Software UART

NuMicro® 32 位系列微控制器範例代碼介紹

文件資訊

代碼簡述	使用 GPIO 和 TIMER 模擬 UART 半雙工通訊傳輸
BSP 版本	M051 Series BSP CMSIS v3.01.001
開發平台	NuMaker-EVB-M051 v3.0

1 功能介紹

1.1 簡介

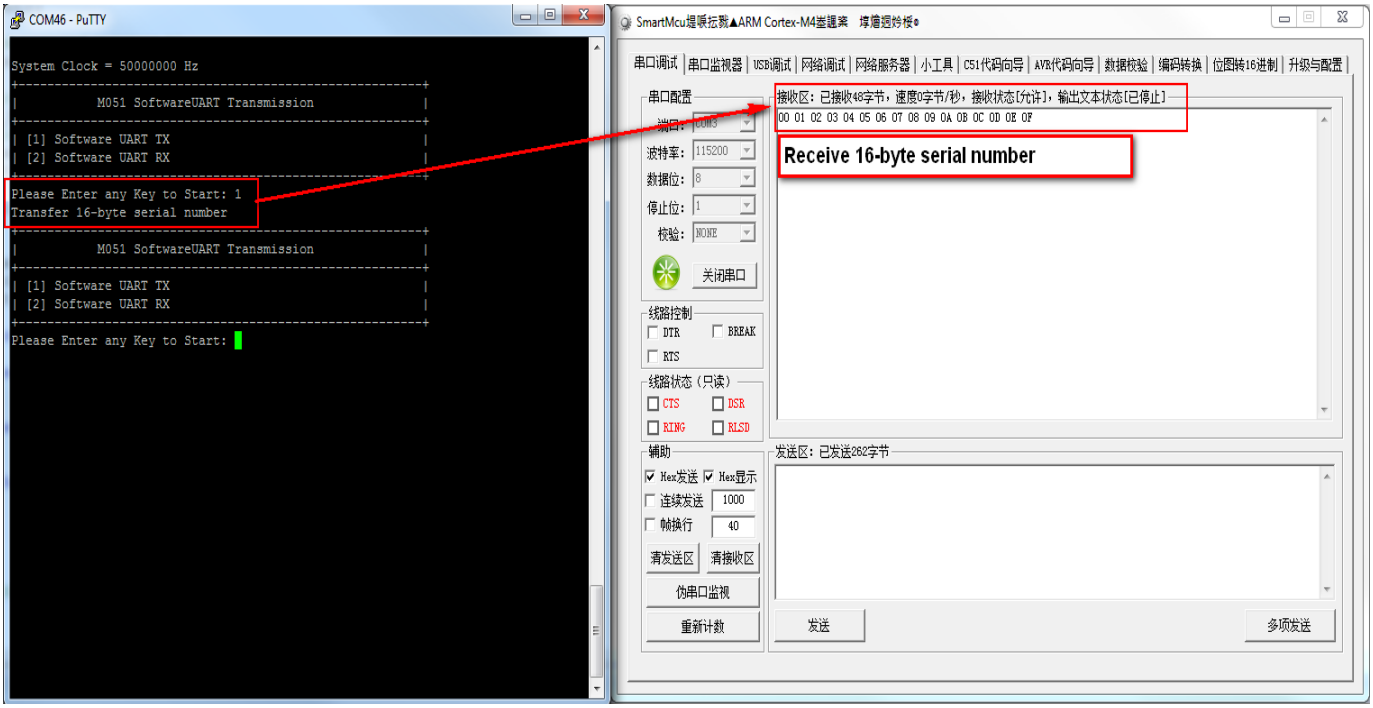
此範例是使用兩根GPIO的IO分別設定為輸出與輸入模式專門負責接收或傳送資料，搭配兩個TIMER計數功能產生週期，來達成模擬 UART_TX 和 UART_RX 的半雙工傳輸功能。

1.2 原理

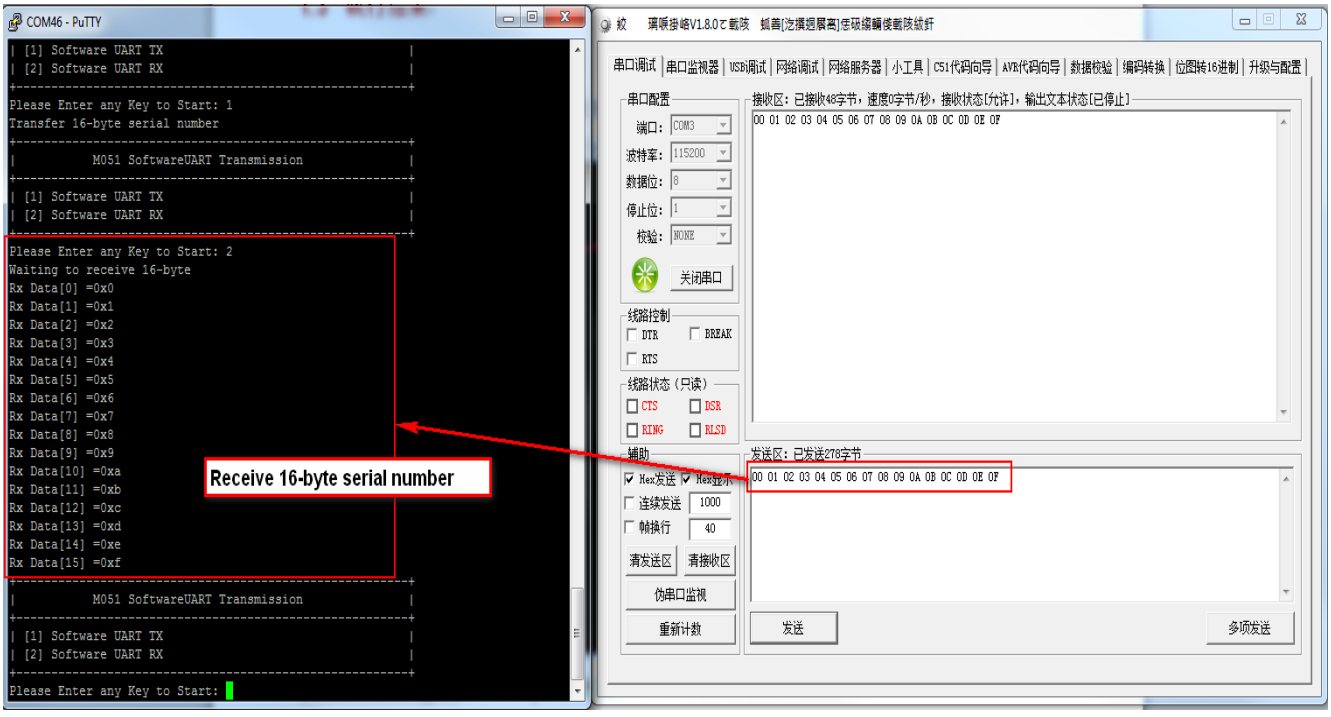
此範例有兩個功能分別是仿真UART 傳送資料 (TX) 和接收資料功能 (RX)，UART TX 部分首先將所要傳送的資料格式組合成所要傳送的位元數(start bit (1) + data bit (5~8) + parity bit (0~1) + stop bit (1~2))，搭配計數器(TIMER1)的週期計數中斷模式，產生所要傳送資料的波特率，再將組合位元組透過GPIO輸出High或Low訊號變化，達成模擬UART傳送資料的通訊傳輸模式。UART RX 部分首先會從通訊格式算出接收的字元數(start bit (1) + data bit (5~8) + parity bit (0~1) + stop bit (1~2))，搭配計數器(TIMER0)的週期計數中斷模式，產生要接收資料的波特率的兩倍速度，透過接收GPIO輸入訊號High或Low變化轉換資料字元組，並對接收完成的字元組會做錯誤驗證和資料轉換，達成模擬UART接收資料的通訊傳輸模式，其中兩倍波特率速度 是為了讓輸入端訊號的擷取點盡量接近中心點位置。

1.3 執行結果

1.3.1 Software UART 傳送資料執行結果



1.3.2 Software UART 接收資料執行結果



2 代碼介紹

2.1.1 Software UART 初始化設定

```
/* Set to use GPIO emulation UART transfer */
#define GPIO_UART_TX       P27
#define GPIO_UART_RX       P26
```

```
void SoftwareUART_Init(sUART_Config *psConfig)
{
        /* Configure P2.6 as Input mode(Rx)*/
        GPIO_SetMode(P2, BIT6, GPIO_PMD_INPUT);
        /* Configure P2.7 as Output mode(Tx)*/
        GPIO_SetMode(P2, BIT7, GPIO_PMD_OUTPUT);
        /*Initial the SoftwareUART configuration setting*/
        SoftwareUART_ConfigInit(psConfig);
        /* Configure SoftwareUART and set SoftwareUART baudrate */
        SoftwareUART_Open(psConfig,115200);
}
```

2.1.2 Software UART 波特率設定

```
void SoftwareUART_Open(sUART_Config *psConfig,uint32_t u32BaudRate)
{
       uint32_t u32TimePeriodic;
       psConfig->u32BaudRate = u32BaudRate;
       /*Setting the UART Rx bit rate*/
       u32TimePeriodic = psConfig->u32BaudRate*2;
       /* Open Timer0 frequency in periodic mode, and enable interrupt */
       TIMER_Open(TIMER0,TIMER_PERIODIC_MODE,u32TimePeriodic);
      /* Enable Timer0 INT */
       TIMER_EnableInt(TIMER0);
      /* Setting the UART Tx bit rate */
       u32TimePeriodic  =  psConfig->u32BaudRate;
       /* Open Timer0 frequency in periodic mode, and enable interrupt */
       TIMER_Open(TIMER1,TIMER_PERIODIC_MODE,u32TimePeriodic);
       /* Enable Timer0 INT */
       TIMER_EnableInt(TIMER1);
                                              .
                                              .
}
```

2.1.3 Software UART 資料格式設定

```
void SoftwareUART_DataFormartConfig(sUART_Config *psConfig)
{

     psConfig->u8DataBits = 8;                /* Setting data length is 8 bits */
     psConfig->u8Parity = PARITY_NONE;        /* No Parity */
     psConfig->u8StopBit = STOP_BIT_1;        /* 1 STOP Bit */
     psConfig->u8TxLatency = 2;               /* Transmission interval is 2 bits rate */
     psConfig->u32SendLen = 16;               /* Send 16 bytes (Tx) */
     psConfig->u32ReceiveLen = 16;            /* Receive 16 bytes (Rx) */
                                              .
                                              .
    /* Configure total communication bits length */
     psConfig->u8CommunBitsLen = psConfig->u8DataBits;

     if(psConfig->u8Pairty != PARITY_NONE)
      psConfig->u8CommunBitsLen += 1;     /* Parity bit */

     if(psConfig->u8StopBit != STOP_BIT_1)
      psConfig->u8CommunBitsLen += 3;     /* Start Bit + 2 Stop Bits */

     else
      psConfig->u8CommunBitsLen += 2;     /* Start Bit + 1 Stop Bit */

}
```

2.1.4 Software UART RX 接收資料

```
void SoftwareUART_ReadData(sUART_Config *psConfig)
{
                                              .
                                              .
       u8RxCount = 0;
      /* Use TIMER0 to emulate the bit rate of UART reception*/
      psConfig->u8RxTiming =0;
      /* Wait to Receive the start bit */
      while(GPIO_UART_RX == 1){};
      psConfig->u8RxStatus = eRxRcvData;

      do{
         while(psConfig->u8RxTiming == 0){};
         /* Receive Data bit */
        if(GPIO_UART_RX == 0)
           psConfig->pu16RxBuff[u32Index] |= (0 << u8RxCount);
        else
           psConfig->pu16RxBuff[u32Index] |= (1 << u8RxCount);
         psConfig->u8RxTiming =0;
         while(psConfig->u8RxTiming == 0){};
         psConfig->u8RxTiming =0;
         u8RxCount++;
     /* Total bits Length (start bit(1)+data bits(5~8)+ parity bit(0-1)+stop bit(1~2))*/
     }while(u8RxCount < psConfig->u8CommunBitsLen);

      u8RxCount =0;
     /* End of reception */
     psConfig->u8RxStatus = eRxIdel;
     psConfig->u8RxTiming =0;

     }
                                              .
                                              .
}
```

```
void TMR0_IRQHandler(void)
{
    /* Clear Timer0 time-out interrupt flag */
    TIMER_ClearIntFlag(TIMER0);
        /* Receiving data time */
    if( g_psSoftwareUART_Config->u8RxStatus == eRxRcvData)
        g_psSoftwareUART_Config->u8RxTiming++;

}
```

2.1.5 Software UART TX 傳送資料

```
void SoftwareUART_SendData(sUART_Config *psConfig)
{
                                                .
                                                .
     psConfig->u8TxStatus = eTxIdel;
     psConfig->u8TxTiming =0;
                                                .
                                                .
    GPIO_UART_TX = 1;
     /* Wait the latency timing */
    u16SendData = psConfig->pu16TxBuff[u32Index];
    while( psConfig->u8TxStatus != eTxActive){};
    psConfig->u8TxStatus = eTxSendData;

   /* Use TIMER1 to emulate the bit rate of UART transmission */
   do{
              psConfig->u8TxTiming =0;
              if((u16SendData & 0x01) == 0x01)
                 GPIO_UART_TX =1;
              else
                 GPIO_UART_TX =0;
              u16SendData = u16SendData >> 1;
              while(psConfig->u8TxTiming == 0){};
     /* Total bits Length(start bit(1)+data bits(5~8)+parity bit(0~1)+stop bit(1~2)) */
   }while(psConfig->u8TxSendCount < (psConfig->u8CommunBitsLen+psConfig->u8TxLatency ));

    psConfig->u8TxStatus = eTxIdel;
    psConfig->u8TxSendCount =0;


                                                .
                                                .
}
```

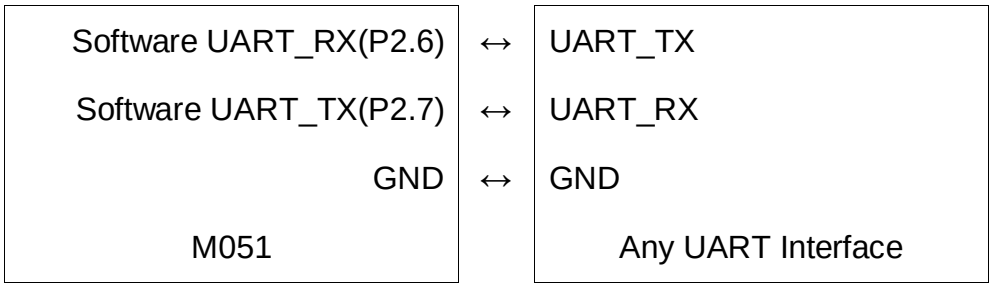
```
void TMR1_IRQHandler(void)
{
    /* Clear Timer1 time-out interrupt flag */
     TIMER_ClearIntFlag(TIMER1);

     g_psSoftwareUART_Config->u8TxSendCount++;
     /*Wait for the Tx transfer start bit to complete*/
     if(g_psSoftwareUART_Config->u8TxStatus == eTxIdel)
     {
        if(g_psSoftwareUART_Config->u8TxSendCount == g_psSoftwareUART_Config->u8TxLatency)
           g_psSoftwareUART_Config->u8TxStatus = eTxActive;
     }/* Tx transmission time */
     else if(g_psSoftwareUART_Config->u8TxStatus == eTxSendData)
              g_psSoftwareUART_Config->u8TxTiming = 1;

}
```

3 軟體與硬體環境

- **軟體環境**
  - BSP 版本
    - M051 Series BSP CMSIS v3.01.001
  - IDE 版本
    - Keil uVersion 4.70
- **硬體環境**
  - 電路元件
    - NuMaker-EVB-M051 v3.0
    - Any UART Interface
    - RS232 to TTL Module
  - 示意圖



4 目錄資訊

- EC_M051_SoftwareUART_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 ExampleCode 路徑中的 KEIL 資料夾，雙擊 SoftwareUART.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
Jul. 5, 2019	1.00	1. 初始發佈.

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