使用ML51实现LoRa模块数据对传

NuMicro® 8 位系列微控制器范例代码介绍

文件信息

代码简述	本范例代码基于NuMicro ML51芯片中的SPI及GPIO功能，实现LoRa模块数据对传
BSP 版本	ML51_BSP_Keil_C51_V1.0.0
开发平台	NT-ML51PC V1.1

1 功能介绍

1.1 简介

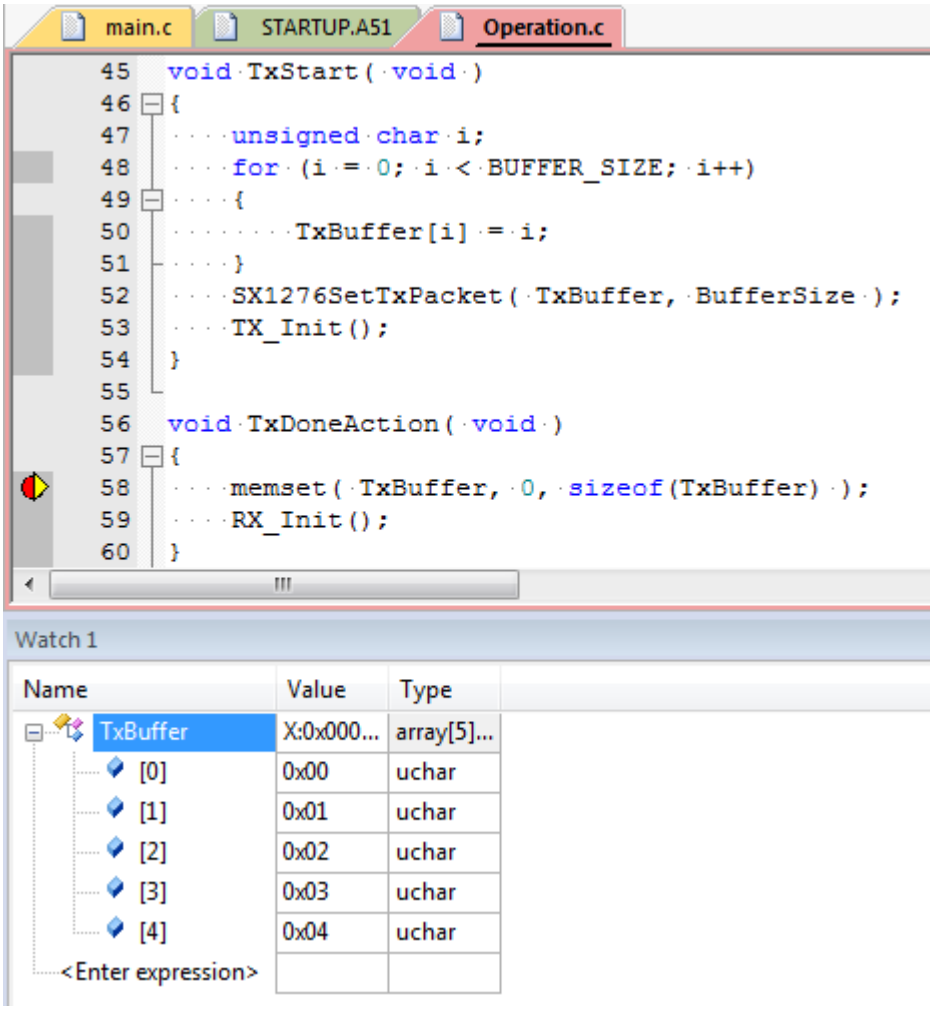
LoRa是LongRange的简称，应用于物联网的低功耗广域网传输技术(Low Power Wide Area Network, LPWAN)。LoRa无线通信技术由美商Semtech并购的法商Cycleo所开发，并与IBM合作制定规范，最后由Semtech、Cisco、IBM三大公司作为核心，组成LoRa联盟推动相关发展，为现今最受产业支持的LPWAN技术。

LoRa的模式如Wi-Fi般，任何人都可以设置基地台来建置网络环境。其具有较高的传输带宽，除了能进行单向传输的省电通讯外，也能够进行数据交换，适合应用于一些较大型的智能工厂中。除此之外，为了因应不同使用目的，LoRa有Class A, Class B, Class C 3个种类。Class A做基本的定时传输用，强调省电、Class B 除基本传输功能外，还增加触发性传输能力、Class C 则提供持续传输功能。

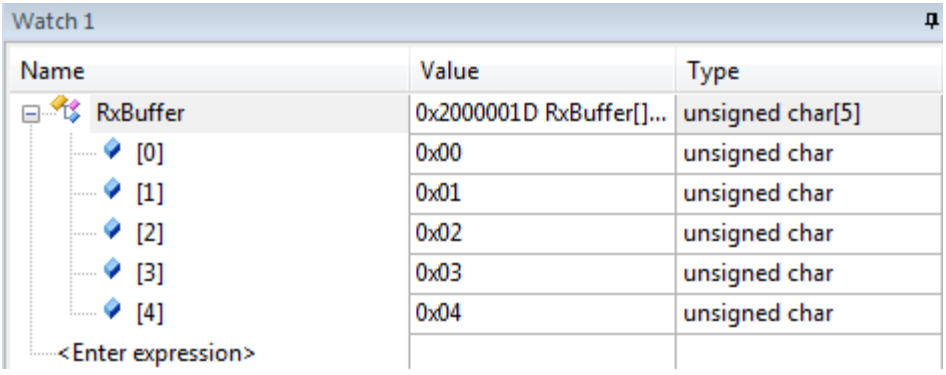
本范例代码基于NuMicro ML51芯片中的SPI及GPIO功能，实现LoRa模块数据对传。

1.2 执行结果

a. TX传送0x00, 0x01, 0x02, 0x03, 0x04，如TxBuffer数组中的数据



b. RX接收到0x00, 0x01, 0x02, 0x03, 0x04，如RxBuffer数组中的数据



2 代码介绍

设定#define TX 1，可以让ML51控制LoRa模块作为TX传送数据。
设定#define TX 0，可以让ML51控制LoRa模块作为RX传送数据。
范例中先呼叫BoardInit()与Radio_Init()进行GPIO与SPI等硬件的初始化，然后开始进行LoRa数据传输测试。

```
#include <stdio.h>
#include "platform.h"
#include "ML51.h"
#include "Operation.h"

/*---------------------------------------------------------------------------------------------------------*/
/*Define                                                                                                   */
/*---------------------------------------------------------------------------------------------------------*/
#define TX 1

/*---------------------------------------------------------------------------------------------------------*/
/*Global variables                                                                                         */
/*---------------------------------------------------------------------------------------------------------*/
extern unsigned char F_RxStart;
extern unsigned char F_TxStart;

/*---------------------------------------------------------------------------------------------------------*/
/* Functions.                                                                                              */
/*---------------------------------------------------------------------------------------------------------*/
int main(void)
{
   BoardInit();
   Radio_Init();

#if TX
    TxStart();
#else
    RX_Init();
#endif

    while (1)
    {
        if (F_RxStart)
        {
            F_RxStart = FALSE;
            RX_Done();
            RxDoneAction();
            RX_Init();
        }
        if (F_TxStart)
        {
            F_TxStart = FALSE;
            TX_Done();
            TxDoneAction();
            TxStart();
        }
    }
}
```

LoRa 接收通过GPIO中断唤醒，模块数据通过SPI进行，初始化步骤如下

```
void SX1276InitIo( void )
{
    /* SPI1 IO define */
    MFP_P32_SPI1_CLK;
```

```
    P32_PUSHPULL_MODE;
    MFP_P31_SPI1_MISO;
    P31_INPUT_MODE;
    P31_PULLUP_ENABLE;
    MFP_P30_SPI1_MOSI;
    P30_PUSHPULL_MODE;
    MFP_P33_GPIO;         /*setting SS use gpio mode */
    P33_PUSHPULL_MODE;

    /*Init DIO0 */
    MFP_P00_GPIO;
    P00_INPUT_MODE;
    P00_PULLDOWN_ENABLE;
    GPIO_EnableInt(PIT0, RISING, EDGE, Port0, 0); /*set DIO0 use pin interrupt */
```

```
void SpiInit( void )
{
    unsigned char u8MasterSlave = SPI_MASTER;
    unsigned char u8SPICLKDIV = 9;
    unsigned char u8SPIMode = SPI_MODE_0;
    unsigned char u8MSBLSB = MSB_FIRST;

    SX1276InitIo();
    set_SPI1SR_DISMODF;       /*Mode fault error detection disable*/
    clr_SPI1CR0_SSOE;         /*SS pin use as GPIO*/
    SFRS = 0;
    SPI1CR0 = 0;
    SPI1CR0 |= (u8MasterSlave << 4) | (u8SPICLKDIV & 0x03) | (u8SPIMode << 2) | (u8MSBLSB
<< 5);
    SPI1CR1 = 0 ;
    SPI1CR1 |= (u8SPICLKDIV & 0x0C) << 2;
    set_SPI1CR0_SPIEN;
```

LoRa模块发送及接收buffer的动作如下

```
void SX1276WriteBuffer( unsigned char addr, unsigned char *buffer, unsigned char size_in )
{
    unsigned char i;

    SPI_SS0_PIN = 0;
    SpiInOut( addr | 0x80 );
    for ( i = 0; i < size_in; i++ )
    {
        SpiInOut( buffer[i] );
    }
    SPI_SS0_PIN = 1;
}

void SX1276ReadBuffer( unsigned char addr, unsigned char *buffer, unsigned char size_in )
{
    unsigned char i;

    SPI_SS0_PIN = 0;
    SpiInOut( addr & 0x7F );

    for ( i = 0; i < size_in; i++ )
    {
        buffer[i] = SpiInOut( 0 );
    }

    SPI_SS0_PIN = 1;
}
```

3 软件与硬件环境

- 软件环境
  - BSP 版本
    - ML51_BSP_Keil_C51_V1.0.0
  - IDE 版本
    - Keil uVersion 4.6 及 PK51 Development Kit V9.52
- 硬件环境
  - 硬件需求
    - NT-ML51PC V1.1 tiny board
    - SX1276 LoRa module board
  - 接线图

NuTiny-SDK-ML51 V1.1		LoRa Module
VCC	↔	VCC
(GPIO INPUT)P00	↔	LORA_DIO0
(GPIO INPUT)P01	↔	LORA_DIO1
(GPIO INPUT)P02	↔	LORA_DIO2
(GPIO INPUT)P03	↔	LORA_DIO3
(GPIO INPUT)P14	↔	LORA_DIO4
(GPIO INPUT)P15	↔	LORA_DIO5
(GPIO OUTPUT)P33	↔	LORA_CS
(SPI CLK)P32	↔	LORA_CLK
(SPI MISO)P31	↔	LORA_MISO
(SPI MOSI)P30	↔	LORA_MOSI
GND	↔	GND

4 目录信息

- EC_ML51_LoRa_Control
  - Library: Sample code header and source files.
    - Device: ML51 device header files.
    - Startup: Keil51 startup files
    - StdDriver: All peripheral driver header and source files.
  - Sample_Code
    - Example: Source file of example code.
      - LoRa_Control LoRa module SX1276 TX/RX driver sample code

5 如何执行范例程序

1. 本项目支持 Keil uVersion 4.6 及以上版本
2. 根据目录信息章节进入 ExampleCode\LoRa_Control\KEIL 文件夹，双击 LoRa_Control.uvproj 开启专案
3. 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
4. 进入除错模式接口
   a. 执行代码

6 修订纪录

日期	版本	描述
Oct. 24, 2019	1.00	1. 初始发布.

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