

## 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

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## 1 功能介绍

### 1.1 简介

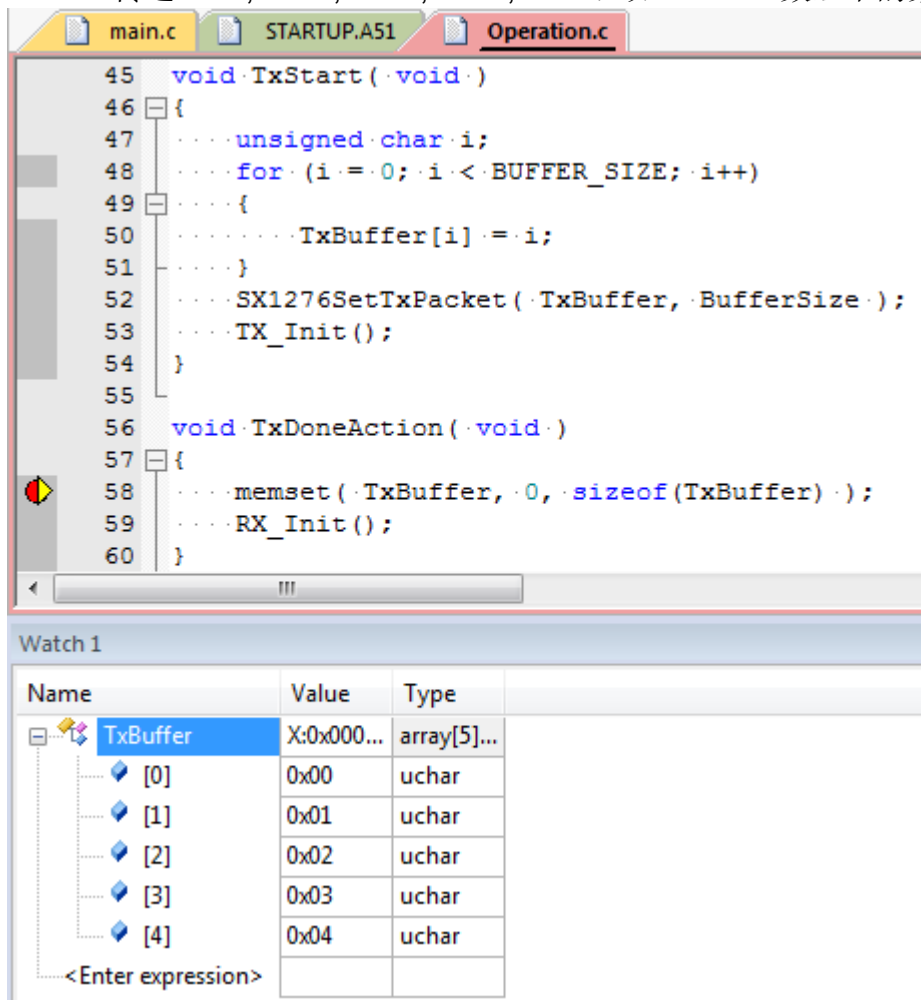
LoRa是LongRange的简称，应用于物联网的低功耗广域网传输技术(Low Power Wide Area Network, LPWAN)。LoRa无线通信技术由美商Semtech并购的法商Cycleo所开发，并与IBM合作制定规范，最后由Semtech、Cisco、IBM三大公司作为核心，组成LoRa联盟推动相关发展，为现今最受产业支持的LPWAN技术。

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



The screenshot shows a code editor with three tabs: main.c, STARTUP.A51, and Operation.c. The Operation.c tab is active, displaying the following code:

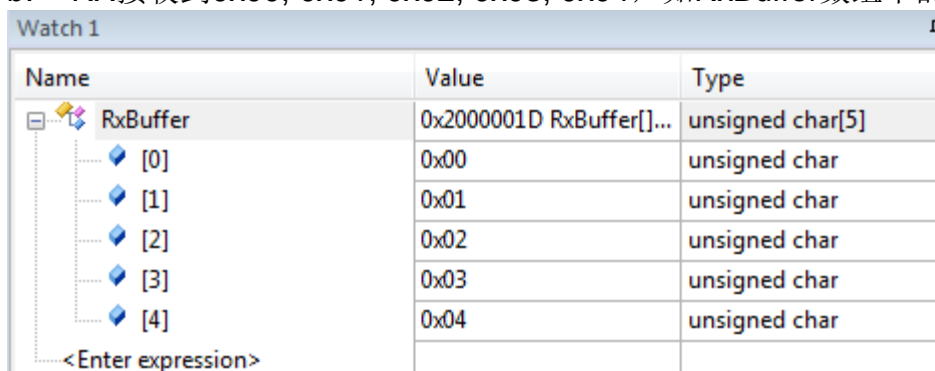
```

45 void TxStart (void)
46 {
47     unsigned char i;
48     for (i = 0; i < BUFFER_SIZE; i++)
49     {
50         TxBuffer[i] = i;
51     }
52     SX1276SetTxPacket (TxBuffer, BufferSize);
53     TX_Init();
54 }
55
56 void TxDoneAction (void)
57 {
58     memset (TxBuffer, 0, sizeof(TxBuffer));
59     RX_Init();
60 }
    
```

Below the code editor is the Watch window, titled "Watch 1". It displays the contents of the TxBuffer array:

Name	Value	Type
TxBuffer	X:0x000...	array[5]...
[0]	0x00	uchar
[1]	0x01	uchar
[2]	0x02	uchar
[3]	0x03	uchar
[4]	0x04	uchar
<Enter expression>		

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



The screenshot shows the Watch window, titled "Watch 1". It displays the contents of the RxBuffer array:

Name	Value	Type
RxBuffer	0x2000001D RxBuffer[5]...	unsigned char[5]
[0]	0x00	unsigned char
[1]	0x01	unsigned char
[2]	0x02	unsigned char
[3]	0x03	unsigned char
[4]	0x04	unsigned char
<Enter expression>		

## 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

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
NuTiny-SDK-ML51 V1.1		LoRa Module


## 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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