pin status is abnormal, and check again
 * One by one detect LCD common pin!
 * Enable LCD COM0 - OK
 * Enable LCD COM1 - Short circuit detected!
```

圖 1- 3 LCD Common 1 Pin 外接 pull low 電阻執行結果，以及列印資訊

LCD Segment 10 Pin 短路到 ICE 的 UART Tx pin 的測試資訊如圖 1- 4 所示:

```
LCD configurations:
 * Clock source is LIRC
 * 8 COM, 40 SEG and 1/4 Bias
 * Driving waveform is Type-A
 * Target frame rate is 64Hz

Working frame rate is 64Hz on Type-A.

 * Trigger the charge pump timeout threshold is 0x3
 * ------------------------------------------
 * [1]: Get the current charge pump timeout value(using active pulse)
 * [2]: Scan all segment pins for short circuit detection
 * [3]: Scan all common pins for short circuit detection
 Fail disable all pin & test again
 If work normaly, turn segment/common pin by pin
Test Item = 2
 * Scan all segment pins and check for short circuits
 * LCD segment pin status is abnormal, and check again
 * One by one detect LCD segment pin!
 * Enable LCD SEG0 - OK
 * Enable LCD SEG1 - OK
 * Enable LCD SEG2 - OK
 * Enable LCD SEG3 - OK
 * Enable LCD SEG4 - OK
 * Enable LCD SEG5 - OK
 * Enable LCD SEG6 - OK
 * Enable LCD SEG7 - OK
 * Enable LCD SEG8 - OK
 * Enable LCD SEG9 - OK
 * Enable LCD SEG10 - Short circuit detected!
```

圖 1- 4 LCD Segment 10 Pin 短路到 ICE 的 UART Tx pin 執行結果，以及列印資訊

2 程式碼介紹

以下編碼是在介紹 ” LCD_Loading_And_Short_Circuit_Detection ”範例的主要程式：

LCD 驅動負載的 Pulse 的模式和 charge pump timeout 閥值設定:

```
#define INACTIVE_PULSE              0
#define ACTIVE_PULSE                1
#define USING_TEST_PULSE            ACTIVE_PULSE
#define USING_TEST_CPT_THRD         3     //Charge pump timeout threshold
```

計算目前最大 LCD 驅動負載的時間：

```
uint32_t LCD_GetMaxChargePumpTimeOutValue(void)
{
    uint32_t u32MaxCTOVal=0;
    uint32_t u32Loop;
    uint32_t u32CTVal;
    for( u32Loop = 0; u32Loop < 5 ; u32Loop++)
    {
        for(u32CTVal = 1; u32CTVal < 0xFFE; u32CTVal++)
        {
            //Send the 5 frame pulse
            LCD_SET_FRAME_COUNTING_VALUE(5);
            LCD_CLEAR_FRAME_COUNTING_END_FLAG();
            LCD_CLEAR_CHARGE_TIMEOUT_FLAG();
            LCD_SET_CHARGE_TIMEOUT_TIME(u32CTVal);
            while(LCD_GET_FRAME_COUNTING_END_FLAG()==0) {};
           //Check the charge pump timeout flag
            if(LCD_GET_CHARGE_TIMEOUT_FLAG()==0)
            {
                break;
            }
            if(u32CTVal%10 == 0)
                printf(">");
        }
        //Get the maximum charge pump time value
        if(u32CTVal > u32MaxCTOVal)
            u32MaxCTOVal = u32CTVal;
        printf("\n");
    }
    return u32MaxCTOVal;
```

```
}
```

檢查 Charge Pump Timeout 是否有發生：

```
uint8_t LCD_CheckChargePumpTimeOut(uint32_t u32CTOVal)
{
    uint32_t u32Loop;
    for( u32Loop=0; u32Loop < 5 ; u32Loop++)
    {
        //Send the 5 frame pulse
        LCD_SET_FRAME_COUNTING_VALUE(5);
        LCD_CLEAR_FRAME_COUNTING_END_FLAG();
        LCD_CLEAR_CHARGE_TIMEOUT_FLAG();
        LCD_SET_CHARGE_TIMEOUT_TIME(u32CTOVal);
        while(LCD_GET_FRAME_COUNTING_END_FLAG()==0) {};
       //Check the charge pump timeout flag
        if(LCD_GET_CHARGE_TIMEOUT_FLAG())
        {
            return 1;
        }
    }
    return 0;
}
```

掃描每根 Segment pin 的 LCD 驅動負載時間是否有超過，來判斷是否有短路的現象:

```
void LCD_SegmentPinShortCircuitScan(uint8_t u8PulseLeve,uint32_t u32CTval)
{
    printf(" * Scan all segment pins and check for short circuits \n");
    LCD_AllDataSet(u8PulseLeve);
    LCD_MultiFunctionPinSet();
    LCD_Segment_MultiFunctionPinOutputMode();
    LCD_Common_MultiFunctionPinOutputMode();

    printf(" * LCD segment pin status is abnormal, and check again \n");
    LCD_MultiFunctionPinClear();
    printf(" * One by one detect LCD segment pin!\n");
    uint8_t Pin_Cnt;
    sMFP_LCD *psPtr = (sMFP_LCD *) g_sLCD_SEG_PIN;

    for(Pin_Cnt=0; Pin_Cnt<sizeof(g_sLCD_SEG_PIN)/sizeof(sMFP_LCD); Pin_Cnt++)
    {
```

```
      printf(" * Enable LCD SEG%d -", Pin_Cnt);
      //Segment Pin Set
      Set_MFP((psPtr+Pin_Cnt)->u8PinID,1, (psPtr+Pin_Cnt)->u8FunVal );
      if(LCD_CheckChargePumpTimeOut(u32CTval))
      {
        printf(" Short circuit detected!\n");
        break;
      }
      else
        printf(" OK\n");
      //Segment Pin Clear
      Set_MFP((psPtr+Pin_Cnt)->u8PinID,0, (psPtr+Pin_Cnt)->u8FunVal );
    }
    printf("\n");
    LCD_Segment_MultiFunctionPinInputMode();
    LCD_Common_MultiFunctionPinInputMode();
}
```

掃描每根 Common pin 的 LCD 驅動負載時間是否有超過，來判斷是否有短路的現象:

```
void LCD_CommonPinShortCircuitScan(uint8_t u8PulseLeve,uint32_t u32CTval)
{
    printf(" * Scan all common pins and check for short circuits \n");
    LCD_AllDataSet(u8PulseLeve);
    LCD_MultiFunctionPinSet();
    LCD_Segment_MultiFunctionPinOutputMode();
    LCD_Common_MultiFunctionPinOutputMode();
    printf(" * LCD common pin status is abnormal, and check again \n");
    LCD_MultiFunctionPinClear();
    printf(" * One by one detect LCD common pin!\n");
    uint8_t Pin_Cnt;
    sMFP_LCD *Ptr = (sMFP_LCD *) g_sLCD_COM_PIN;

    for(Pin_Cnt=0; Pin_Cnt<sizeof(g_sLCD_COM_PIN)/sizeof(sMFP_LCD); Pin_Cnt++)
    {
      printf(" * Enable LCD COM%d -", Pin_Cnt);
      // Common Pin Set
      Set_MFP((Ptr+Pin_Cnt)->u8PinID,1, (Ptr+Pin_Cnt)->u8FunVal);

      if(LCD_CheckChargePumpTimeOut(u32CTval))
      {
        printf(" Short circuit detected!\n");
        break;
      }
      else
        printf(" OK\n");
    // Common Pin Clear
    Set_MFP((Ptr+Pin_Cnt)->u8PinID,0, (Ptr+Pin_Cnt)->u8FunVal);

    }
    printf("\n");
    LCD_Segment_MultiFunctionPinInputMode();
    LCD_Common_MultiFunctionPinInputMode();
}
```

3 軟體與硬體需求

3.1 軟體需求

- BSP 版本
  - M251/M252/M254/M256/M258 Series CMSIS BSP V3.01.002
- IDE 版本
  - Keil uVersion 5.26

3.2 硬體需求

- 電路元件
  - NuMaker-M258KE Ver1.1
  - NuMaker – TNLCDSub_M258K_4.8V_V1.0
- 示意圖

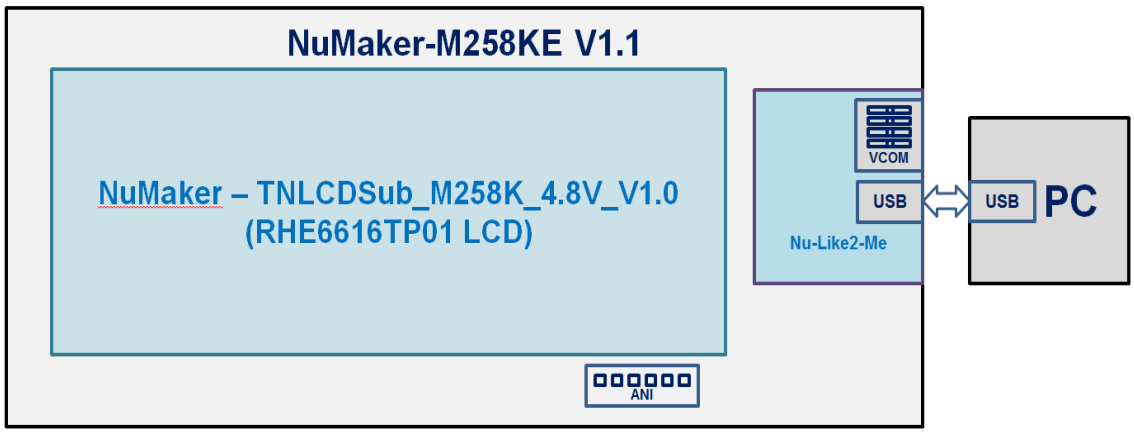

圖 3-1 硬體線路連接示意圖

本範例測試一，需要外接 pull down 電阻來增加整體驅動負載，模擬 LCD 腳位短路的環境，User 可以選擇下面 5 個接口外接 pull down 電阻腳位，如圖 3-2 所示。

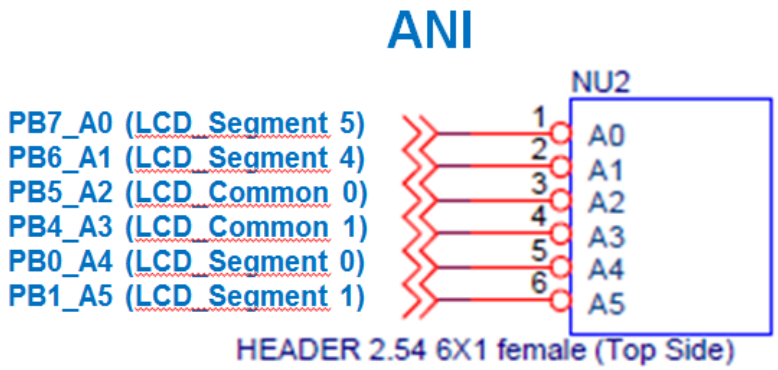

圖 3-2 外接 pull low 電阻的接口示意圖

本範例測試二時需將 Switch 切換到跟 ICE_TX 連接在一起，透過 ICE_TX 來增加整體驅動負載，模擬 LCD 腳位短路的環境，如圖 3-3 所示。

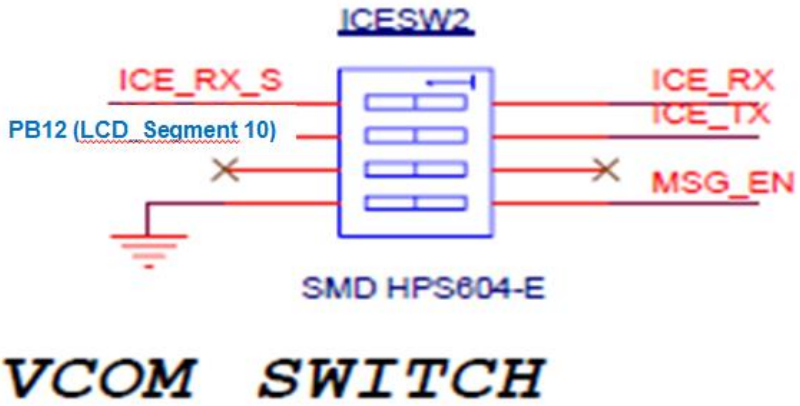

圖 3-3 外接 ICE_TX 線路示意圖

4 目錄資訊

EC_M258_Loading_And_Short_Circuit_Detection_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

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 M258_Loading_And_Short_Circuit_Detection.uvprojx。
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
2021.10.28	1.00	1. 初始發布.

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