

## NUC505从内部SPI flash拨放MP3檔

NuMicro® 32 位系列微控制器范例代码介绍

### 文件信息

代码简述	本范例代码从NUC505内部SPI flash读取MP3档案拨放
BSP 版本	NUC505 Series BSP CMSIS V3.02.000
开发平台	NuTiny-EVB-NUC505 V1.6

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# 1 功能介绍

## 1.1 简介

范例程序中，NUC505使用内部音讯译码器，读取存在内部SPI flash的MP3档并且拨放。使用者需先刻录MP3档至内部SPI flash，并从config.h档中的MP3\_address去指定MP3文件储存位置以及用MP3File\_Size去指定MP3档案大小。请注意MP3档案不可超过NUC505内存位置。程序会先搜寻MP3档头，来验证储存是否为MP3档。

MP3档案存放地址范围	MP3档案位置参数	MP3档案大小参数
0x11000~0x1F_FFFF	MP3_address	MP3File_Size

NUC505支持单/双声道，数据长度为16 bits格式，取样率为8k, 11025, 12k, 16k, 22050, 24k, 32k, 44100和48k，程序代码会自动依照不同取样率设定APLL数值。

## 1.2 执行结果

执行后会打印出以下信息

```
Relocate vector table in SRAM (0x20000000) for fast interrupt handling, size = 0xbc.
+-----+
|           Play MP3 from internal Flash Sample Code           |
+-----+
Please store MP3 first in the internal Flash.
MP3 storage location cannot exceed flash size
NOTE: Need head-phone.

MP3 pre-stored in internal SPI Flash address from 0x00011000
168 byte(s) to the 1st frame.
====[MP3 Info]=====
FileSize = 416 KB
SampleRate = 44100
BitRate = 320000
Channel = 2
=====

Configure Internal CODEC ... [OK]
Start playing ...
Exit MP3
Stop ...
```

## 2 代码介绍

首先在main.c中对NUC505做初始化设定，并且把程序代码放入SRAM中执行以增加其执行速度，根据WAVFile\_address所设定位置读取MP3文件播放。

```
int32_t main(void)
{
    /* Init System, IP clock and multi-function I/O */
    SYS_Init();

    /* Init UART0 to 115200-8n1 for print message */
    UART0_Init();

    /* Relocate vector table in SRAM for fast interrupt handling. */
    {
        extern uint32_t __Vectors[];
        extern uint32_t __Vectors_Size[];
        extern uint32_t Image$$ER_VECTOR2$$ZI$$Base[];

        printf("Relocate vector table in SRAM (0x%08X) for fast interrupt handling, size =
0x%x.\n", Image$$ER_VECTOR2$$ZI$$Base, (unsigned int) __Vectors_Size);
        memcpy((void *) Image$$ER_VECTOR2$$ZI$$Base, (void *) __Vectors, (unsigned int)
__Vectors_Size);
        SCB->VTOR = (uint32_t) Image$$ER_VECTOR2$$ZI$$Base;
    }
    /* Init I2S */
    I2S_Init();

    printf("+-----+\n");
    printf("|          Play MP3 from internal Flash Sample Code          |\n");
    printf("+-----+\n");
    printf(" Please store MP3 first in the internal Flash.\n");
    printf(" MP3 storage location cannot exceed flash size\n");
    printf(" NOTE: Need head-phone. \n\n");

    /* Play MP3 from internal flash at MP3_address*/
    MP3Player(MP3_address);

    while (1);
}
```

在MP3Player(MP3\_address)函式中，程序会先搜寻MP3档头，来验证储存是否为MP3檔，并且读取MP3文件相关信息，并根据取样率对APLL做设定。

```
/* Parse MP3 header */
i320offset = MP3_ParseHeaderInfo(MP3StartAddr);

if (i320offset < 0)
    return;
else {
    /* Check if the MP3 SamplRate frequency is 11025 multiples */
    if (audioInfo.mp3SampleRate % 11025) {
        /* APLL is 49152031Hz for 12k, 16k, 24k, 32k, 48k, and 96k sampling rate */
        CLK_SET_APLL(CLK_APLL_49152031);
        if (audioInfo.mp3SampleRate == 8000)
            CLK_SetModuleClock(I2S_MODULE, CLK_I2S_SRC_APLL, 1);
    }
}
```

MP3经过译码之后使用Ping-pong buffer机制拨放，其流程如下：

```
/* Decode finished, try to copy pcm data to audio buffer */
if (audioInfo.mp3Playing) {
    /* If next buffer is still full (playing), wait until it's empty */
    if (aPCMBuffer_Full[u8PCMBufferTargetIdx] == 1)
        while (aPCMBuffer_Full[u8PCMBufferTargetIdx]);
} else {
    /* All buffers are full, wait */
    if ((aPCMBuffer_Full[0] == 1) && (aPCMBuffer_Full[1] == 1)) {
        /* Start to play */
        StartPlay();
        while (aPCMBuffer_Full[0]);
    }
}
for (i = 0; i < (int)Synth.pcm.length; i++) {
    /* Get the left/right samples */
    sampleL = Synth.pcm.samples[0][i];
    sampleR = Synth.pcm.samples[1][i];
    //FIXME mono application
    //if ( audioInfo.mp3Channel )
    //    sampleR = sampleL;

    /* Fill PCM data to I2S(PDMA) buffer */
    aPCMBuffer[u8PCMBufferTargetIdx][pcmbuf_idx++] = sampleR | (sampleL << 16);
}
```

```
    /* Need change buffer ? */
    if (pcmbuf_idx == PCM_BUFFER_SIZE) {
        NVIC_DisableIRQ(I2S_IRQn);
        /* Set buffer full flag */
        aPCMBuffer_Full[u8PCMBufferTargetIdx] = 1;
        NVIC_EnableIRQ(I2S_IRQn);
        u8PCMBufferTargetIdx ^= 1;
        pcmbuf_idx = 0;
        //printf("change to ==>%d ..\n", u8PCMBufferTargetIdx);
    }
}
```

在nuc505\_isr.c, 当数据传送完毕时清除缓冲区(buffer)满溢旗标。

```
void I2S_IRQHandler(void)
{
    uint32_t u32I2SIntFlag;

    /* Check interrupt flag */
    u32I2SIntFlag = I2S_GET_INT_FLAG(I2S, I2S_STATUS_TDMATIF_Msk |
    I2S_STATUS_TDMAEIF_Msk);

    if (u32I2SIntFlag & I2S_STATUS_TDMATIF_Msk) {
        I2S_CLR_INT_FLAG(I2S, I2S_STATUS_TDMATIF_Msk);

        /* Buffer 0 transfer completed, clear buffer full flag */
        aPCMBuffer_Full[0] = 0;
    } else if (u32I2SIntFlag & I2S_STATUS_TDMAEIF_Msk) {
        I2S_CLR_INT_FLAG(I2S, I2S_STATUS_TDMAEIF_Msk);
        /* Buffer 1 transfer completed, clear buffer full flag */
        aPCMBuffer_Full[1] = 0;
    }
}
```

### 3 软件与硬件环境

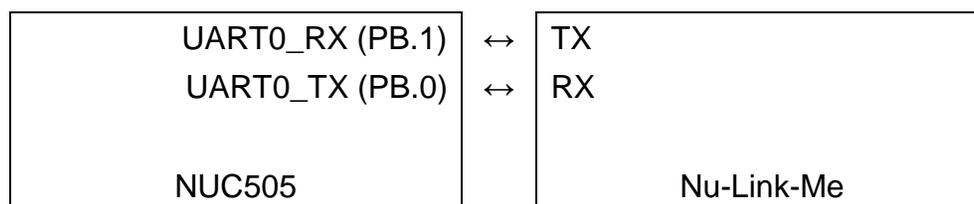
- 软件环境

- BSP 版本
  - ◆ NUC505 Series BSP CMSIS V3.02.000
- IDE 版本
  - ◆ Keil uVersion 5.26

- 硬件环境

- 电路组件
  - ◆ NuTiny-EVB-NUC505 V1.6
  - ◆ 3.5 mm 接头耳机
- 示意图

使用 3.5 mm 接头耳机连接板上的 HP OUT 底座，并透过 NUC505 的 UART0\_RX(PB.1)、UART0\_TX(PB.0)连接至 Nu-Link Me，打印讯息。设置终端机的 COM Port 与 Baud，COM Port 的编号可在设备管理器中找到「NuBridge Virtual Com Port (COMX)」，Baud 设置为 115200。



## 4 目录信息

### 📁 EC\_NUC505\_MP3PlayerSPIFlash\_V1.00

📁 Library	Sample code header and source files
📁 CMSIS	Cortex <sup>®</sup> Microcontroller Software Interface Standard (CMSIS) by Arm <sup>®</sup> Corp.
📁 Device	CMSIS compliant device header file
📁 StdDriver	All peripheral driver header and source files
📁 SampleCode	
📁 ExampleCode	Source file of example code
📁 ThirdParty	
📁 FatFs	A generic FAT file system module for small embedded systems. Its official website is: <a href="http://elm-chan.org/fsw/ff/00index_e.html">http://elm-chan.org/fsw/ff/00index_e.html</a> .
📁 LibMAD	A MPEG audio decoder library which currently supports MPEG-1 and the MPEG-2 extension to lower sampling frequencies, as well as the de facto MPEG 2.5 format. All three audio layers — Layer I, Layer II, and Layer III (i.e. MP3) are fully implemented. This library is distributed under GPL license. Please contact Underbit Technologies ( <a href="http://www.underbit.com/">http://www.underbit.com/</a> ) for the commercial license

## 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 MP3PlayerSPIFlash.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. 03, 2019	1.00	1. 初始发布.

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