

GigaDevice Semiconductor Inc.

**Introduction of library invocation scheme
based on MDK implementation**

**Application Note
AN075**

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1. Introduction

This application note is dedicated to software code design, which aims to achieve collaborative development and reduce code downloads by decentralizing image files.

This application note will describe the method of dispersing an image by implementing a software algorithm to calculate CRC MPEG-2, of course, the implementation method is not limited to the method described in this application note, and customers can also use other methods to achieve the same purpose.

This application note is theoretically applicable to all GD32 MCU products developed using MDK.

2. Application scenario analysis

2.1. Application scenario

In the process of product application development, the following scenarios are often encountered:

Scenario 1, in the development of relatively large application code, it is often found that most of the code functions are normal, and a small part of the code needs to be adjusted continuously. When adjusting this part of the code, the entire application code will be recompiled and downloaded. When the entire application is relatively large (for example, the bin file is larger than 1MB), the download time of the entire code will become very long, often exceeding 3 minutes. At this time, if only the modified part of the code is updated without modifying other codes, It can greatly improve the development efficiency and improve the development experience.

Scenario 2, some algorithm developers will solidify their developed algorithms to a fixed position on the chip, and solution providers will develop their own applications based on the solidified algorithms.

This application note describes a collaboratively developed approach to a software-based CRC algorithm.

3. The method implemented by the demo

3.1. Overview

CRC (Cyclic Redundancy Check): It is the most commonly used error checking code in the field of data communication. It is characterized in that the length of the information field and the check field can be arbitrarily selected. Cyclic redundancy check is a data transmission error detection function, which performs polynomial calculation on data and attaches the obtained result to the back of the frame. The receiving device also performs a similar algorithm to ensure the correctness and integrity of data transmission.

This section will implement the algorithm for calculating CRC MPEG-2 by software, and separate the execution file of the algorithm from the execution file of the main calling code to realize cooperative development. Since this article mainly describes the method of realizing separation and development, it will not introduce the implementation of CRC algorithm in detail.

3.2. MPEG-2 software algorithm project creation

The software project used in this section will be based on the firmware library project of GD32W51x, and will be implemented based on GD32W515P-EVAL-V1.1.

First, obtain the firmware library project of GD32W51x from the official website. The firmware library project used in this article is version V1.0.0. After the acquisition is successful, you need to confirm whether the software and hardware functions are normal.

Create a new directory and source code file, as shown in [Figure 3-1. modify of the Template](#). Create the mpeg2 directory under the Template directory to save the CRC code file, [Figure 3-2. The content of the Mpeg2 directory](#) shows the contents of the folder, There are only 2 files in this folder, crc.c and crc.h.

Figure 3-1. modify of the Template



名称	修改日期	类型	大小
IAR_Project	2022/7/4 10:29	文件夹	
Keil_Project	2022/7/4 10:29	文件夹	
mpeg2	2022/7/4 10:29	文件夹	
gd32w51x_it.c	2022/6/30 14:45	C 文件	4 KB
gd32w51x_it.h	2022/6/30 14:45	C/C++ Header	3 KB
gd32w51x_libopt.h	2022/6/30 14:45	C/C++ Header	3 KB
main.c	2022/6/30 16:12	C 文件	4 KB
main.h	2022/6/30 14:45	C/C++ Header	2 KB
readme.txt	2022/6/30 14:45	文本文档	2 KB
systick.c	2022/6/30 14:45	C 文件	3 KB
systick.h	2022/6/30 14:45	C/C++ Header	2 KB

Figure 3-2. The content of the Mpeg2 directory



名称	修改日期	类型	大小
crc.c	2022/6/30 16:13	C 文件	2 KB
crc.h	2022/6/30 16:13	C/C++ Header	1 KB

[Table 3-1. crc.h code cell](#) is the code in crc.h, there are two function declarations in crc.h, these two functions are implemented in crc.c for external calls.

Table 3-1. crc.h code cell

```

#ifndef _CRC_H
#define _CRC_H

void crc32_mpeg2_init(unsigned int poly, unsigned int *crc_table);
unsigned int crc32_mpeg2_calc(unsigned int crc, unsigned int *crc_table, void* input, int len);

#endif

```

The function `crc32_mpeg2_init` is used to initialize the CRC calculation table, [Table 3-2. `crc32_mpeg2_init` code cell](#) shows its implementation.

Table 3-2. `crc32_mpeg2_init` code cell

```

/*!
 * \brief generate crc MPEG-2 table
 * \param[in] poly: crc polynomial, for MPEG-2 it is 0x4C11DB7
 * \param[in] crc_table: a pointer to a polynomial table, at least size is 256
 * \param[out] crc_table: a pointer to generated polynomial table
 * \retval none
 */
void crc32_mpeg2_init(unsigned int poly, unsigned int *crc_table)
{
    int i;
    int j;
    unsigned long c;

    for (i = 0; i < 256; i++) {
        c = i;
        c = i << 24;

        for (j = 0; j < 8; j++){
            if (c & 0x80000000){
                c = (c << 1) ^ poly;
            } else {
                c = ((c << 1));
            }
        }
        crc_table[i] = c;
    }
}

```

The function `crc32_mpeg2_calc` is used for CRC calculation, [Table 3-3. `crc32_mpeg2_calc`](#)

[code cell](#) shows its implementation.

Table 3-3. crc32_mpeg2_calc code cell

```

  /*!
  \brief      calculate crc MPEG-2
  \param[in]  crc: initial value, for MPEG-2 it is 0xFFFFFFFF
  \param[in]  crc_table: a pointer to a polynomial table, at least size is 256
  \param[in]  input: a pointer to need calculate data
  \param[in]  len: length of need calculate data
  \param[out] none
  \retval     calculate result
  */
  unsigned int crc32_mpeg2_calc(unsigned int crc, unsigned int *crc_table, void* input, int len)
  {
    int i;
    unsigned char index;
    unsigned char* pch;
    pch = (unsigned char*)input;
    for (i = 0; i < len; i++) {
      index = (unsigned char)((crc >> 24) ^ *pch);
      crc = (crc << 8) ^ crc_table[index];
      pch++;
    }
    return crc;
  }

```

Add CRC test code cell in main.c, and call this function in the main function, the test function will calculate its MPEG-2 CRC for the input data "123456789" check value, [Table 3-4. CRC test code cell](#) shows the test code cell.

Table 3-4. CRC test code cell

```

  unsigned int crc_table[256] = {0};

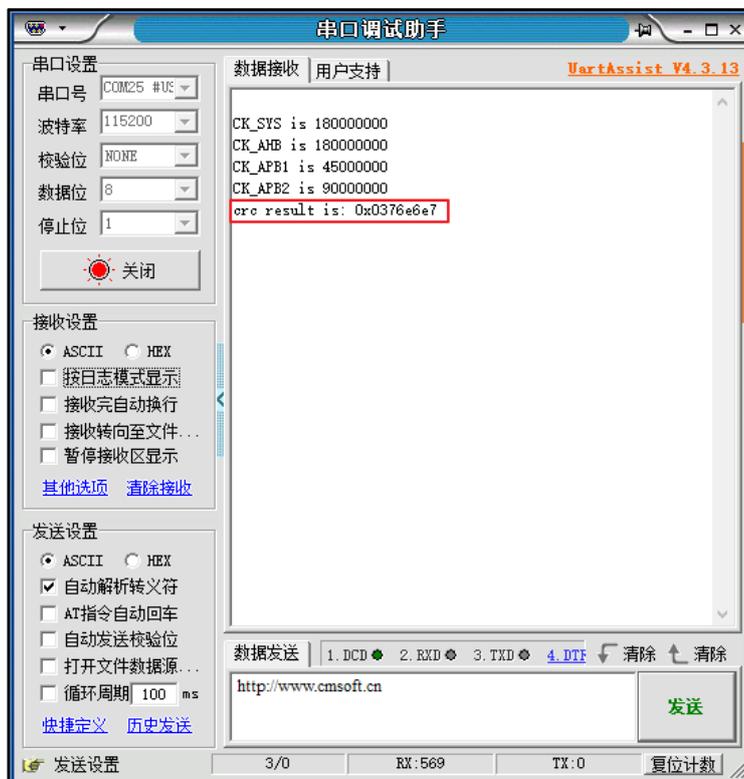
  void crc_test(void)
  {
    unsigned int crc;
    crc32_mpeg2_init(0x4C11DB7, crc_table);

    crc = 0xFFFFFFFF;
    crc = crc32_mpeg2_calc(crc, crc_table, "123456789", 9);
    printf("\r\n crc result is: 0x%08x\r\n", crc);
  }

```

[Figure 3-3. CRC test code calculation result](#), shows the calculation results in the serial port software.

Figure 3-3. CRC test code calculation result



The calculation results of the third-party software are shown in [Figure 3-4. Third-party software MPEG-2 CRC calculation result](#), which are consistent with the calculation results of the program we designed, so we can know that the designed software MPEG-2 CRC calculation algorithm is correct.

Figure 3-4. Third-party software MPEG-2 CRC calculation result

CRC (循环冗余校验) 在线计算

Hex Ascii 校验文件

需要校验的数据 :
 123456789

输入的数据为ascii字符串, 例如: 1234

参数模型 NAME : CRC-32/MPEG-2 x32+x26+x23+x22+x16+x12+x11+x10+x8+x7+x5+x4+ ▼

宽度 WIDTH : 32 ▼

多项式 POLY (Hex) : 04C11DB7 例如: 3D65

初始值 INIT (Hex) : FFFFFFFF 例如: FFFF

结果异或值 XOROUT (Hex) : 00000000 例如: 0000

输入数据反转 (REFIN) 输出数据反转 (REFOUT)

计算 清空

校验计算结果 (Hex) : 0376E6E7 复制

高位在左低位在右, 使用时请注意高低位顺序!!!

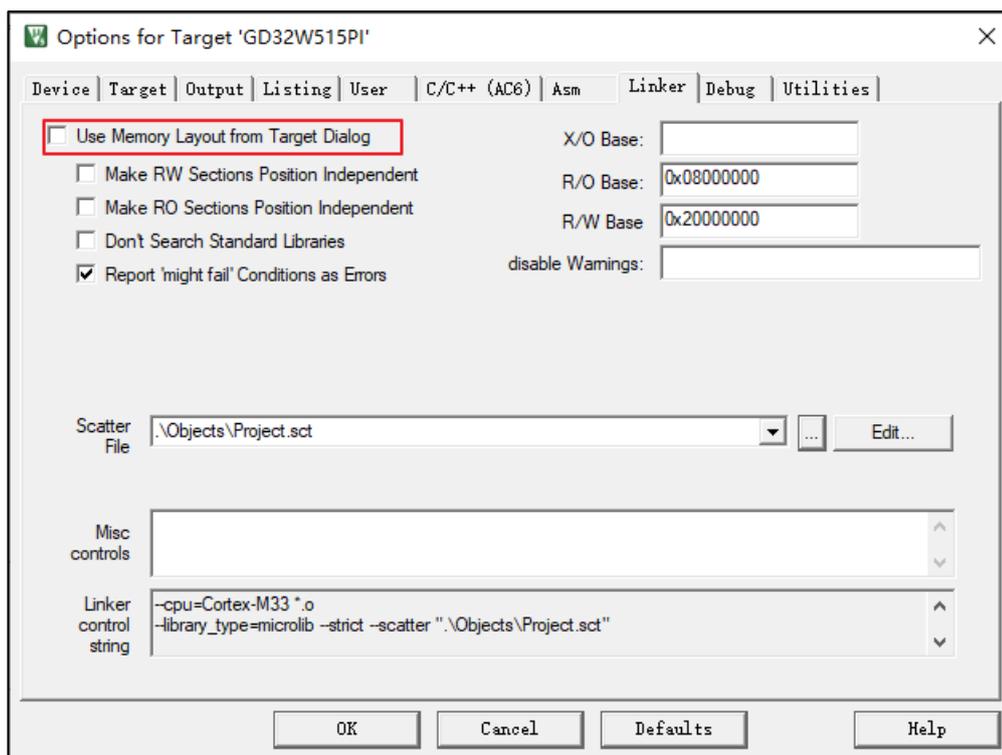
校验计算结果 (Bin) : 00000011011101101110011011100111 复制

3.3. Separate CRC calculation code

The content of this section will be based on the content of the previous section, scatter and load the code of MPEG-2 CRC calculation to the specified location, and other projects can directly call the code of the specified location to realize the CRC calculation.

Open the project's options page, remove the default option under Linker, and use the scatter-loading file to allocate the project's memory, [Figure 3-5. Linker set](#) shows the linker set.

Figure 3-5. Linker set



Make the following changes in the default scatter-loading file, change the size of the first load area LR_IROM1 to 0x0000FFFF, change the size of the first execution area ER_IROM1 to 0x0000FFFF, and create a new load area for LR_CODE_2, whose starting address is next to LR_IROM1, and the size is also 0x0000FFFF, defined an execution area CRC_TEST, which start address is consistent with LR_CODE_2, and all the codes of crc.o are placed in this area.

[Table 3-5. scatter-loading file code cell](#) shows those changes.

Table 3-5. scatter-loading file code cell

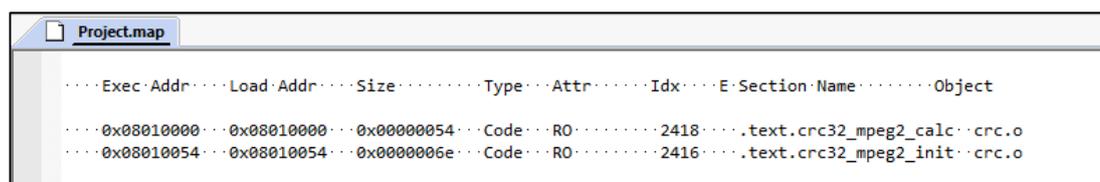
```

. *****
;
; *** Scatter-Loading Description File generated by uVision ***
; *****
;

LR_IROM1 0x08000000 0x0000FFFF { ; load region size_region
    ER_IROM1 0x08000000 0x0000FFFF { ; load address = execution address
        *.o (RESET, +First)
        *(InRoot$$Sections)
        .ANY (+RO)
        .ANY (+XO)
    }
    RW_IRAM1 0x20000000 0x00070000 { ; RW data
        .ANY (+RW +ZI)
    }
}

LR_CODE_2 0x08010000 0xFFFF {
    CRC_TEST 0x08010000 {
        crc.o
    }
}
    
```

Compile the project again. The map file after the project is compiled, shows that the two functions `crc32_mpeg2_calc` and `crc32_mpeg2_init` defined in `crc.o` are located at `0x08010000` and `0x08010054`, consistent with what we defined in the scatter-loading file, [Figure 3-6. the map file](#) shows the address location of `crc32_mpeg2_calc` and `crc32_mpeg2_init`. After downloading the program to the development board, you can see that the printed result is the same as the result of the unmodified project. At this time, the location where the chip `0x08010000` starts is stored with executable code that can perform mpeg-2 calculations. If it is not erased, the code will always be stored here, and other programs can call this function.

Figure 3-6. the map file


Exec Addr	Load Addr	Size	Type	Attr	Idx	E	Section Name	Object
0x08010000	0x08010000	0x00000054	Code	RO	2418		text.crc32_mpeg2_calc	crc.o
0x08010054	0x08010054	0x0000006e	Code	RO	2416		text.crc32_mpeg2_init	crc.o

3.4. Calling the CRC algorithm function in a new project

Now we can create other projects and implement the CRC calculation by calling the code at

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the beginning of 0x08010000, but for the convenience of calling we will create a library file to participate in the compilation of the new project, instead of calling directly through the address, the content of this section will be focus on describing the method of implementation.

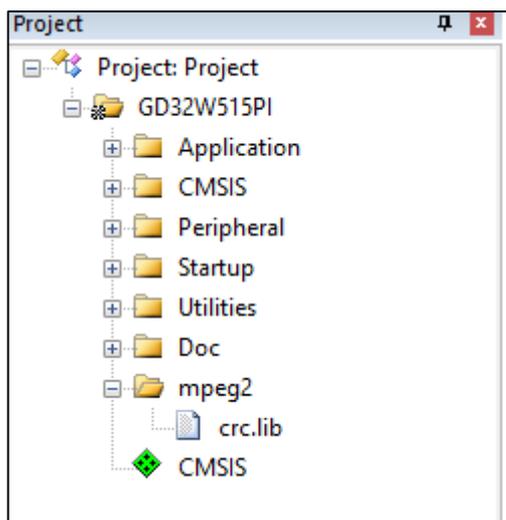
First, reopen a firmware library project, create an mpeg2 folder in the same way, copy the crc.h file from the previous summary to this directory in the project, and create a crc.lib library file, add content which show in [Figure 3-7. crc library file](#).

Figure 3-7. crc library file

```
0x08010000 T crc32_mpeg2_calc
0x08010054 T crc32_mpeg2_init
```

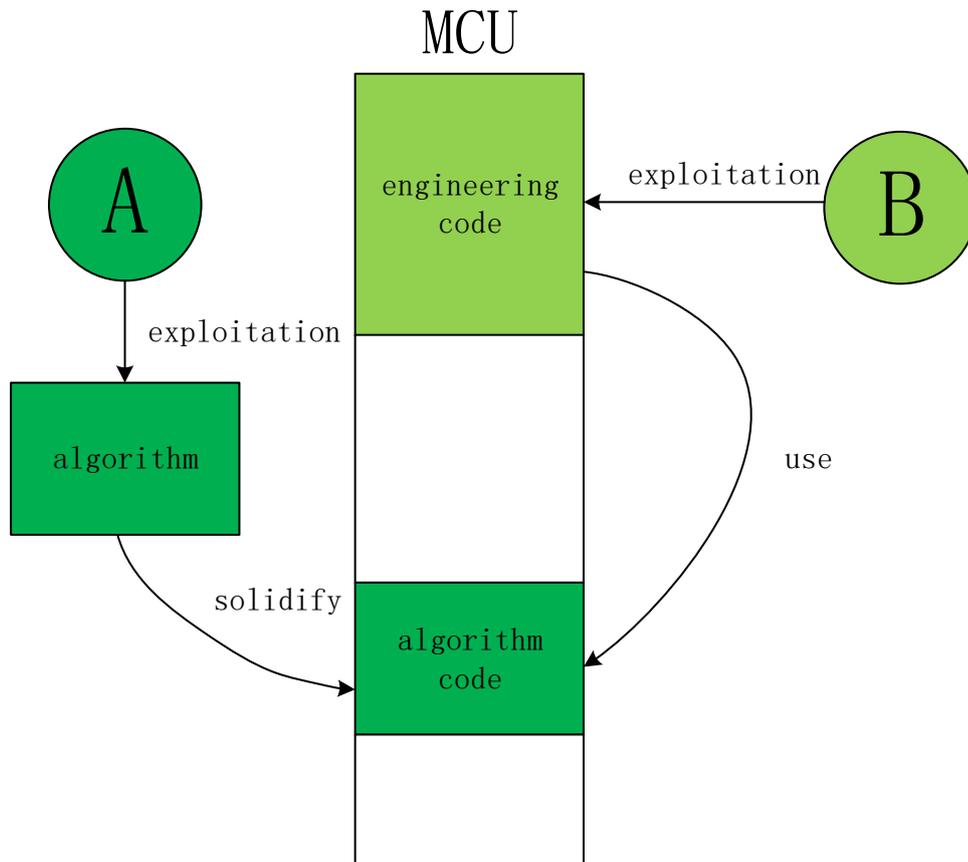
Add the library to the project, [Figure 3-8. directory structure of the new](#) shows directory structure of the new project, add crc_test test function in main.c, [Table 3-4. CRC test code cell](#) shows the test function, compile and download to the development board, will find that the crc value calculated by the serial port output is still correct.

Figure 3-8. directory structure of the new



If we regard the code development of software crc calculation as the function code or algorithm code developed by A, A can download and solidify it into the chip after completing, B can use the code to develop his own functions. This constitutes the most basic framework for cooperative development like [Figure 3-9. basic framework for cooperative development](#).

Figure 3-9. basic framework for cooperative development



Note: There are many ways to solidify the code into the chip. For example, you can use the image tool to generate the hex file from the algorithm and solidify it into the chip from B, which is not limited to the method described above.

4. Revision history

Table 4-1. Revision history

Revision No.	Description	Date
1.0	Initial Release	Jul.18 2022

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