QSPI與I2S使用PDMA傳輸

NuMicro® 32 位系列微控制器範例代碼介紹

文件資訊

代碼簡述	QSPI 與 I2S 使用 PDMA 傳輸資料範例代碼
BSP 版本	M480 BSP CMSIS V3.03.001
開發平台	NuMaker-PFM-M487 Ver3.0

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1 功能介紹

1.1 簡介

QSPI與I2S使用PDMA傳輸資料，QSPI0示範如何使用Basic模式傳輸資料，I2S0示範如何使用Scatter-Gather模式傳輸。

1.2 原理

將QSPI0的TX與RX對接，I2S0的TX和RX對接進行測試。程式裡設置了64筆32bit的數據資料透過PDMA Basic 模式將資料放到QSPI0的TX，QSPI0把資料從TX傳輸給RX，RX藉由PDMA Basic 模式的方式傳到記憶體的MasterRxBuffer中，I2S0的TX再通過PDMA Scatter-Gather 模式從記憶體MasterRxBuffer中獲取資料，傳給I2S0的RX，然後經過PDMA Scatter-Gather 模式傳給記憶體SlaveRxBuffer，最後將SlaveRxBuffer中的64筆資料透過UART0資料列印出來，並驗證資料互傳是否成功。(由於I2S在開始傳輸資料前會先打一筆無效資料，故SlaveRxBuffer資料陣列需宣告為65筆。)

1.3 執行結果

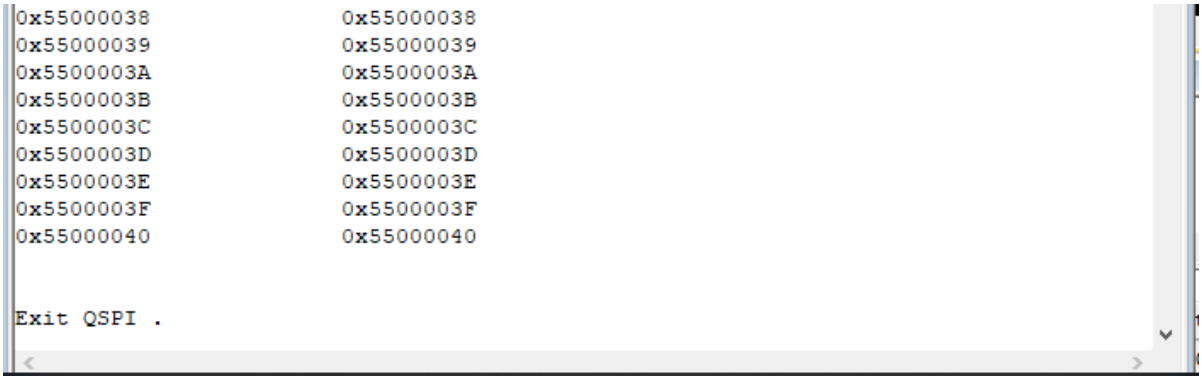
執行結果，以及打印資料。
QSPI傳輸資料如下

UART #1

```
+------------------------------------------------------------+
|                  QSPI + I2S + PDMA Sample Code             |
+------------------------------------------------------------+


QSPI0 to I2S0 Loop test with PDMA

QSPI0 TX                QSPI0 RX
0x55000001              0x55000001
0x55000002              0x55000002
0x55000003              0x55000003
0x55000004              0x55000004
0x55000005              0x55000005
0x55000006              0x55000006
0x55000007              0x55000007
0x55000008              0x55000008
0x55000009              0x55000009
0x5500000A              0x5500000A
0x5500000B              0x5500000B
0x5500000C              0x5500000C
0x5500000D              0x5500000D
0x5500000E              0x5500000E
0x5500000F              0x5500000F
0x55000010              0x55000010
0x55000011              0x55000011
0x55000012              0x55000012
0x55000013              0x55000013
0x55000014              0x55000014
0x55000015              0x55000015
0x55000016              0x55000016
0x55000017              0x55000017
0x55000018              0x55000018
0x55000019              0x55000019
0x5500001A              0x5500001A
0x5500001B              0x5500001B
0x5500001C              0x5500001C
0x5500001D              0x5500001D
0x5500001E              0x5500001E
0x5500001F              0x5500001F
0x55000020              0x55000020
0x55000021              0x55000021
0x55000022              0x55000022
0x55000023              0x55000023
0x55000024              0x55000024
0x55000025              0x55000025
0x55000026              0x55000026
0x55000027              0x55000027
0x55000028              0x55000028
0x55000029              0x55000029
0x5500002A              0x5500002A
0x5500002B              0x5500002B
0x5500002C              0x5500002C
0x5500002D              0x5500002D
0x5500002E              0x5500002E
0x5500002F              0x5500002F
0x55000030              0x55000030
0x55000031              0x55000031
0x55000032              0x55000032
0x55000033              0x55000033
0x55000034              0x55000034
0x55000035              0x55000035
0x55000036              0x55000036
0x55000037              0x55000037
```


0x55000038 0x55000038
0x55000039 0x55000039
0x5500003A 0x5500003A
0x5500003B 0x5500003B
0x5500003C 0x5500003C
0x5500003D 0x5500003D
0x5500003E 0x5500003E
0x5500003F 0x5500003F
0x55000040 0x55000040
Exit QSPI .

I2S 傳輸資料如下

UART #1

I2S TX Buffer	I2S RX Buffer
0x55000001	0x55000001
0x55000002	0x55000002
0x55000003	0x55000003
0x55000004	0x55000004
0x55000005	0x55000005
0x55000006	0x55000006
0x55000007	0x55000007
0x55000008	0x55000008
0x55000009	0x55000009
0x5500000A	0x5500000A
0x5500000B	0x5500000B
0x5500000C	0x5500000C
0x5500000D	0x5500000D
0x5500000E	0x5500000E
0x5500000F	0x5500000F
0x55000010	0x55000010
0x55000011	0x55000011
0x55000012	0x55000012
0x55000013	0x55000013
0x55000014	0x55000014
0x55000015	0x55000015
0x55000016	0x55000016
0x55000017	0x55000017
0x55000018	0x55000018
0x55000019	0x55000019
0x5500001A	0x5500001A
0x5500001B	0x5500001B
0x5500001C	0x5500001C
0x5500001D	0x5500001D
0x5500001E	0x5500001E
0x5500001F	0x5500001F
0x55000020	0x55000020
0x55000021	0x55000021
0x55000022	0x55000022
0x55000023	0x55000023
0x55000024	0x55000024
0x55000025	0x55000025
0x55000026	0x55000026
0x55000027	0x55000027
0x55000028	0x55000028
0x55000029	0x55000029
0x5500002A	0x5500002A
0x5500002B	0x5500002B
0x5500002C	0x5500002C
0x5500002D	0x5500002D
0x5500002E	0x5500002E
0x5500002F	0x5500002F
0x55000030	0x55000030
0x55000031	0x55000031
0x55000032	0x55000032
0x55000033	0x55000033
0x55000034	0x55000034
0x55000035	0x55000035
0x55000036	0x55000036
0x55000037	0x55000037
0x55000038	0x55000038
0x55000039	0x55000039
0x5500003A	0x5500003A
0x5500003B	0x5500003B
0x5500003C	0x5500003C
0x5500003D	0x5500003D
0x5500003E	0x5500003E

```
0x5500003F              0x5500003F
0x55000040              0x55000040


Exit I2S .
```

2 代碼介紹

QSPI0 使用 PDMA Basic 模式傳輸：

```
    /* Enable PDMA channels */
    PDMA_Open(PDMA, (1 << QSPI_MASTER_TX_DMA_CH) | (1 << QSPI_MASTER_RX_DMA_CH) );

    /* Set transfer width (32 bits) and transfer count */
    PDMA_SetTransferCnt(PDMA, QSPI_MASTER_TX_DMA_CH, PDMA_WIDTH_32, TEST_COUNT);

    /* Set source/destination address and attributes */
    PDMA_SetTransferAddr(PDMA, QSPI_MASTER_TX_DMA_CH,
    (uint32_t)g_au32MasterToSlaveTestPattern, PDMA_SAR_INC, (uint32_t)&QSPI0->TX,
    PDMA_DAR_FIX);

    /* Set request source; set basic mode. */
    PDMA_SetTransferMode(PDMA, QSPI_MASTER_TX_DMA_CH, PDMA_QSPI0_TX, FALSE, 0);

    /* Single request type. SPI only support PDMA single request type. */
    PDMA_SetBurstType(PDMA, QSPI_MASTER_TX_DMA_CH, PDMA_REQ_SINGLE, 0);

    /* Disable table interrupt */
    PDMA->DSCT[QSPI_MASTER_TX_DMA_CH].CTL |= PDMA_DSCT_CTL_TBINTDIS_Msk;

    /* Set transfer width (32 bits) and transfer count */
    PDMA_SetTransferCnt(PDMA, QSPI_MASTER_RX_DMA_CH, PDMA_WIDTH_32, TEST_COUNT);

    /* Set source/destination address and attributes */
    PDMA_SetTransferAddr(PDMA, QSPI_MASTER_RX_DMA_CH, (uint32_t)&QSPI0->RX, PDMA_SAR_FIX,
    (uint32_t)g_au32MasterRxBuffer, PDMA_DAR_INC);

    /* Set request source; set basic mode. */
    PDMA_SetTransferMode(PDMA, QSPI_MASTER_RX_DMA_CH, PDMA_QSPI0_RX, FALSE, 0);

    /* Single request type. SPI only support PDMA single request type. */
    PDMA_SetBurstType(PDMA, QSPI_MASTER_RX_DMA_CH, PDMA_REQ_SINGLE, 0);

    /* Disable table interrupt */
    PDMA->DSCT[QSPI_MASTER_RX_DMA_CH].CTL |= PDMA_DSCT_CTL_TBINTDIS_Msk;

    /* Enable SPI master DMA function */
    QSPI_TRIGGER_TX_PDMA(QSPI0);
    QSPI_TRIGGER_RX_PDMA(QSPI0);
```

I2S 使用 PDMA Scatter-Gather 模式傳輸：

```
    /* Enable PDMA channels */
    PDMA_Open(PDMA, (1 << I2S0_TX_DMA_CH) | (1 << I2S0_RX_DMA_CH));

    /* Tx description */
    g_asDescTable_TX[0].CTL = ((BUFF_LEN - 1) << PDMA_DSCT_CTL_TXCNT_Pos) | PDMA_WIDTH_32
    | PDMA_SAR_INC | PDMA_DAR_FIX | PDMA_REQ_SINGLE | PDMA_OP_SCATTER;
    g_asDescTable_TX[0].SA = (uint32_t)&g_au32MasterRxBuffer;
    g_asDescTable_TX[0].DA = (uint32_t)&I2S0->TXFIFO;
    g_asDescTable_TX[0].FIRST = (uint32_t)&g_asDescTable_TX[1] - (PDMA->SCATBA);

    g_asDescTable_TX[1].CTL = ((BUFF_LEN - 1) << PDMA_DSCT_CTL_TXCNT_Pos) | PDMA_WIDTH_32
    | PDMA_SAR_INC | PDMA_DAR_FIX | PDMA_REQ_SINGLE | PDMA_OP_BASIC;
    g_asDescTable_TX[1].SA = (uint32_t)&g_au32MasterRxBuffer[BUFF_LEN];
    g_asDescTable_TX[1].DA = (uint32_t)&I2S0->TXFIFO;
    g_asDescTable_TX[1].FIRST = (uint32_t)&g_asDescTable_TX[0] - (PDMA->SCATBA);
```

```
    /* Rx description */
    g_asDescTable_RX[0].CTL = ((BUFF_LEN - 1) << PDMA_DSCT_CTL_TXCNT_Pos) | PDMA_WIDTH_32
    | PDMA_SAR_FIX | PDMA_DAR_INC | PDMA_REQ_SINGLE | PDMA_OP_SCATTER;
    g_asDescTable_RX[0].SA = (uint32_t)&I2S0->RXFIFO;
    g_asDescTable_RX[0].DA = (uint32_t)&g_au32SlaveRxBuffer;
    g_asDescTable_RX[0].FIRST = (uint32_t)&g_asDescTable_RX[1] - (PDMA->SCATBA);

    g_asDescTable_RX[1].CTL = (((BUFF_LEN+1) - 1) << PDMA_DSCT_CTL_TXCNT_Pos) |
    PDMA_WIDTH_32 | PDMA_SAR_FIX | PDMA_DAR_INC | PDMA_REQ_SINGLE | PDMA_OP_BASIC;
    g_asDescTable_RX[1].SA = (uint32_t)&I2S0->RXFIFO;
    g_asDescTable_RX[1].DA = (uint32_t)&g_au32SlaveRxBuffer[BUFF_LEN];
    g_asDescTable_RX[1].FIRST = (uint32_t)&g_asDescTable_RX[0] - (PDMA->SCATBA);

    /* Set PDMA Transfer Mode */
    PDMA_SetTransferMode(PDMA, I2S0_TX_DMA_CH, PDMA_I2S0_TX, 1,
    (uint32_t)&g_asDescTable_TX[0]);
    PDMA_SetTransferMode(PDMA, I2S0_RX_DMA_CH, PDMA_I2S0_RX, 1,
    (uint32_t)&g_asDescTable_RX[0]);
```

3 軟體與硬體環境

- **軟體環境**
  - BSP 版本
    - M480 Series BSP CMSIS v3.03.000
  - IDE 版本
    - Keil uVersion 5.26
- **硬體環境**
  - 電路元件
    - NuMaker-PFM-M487 Ver3.0

4 目錄資訊

- EC_M480_QSPI_PDMA_I2S_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 M480_QSPI_PDMA_I2S.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
Sep. 10, 2019	1.00	1. 初始發布.

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