Software UART

NuMicro® 32 位系列微控制器范例代码介绍

文件信息

代码简述	使用 GPIO 和 TIMER 仿真 UART 半双工通讯传输
BSP 版本	M051 Series BSP CMSIS v3.01.001
开发平台	NuMaker-EVB-M051 v3.0

1 功能介绍

1.1 简介

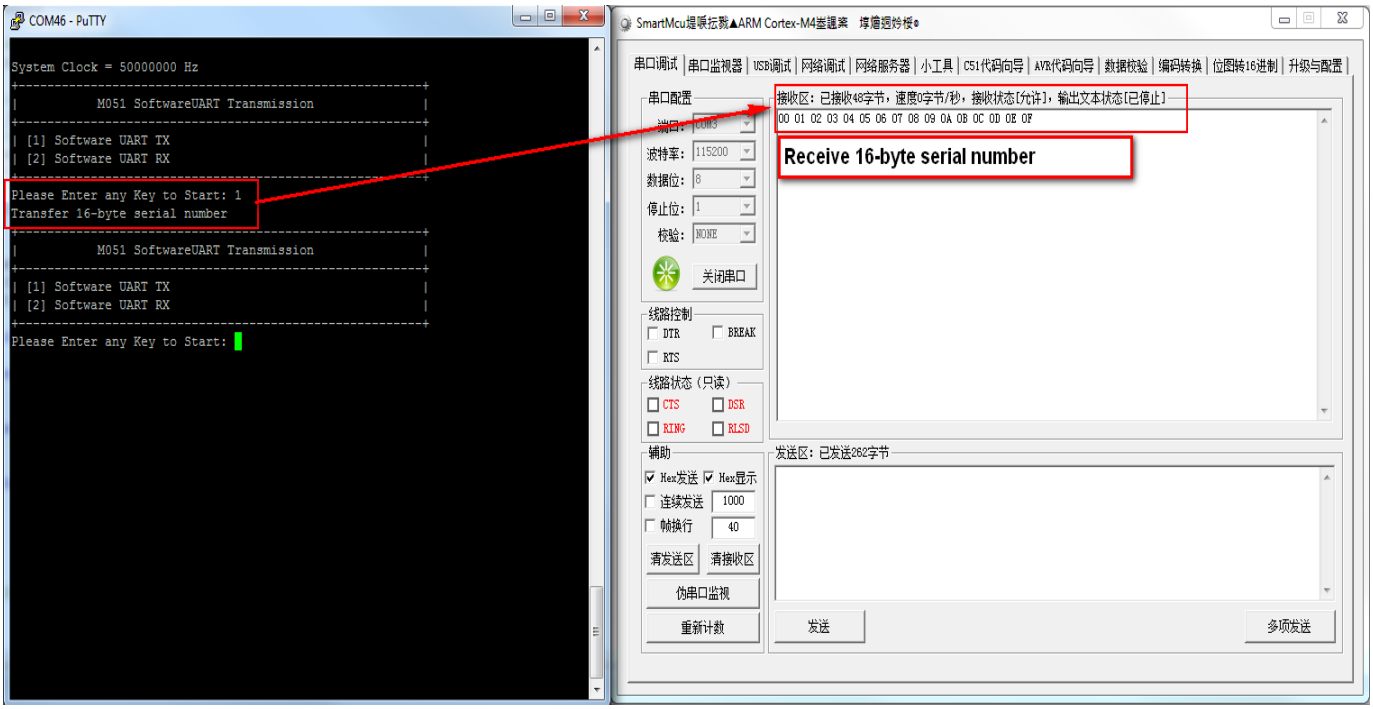
此范例是使用两根GPIO的IO分别设定为输出与输入模式专门负责接收或传送数据，搭配两个TIMER计数功能产生周期，来达成仿真 UART_TX 和 UART_RX 的半双工传输功能。

1.2 原理

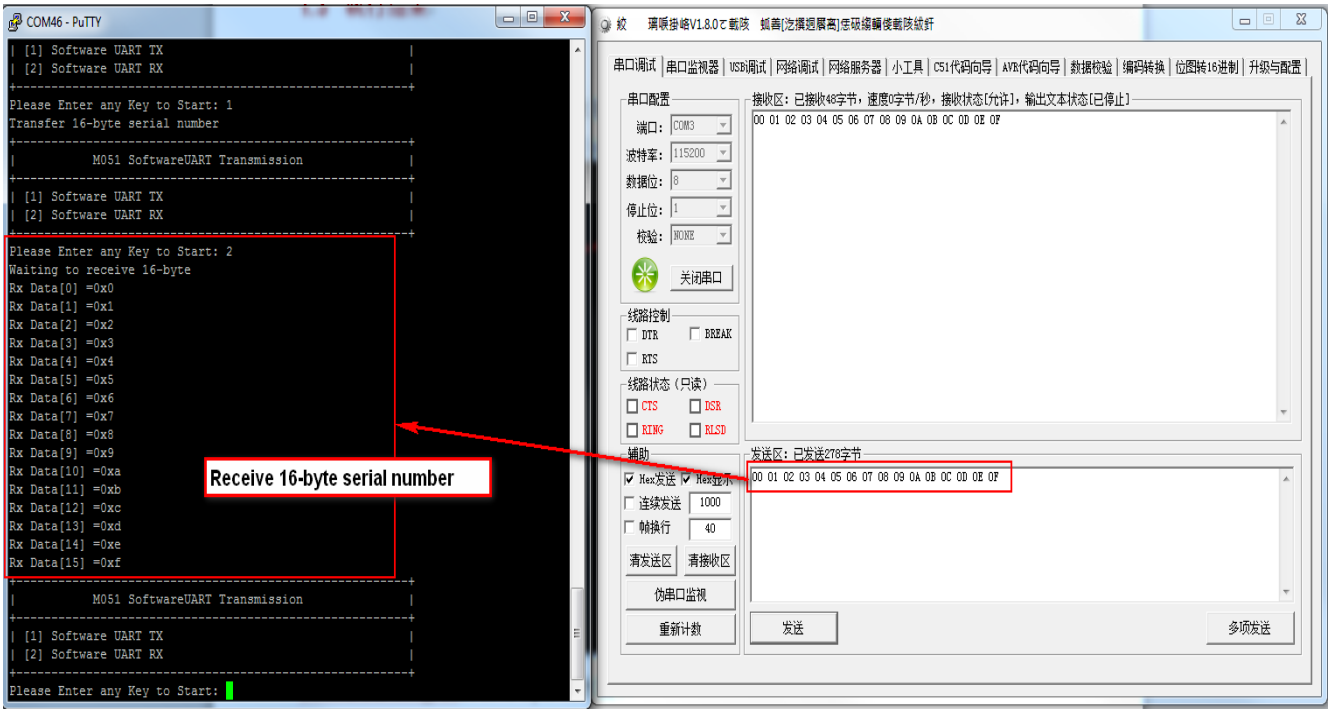
此范例有两个功能分别是仿真UART 传送数据 (TX) 和接收数据功能 (RX)，UART TX 部分首先将所要传送的数据格式组合成所要传送的位数(start bit (1) + data bit (5~8) + parity bit (0~1) + stop bit (1~2))，搭配计数器(TIMER1)的周期计数中断模式，产生所要传送数据的波特率，再将组合字节透过GPIO输出High或Low讯号变化，达成仿真UART传送数据的通讯传输模式。
UART RX 部分首先会从通讯格式算出接收的字符数(start bit (1) + data bit (5~8) + parity bit (0~1) + stop bit (1~2))，搭配计数器(TIMER0)的周期计数中断模式，产生要接收数据的波特率的两倍速度，透过接收GPIO输入讯号High或Low变化转换数据字符组，并对接收完成的字符组会做错误验证和数据转换，达成仿真UART接收数据的通讯传输模式，其中两倍波特率速度 是为了让输入端讯号的撷取点尽量接近中心点位置。

1.3 执行结果

1.3.1 Software UART 传送数据执行结果



1.3.2 Software UART 接收数据执行结果



2 代码介绍

2.1.1 Software UART 初始化设定

```
/* 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 波特率设定

```
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 数据格式设定

```
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 接收数据

```
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 传送数据

```
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;

                                                .
                                                .
}
```

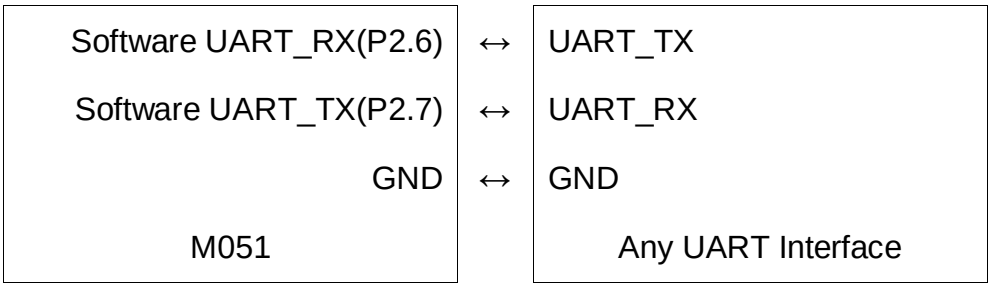
```
void TMR1_IRQHandler(void)
{
    /* Clear Timer1 time-out interrupt flag */
     TIMER_ClearIntFlag(TIMER1);

     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 软件与硬件环境

- 软件环境
  - BSP 版本
    - M051 Series BSP CMSIS v3.01.001
  - IDE 版本
    - Keil uVersion 4.70
- 硬件环境
  - 电路组件
    - NuMaker-EVB-M051 v3.0
    - Any UART Interface
    - RS232 to TTL Module
  - 示意图



4 目录信息

- 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 如何执行范例程序

1. 根据目录信息章节进入 ExampleCode 路径中的 KEIL 文件夹，双击 SoftwareUART.uvproj。
2. 进入编译模式接口
   a. 编译
   b. 下载代码至内存
   c. 进入 / 离开除错模式
3. 进入除错模式接口
   a. 执行代码

6 修订纪录

Date	Revision	Description
Jul. 5, 2019	1.00	1. 初始发布.

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