

使用ML51實現LoRa模組資料對傳

NuMicro® 8 位系列微控制器範例代碼介紹

文件資訊

代碼簡述	本範例代碼基於NuMicro ML51晶片中的SPI及GPIO功能，實現LoRa模組資料對傳
BSP 版本	ML51_BSP_Keil_C51_V1.0.0
開發平台	NT-ML51PC V1.1

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1 功能介紹

1.1 簡介

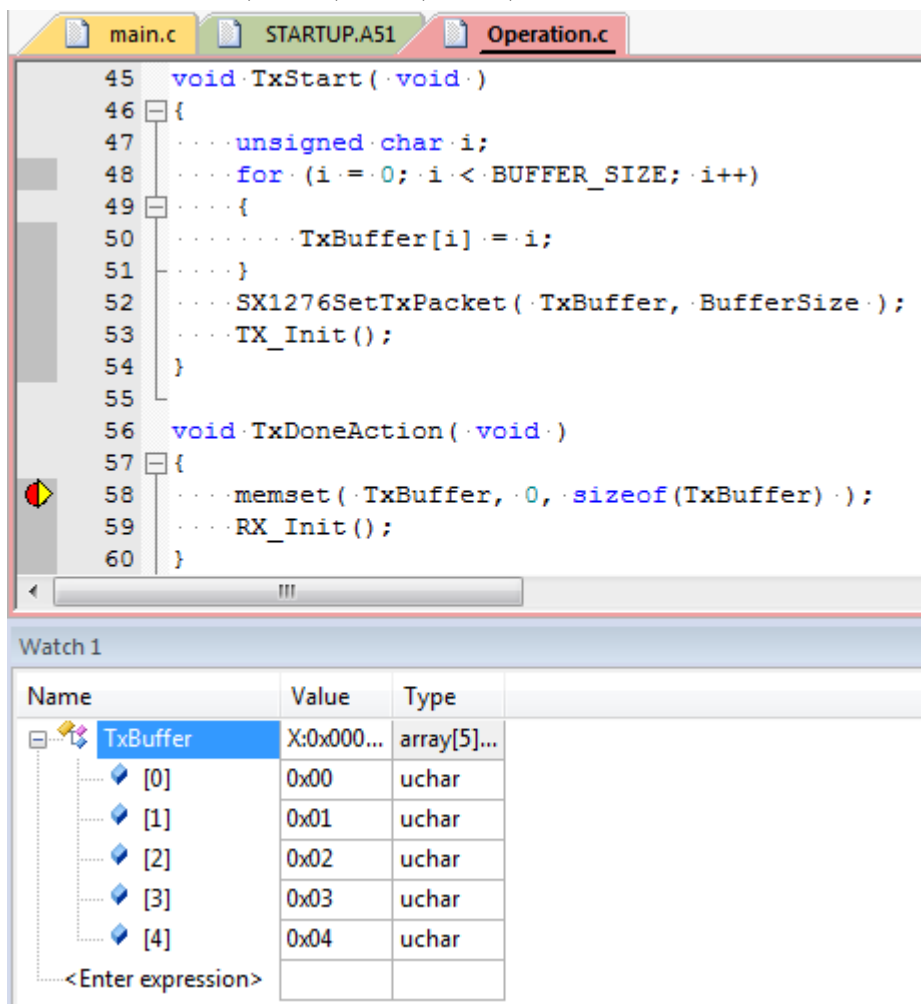
LoRa是LongRange的簡稱，應用於物聯網的低功耗廣域網路傳輸技術(Low Power Wide Area Network, LPWAN)。LoRa無線通訊技術由美商Semtech併購的法商Cycleo所開發，並與IBM合作制定規範，最後由Semtech、Cisco、IBM三大公司作為核心，組成LoRa聯盟推動相關發展，為現今最受產業支持的LPWAN技術。

LoRa的模式如Wi-Fi般，任何人都可以設置基地台來建置網路環境。其具有較高的傳輸頻寬，除了能進行單向傳輸的省電通訊外，也能夠進行數據交換，適合應用於一些較大型的智慧工廠中。除此之外，為了因應不同使用目的，LoRa有Class A, Class B, Class C 3個種類。Class A 做基本的定時傳輸用，強調省電、Class B 除基本傳輸功能外，還增加觸發性傳輸能力、Class C 則提供持續傳輸功能。

本範例代碼基於NuMicro ML51晶片中的SPI及GPIO功能，實現LoRa模組資料對傳。

1.2 執行結果

- a. TX傳送0x00, 0x01, 0x02, 0x03, 0x04 · 如TxBuffer陣列中的資料



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:

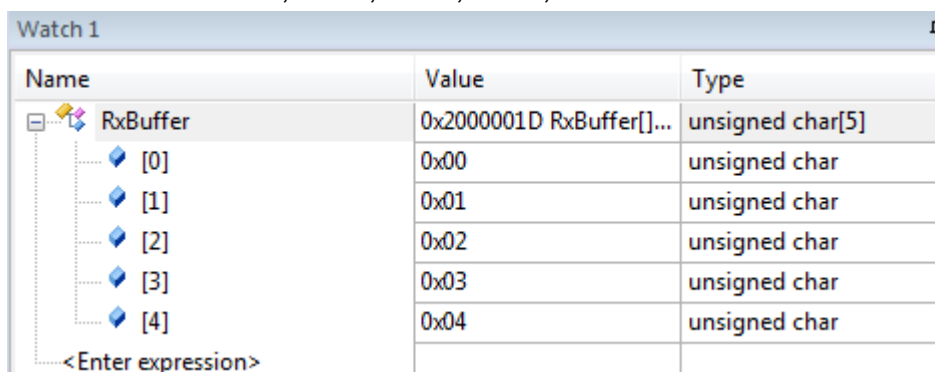
```

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 a Watch window titled "Watch 1". It contains a table with the following data:

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陣列中的資料



The screenshot shows a Watch window titled "Watch 1". It contains a table with the following data:

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 代碼介紹

設定#define TX 1，可以讓ML51控制LoRa模組作為TX傳送資料。

設定#define TX 0，可以讓ML51控制LoRa模組作為RX傳送資料。

範例中先呼叫BoardInit()與Radio_Init()進行GPIO與SPI等硬體的初始化，然後開始進行LoRa資料傳輸測試。

```
#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 接收通過GPIO中斷喚醒，模塊數據通過SPI進行，初始化步驟如下

```
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 DI00 */
MFP_P00_GPIO;
P00_INPUT_MODE;
P00_PULLDOWN_ENABLE;
GPIO_EnableInt(PIT0, RISING, EDGE, Port0, 0); /*set DI00 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模塊發送及接收buffer的動作如下

```

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 軟體與硬體環境

● 軟體環境

■ BSP 版本

◆ ML51_BSP_Keil_C51_V1.0.0

■ IDE 版本

◆ Keil uVersion 4.6 及 PK51 Development Kit V9.52

● 硬體環境

■ 硬體需求

◆ NT-ML51PC V1.1 tiny board

◆ SX1276 LoRa module board

■ 接線圖

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 目錄資訊

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 如何執行範例程式

1. 本專案支援Keil uVersion 4.6 及PK51 Development Kit V9.52 以上版本
2. 根據目錄資訊章節進入ExampleCode\LoRa_Control\KEIL資料夾，雙擊LoRa_Control.uvproj開啟專案
3. 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
4. 進入除錯模式介面
 - a. 執行代碼

6 修訂紀錄

日期	版本	描述
Oct. 24, 2019	1.00	1. 初始發布.

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