**Freescale Semiconductor**
Application Note

Document Number: AN3389

# Creating an External Flash Algorithm

**by Ildar Saifutdinov and Sebastien Duchamp**

## 1 Introduction

This document explains how to use a Flash Tool Kit to support additional flash devices on the ColdFire® CodeWarrior™ Flash Programmer by creating new programming algorithms. This document:

- Helps you confirm whether a new flash algorithm is necessary
- Provides instructions
- Provides an example project

## 2 Preliminary Background

Before you program or erase any flash device, you must ensure the CPU can access it. For example, you might need a different debug setup that requires modifications to the debugger configuration file. Consider the following before you begin:

- Read the flash device ID to verify correct connection and programmability. *Application Note 2980 Troubleshooting the Flash Programmer* provides instructions.

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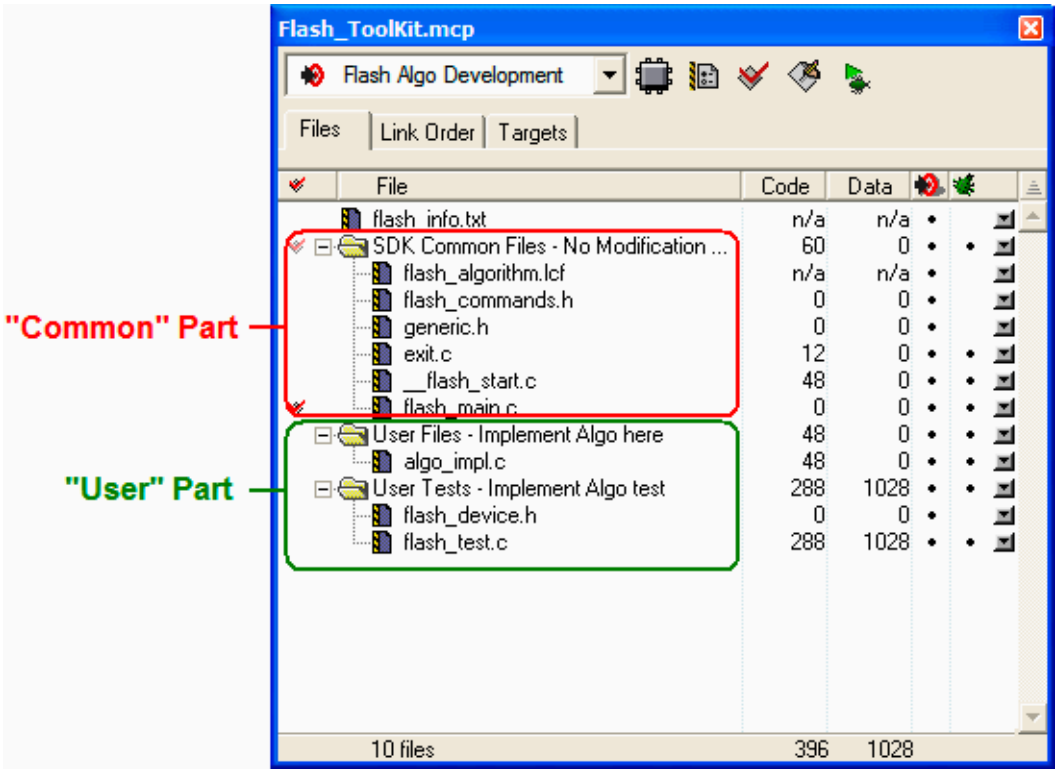
- Note that many manufacturers use the same flash-device algorithms, so it is likely that flashes can be programmed using algorithms included with CodeWarrior software. In addition, many manufacturers produce devices compatible with Intel or AMD.
- Check whether a new flash device can be programmed with the same algorithms that Intel or AMD use, as described in Section 7.
- Refer to the *Application Note 3390 Adding Device(s) to the Flash Programmer* to determine if a flash device is programmable with an algorithm already included with the CodeWarrior software.
- Follow the steps in Section 5 if the flash device cannot be programmed with an existing algorithm.

# 3 Flash Tool Kit Overview

The Flash Took Kit described in this document helps you develop flash programming algorithms for the CodeWarrior Flash Programmer, as shown in Figure 1. This section and Section 4 provide important information needed before you begin creating a flash programming algorithm.

**Figure 1. Flash Tool Kit**



## 3.1 Flash Tool Kit General Structure

The flash programmer Flash Tool Kit (FTK) application is divided into four different sets of files:

1. FTK Common Files (No Modification Needed) contain initialization and other files. This component is common for any flash device and you should not change it while developing the new flash programming algorithm. It consists of the following files:
   - `flash_algorithm.lcf` file – linker command file. This linker command file is set up according to the rules for flash programming applet allocation in physical memory.
   - `flash_commands.h` – header file with API to CodeWarrior Flash Programmer commands definition
   - `generic.h` – header file with the generic data structures and definitions used by the flash programming algorithms
   - `exit.c` – exit point for the flash programming applet
   - `__flash_start.c` – flash programmer start-up initialization file
   - `flash_main.c` – main function and API to the CodeWarrior Flash Programmer
2. User Files (Implement Algo) contain flash device specific files. This component is modified for any flash devices depending on the flash programming algorithm to be used. It consists of the following files:
   - `algo_impl.c` – functions to implement for the flash device flash algorithm, such as **ID, erase_sector, erase_chip, write**
3. User Files (Implement Algo Tests) contain flash device specific files. This component is considered to be modified for any flash devices depending on the flash programming algorithm to be used. It comprises the following files:
   - `flash_test.c` – sample code with the flash unit test functionality implementation
   - `flash_device.h` – custom flash device definition file
4. `flash_info.txt` file. This file contains CodeWarrior Flash Programmer commands description.

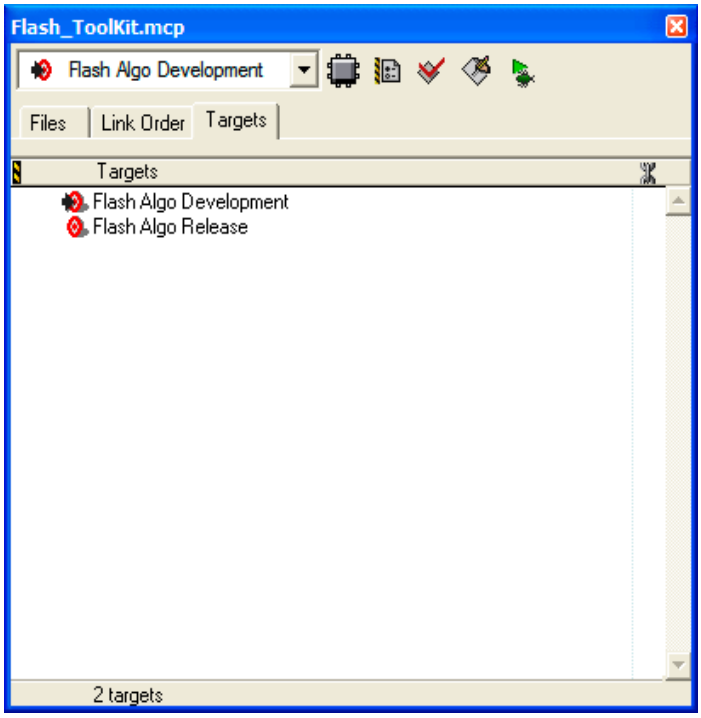
To create the new algorithm for flash programming, make all changes to `algo_impl.c` (flash device algorithm implementation) and `flash_device.h`/`flash_test.c` files (flash device tests).

## 3.2 Flash Tool Kit Build Targets

Several build targets are predefined in the Flash Tool Kit (FTK):

- Flash Algo Development – flash algorithm development and test application. The **ELF** executable file, created in Flash Algo Development, should be used to develop, debug, and test the new CodeWarrior Flash Programmer algorithm.
- Flash Algo Release – create flash algorithm applet. CodeWarrior Flash Programmer uses the **ELF** executable file, created in Flash Algo Release. This build target shares the flash device algorithm with the Flash Algo Development build target; it differs, however, because it cannot be debugged or tested (Figure 2.)

**Figure 2. Flash Tool Kit Targets**



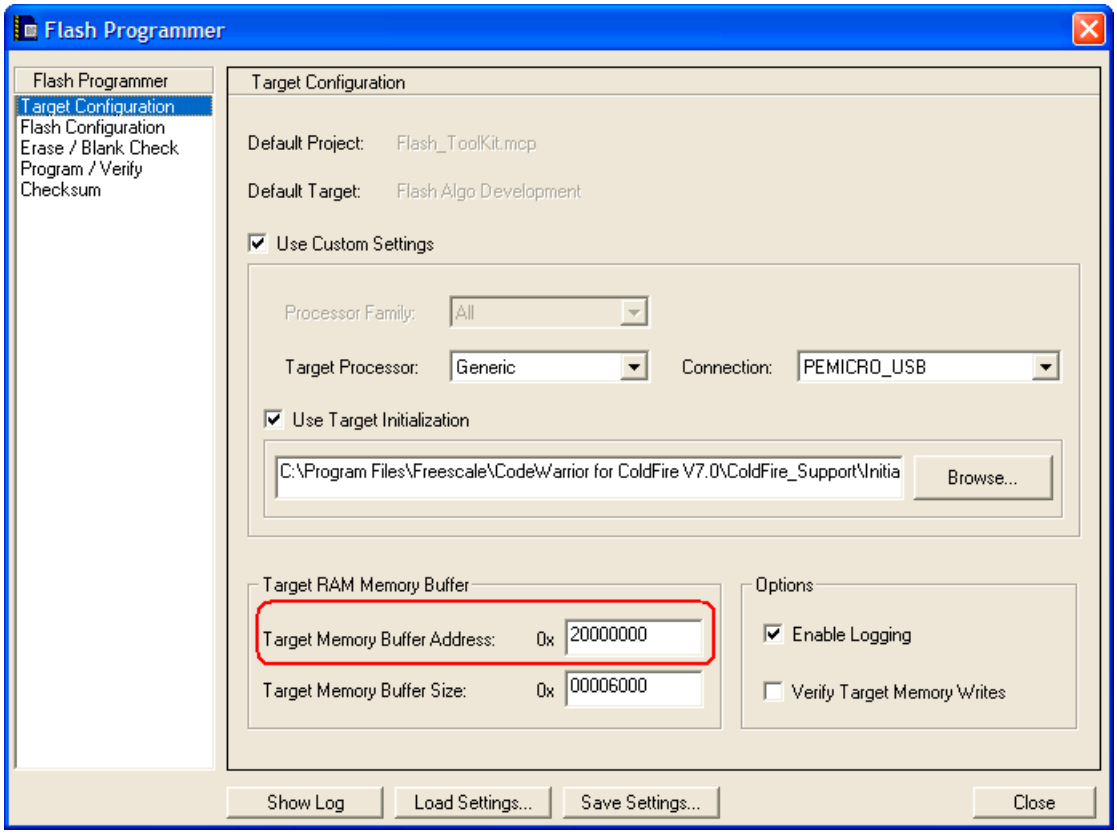

# 4 Flash Programmer API

The CodeWarrior Flash Programmer communicates with the flash programming algorithm applet through four different commands:

- get ID
- erase sector
- erase chip
- program

The CodeWarrior Flash Programmer uses an exchange zone in target memory to communicate with the flash applet. The Flash Programmer Target Configuration specifies the Target Memory Buffer; the exchange zone is at the start of this buffer, as shown in Figure 3.

**Figure 3. Target Configuration Buffer Memory Area Start Address**




In this application note, `scratchMemStart` is the starting address of this zone.

Depending on the actions the Flash Programmer requires of the applet, these exchange zone settings may differ.

## Parameter_block_t Structure

On the flash applet side, the commands from the CodeWarrior Flash Programmer go through the Parameter_block_t structure, mapped in memory, starting from the scratchMemStart address.

All commands from CodeWarrior Flash Programmer are already encoded in flash_main.c file. This file can be used for the new flash programming algorithm without changes. After loading the flash applet to the target board, CodeWarrior Flash Programmer writes the `startMemScratch` address in the D7 register (Listing 1).

**Listing 1. Parameter_block_t Pointer Initialization**

```
void main(void)
{
    unsigned long num_errors;
    parameter_block_t *_params;
    long  res=0;

#ifdef FLASH_ALGO_TEST
```

```
    int testnumber = 0;
    _params  = (parameter_block_t *)(unsigned int)&data_1;
#else
    asm
    {
        move.l      D7,res
    }
_params  = (parameter_block_t *)res;
```

For the detailed description of the Parameter_block_t structure refer to Listing 2.

**Listing 2. Parameter_block_t Structure Details**

```
      typedef struct pb {
      unsigned long  function;       /* What function to perform ?    */
      pointer_t      base_addr;      /* where are we going to operate */
      unsigned long  num_items;      /* number of items */
      unsigned long  result_status;
      pointer_t      items;
      } parameter_block_t;
```

Listing 2 definitions:

- function – command from CodeWarrior Flash Programmer to be executed
- base_addr – start address of the flash memory
- num_items – number of the data to be transferred from CodeWarrior Flash Programmer to the flash programming applet
- result_status – status of the command; through this field, the flash programming applet notifies CodeWarrior Flash Programmer about the status of the command being executed
- items – start address of the data to be transferred from CodeWarrior Flash Programmer to the flash programming applet

## ID

The CodeWarrior Flash Programmer uses the getting chip ID command right after the flash algorithm is loaded to the memory buffer to check if the applet runs. For the ID command, CodeWarrior Flash Programmer:

- loads the flash programming applet to the target board.
- sets the command ID, as shown in the function field of Listing 2.
- runs flash programming applet.
- waits while flash applet stops execution.
- checks the status of the command being executed, as shown in the result_status field of Listing 2.

### fEraseChip

The full chip erase command is called by CodeWarrior Flash Programmer when a full chip erase is performed. For the fEraseChip command, CodeWarrior Flash Programmer:

- loads the flash programming applet to the target board.
- sets the command fEraseChip, as shown in the function field of Listing 2.
- runs the flash programming applet.
- waits while the flash applet stops execution.
- checks the status of the command being executed, as shown in the result_status field of Listing 2.

**NOTE** Some flash devices do not support the full chip erase command. Check the flash device's specifications, available from the manufacturer.

### fEraseSector

The sector erase command is called by the CodeWarrior Flash Programmer when a set of sectors in flash memory must be erased. For the fEraseSector command, CodeWarrior Flash Programmer:

- loads the flash programming applet to the target board.
- sets the command fEraseSector. as shown in the function field of Listing 2.
- specifies number of blocks to be erased, as shown in the num_items field of Listing 2.
- specifies start-up address of each block to be erased, as shown in the items field of Listing 2.
- runs the flash programming applet.
- waits while the flash applet stops execution.
- checks the status of the command being executed, as shown in the result_status field of Listing 2.

### fWrite

The fWrite program buffer command is called by the flash programmer to program a set of values at a specific address. For the fEraseSector command, CodeWarrior Flash Programmer:

- loads the flash programming applet to the target board.
- sets the command fWrite, as shown in the function field of Listing 2.
- specifies number of bytes to be programmed, as shown in the num_items field of Listing 2.
- specifies start-up address of data to be programmed, as shown in the items field of Listing 2.

- runs flash programming applet.
- waits while flash applet stops execution.
- checks the status of the command being executed, as shown in the result_status field of Listing 2.

# 5 Creating a New Flash Programming Algorithm

In this section, step-by-step instructions show you how to use the Flash Tool Kit to create a new CodeWarrior Flash Programmer flash programming algorithm for a flash device not integrally supported by the CodeWarrior software.

1. Store an original version of the Flash Tool Kit files from the CodeWarrior delivery.
2. Copy `FlashToolKitTemplate` and `Common_Files` folders to a different working location.
3. Check the folder:
   `Freescale\CodeWarrior for ColdFire V7.x\ColdFire_Tools\FlashToolKit`
4. Open Flash Tool Kit project
   a) Locate the Flash Tool Kit project named `Flash_ToolKit.mcp` in the `FlashToolKitTemplate` folder.
   b) Open `Flash_ToolKit.mcp` project with the CodeWarrior for ColdFire Development Studio as shown in Figure 4.
   c) Upon being opened, Flash Tool Kit will appear as shown in Figure 1.
   d) Ensure the Flash Algo Development build target is selected.
5. Correct derivative family – ensure correct **Target Processor** is used in the **Debugger Settings Target Settings Panel**.
6. Configuration and memory files – ensure the correct mem and cfg file are used for the connected hardware in the **Debugger Settings Target Settings Panel**.
   a) For supported Freescale Evaluation Boards, you can use the debugger config files (*.cfg), and the debugger mem files (*.mem) available with the CodeWarrior Development Studio. Check the folder:
   `Freescale\CodeWarrior for ColdFire V7.x`
   `\ColdFire_Support\Initialization_Files`
   b) For example, the configuration settings for the MCF5282EVB board are shown in Figure 5.

**Figure 4. Flash Tool Kit Project Opening**

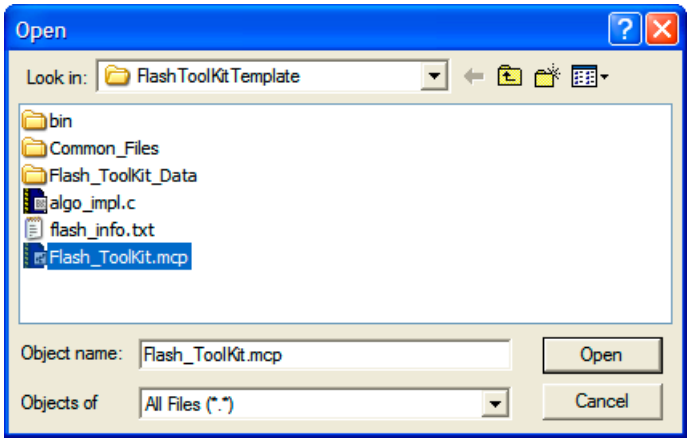
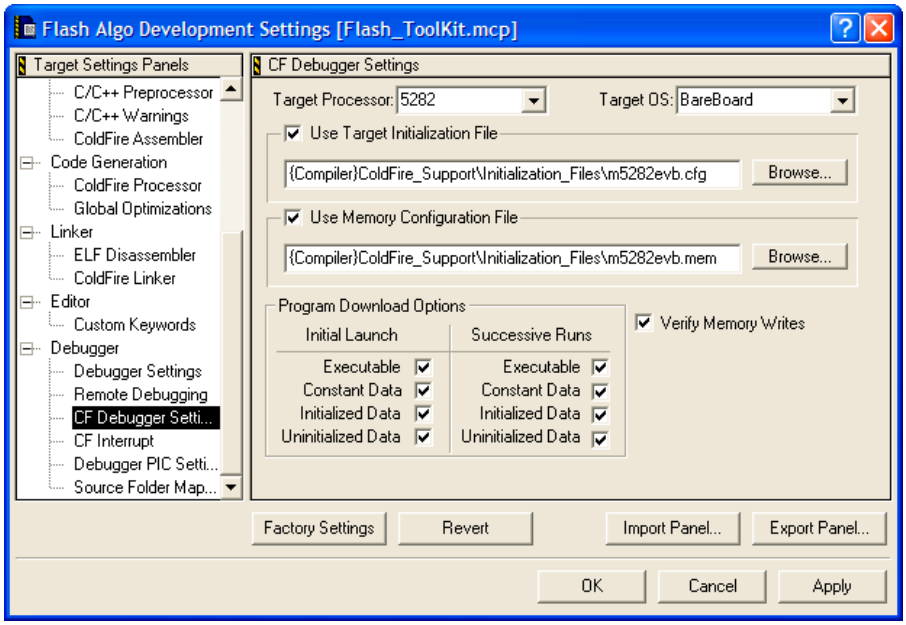


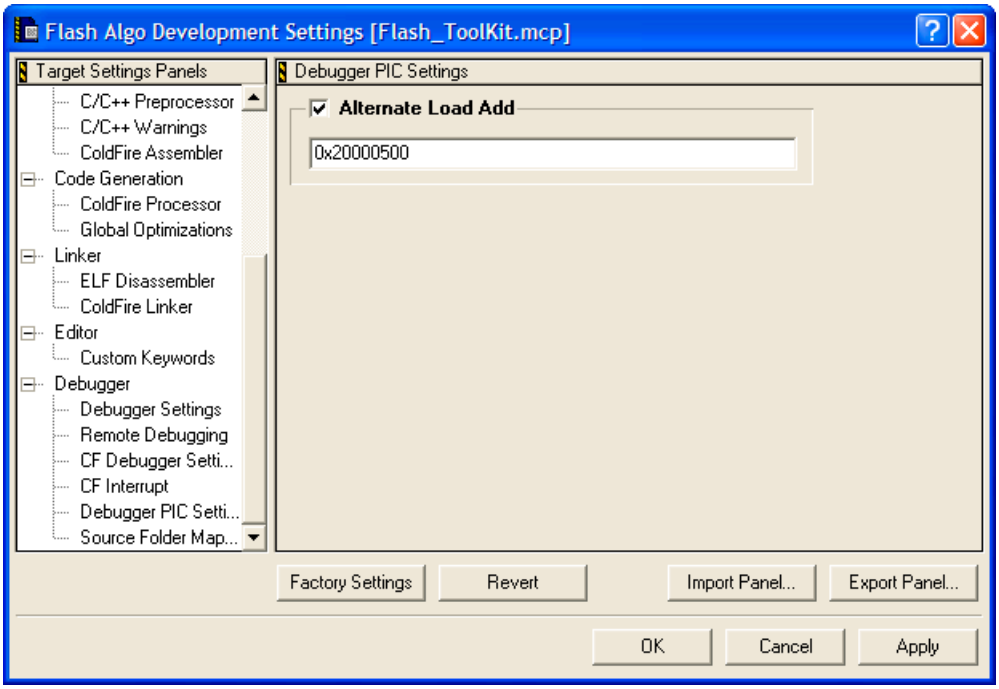

**Figure 5. Hardware Configuration Settings**




**NOTE** Where custom hardware design exists, the debugger configuration file and the memory mapping file must be written. In this case, the memory initialization for the flash device should be checked before trying to create the new flash programming algorithm. Refer to the information under Section 2.

7. Specify an alternate loading address.
   a) The flash algorithm, a PIC\PID application, can run from anywhere in memory. An alternate loading address is where the flash applet code will be loaded and executed on the target board. This address can be either in internal or external RAM memory, as shown in Figure 6.

**Figure 6. Alternate Loading Address Settings**




b) The Alternate Load Address should match the address where the code is linked. By default, the flash programming algorithm will be compiled to start at address 0x500; refer to the `TEXT` start address value in the `flash_algorithm.lcg` linker command file as shown in Figure 7.

c) If the custom board's address space where you want to debug the applet is other than 0x0, the alternate address must be changed. For example: if RAM is allocated starting from address 0x2000000, the alternate loading address will be 0x20000000+0x500 = 0x20000500.

**Figure 7. Code Start Address Definition in flash_algorithm.lcf File**

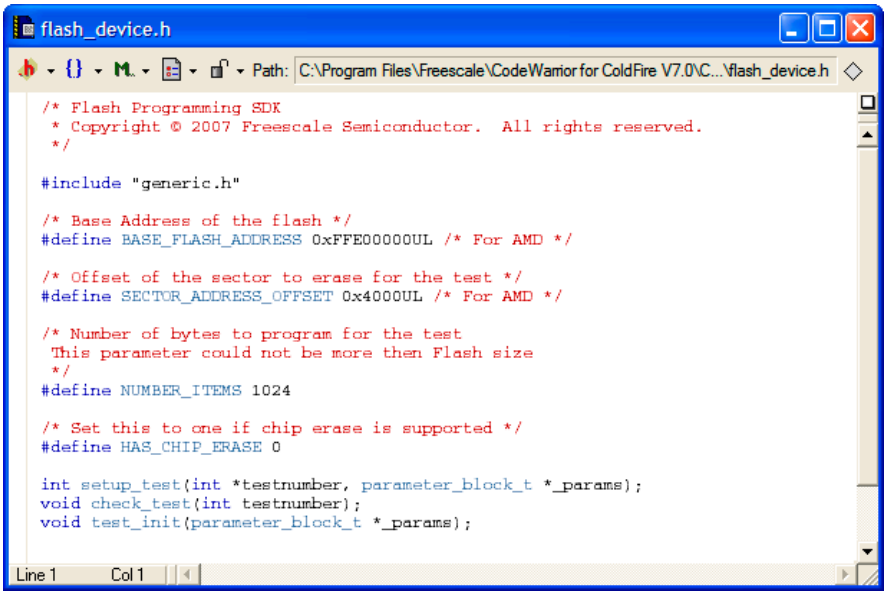
```
# Sample Linker Command File for CodeWarrior for ColdFire

#  NOTE: The debugger uses the Illegal Instruction Vector to stop.
#  A small subroutine is written at the location VBR+0x408-VBR+0x40B
#  to handle the exception.  The Illegal Instruction Vector in
#  the the vector table at VBR+0x10 is then pointed to it.  When the
#  debugger encounters an illegal instruction, it jumps to this
#  subroutine, which ends with an RTE, then exits.
#  Do not overwrite this area of memory otherwise the debugger may not
#  exit properly.

MEMORY {
    TEXT (RX) : ORIGIN = 0x00000500, LENGTH = 0 # using External DRAM
    DATA (RW) : ORIGIN = AFTER(TEXT), LENGTH = 0
}
```

**NOTE** The value of `scratchMemstart` address is set from the user interface.

**Figure 8. Code in the Flash_Device.h File**




8. Modify `algo_impl.c` file
   a) The flash algorithm functionality file `algo_impl.c` shall be modified and filled with the correct programming commands, as recommended by the flash device manufacturer.
9. Modify ID function in `algo_impl.c` file
   a) By default, the ID function in `algo_impl.c` file looks as shown in Listing 3.

**Listing 3. ID Function Template in algo_impl.c File**

```
retval_t ID(parameter_block_t *p_pb)
{
    retval_t result = 0;
    volatile unsigned long* item_addr = (p_pb->items).l;
    /* Add code: the correct access size depending on the bus must be used for the base_addr */
    volatile unsigned short *base_addr = (p_pb->base_addr).w;

    /* Add code: first of all reset the device.
     The fID is not called in the new flash programmer plugin therefore
     the flash chip must always be bring into the read state.
    */

    /* Add code: read the device ID */

    /* we currently assume that we have the right value */
    /* anyway, the IDE have to care about the flash ID and compare with the xml file */
    return result;
}
```

   b) The following definitions pertain to Listing 3:
      – parameter_block_t *p_pb – pointer to the parameter_block_t structure to be passed to the ID function

– retval_t – result of the function execution

c) The correct command sequence should be created for the ID function based on the recommendations of the flash device manufacturer, as described in Section 6.1.1.

10. Modify erase_sector Function

a) By default, the `erase_sector` function in `algo_impl.c` file appears as shown in Listing 4.

**Listing 4. Function Template erase_sector in algo_impl.c**

```
retval_t erase_sector(parameter_block_t *p_pb, unsigned long sect_index)
{
    int timed_out, got_it;
    retval_t result = 0;
    /* Add code: the correct access size depending on the bus must be used for the base_addr */

    volatile unsigned short *base_addr = ((unsigned short **)(p_pb->items).w)[sect_index];

    /* Add code: first of all reset the device.
     The fID is not called in the new flash programmer plugin therefore
     the flash chip must always be bring into the read state.
    */

    /* Add code: erase one sector */
    /* Add code: wait for status */
    /* Add code: handle error (and timeout if needed) */
    /* Add code: put back the flash in read state */

    return result;
}
```

b) Listing 4 definitions:

– parameter_block_t *p_pb – pointer to the parameter_block_t structure to be passed to the erase_sector function

– unsigned long sect_index – index of the sector to be erased

– retval_t – result of the function execution

c) Based on recommendations from the flash device manufacturer, the correct command sequence must be created for flash-sector erasing, as described in Section 6.1.2.

11. Modify erase_chip Function

a) By default, the `erase_chip` function in `algo_impl.c` file looks as presented in Listing 5.

**Listing 5. Function Template erase_chip in algo_impl.c File**

```
retval_t erase_chip(parameter_block_t *p_pb)
{
    int errors = 0;
    retval_t result = 0;
    unsigned short stat;
    int got_it;

    /* Add code: the correct access size depending on the bus must be used for the base_addr */
    volatile unsigned short *base_addr = (p_pb->base_addr).w;

    /* Add code: first of all reset the device.
     The fID is not called in the new flash programmer plugin therefore
```

```
     the flash chip must always be bring into the read state.
    */

    /* Add code: erase one sector */

    /* Add code: wait for status */

    /* Add code: handle error (and timeout if needed) */

    /* Add code: put back the flash in read state */

    return result;
}
```

b) Listing 5 definitions:

i) parameter_block_t *p_pb – pointer to the parameter_block_t structure to be passed to the erase_chip function

ii) retval_t – result of the function execution

iii) Create the correct command sequence for full-flash chip erasing based upon recommendations from the flash device manufacturer, as shown in Section 6.1.3.

12. Modify write function

a) By default, the `write` function in `algo_impl.c` file looks as it appears in Listing 6.

**Listing 6. Function Template write in algo_impl.c File**

```
retval_t write(parameter_block_t *p_pb)
{
    int timed_out, got_it;
    unsigned long i;
    unsigned short stat;
    retval_t errors = 0;
   /* Add code: the correct access size depending on the bus must be used for the base_addr */
    volatile unsigned short *base_addr = (p_pb->base_addr).w;

    /* Add code: first of all reset the device.
     The fID is not called in the new flash programmer plugin therefore
     the flash chip must always be bring into the read state.
    */

    /* Add code: program the bytes pointed in the buffer : p_pb->items,
        they are  p_pb->num_items bytes
        handle error (and timeout if needed) for each of the program sequence
    */


    /* Add code: put back the flash in read state */

  return errors;
```

b) Listing 6 definitions:

i) parameter_block_t *p_pb – pointer to the parameter_block_t structure to be passed to the write function

ii) retval_t – result of the function execution

c) Create the correct command sequence for flash device programming according to recommendations of the flash device manufacturer, as described in Section 6.1.4.

13. Flash programming applet unit testing
    a) For flash programming algorithm testing, define custom flash device parameters in the `flash_device.h` file. The following parameters should have correct definitions.
       – `BASE_FLASH_ADDRESS` – ColdFire CPU view of the flash device's address
       – `SECTOR_ADDRESS_OFFSET` – memory sector size
       – `NUMBER_ITEMS` – test parameter, which defines how much data is programmed during the flash program testing.
    b) Refer to Listing 7.

**NOTE** Refer to the flash device manufacturer for the flash device memory organization. Refer to hardware description for the flash device addressing.

**Listing 7. Function Template write in algo_impl.c File**

```
/* Base Address of the flash */
#define BASE_FLASH_ADDRESS 0xFFE00000UL

/* Offset of the sector to erase for the test */
#define SECTOR_ADDRESS_OFFSET 0x4000UL

/* Number of bytes to program for the test
 This parameter could not be more then Flash size
 */
#define NUMBER_ITEMS 1024

/* Set this to one if chip erase is supported */
#define HAS_CHIP_ERASE 1
```

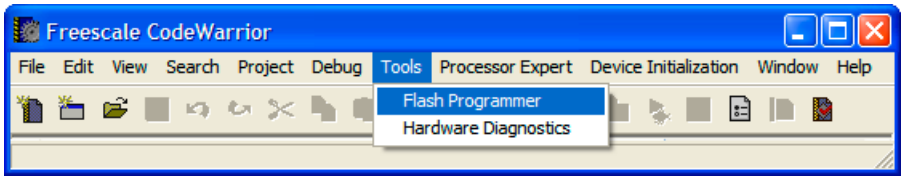
14. Compile flash algo development target
    a) During new algorithm creation and testing, use the Flash Algo Development build target of the Flash Development Kit. Compile the Flash Algo Development target with needed modifications to `flash_algo.c` for flash programming procedures. Compilation will result in creation of a new `flashalgodev.elf` file.
15. Flash algorithm unit test
    a) To simplify flash programming algorithm creation and testing, flash test functionality is included with the Flash Tool Kit in the Flash Algo Development build target. Check the file `flash_test.c` for it. Unit test functions contain basic functionality required for the flash programming; the following tests are performed:
       i) check flash device's ID
       ii) erase flash memory sector
       iii) program flash memory sector with the predefined data (in sample code the incrementing counter is used)
    b) Load the file `flashalgodev.elf` and run it on the target board. Check the tests results. As an example of the test working refer to Section 6.2.

16. Compile flash algo release target
    a) When the flash programming algorithm for the new flash device works correctly (as confirmed in unit testing), compile the Flash Algo Release target. The output of the Flash Algo Release file — `flashalgorelease.elf` — must be copied to the following folder:

    ```
    Freescale\CodeWarrior for ColdFire V7.x
    \bin\Plugins\Support\Flash_Programmer\ColdFire
    ```

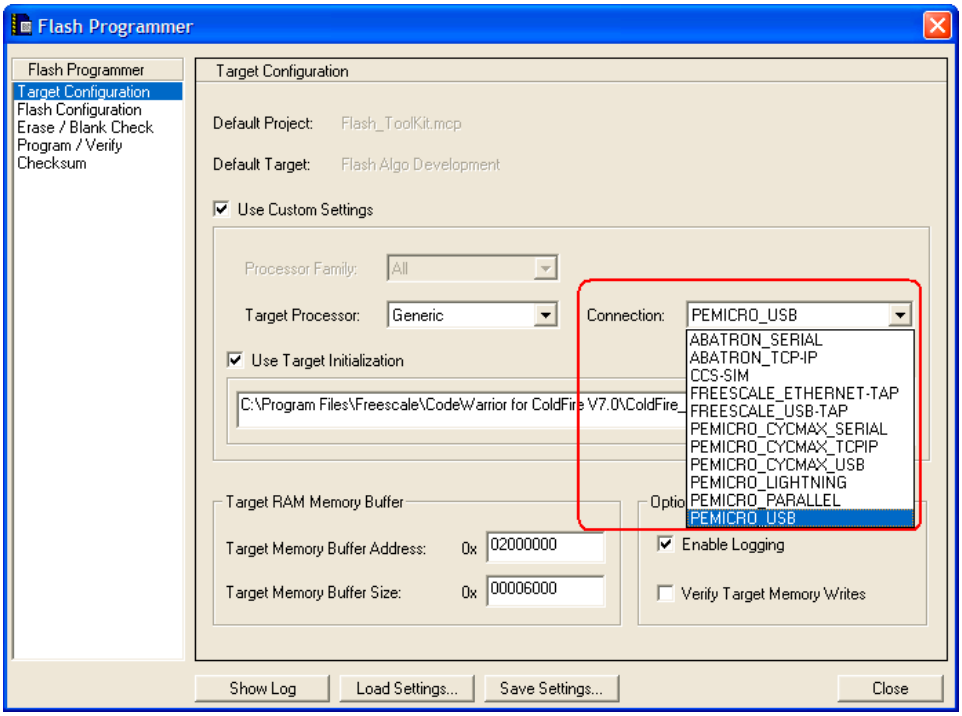
17. New flash device addition to the flash programmer
    a) The application note *AN 3390 Adding Device(s) to the Flash Programmer* provides a detailed description about adding a new flash device. Refer to this application note and do the steps it describes. As an example refer to Section 6.3.
18. Set flash device configuration in flash programmer.
    a) Do the following to set the flash device configuration correctly in CodeWarrior Flash Programmer:
        i) The CodeWarrior IDE must be closed (if opened) and opened again for you to use new data from the updated `FPDeviceConfig.xml` file.
        ii) Open the CodeWarrior Flash Programmer window. From CodeWarrior menu: `Tools->Flash Programmer`, as shown in Figure 9.

**Figure 9. Opening the CodeWarrior Flash Programmer**



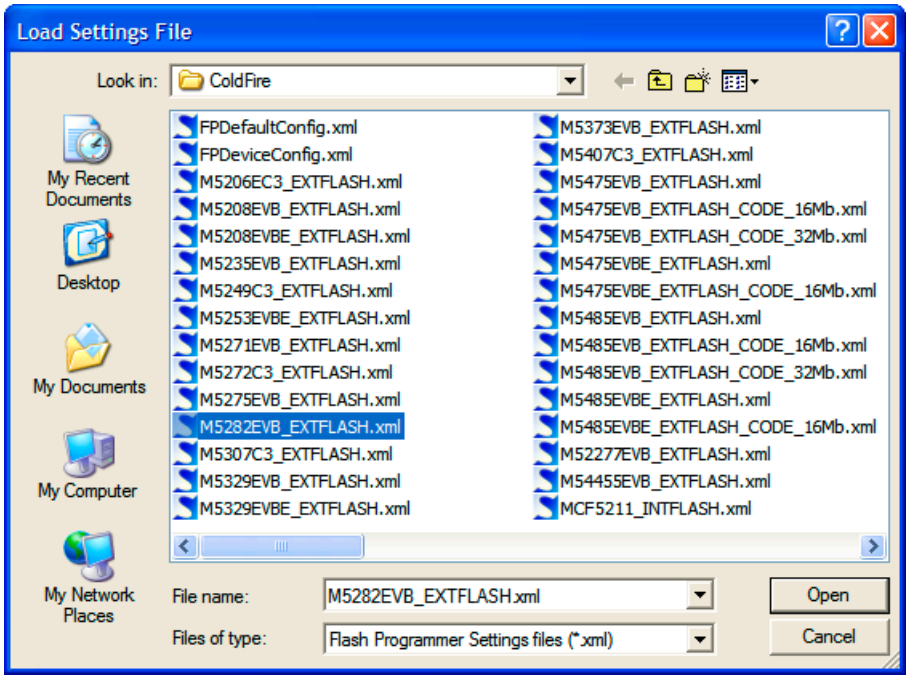

        iii) Load Target Configuration settings. As an example, the modified file `NewFlashDevice.xml` is loaded, as shown in Figure 11.

**Figure 10. Target Hardware Connection Settings**



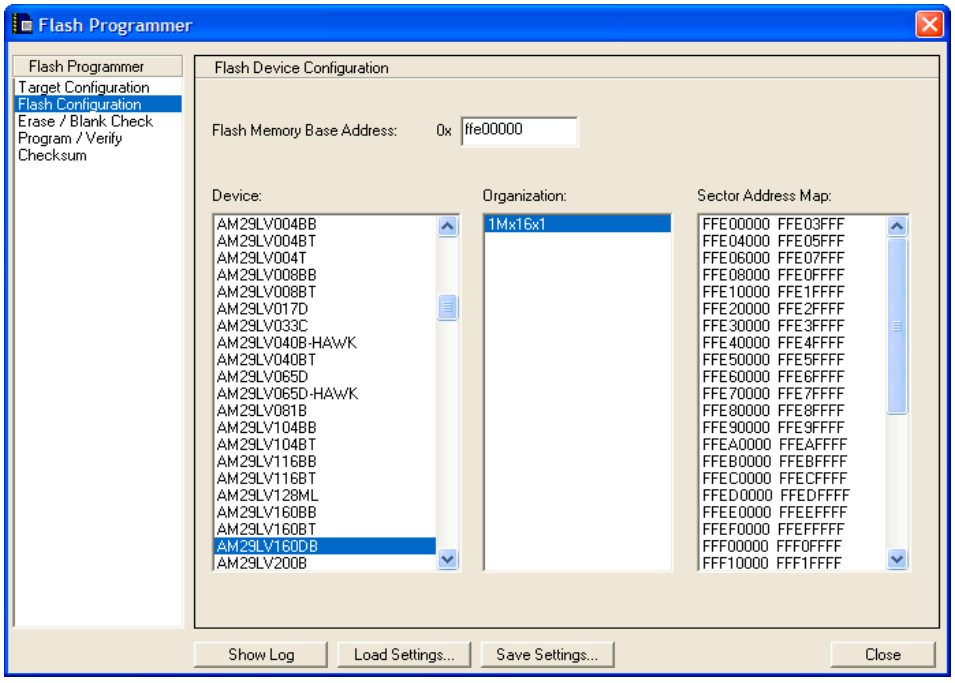

iv) Set the correct connection to the target, as shown in Figure 10.

**Figure 11. Loading Target Configuration Settings**



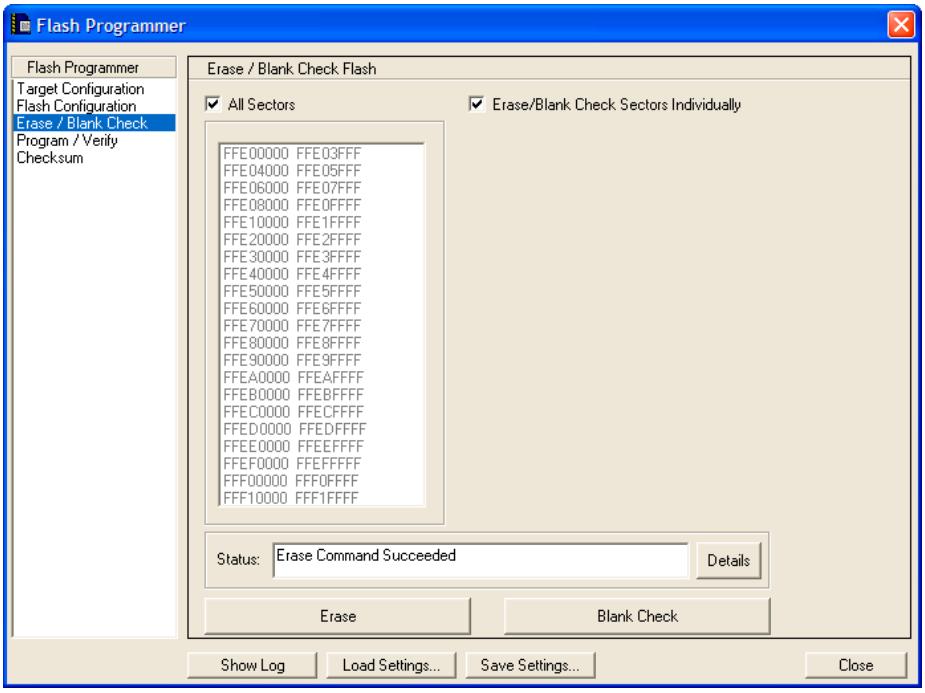

v) The flash device configuration checks the loaded configuration data for correspondence. As an example for the AMD16x1 device, refer to Figure 12.

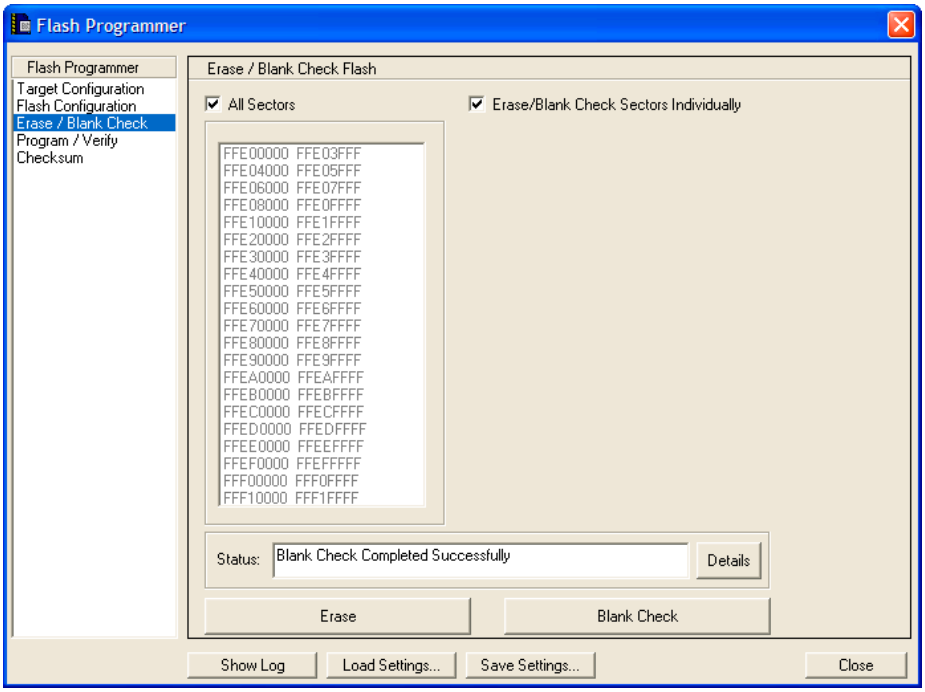
**Figure 12. CodeWarrior Flash Programmer Flash Device Configuration**



19. Erase and blank check the flash device
    a) Check that the flash device can be erased by clicking the **`Erase`** button in the **`Erase/Blank Check`** window. Check that the Blank Check test passed: click the **Blank Check** button in the **Erase/Blank Check** window, as shown in Figure 13.

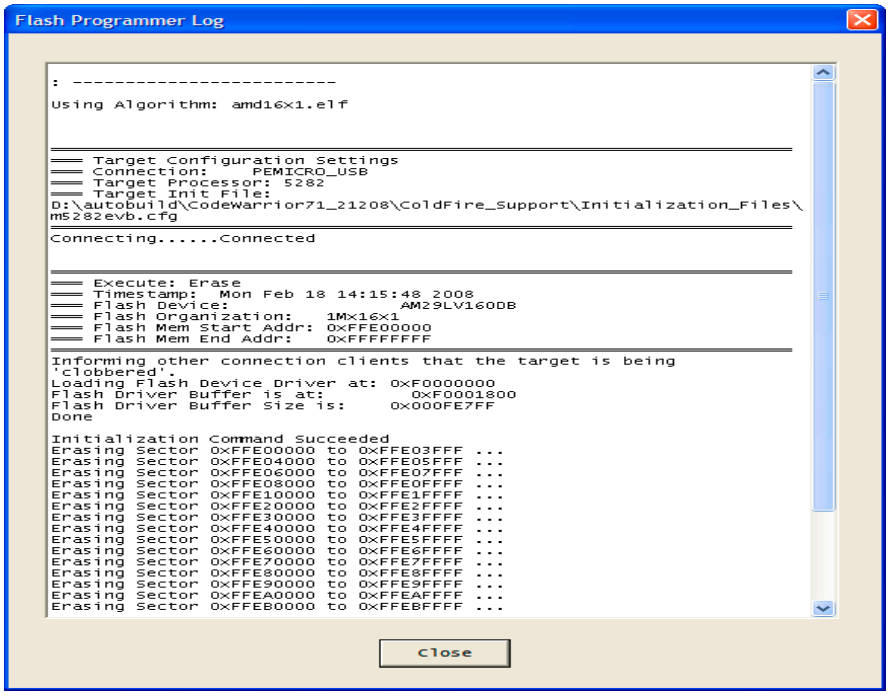
**Figure 13. CodeWarrior Flash Programmer Erase/Blank Check Flash Device**



b) In the log file, check that the correct flash programming algorithm is used for NewFlashDevice programming. Click the **ShowLog** button in **Erase/Blank Check** window. Refer to the example log in Figure 14.

**Figure 14. Flash Programming Log Window**




20. Programming test:

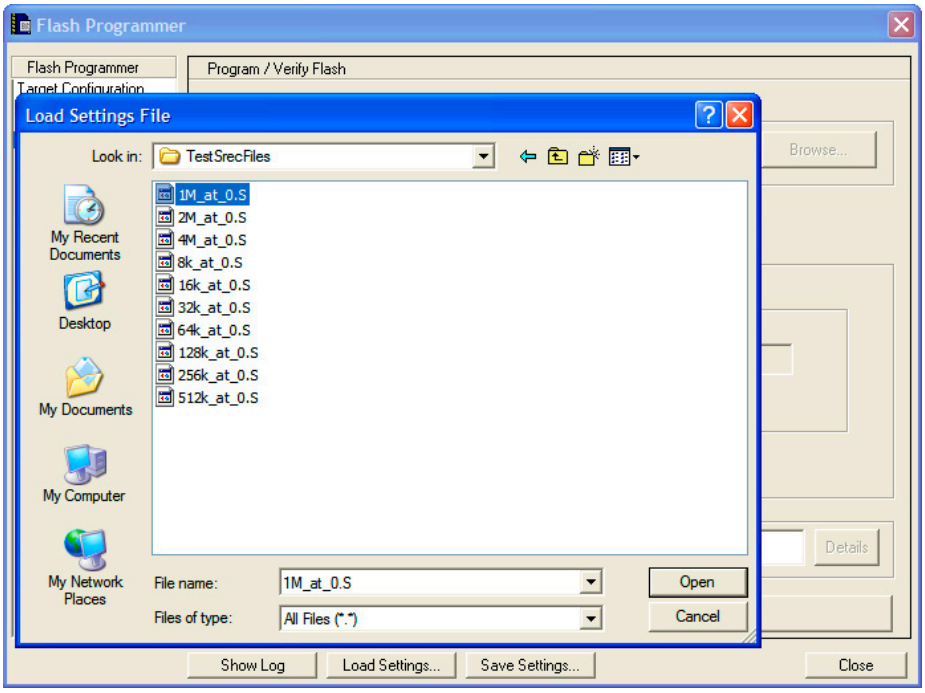
a) Different-sized binary S-record files are available in the Flash Toolkit delivery to check whether the flash device can be programmed. The path to the S-record files is:

```
Freescale\CodeWarrior for ColdFire V7.x
\ColdFire_Tools\FlashToolKit\SrecTestFiles
```

i) They are: `64k_at_0.S`, `128k_at_0.S`, `256k_at_0.S`, `1M_at_0.S`, `2M_at_0.S` and `4M_at_0.S`. Depending on the file name, test files are differently sized. For example file `256k_at_0.S` is 256 Kilobyte-sized and is linked to the 0 start-up address.

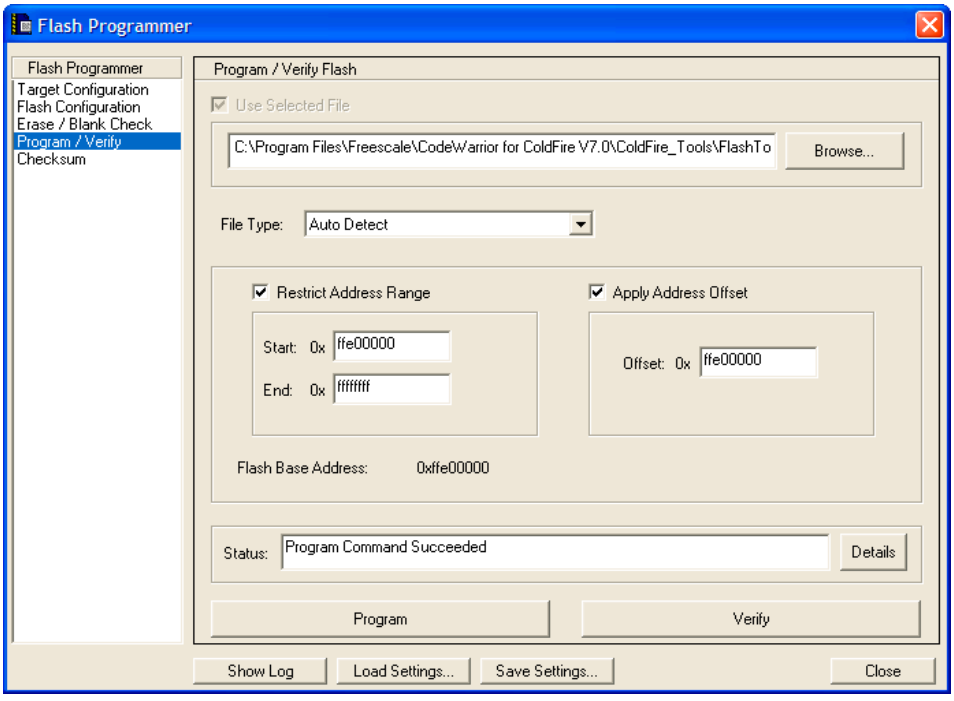
b) Choose the Program/Verify sub-menu in CodeWarrior Flash Programmer. For programming the AMD 16x1, the `1M_at_0.S` file is used, as shown in Figure 15.

**Figure 15. Dummy file for Flash Program Testing Selection**




c) Specify **Restrict Address Range** and **Apply Address Offset** for the flash device being used (Figure 16.)

**Figure 16. Restrict Address Range and Apply Address Offset Settings**



d) Figure 16. definitions:

i) **Restrict Address Range** – address range of the flash device

ii) **Apply Address Offset** – start address, where the test data is programmed in the flash; it should be the flash device start address.

e) Check that the flash is programmed and the **Program Command Succeeded** message is shown after clicking the **Program** button, as shown in Figure 16.

---

**NOTE** In case of the flash device cannot be programmed, check: 1) successful erasure of flash device; 2) hardware connection correctly setup.

---

21. Verify programmed data:

a) If the flash device is successfully programmed, perform the **Verify** command (Figure 16.) Check that the status is: **Verify Command Succeeded**.

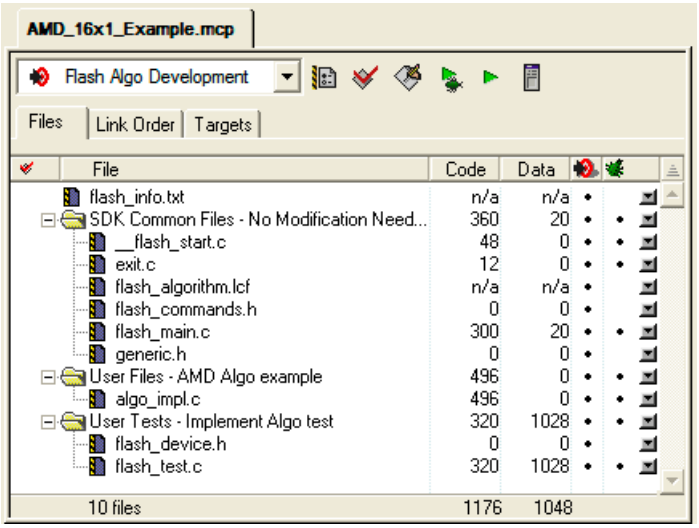
b) If all tests pass correctly, you have completed creation of a the new flash programming algorithm. The new flash device can be programmed with CodeWarrior Flash Programmer without limitation.

# 6 Flash Programming Examples

## 6.1 Flash Programming Algorithm for AMD 16x1 Flash Devices

The `AMD_16x1_Example.mcp` project (Figure 17.) illustrates how the Flash Development Kit is used to program AMD 16x1 flash algorithms.

**Figure 17. ColdFire CodeWarrior Main View of AMD_16x1_Example.mcp Project**



### 6.1.1 Implementation: ID Function Implementation for AMD 16x1 Flash Devices

The sequence for getting the Manufacturer ID and Device ID, based on the AMD flash specification, is shown in Figure 18.

**Figure 18. ID Command Sequence for the AMD Flash**

| Command Sequence (Note 1) | Cycles | Bus Cycles | | | | | |
|---|---|---|---|---|---|---|---|
| | | First | | Second | | Third | |
| | | Addr | Data | Addr | Data | Addr | Data |
| Manufacturer ID | 4 | 555 | AA | 2AA | 55 | (BA)555 | 90 |
| Device ID | 6 | 555 | AA | 2AA | 55 | (BA)555 | 90 |

**Listing 8. ID Function Sample Code for AMD Flashes**

```
retval_t ID(parameter_block_t *p_pb)
{
    volatile unsigned short *baseaddress = (p_pb->base_addr).w;
    retval_t result = 0;

    /* reset */
    *(baseaddress) = (unsigned short)0xF0F0;

    /* setup for get id */
    *(baseaddress + 0x555) = (unsigned short)0xAA;
    *(baseaddress + 0x2AA) = (unsigned short)0x55;
    *(baseaddress + 0x555) = (unsigned short)0x90;

#ifdef FLASH_ALGO_TEST
    /* get id */
    mf_id     = *(baseaddress);
    part_id   = *(baseaddress + 1);
#endif

    /* read mode again */
    *(baseaddress) = (unsigned char)0xF0;

    return result;
}
```

When using the Algo Development build target, the device ID and manufacturer's ID are read from the flash device and stored in the `part_id` and `mf_id` variables (Listing 8). Check these during the flash algorithm testing.

### 6.1.2 Implementation: Function erase_sector for AMD 16x1 Flash Devices

The sequence for the Sector Erase command implementation, based on the AMD flash specification, is shown in Figure 19.

**Figure 19. Sector Erase Command Sequence for AMD Flash**

| Command Sequence (Note 1) | Cycles | Bus Cycles (Notes 2–5) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | First | | Second | | Third | | Fourth | | Fifth | | Sixth | |
| | | Addr | Data | Addr | Data | Addr | Data | Addr | Data | Addr | Data | Addr | Data |
| Sector Erase | 6 | 555 | AA | 2AA | 55 | 555 | 80 | 555 | AA | 2AA | 55 | SA | 30 |

Refer to the actual encoding of the `erase_sector` function for AMD flashes in Listing 9.

**Listing 9. Function erase_sector Sample Code for AMD Flashes**

```
retval_t erase_sector(parameter_block_t *p_pb, unsigned long sect_index)
{
    volatile unsigned short *sectoraddress = ((unsigned short **)(p_pb->items).w)[sect_index];
    volatile unsigned short read;
    retval_t result = 0;

    /* first of all reset the device. The fID is no longer called in the new
     flash programmer plugin (it was used in the old AMC MWX-ICE) therefore
     the flash chip must always be bring into the read state.
    */

    /* reset sector */
    *(sectoraddress) = (unsigned short)0xF0F0;

    /* erase sector */
    *(sectoraddress + 0x555) = (unsigned short)0xAA;
    *(sectoraddress + 0x2AA) = (unsigned short)0x55;
    *(sectoraddress + 0x555) = (unsigned short)0x80;
    *(sectoraddress + 0x555) = (unsigned short)0xAA;
    *(sectoraddress + 0x2AA) = (unsigned short)0x55;
    *(sectoraddress) = (unsigned short)0x30;

    read = *(sectoraddress);

    /*
    Wait for the status value to be read from *addr or
    how_long ticks to pass.  If how_long ticks pass,
    a non-0 value will be returned.
    On the AMD chips, DQ7 is inverted until the embedded
    algorithm is completed when it flips to the correct
    value.  The parameter 'hi' will indicate whether that
    value is set or cleared.
    */
    while ((read & 0x0080) != 0x0080)
    {
        read = *(sectoraddress);
    }

    /* read mode again */
    *(sectoraddress) = (unsigned char)0xF0;

    return result;
}
```

### 6.1.3 Implementation: Function erase_chip for AMD 16x1 Flash Devices

The sequence for the **Chip Erase** command, based on the AMD flash specification, is shown in Figure 20. and Listing 10.

**Figure 20. Chip Erase Command Sequence for AMD Flash**

| Command Sequence (Note 1) | Cycles | Bus Cycles (Notes 2–5) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | First | | Second | | Third | | Fourth | | Fifth | | Sixth | |
| | | Addr | Data | Addr | Data | Addr | Data | Addr | Data | Addr | Data | Addr | Data |
| Chip Erase | 6 | 555 | AA | 2AA | 55 | 555 | 80 | 555 | AA | 2AA | 55 | 555 | 10 |

**Listing 10. Function erase_chip Encoding for AMD Flashes**

```
retval_t erase_chip(parameter_block_t *p_pb)
{
    int errors = 0;
    retval_t result = 0;
    unsigned short stat;
    unsigned short mask = (unsigned short)DQ7;
unsigned short masked_src = (unsigned short)DQ7;
    int got_it;
    volatile unsigned short *base_addr = (p_pb->base_addr).w;

    /* first of all reset the device. The fID is no longer called in the new
     flash programmer plugin (it was used in the old AMC MWX-ICE) therefore
     the flash chip must always be bring into the read state.
    */
    *base_addr = (unsigned short)0xF0F0;

/* erase chip */
    *(base_addr + 0x555) = (unsigned short)0xAA;
    *(base_addr + 0x2AA) = (unsigned short)0x55;
    *(base_addr + 0x555) = (unsigned short)0x80;

    *(base_addr + 0x555) = (unsigned short)0xAA;
    *(base_addr + 0x2AA) = (unsigned short)0x55;
    *(base_addr + 0x555) = (unsigned short)0x10;

/* Wait for status operation */
    mask &= 0x0080;          /* Only dq7 flips */
    masked_src &= 0x0080;
    while ( 1 )
    {
        if ( (*base_addr & mask) == masked_src )
        {
        break;
        }
    }

    /* return to read arry mode */
    *base_addr = (unsigned char)READ;

    return result;
}
```

### 6.1.4 Implementation: Function write for AMD 16x1 Flash Devices

In terms of AMD flash devices specification, the write function realizes the **Program** command. The sequence for the Program command, according to the AMD specification, is shown in Figure 21.

**Figure 21. Program Command Sequence for AMD Flash**

| Command Sequence | Cycles | Bus Cycles | | | | | |
|---|---|---|---|---|---|---|---|
| | | First | | Second | | Third | |
| | | Addr | Data | Addr | Data | Addr | Data |
| Program | 4 | 555 | AA | 2AA | 55 | 555 | A0 |

Refer to the actual encoding of the `write` function for AMD flashes as shown in the file `amd_16x1_sample.c` in Listing 11.

**Listing 11. Sample write Function Code for AMD Flashes**

```
retval_t write(parameter_block_t *p_pb)
       {
           int timed_out, got_it;
           unsigned long i;
           unsigned short stat;
           retval_t errors = 0;
           unsigned short mask = (unsigned short)DQ7;
       unsigned short masked_src = (unsigned short)DQ7;
           volatile unsigned short *base_addr = (p_pb->base_addr).w;
           unsigned short *buffer = (p_pb->items).w;
           unsigned long buffer_len = p_pb->num_items;
           unsigned long how_many = buffer_len / sizeof(unsigned short);

           if ( buffer_len % sizeof(unsigned short) ) {
               /* we need to fill the remaining bytes with 'ff' -- this assumes
               byte accesses to DRAM will work */
               char *p = (char *)((unsigned long)buffer + buffer_len);
               *p++ = '\xff';
               how_many++ ;
           }

           /* first of all reset the device. The fID is no longer called in the new
            flash programmer plugin (it was used in the old AMC MWX-ICE) therefore
            the flash chip must always be bring into the read state.
           */
           *base_addr = (unsigned short)RESET;

           for (i = 0; (i < how_many) && !errors; i++){

               unsigned short *c = (unsigned short*)((unsigned long)base_addr & ~0x1fff);
               *((c) + 0x555) = 0xaa;
               *((c) + 0x2aa) = 0x55;
               *((c) + 0x555) = 0xa0;

               *base_addr = *buffer;
       /* Wait for status operation */
           mask &= 0x0080;          /* Only dq7 flips */
           masked_src = (unsigned short)((unsigned char)DQ7 & *buffer);
           masked_src &= 0x0080;
```

```
            while ( 1 )
            {
                if ( (*base_addr & mask) == masked_src )
                {
                break;
                }
            }

                base_addr++;
                buffer++;
            }

            /* go back to the last access */
            --base_addr;

            /* read mode again */
            *base_addr = (unsigned char)0xF0;

            return errors;
}
```

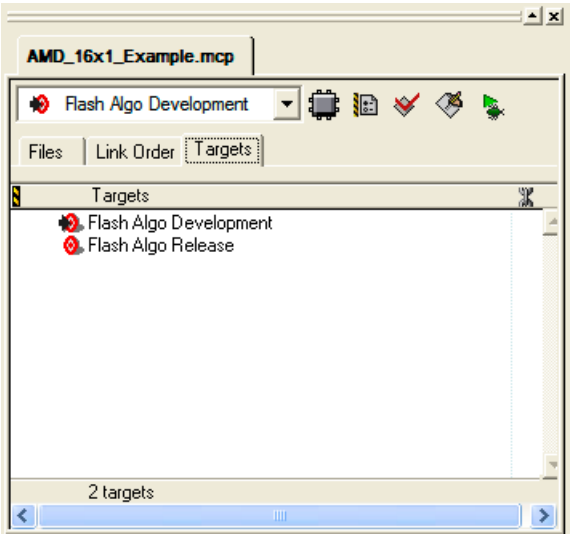
## 6.2 AMD 16x1 Flash Programming Algorithm Unit Testing

This section illustrates an example flash test application working with AMD 16x1. The flash programming applet is tested on a Freescale `M5282EVB` with an `Am29PL160CB` flash device.

### 6.2.1 Flash Testing Setup

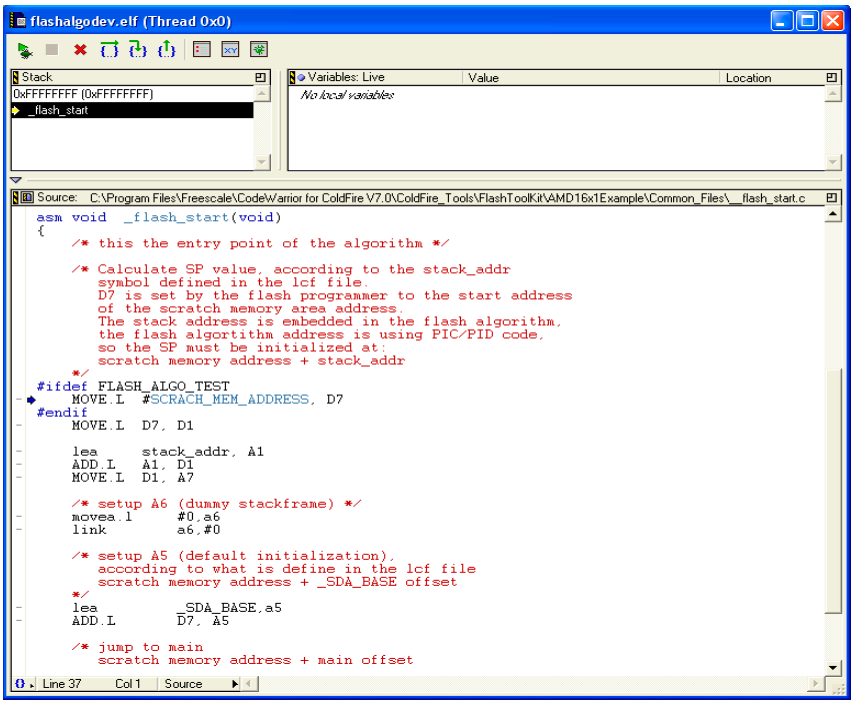
Use the Algo Development target — shown in Figure 22. — to run the flash programming test application.

**Figure 22. Targets in AMD_16x1_Example.mcp Project**




Upon loading, the application stops at the `_flash_start()` function as shown in Figure 23.

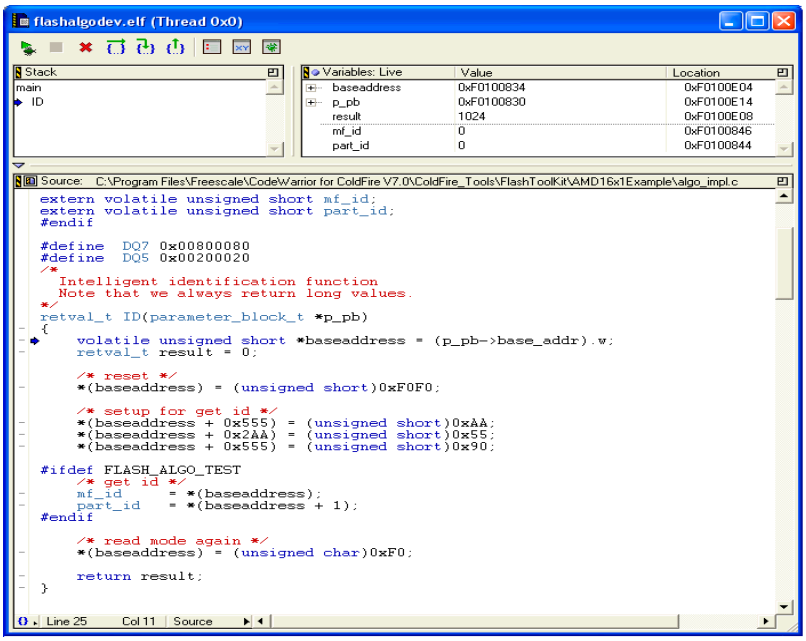
**Figure 23. Unit Test Application Start-up Point**




## 6.2.2 Test One: Read Manufacturer and Device ID

After the Run command is executed the application stops at the first test check point, as shown in Figure 24.

**Figure 24. Read Manufacturer and Device ID**

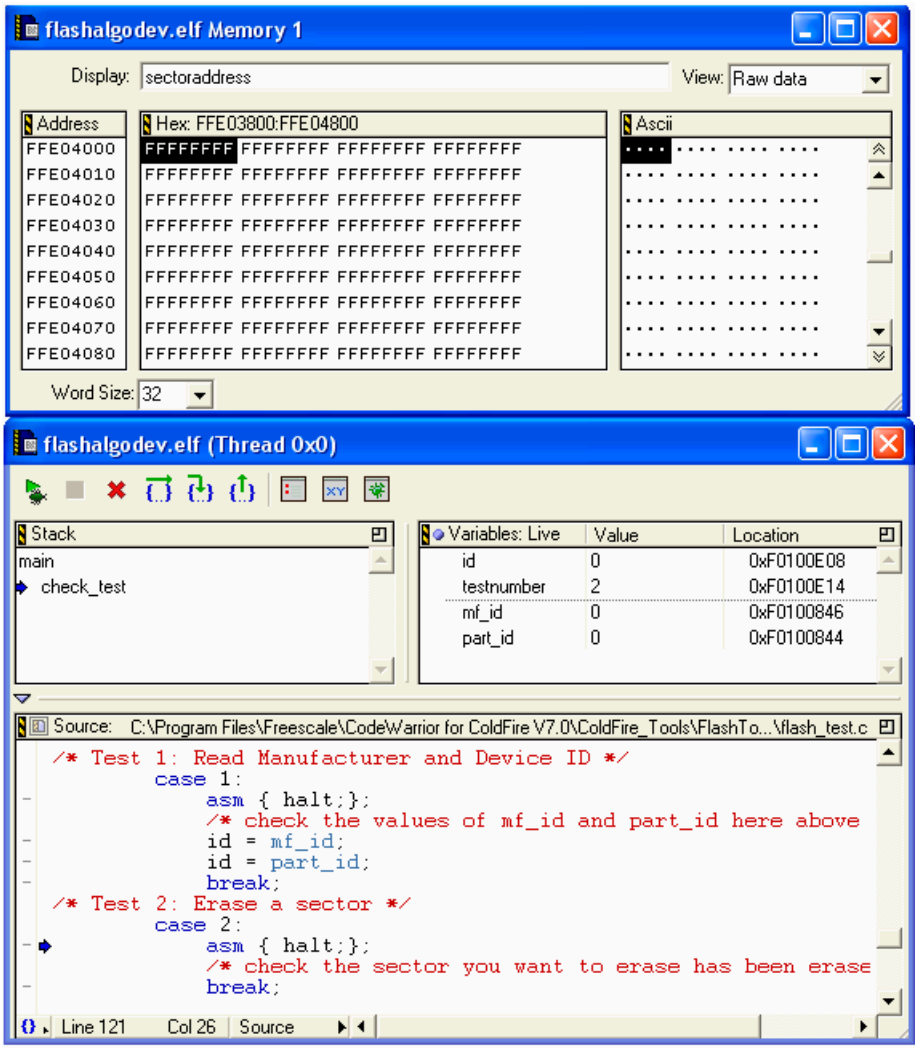


The results of Test One display the manufacturer ID code 0x01 (for AMD) and the device ID code 0x2245 (for the Am29PL160CB flash device). This confirms basic read/write functionality of the flash devices.

### 6.2.3 Test Two: Erase a Sector

With another **Run** command execution the application stops at the Test Two check point, as shown in Figure 25. In Test Two the sector number one of the flash memory is erased. From the sample flash device definition for AMD 16x1 we have: BASE_FLASH_ADDRESS equal to 0xFFE00000 and the SECTOR_ADDRESS_OFFSET equal to 0x4000. Thus for sector 1, flash memory is erased starting at address 0xFFE04000 in memory. To check that the **Erase a Sector** command works correctly the memory window was opened with the memory region starting at address 0xFFE04000. Upon erasure, flash memory sector contains 0xFFFFFFFF data in its memory.

**Figure 25. Erase Sector Functionality Check Point**

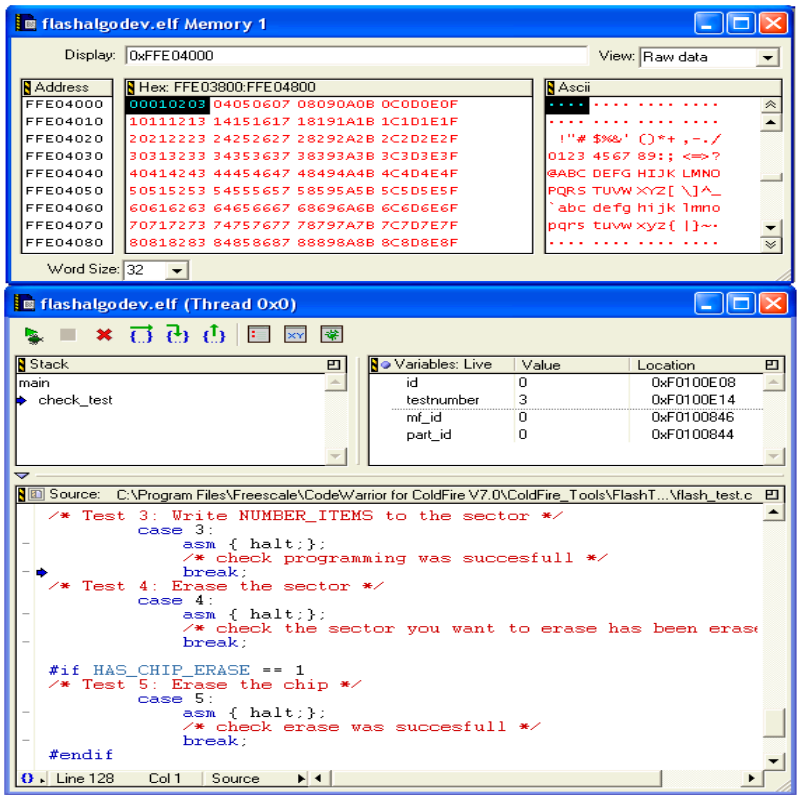


The results of Test Two show that flash memory, starting at address `0xFFE04000`, is erased. This confirms that the sector erase function works correctly.

### 6.2.4 Test Three: Program Flash Memory

Another execution of the Run command stops the test application at the Test Three check point, as shown in Figure 26. Test Three fills sector one in flash memory with an incremental counter. The number of the bytes written to flash memory is determined by the `NUMBER_ITEMS` parameter in `flash_device.h` file. To verify that the flash programming algorithm works correctly and the write function of the flash performs correctly, check the memory region of flash sector one. In this case, check the memory starting at address `0xFFE04000`.

**Figure 26. Program Functionality Check Point**

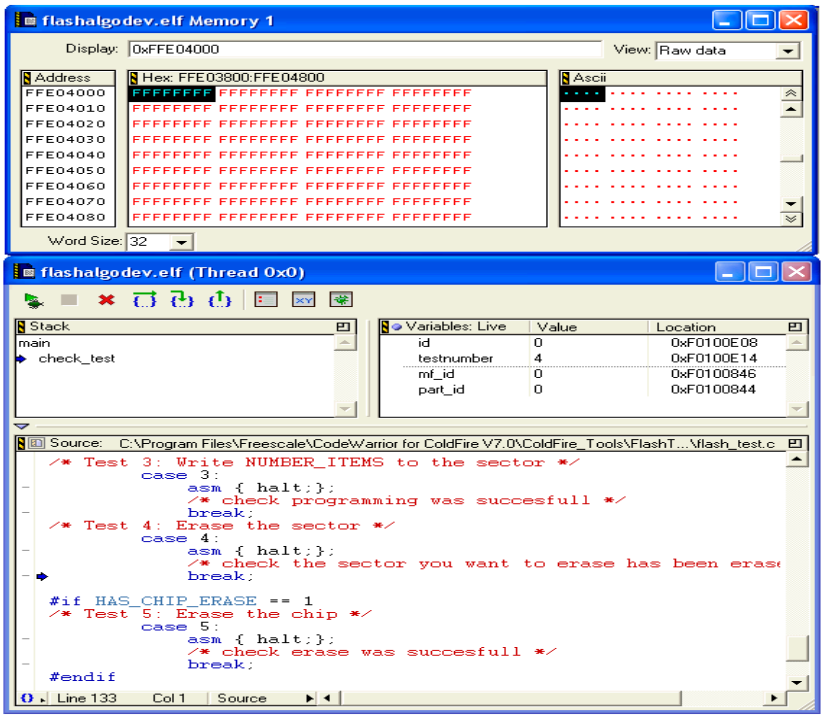



The results of Test Three show that flash memory, starting at address `0xFFE04000`, is changed and contains an increment by one datum. This confirms that the write function works correctly.

### 6.2.5 Test Four: Erase a Sector

Erase Sector One of flash memory again to check that the above results are not produced in error (Figure 27.)

**Figure 27. Erasing Sector One of Flash Memory After Programming**

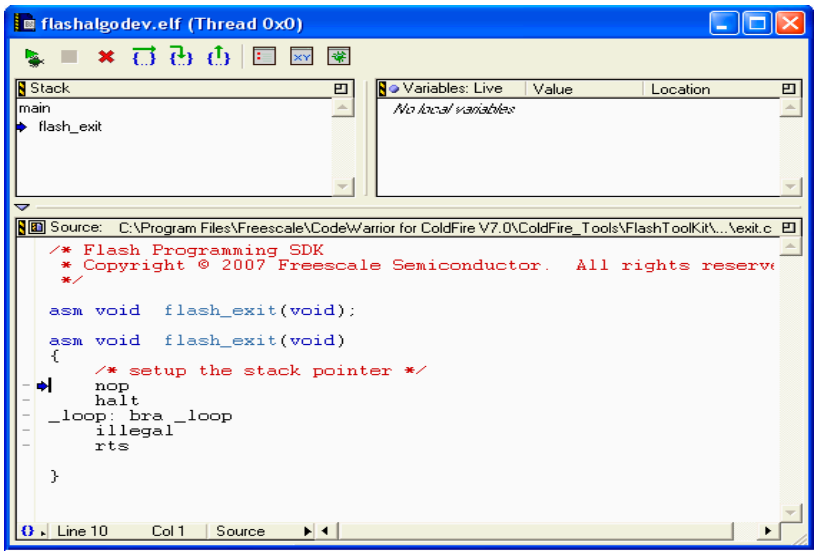



Check the memory starting at address `0xFFE04000` to verify that the flash memory region erased correctly. In this example, since the modified memory region contains `0xFFFFFFFF`, sector data was erased successfully.

## 6.2.6 Flash Testing End Point

After finishing, the flash test application goes to the `flash_exit()` end point, as shown in Figure 28.

**Figure 28. Flash Testing End Point**



*When this test is complete, you can use the flash programming algorithm with the CodeWarrior Flash Programmer.*

## 6.3 Adding Flash Device Configuration to FPDeviceConfig.xml

To add a new device to the CodeWarrior Flash programmer add the new structured table of the flash device information to the master configuration file (`FPDeviceConfig.xml`). This master file is found in the following folder:

```
Freescale\CodeWarrior for ColdFire V7.x
\bin\Plugins\Support\Flash_Programmer\ColdFire\ (Windows)
```

NewFlashDevice is the new flash device that works with the `flashalgorelease.elf` executable, as shown in Listing 12.

**Listing 12. Configuration Settings for NewFlashDevice in FPDeviceConfig.xml File**

```
</device>
<comment>
##############################################################################
# This configuration is for the NewFlashDevice #
##############################################################################
</comment>
<device>
   <name>NewFlashDevice</name>
   <manufacturerid>01</manufacturerid>
   <chiperase>TRUE</chiperase>
   <sectorcount>11</sectorcount>
   <sectorname>0</sectorname>
   <sectorname>1</sectorname>
   <sectorname>2</sectorname>
   <sectorname>3</sectorname>
   <sectorname>4</sectorname>
   <sectorname>5</sectorname>
   <sectorname>6</sectorname>
   <sectorname>7</sectorname>
   <sectorname>8</sectorname>
   <sectorname>9</sectorname>
   <sectorname>10</sectorname>
   <sectorstart>000000</sectorstart>
   <sectorend>003fff</sectorend>
   <sectorstart>004000</sectorstart>
   <sectorend>005fff</sectorend>
   <sectorstart>006000</sectorstart>
   <sectorend>007fff</sectorend>
   <sectorstart>008000</sectorstart>
   <sectorend>03ffff</sectorend>
   <sectorstart>040000</sectorstart>
   <sectorend>07ffff</sectorend>
   <sectorstart>080000</sectorstart>
   <sectorend>0bffff</sectorend>
   <sectorstart>0c0000</sectorstart>
   <sectorend>0fffff</sectorend>
   <sectorstart>100000 </sectorstart>
   <sectorend>13ffff</sectorend>
   <sectorstart>140000</sectorstart>
   <sectorend>17ffff</sectorend>
   <sectorstart>180000</sectorstart>
   <sectorend>1bffff</sectorend>
```

```
   <sectorstart>1c0000</sectorstart>
   <sectorend>1fffff</sectorend>
   <organizationcount>1</organizationcount>
   <organization>1Mx16x1</organization>
   <id>2245</id>
   <algorithm>flashalgorelease.elf</algorithm>
</device>
<comment>
```

Listing 12 definitions:

- `NewFlashDevice` - the name of the new flash device for which the new flash programming algorithm is created
- `flashalgorelease.elf` - name of the flash programming algorithm that will be used to program flash device

The `NewFlashDevice` configuration appears in the Flash Programmer window, as shown in Figure 12.

## 6.4 Updating the Flash Settings xml File for Flash Programmer

Update the custom board configuration file to have correct configuration settings that work with the new flash device.

For example, the sample flash programming applet for AMD 16x1 is compiled to work with the `MCF5282EVB EVB` board. A new file named `NewFlashDevices.xml` is generated based on `M5282EVB.xml` and is modified to work with the `NewFlashDevice`, as described in the `FPDeviceConfig.xml` file. Refer to Section 6.3. If another board is used, find the `[BOARD].xml` file for that board; this file can be used as a template to create one to work with the new flash device. Check the folder:

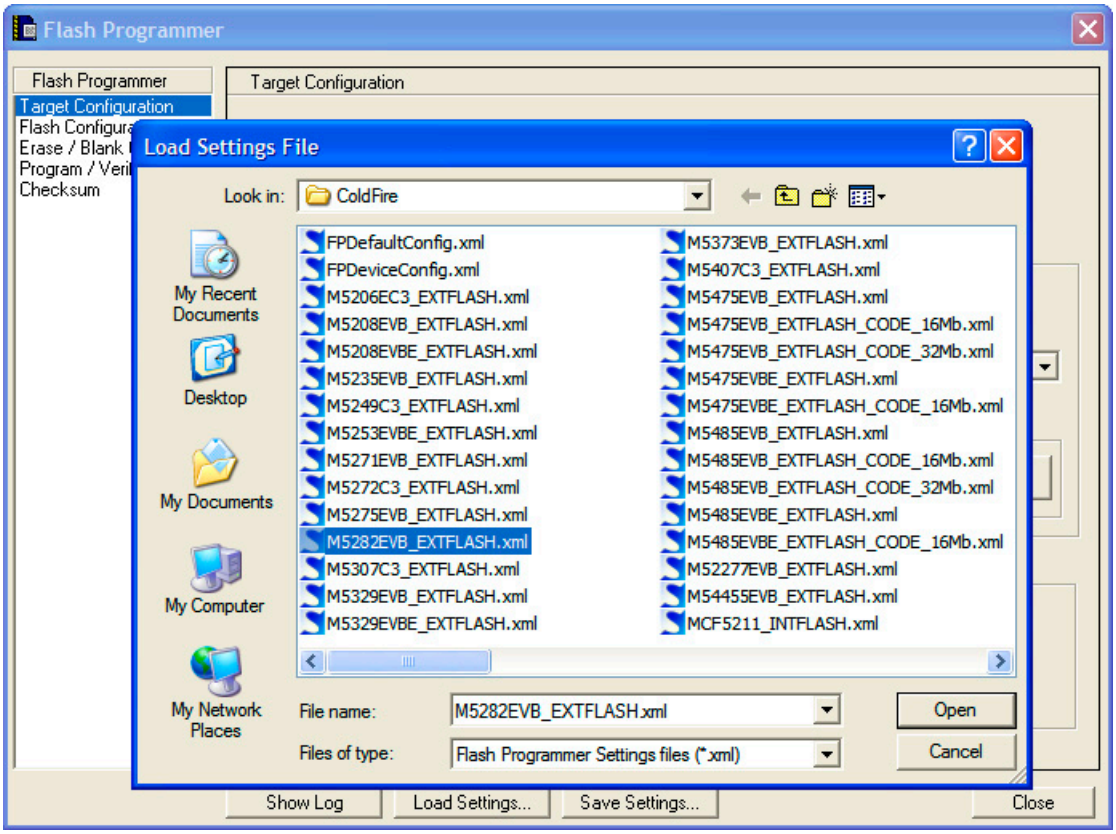
```
Freescale\CodeWarrior for ColdFire V7.x
\ColdFire_Support\bin\Plugins\Support\Flash_Programmer\ColdFire
```

To create NewFlashDevices.xml file for `MCF5282EVB EVB` board:

1. Open the `M5282EVB.xml` file with the CodeWarrior's Flash Programmer as shown in Figure 29. If other hardware is used open the `[BOARD].xml` configuration file, where BOARD is the name of the core used.
   a) For target configuration `[BOARD].xml` files check the folder:

   ```
   Freescale\CodeWarrior for ColdFire V7.x
   \bin\Plugins\Support\Flash_Programmer\ColdFire
   ```

**Figure 29. Opening the M5282EVB.xml File**

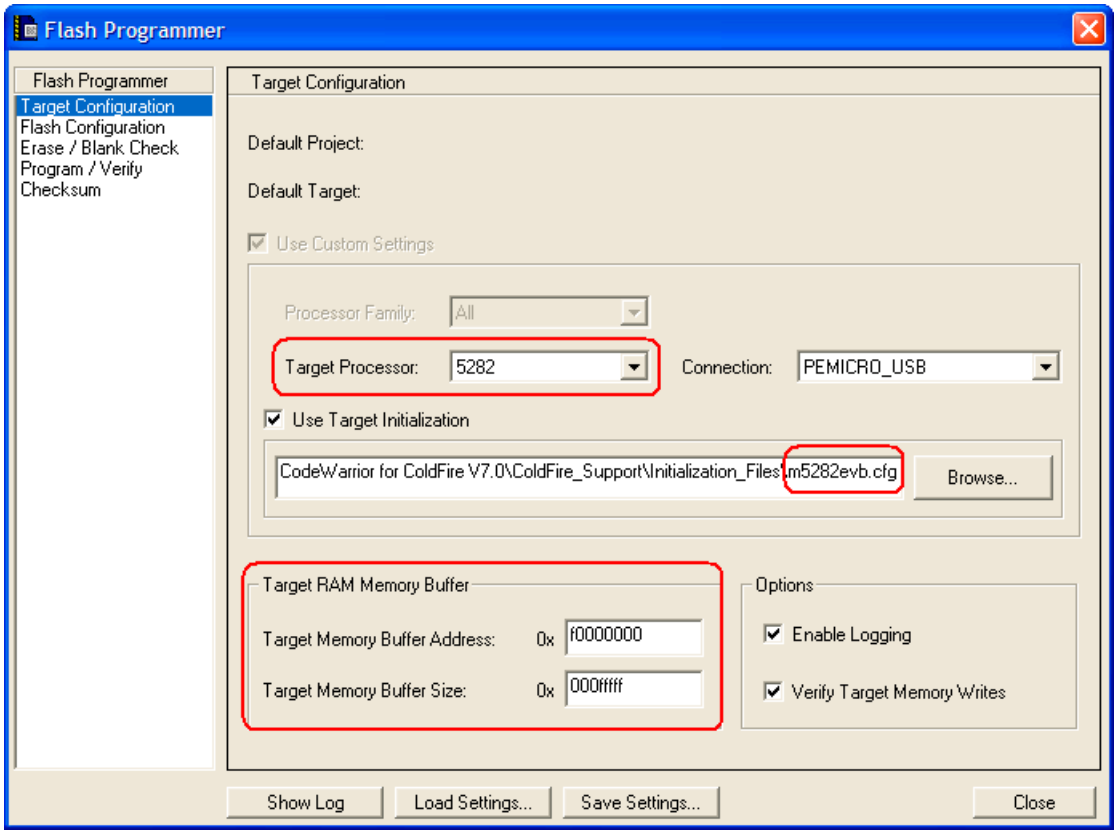



2. Check the target configuration settings as shown in Figure 30. The following parameters should be set correctly for the hardware used:
   a) Target Processor – set the target processor name correctly for the hardware used.
   b) Use Target Initialization – set the correct path to the target processor configuration file. In the provided example for the `5282EVB` board, the `M5282EVB.cfg` file is used. For the processor configuration files please check the folder:

      ```
      Freescale\CodeWarrior for ColdFire V7.x
      \ColdFire_Support\Initialization_Files
      ```

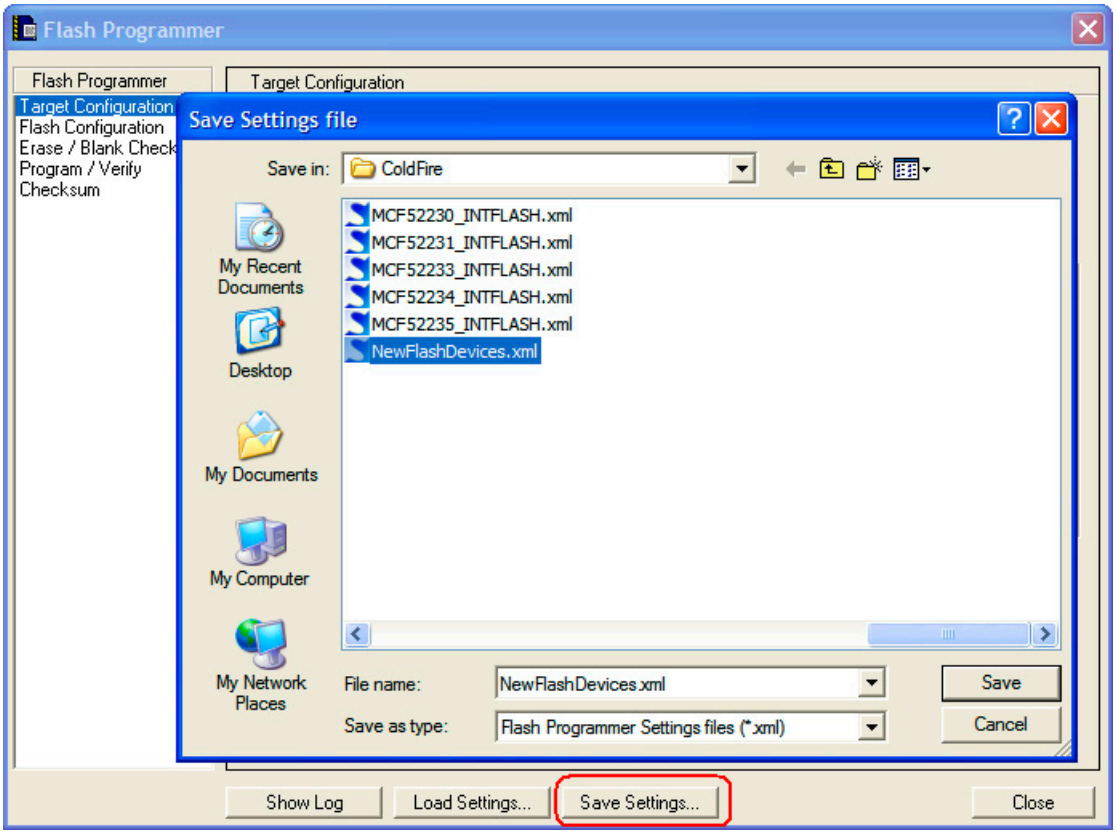
   c) Target Memory Buffer Address – target RAM memory start-up address.
   d) Target Memory Buffer Size – target RAM memory size.

**Figure 30. Checking Target Configuration Settings in [BOARD].xml File**



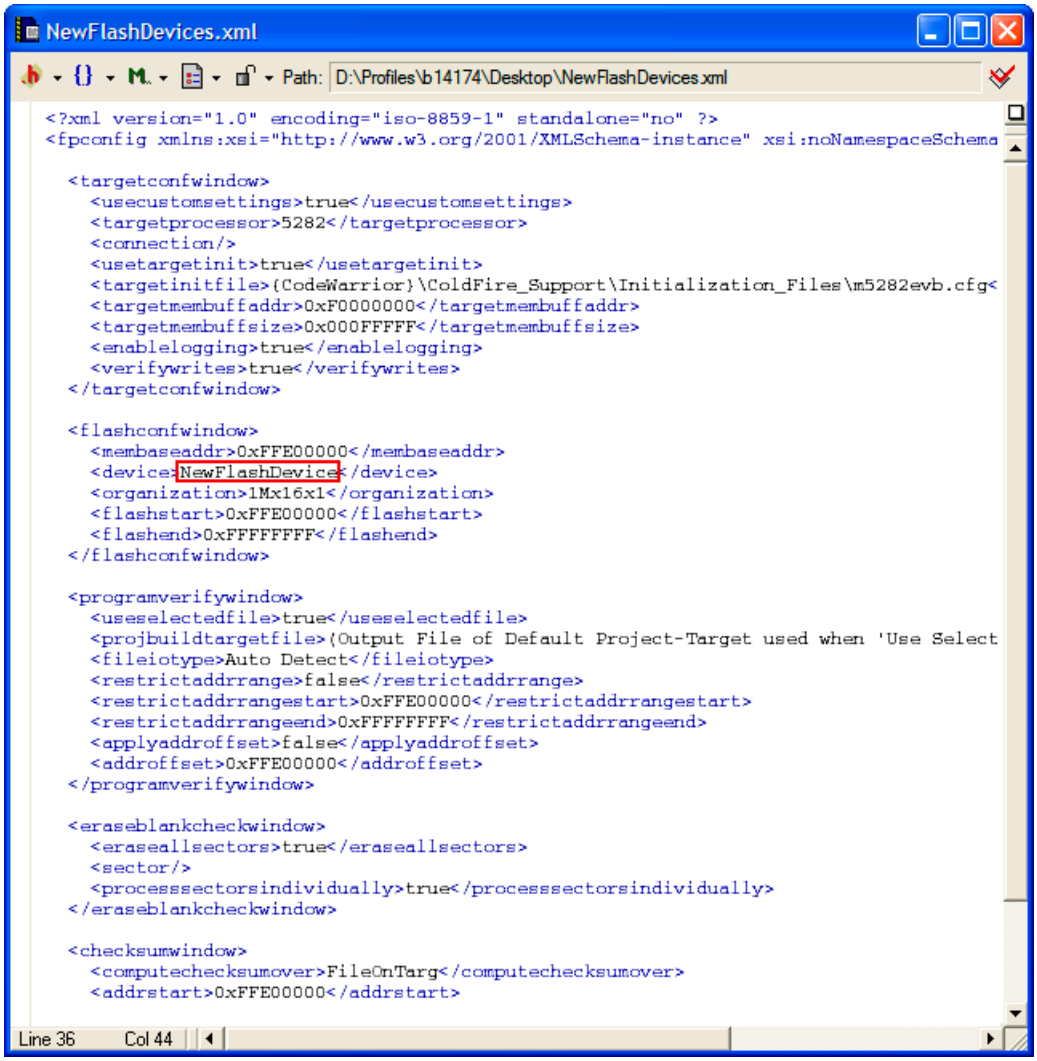

3. If configuration is correct for the targeted hardware save the target board configuration as `NewFlashDevices.xml`, as shown in Figure 31.

**Figure 31. Saving Target Hardware Configuration Settings for NewFlashDevices.xml File**




4. Modify the `NewFlashDevices.xml` file as shown in Figure 32.

**Figure 32. NewFlashDevices.xml File Changes**




5. Check that the following parameters are set correctly for the `NewFlashDevice` in the `NewFlashDevices.xml` file:
   a) `<targetprocessor>` – set target processor name correctly for the hardware used.
   b) `<targetinitfile>` - set the correct path to the target processor configuration file. In provided example for `5282EVB` board, `M5282EVB.cfg` file being used. For the processor configuration files please check the folder:

      ```
      Freescale\CodeWarrior for ColdFire V7.x
      \ColdFire_Support\Initialization_Files
      ```

   c) `<organization>` – check the hardware organization for the new flash devices. In the provided example for AMD 16x1, one 1 Mbyte 16x1 AMD flash device is present on the tested `5282EVB` board.

d) `<flashstart>` – check the hardware organization for the start-up address of the flash device being used. Check the same data for the `<restrictaddrrangestart>` and `<addrstart>` parameters.

e) `<addrsize>` – set correct size of the new flash device.

f) `<flashend>` – set the end address of the flash device. This parameter can be calculated as a `<flashstart> + <addrsize>`. Check the same data for the `<restrictaddrrangeend>` and `<addrstart>` parameters.

g) After you change `FPDeviceConfig.xml` and the custom configuration file (`NewFlashDevices.xml` in this example), *the CodeWarrior Flash Programmer is ready to work with the new flash device.*

# 7 Chip Makers' Flash Programming Recommendations

In general, flash programming algorithms from different flash manufacturers are similar. Most manufacturers use the same algorithms for programming flash devices. For example, the same algorithms may be used for programming AMIC 16x1 flash devices and AMD 16x1 flashes. Most of the flash manufacturers have sample flash programming algorithms on the web.

## 7.1 Alliance Flash Devices

AMD's (Spansion's) flash programming algorithms should be usable. Check flash device specifications available from the manufacturer. Manufacturer's site: http://www.alsc.com.

## 7.2 AMIC Flash Devices

Depending on the particular flash device, the same flash programming algorithms available for AMD (Spansion) or Atmel should be usable. Check flash device specifications available from the manufacturer. Manufacturer's site: http://www.amictechnology.com.

## 7.3 AMD (Spansion) Flash Devices

Flash programming algorithms are already supported in CodeWarrior Flash Programmer. AMD does not produce its own flash devices any more (Fujitsu and AMD founded Spansion for flash manufacturing). Manufacturer's site: http://www.spansion.com.

## 7.4 Atmel Flash Devices

Due to the lack of testing hardware, flash programming algorithms for Atmel are not supported in the CodeWarrior ColdFire Flash Programmer. The flash programming algorithm for Atmel flash devices, however, is similar to the algorithm used for AMD flash programming.

Refer to the Atmel flash device specification for the correct programming commands and device ID variables. An application note, *Programming Atmel's AT29 Flash Family*, is available from the manufacturer's web site. The application note contains code examples for Atmel flash device programming. Manufacturer's site: http://www.atmel.com.

## 7.5 Catalyst Flash Devices

Intel's flash programming algorithms should work. Check flash device specifications available from the manufacturer. Most of the flash devices from Catalist are fully identical to the flash devices from Intel. For example: the `CAT28F001` from Catalist is the equivalent of Intel's `IN28F001`. Manufacturer's site: http://www.catsemi.com/index.html.

## 7.6 EON Flash Devices

AMD's (Spansion's) flash programming algorithms should be usable. Check flash device specifications available from the manufacturer. Most of the flash devices from EON have direct references to AMD flash devices. Manufacturer's site: http://www.eonsdi.com.

## 7.7 Fujitsu Flash Devices

AMD's (Spansion's) flash programming algorithms should be usable. Check flash device specifications available from the manufacturer. Fujitsu no longer produces its own flash devices. Manufacturer's site: http://www.spansion.com.

## 7.8 Hyundai Flash Devices

AMD's (Spansion's) flash programming algorithms should be usable. Check flash device specifications available from the manufacturer. Hyundai founded a new semiconductor company named Hynix. Most of the flash devices from Hynix make direct reference to AMD flash devices. Manufacturer's site: http://www.hynix.com.

## 7.9 Intel Flash Devices

Flash programming algorithms for Intel flash devices are already supported in CodeWarrior Flash Programmer. Manufacturer's site: http://www.intel.com.

## 7.10 Micron Flash Devices

Intel's flash programming algorithms should work. Check flash device specifications available from the manufacturer. Most of the flash devices from Micron make direct reference to Intel flashes. Manufacturer's site: http://www.micron.com.

## 7.11 MXIC Flash Devices

AMD's (Spansion's) flash programming algorithms should be usable. Check flash device specifications available from the manufacturer. Most of the flash devices from MXIC make direct reference to AMD flash devices. The document *MX_FlashSampleCode.pdf* is available from the MXIC web site. The document contains sample flash programming code suitable for both MXIC and AMD flash devices. Manufacturer's site: http://www.mxic.com.tw.

## 7.12 Samsung Flash Devices

The CodeWarrior flash programmer does not support flash programming algorithms for Samsung. Samsung uses its own algorithm — incompatible with other vendors — for flash programming. A sample programming algorithm for Samsung flash devices, presented as a CodeWarrior for ARM project, is available from the manufacturer's web site. Manufacturer's site: www.samsung.com/products/semiconductor/OneNAND.

## 7.13 Sharp Flash Devices

Intel's flash programming algorithms should be usable. Check flash device specifications available from the manufacturer. Manufacturer's site: http://www.sharpsma.com.

## 7.14 Spansion Flash Devices

Flash programming algorithms for Spansion flash devices are already supported in CodeWarrior Flash Programmer. Manufacturer's site: http://www.spansion.com.

## 7.15 SST Flash Devices

Depending on the particular flash device, the same flash programming algorithms available for AMD (Spansion), Atmel, or Intel should be usable. Check flash device specifications available from the manufacturer. Manufacturer's site: http://www.sst.com/about.

## 7.16 ST Flash Devices

AMD's (Spansion's) flash programming algorithms should be usable. Check flash device specifications available from the manufacturer. Sample flash programming application code is available for downloading from the ST web site. Manufacturer's site: http://www.st.com.

## 7.17 Toshiba Flash Devices

Intel's flash programming algorithms should work. Check flash device specifications available from the manufacturer. Manufacturer's site: http://www.semicon.toshiba.co.jp/eng.

## 7.18 White Flash Devices

AMD's (Spansion's) flash programming algorithms should be usable. Check flash device specifications available from the manufacturer. Manufacturer's site: http://www.wedc.com.

## 7.19 Winbond Flash Devices

AMD's (Spansion's) flash programming algorithms should be usable. Check flash device specifications available from the manufacturer.Manufacturer's site: http://www.winbondusa.com/mambo/content/view/289/553.

***How to Reach Us:***

**Home Page:**
www.freescale.com

**E-mail:**
support@freescale.com

**USA/Europe or Locations Not Listed:**
Freescale Semiconductor
Technical Information Center, CH370
1300 N. Alma School Road
Chandler, Arizona 85224
+1-800-521-6274 or +1-480-768-2130
support@freescale.com

**Europe, Middle East, and Africa:**
Freescale Halbleiter Deutschland GmbH
Technical Information Center
Schatzbogen 7
81829 Muenchen, Germany
+44 1296 380 456 (English)
+46 8 52200080 (English)
+49 89 92103 559 (German)
+33 1 69 35 48 48 (French)
support@freescale.com

**Japan:**
Freescale Semiconductor Japan Ltd.
Headquarters
ARCO Tower 15F
1-8-1, Shimo-Meguro, Meguro-ku,
Tokyo 153-0064, Japan
0120 191014 or +81 3 5437 9125
support.japan@freescale.com

**Asia/Pacific:**
Freescale Semiconductor Hong Kong Ltd.
Technical Information Center
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Tai Po Industrial Estate
Tai Po, N.T., Hong Kong
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