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**M16C/5M Group**

R01AN0423EJ0100

E<sup>2</sup>PROM Emulation Data Flash

Rev.1.00

Using the E<sup>2</sup>PROM Emulation Data FlashDec. 15, 2010

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**1. Abstract**

This document describes the setting method and an application example of the E<sup>2</sup>PROM emulation data flash (hereafter referred to as E<sup>2</sup>dataFlash) in the M16C/5M Group.

**2. Introduction**

The application example described in this document applies to the following microcomputers (MCU):

- MCU: M16C/5M Group

This application note can be used with other M16C Family MCUs which have the same special function registers (SFRs) as the above group. Check the user's manual for any modifications to functions. Careful evaluation is recommended before using the program described in this application note.

### 3. Overview

The E<sup>2</sup>dataFlash is a data flash that utilizes the strengths of serial E<sup>2</sup>PROMs. The units erased are considerably smaller than that of the data flash, and the E<sup>2</sup>dataFlash can be programmed or erased without stopping the CPU.

Table 3.1 lists the E<sup>2</sup>dataFlash Specifications.

**Table 3.1 E<sup>2</sup>dataFlash Specifications**

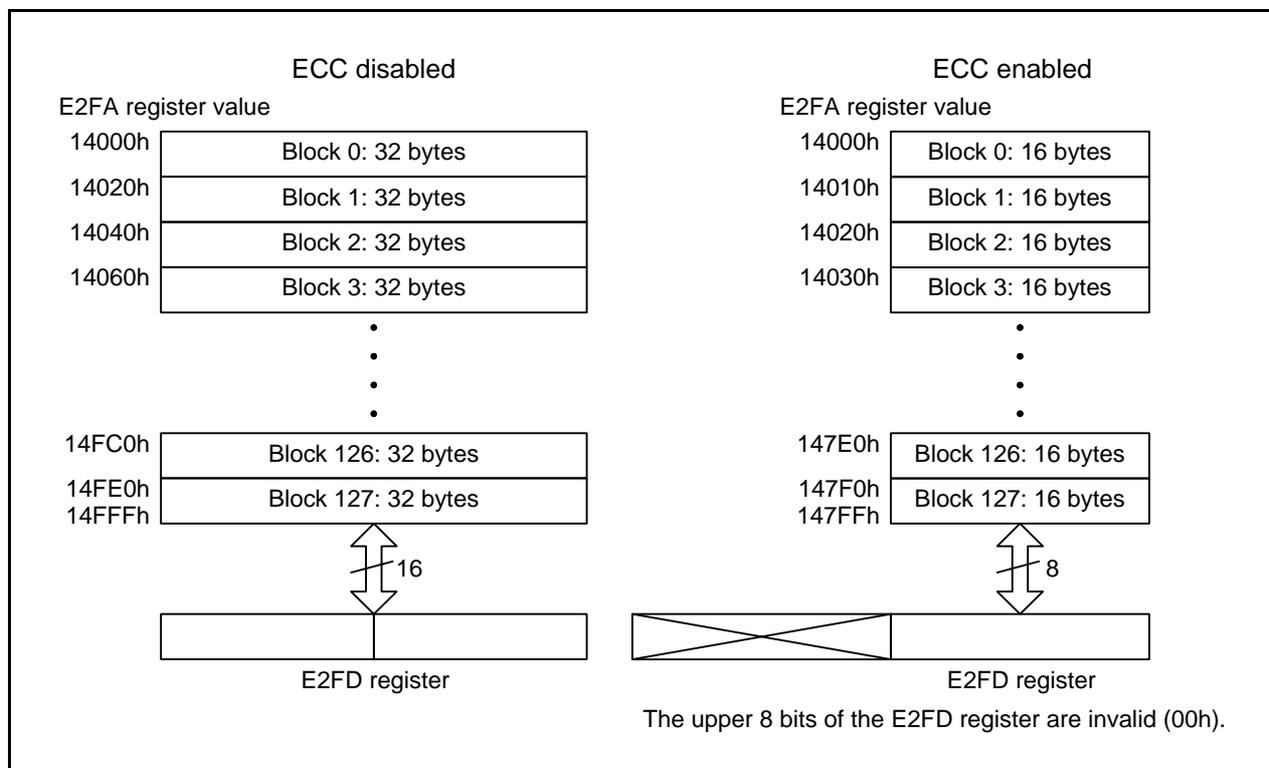
Item	Specification	
	ECC disabled	ECC enabled
Memory size	4 Kbytes	2 Kbytes
Block size	32 bytes	16 bytes
Number of blocks	128 blocks	
Unit to be programmed	2 bytes	1 byte
Unit to be erased	1 block (after erase, the memory value is 1.)	
How to control program and erase	By software commands	
Software commands	4	
Error correction	None	Corrects 1-bit error per byte

ECC: Error Check and Correct

#### 3.1 Block Configuration

When ECC is disabled, the E<sup>2</sup>dataFlash consists of 32 bytes × 128 blocks of flash memory and 16 bytes × 128 blocks when ECC is enabled.

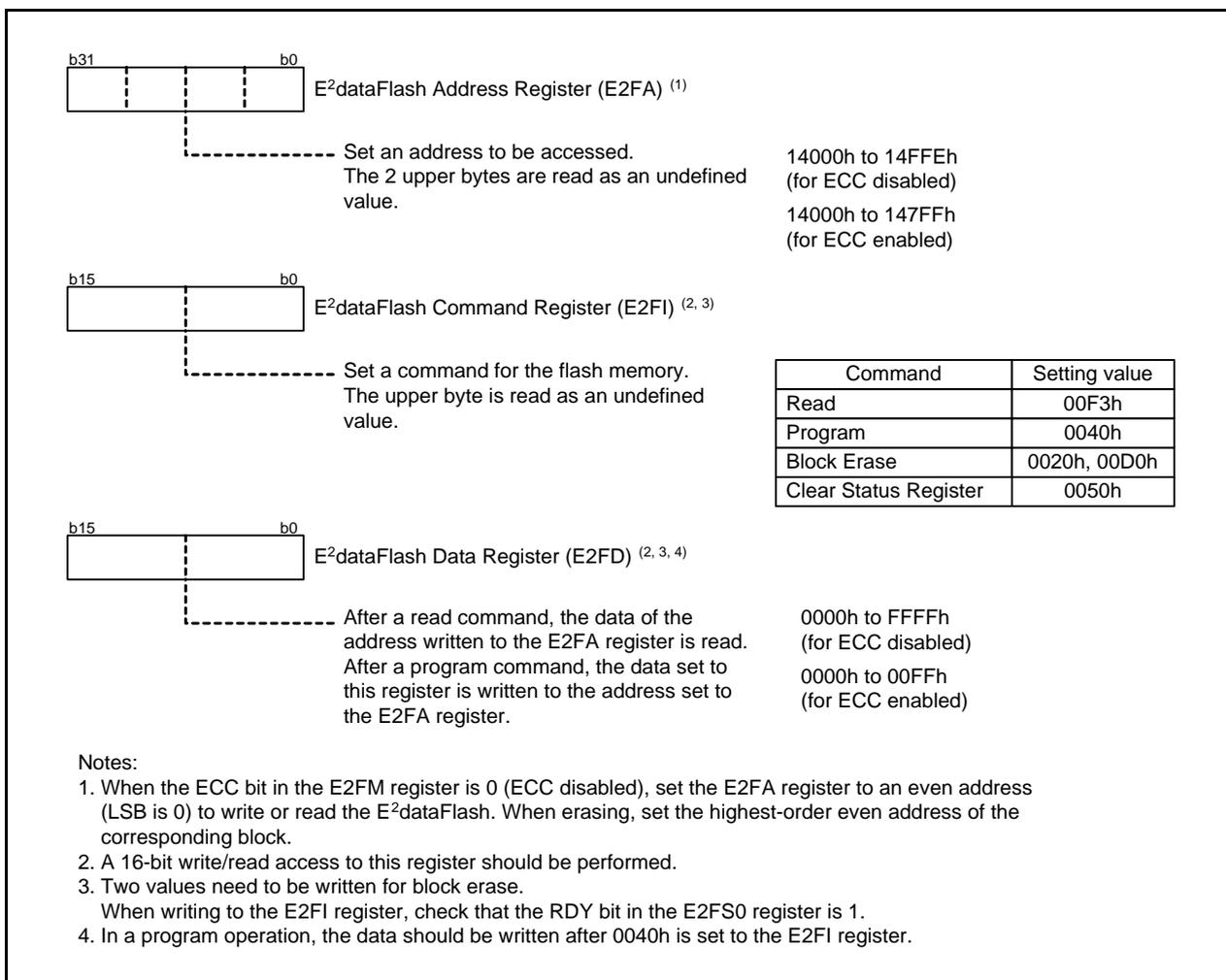
Figure 3.1 shows the E<sup>2</sup>dataFlash Memory Configuration.



**Figure 3.1 E<sup>2</sup>dataFlash Memory Configuration**

### 3.2 E<sup>2</sup>dataFlash Access Method

The CPU indirectly accesses the E<sup>2</sup>dataFlash via registers E2FA, E2FI, and E2FD that are allotted for SFR space. Figure 3.2 shows Registers E2FA, E2FI, and E2FD.



**Figure 3.2 Registers E2FA, E2FI, and E2FD**

### 3.3 Operational Procedures

When operating the E<sup>2</sup>dataFlash, confirm that the RDY bit in the E2FS0 register is 1 (ready), and then execute the read, program, block erase, and clear status operations following the steps shown in Figure 3.3 to Figure 3.6. Do not program or erase the E2dataFlash during programming or erasing program ROM 1, program ROM 2, or the data flash. Do not overwrite data to an address that has already been written.

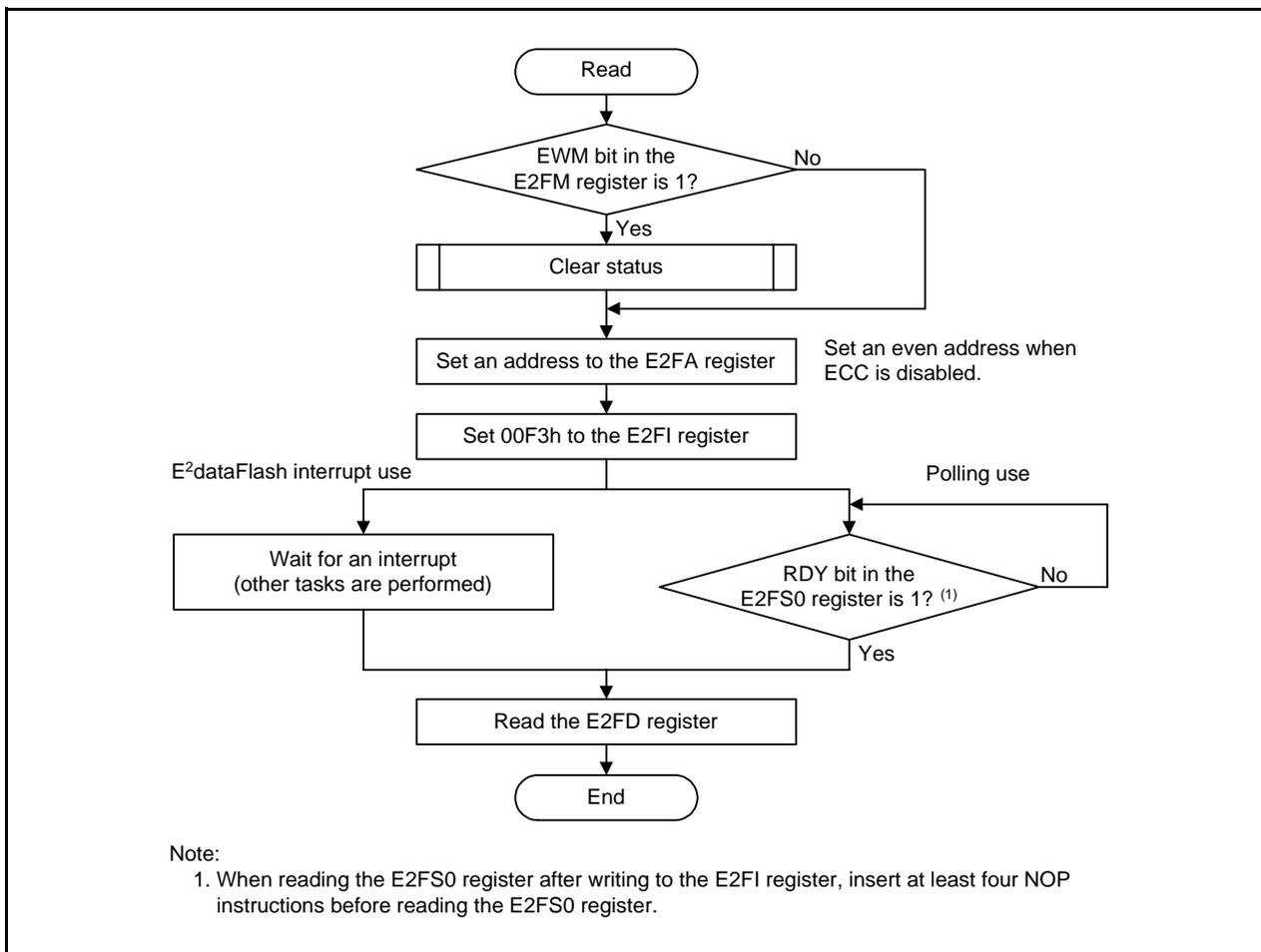


Figure 3.3 Read Operation Example

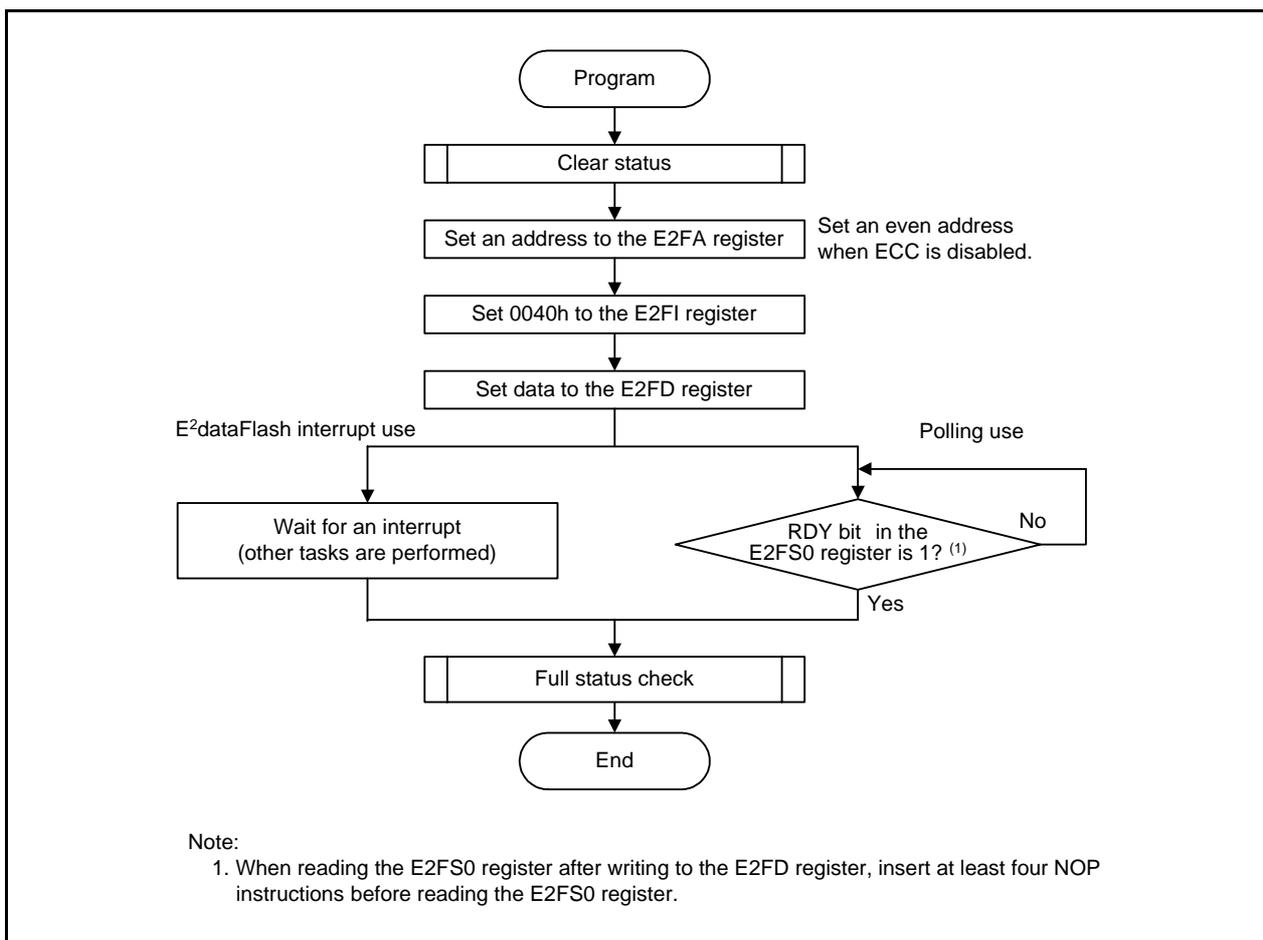


Figure 3.4 Program Operation Example

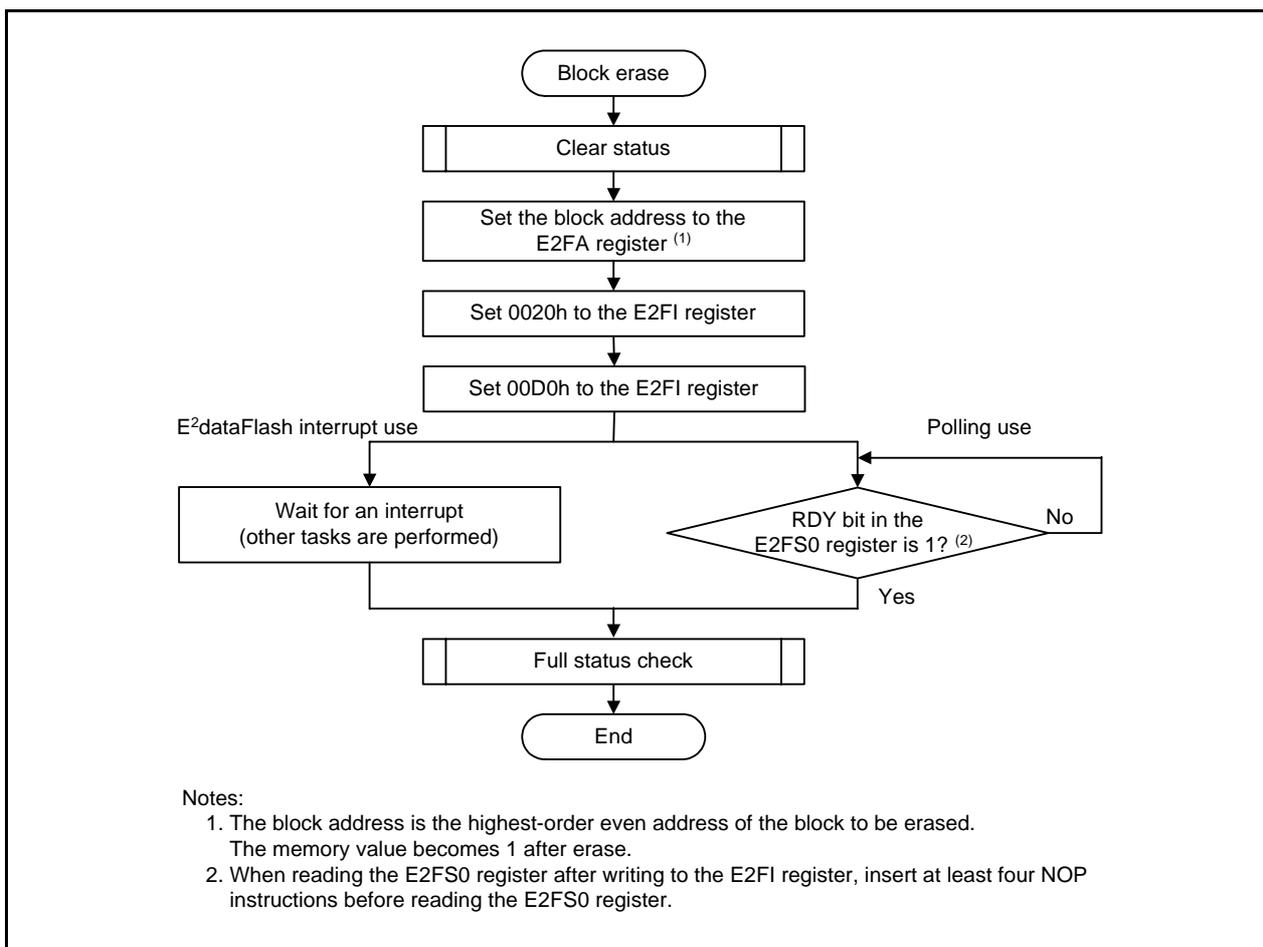


Figure 3.5 Block Erase Operation Example

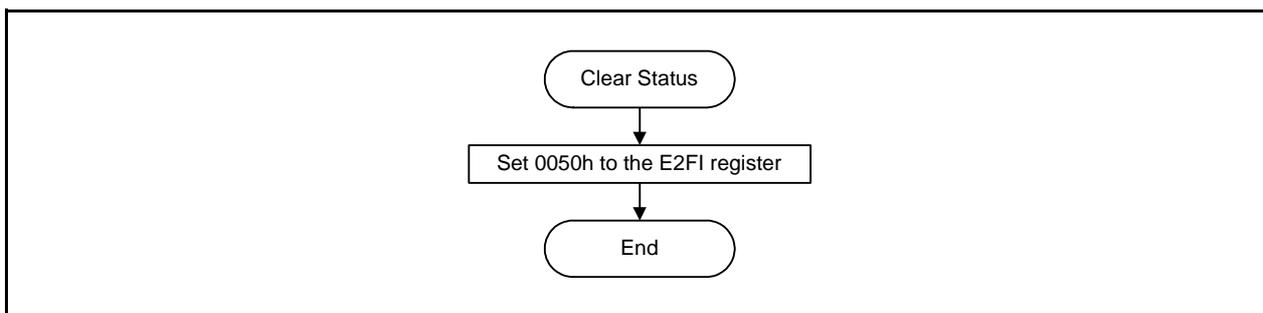
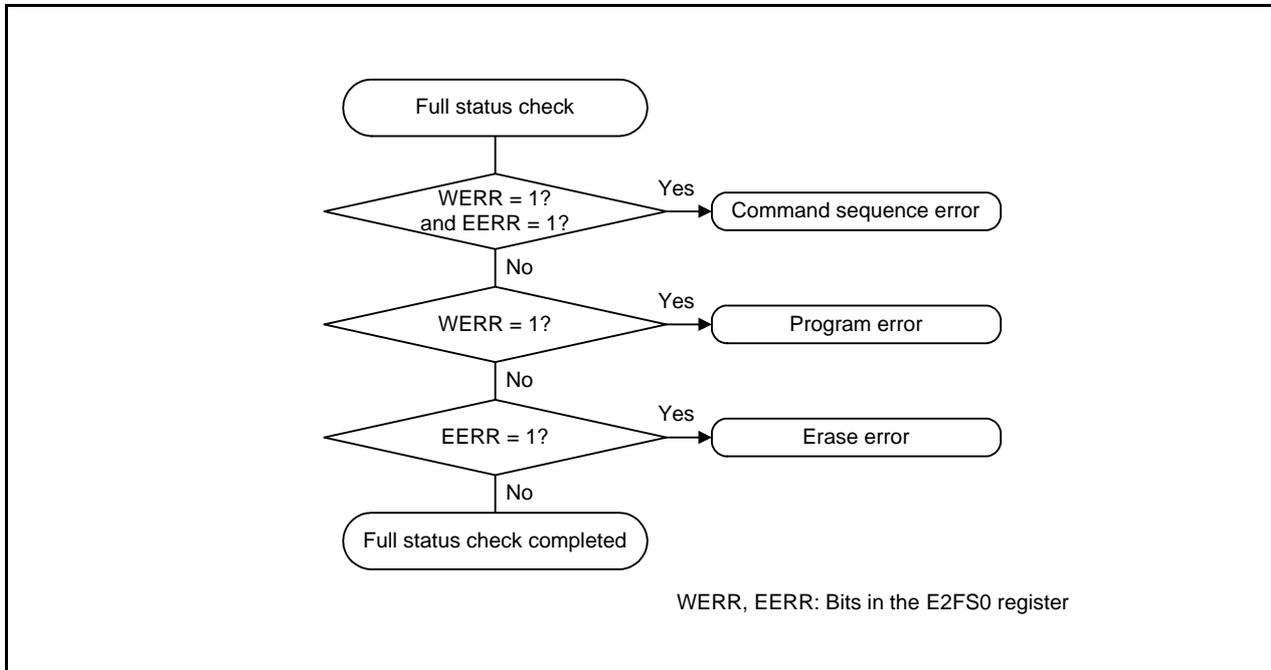


Figure 3.6 Clear Status Operation Example

### 3.4 Full Status Check

If an error occurs, the WERR or EERR bit in the E2FS0 register becomes 1, indicating the occurrence of an error. Therefore, the execution results can be confirmed by checking the status of these bits (full status check).

Figure 3.7 shows the Full Status Check.



**Figure 3.7 Full Status Check**

#### 3.4.1 Error Processing Procedures

When errors occur, follow the procedures below.

Do not execute the program command or block erase command when the WERR or EERR bit is 1 (completed in error). Execute each command after executing the clear status register command.

##### Command sequence error

- (1) Execute the clear status register command and set the WERR or EERR bit to 0 (no error).
- (2) Check to see that the command is written correctly and execute the command again.

A command sequence error occurs when writing data other than `xxD0h` and `xxFFh` in the second bus cycle of the block erase command. When writing `xxFFh` in the second bus cycle of the block erase command, the E<sup>2</sup>dataFlash becomes the state before executing the command, and the command code written in the first bus cycle is cancelled.

##### Erase error

- (1) Execute the clear status register command and set the EERR bit to 0 (no erase error).
- (2) Execute the block erase command again.

Execute (1) and (2) until an erase error does not occur.

If an error still occurs after executing (1) and (2) three times, do not use that block.

##### Program error

- (1) Execute the clear status register command and set the WERR bit to 0 (no write error).
- (2) Execute the block erase command.
- (3) Execute the program command.

If an error still occurs, do not use that address.

## 4. Application Example

The application example below shows E<sup>2</sup>dataFlash settings and usable area.

ECC: Disabled

Area used: Block 0 (14000h to 1401Fh)

### 4.1 Application Example Outline

The application example outline is as follows:

- (1) Initialize the CPU.
- (2) Initialize the E<sup>2</sup>dataFlash (ECC disabled).
- (3) Erase block 0. When an error occurs, retry three times.
- (4) If erasing is successful in step (3), set 32-byte data to block 0. If an error occurs, retry once.
- (5) If writing is successful in step (4), read 32-byte data in block 0, and store the data to RAM.

If erasing fails during step (3), the program function and read function will not be executed. If writing fails during step (4), the read function will not be executed.

Figure 4.1 shows an Application Example Operation Outline.

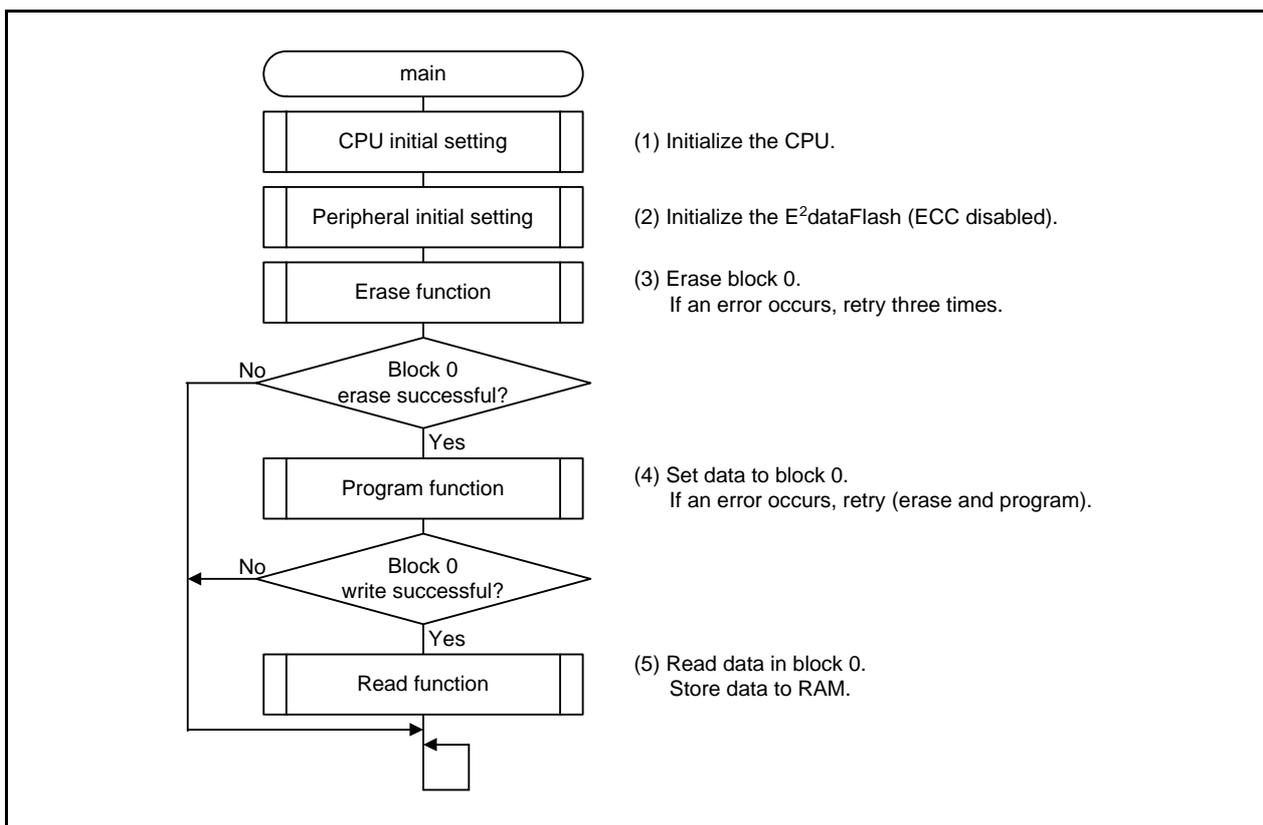


Figure 4.1 Application Example Operation Outline

## 4.2 Data Type Definition

This application note uses a data type that is redefined using typedef. Table 4.1 lists the Redefined Data Type.

**Table 4.1 Redefined Data Type**

Data Type	Original Definition Data Type	Sign	Byte Length
int8_t	signed char	Signed	1
uint8_t	unsigned char	Unsigned	1
int16_t	signed short	Signed	2
uint16_t	unsigned short	Unsigned	2
int32_t	signed long	Signed	4
uint32_t	unsigned long	Unsigned	4

### 4.3 Function Tables

Declaration	void make_data(uint16_t *data)	
Outline	Make write data	
Argument	Argument name	Meaning
	uint16_t *data	Write data table start address
Variable (global)	None	
Returned value	None	
Function	Creates 32-byte (1 word add space between x and 16) data to write to block 0 in the E <sup>2</sup> dataFlash. The sample program uses values from 0000h to 000Fh.	

Declaration	uint8_t erase_function(void)		
Outline	Erase function		
Argument	None		
Variable (global)	None		
Returned value	Type	Value	Meaning
	uint8_t	SUCCESS	Erase successful
		FAIL	Erase failed
Function	Executes the block erase operation. When the erase operation is completed, the returned value will be SUCCESS (erase successful). When an error occurs during the erase operation, if an error still occurs after retrying three times, the returned value will be FAIL (erase failed).		

Declaration	uint8_t block_erase_operation(uint16_t far* address)		
Outline	Block erase operation		
Argument	Argument name	Meaning	
	uint16_t far* address	The highest-order even address of the block to be erased.	
Variable (global)	None		
Returned value	Type	Value	Meaning
	uint8_t	SUCCESS	Erase successful
		FAIL	Erase failed
Function	Executes the block erase command, and erases the specified block. After erasing, executes the full status check.		

Declaration	uint8_t program_function(uint16_t *program_data)		
Outline	Program function		
Argument	Argument name	Meaning	
	uint16_t *program_data	Write data address	
Variable (global)	None		
Returned value	Type	Value	Meaning
	uint8_t	SUCCESS	Write successful
FAIL		Write failed	
Function	Executes program operation. When the write operation is completed, the returned value will be SUCCESS (write successful). If an error occurs during the write operation, the erase function is executed, and the program operation is executed again. Even if an error still occurs, the returned value will be FAIL (write failed).		

Declaration	uint8_t program_operation(uint16_t far* address, uint16_t program_data)		
Outline	Program operation		
Argument	Argument name	Meaning	
	uint16_t far* address	Write address to E <sup>2</sup> dataFlash	
	uint16_t program_data	2-byte write data	
Variable (global)	None		
Returned value	Type	Value	Meaning
	uint8_t	SUCCESS	Write successful
		FAIL	Write failed
Function	Executes the program command, and writes data to the specified address. After writing, executes the full status check.		

Declaration	void read_function(void)	
Outline	Read function	
Argument	None	
Variable (global)	Variable name	Contents
	uint16_t read_buff[i]	Array to store the read data
Returned value	None	
Function	Executes the read operation, and reads the data in block 0. Stores the read data in RAM.	

Declaration	uint16_t read_operation(uint16_t far* address)		
Outline	Read operation		
Argument	Argument name	Meaning	
	uint16_t far* address	Read address of E <sup>2</sup> dataFlash	
Variable (global)	None		
Returned value	Type	Value	Meaning
	uint16_t	0x0000 to 0xFFFF	2-byte read data
Function	Executes the read command, and reads the data in the specified address. Returned value will be 2-byte data read from the E2FD register.		

Declaration	void clear_status(void)	
Outline	Clear status operation	
Argument	None	
Variable (global)	None	
Returned value	None	
Function	Executes the clear status register command.	

Declaration	uint8_t full_status_check(void)		
Outline	Full status check		
Argument	None		
Variable (global)	None		
Returned value	Type	Value	Meaning
	uint8_t	COMPLETE	No error
		CMD_SEQ_ERR	Command sequence error
		PRG_ERR	Program error
ERS_ERR		Erase error	
Function	Executes the full status check, and returns the result.		

### 4.4 Sample Program Flowchart

Figure 4.2 to Figure 4.11 show sample program flowcharts.

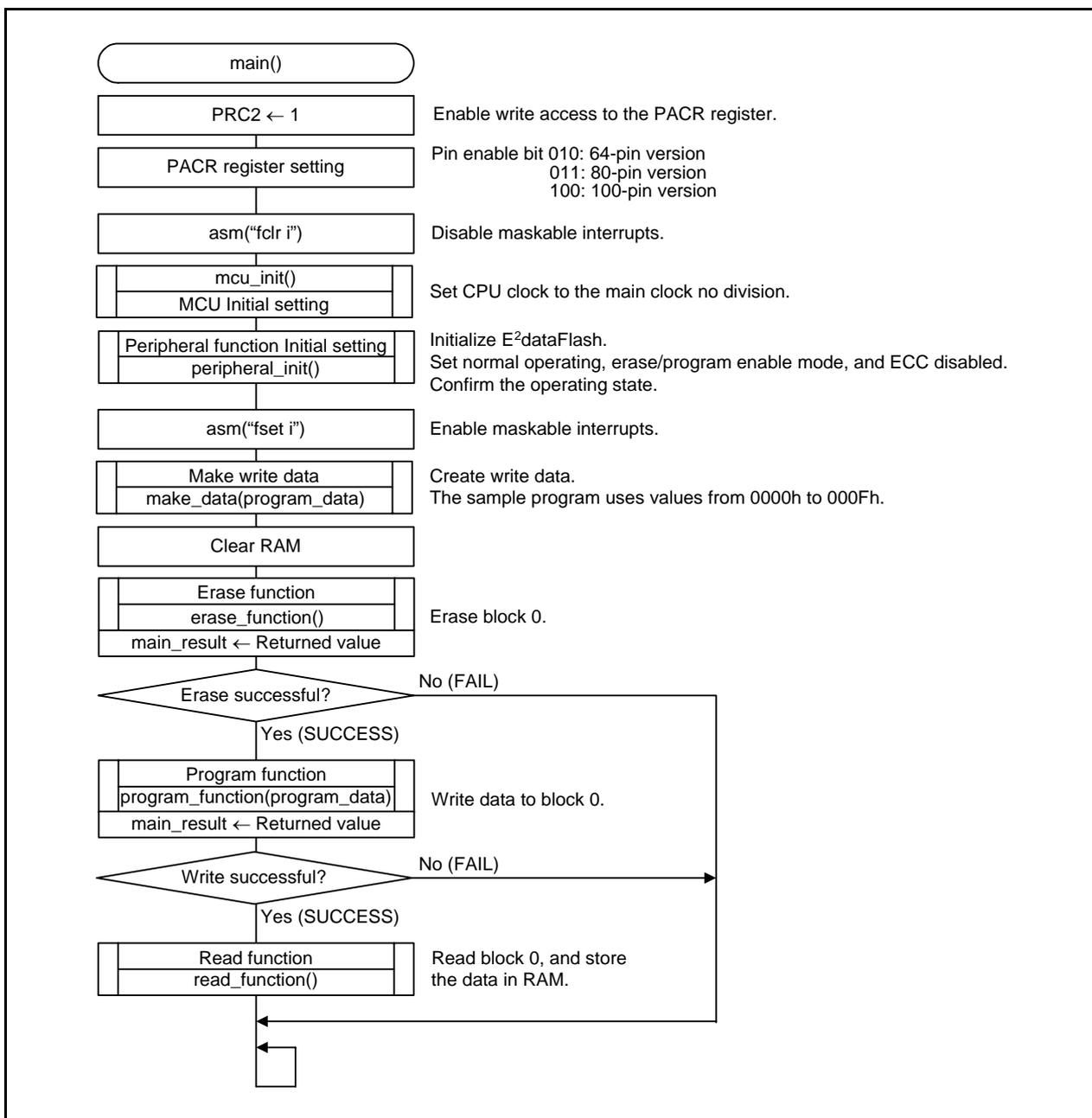


Figure 4.2 Main Program

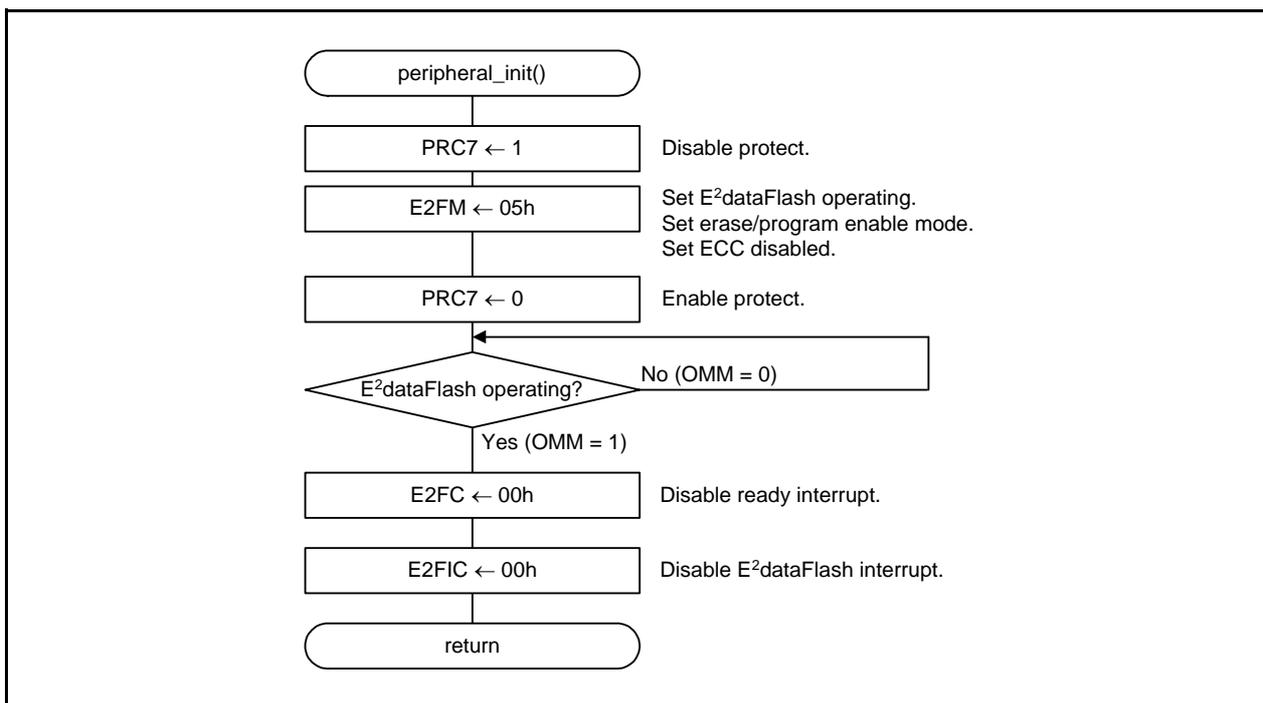


Figure 4.3 Peripheral Function Initial Setting

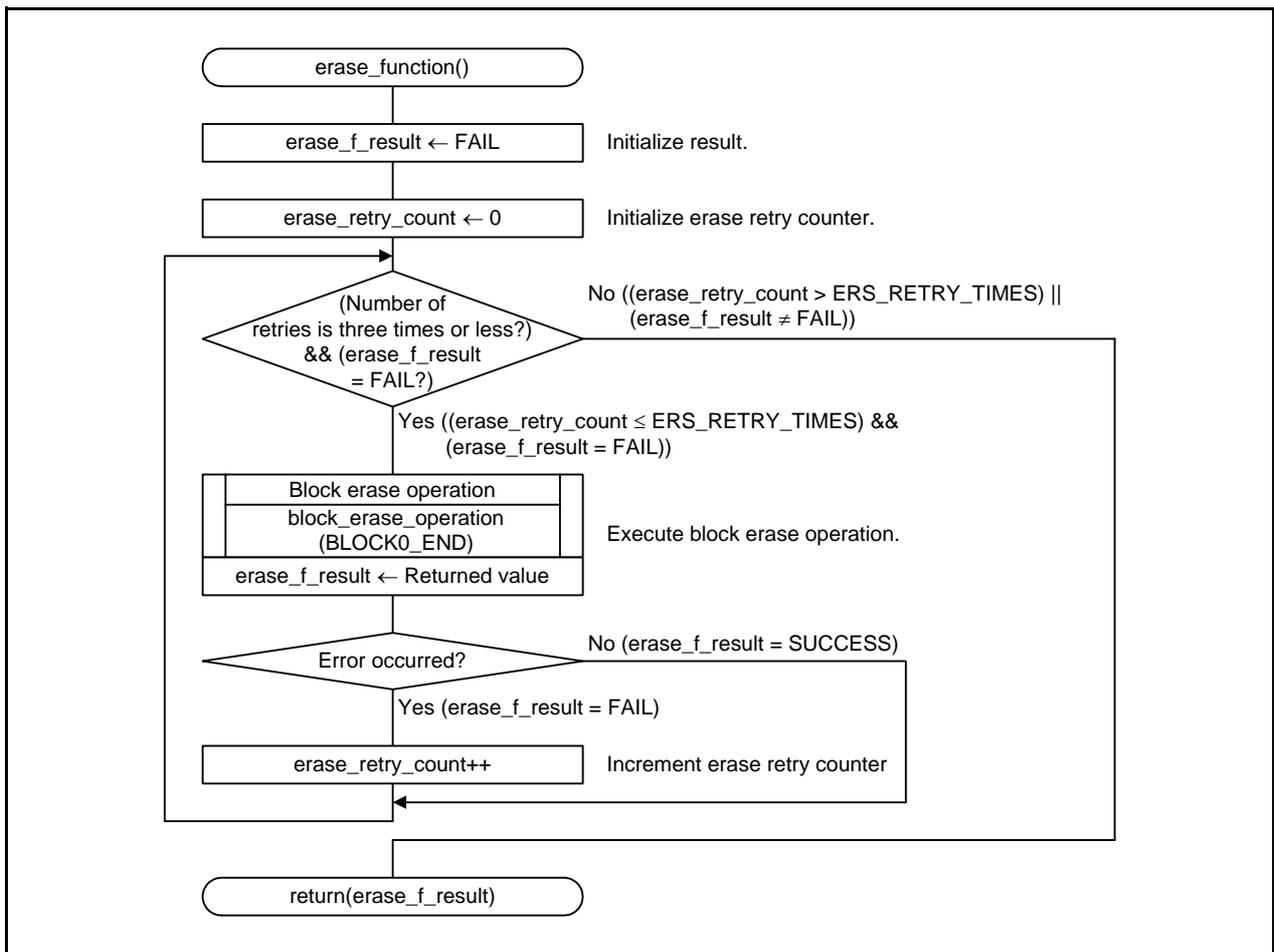
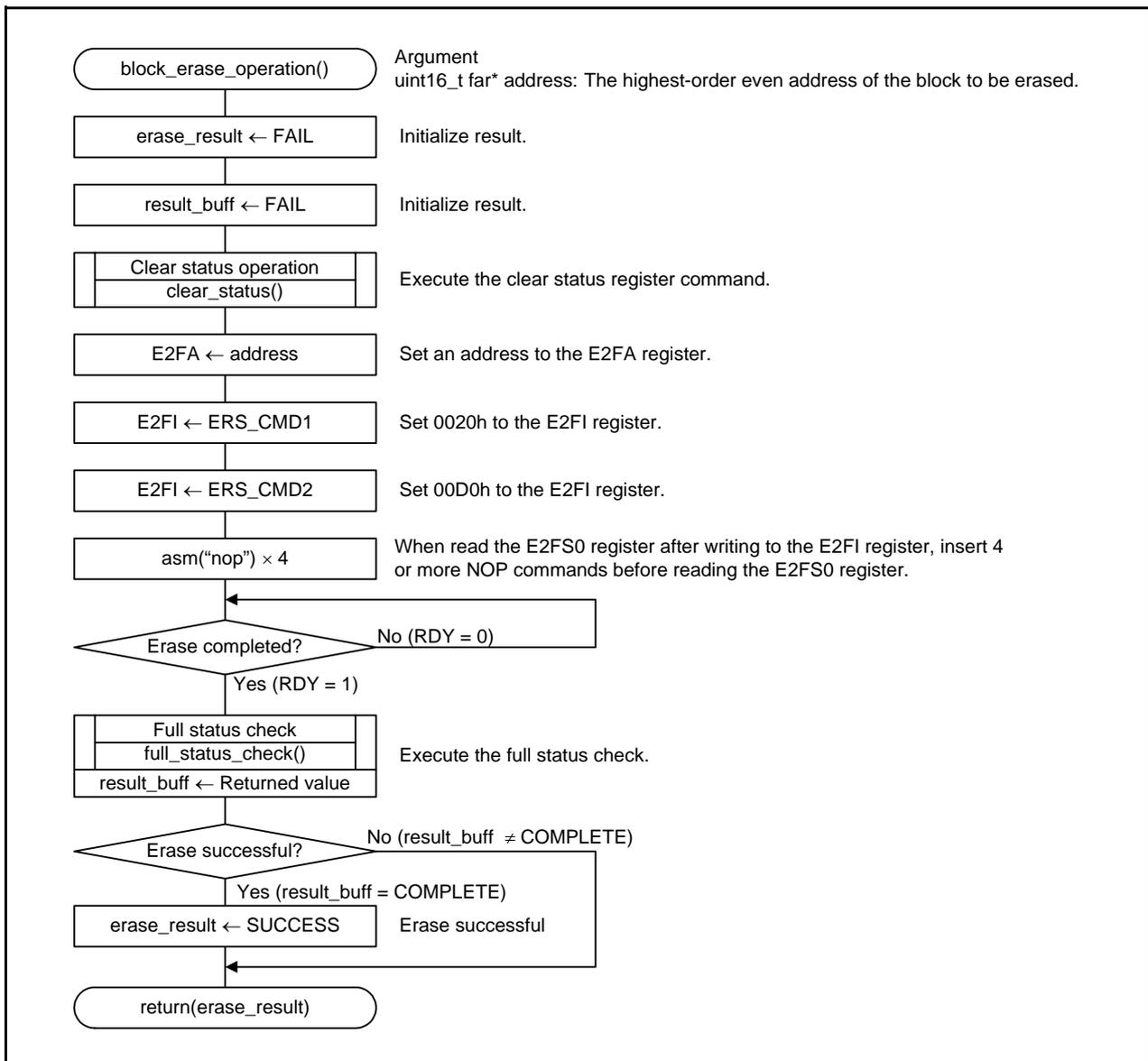


Figure 4.4 Erase Function



**Figure 4.5 Block Erase Operation**

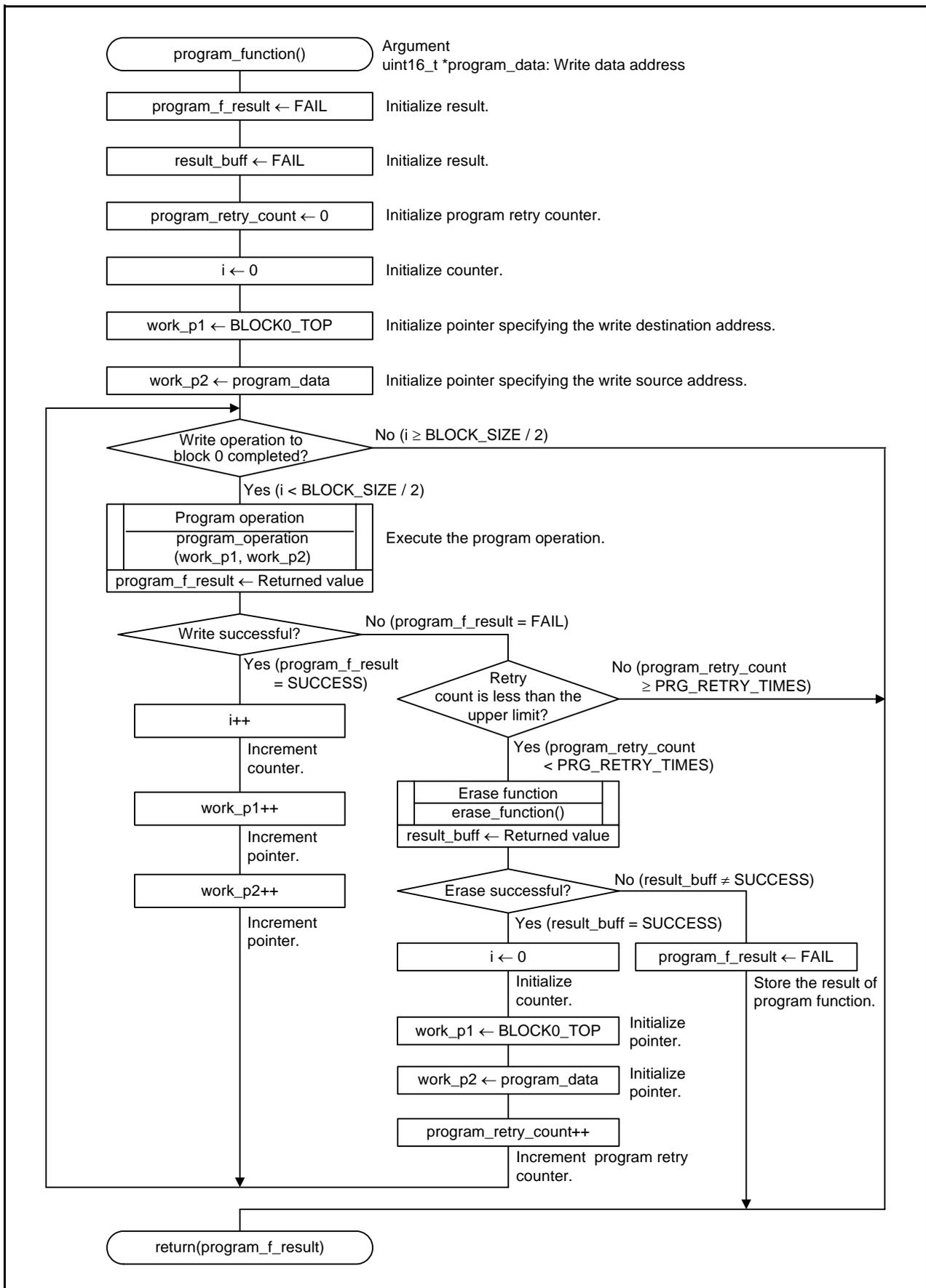


Figure 4.6 Program Function

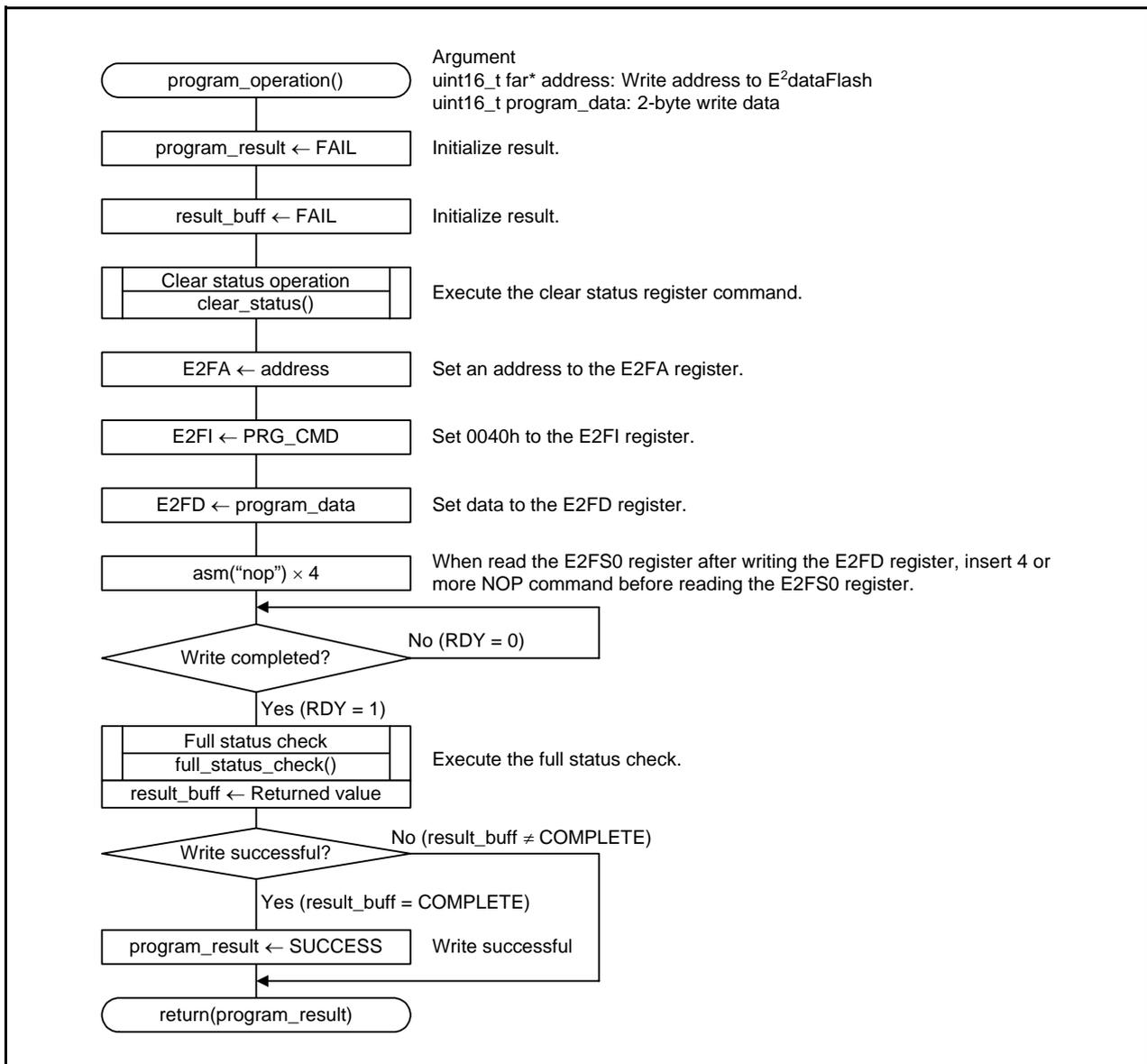


Figure 4.7 Program Operation

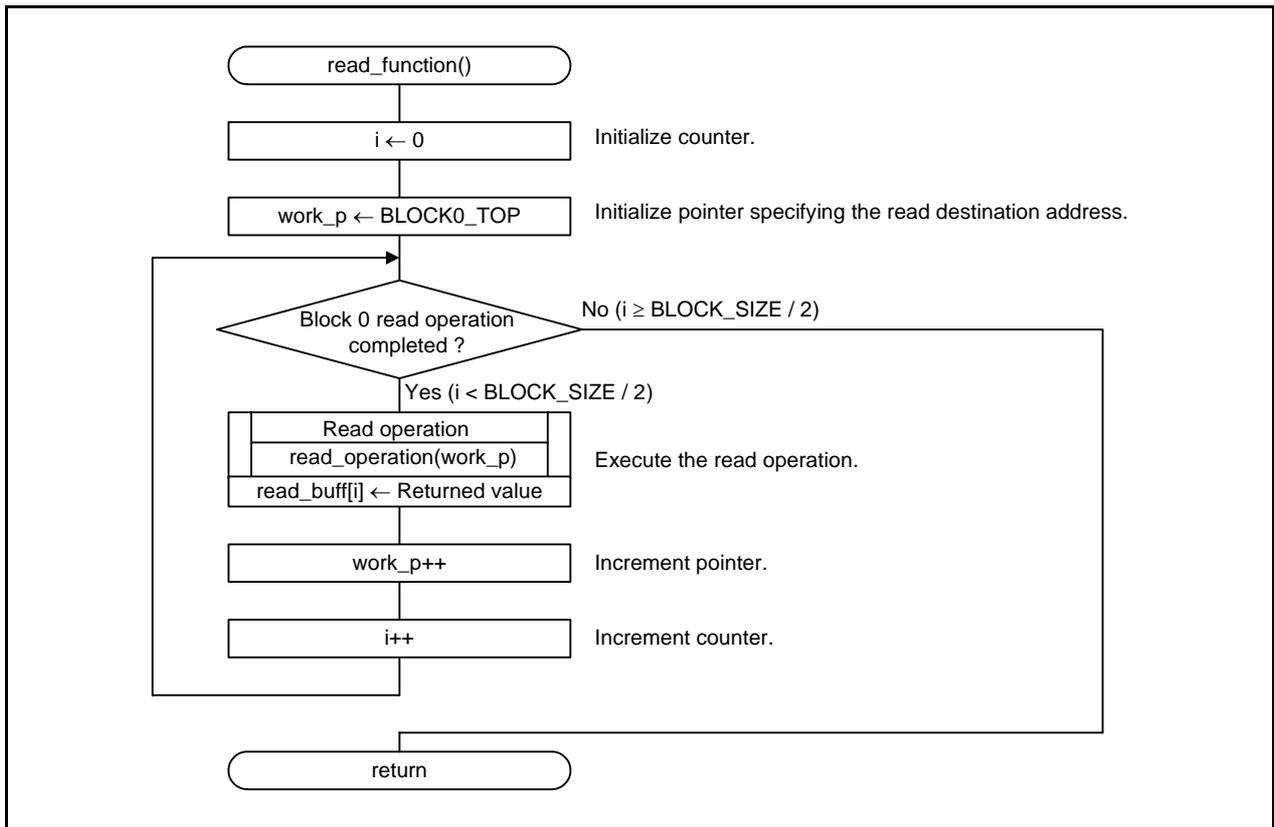


Figure 4.8 Read Function

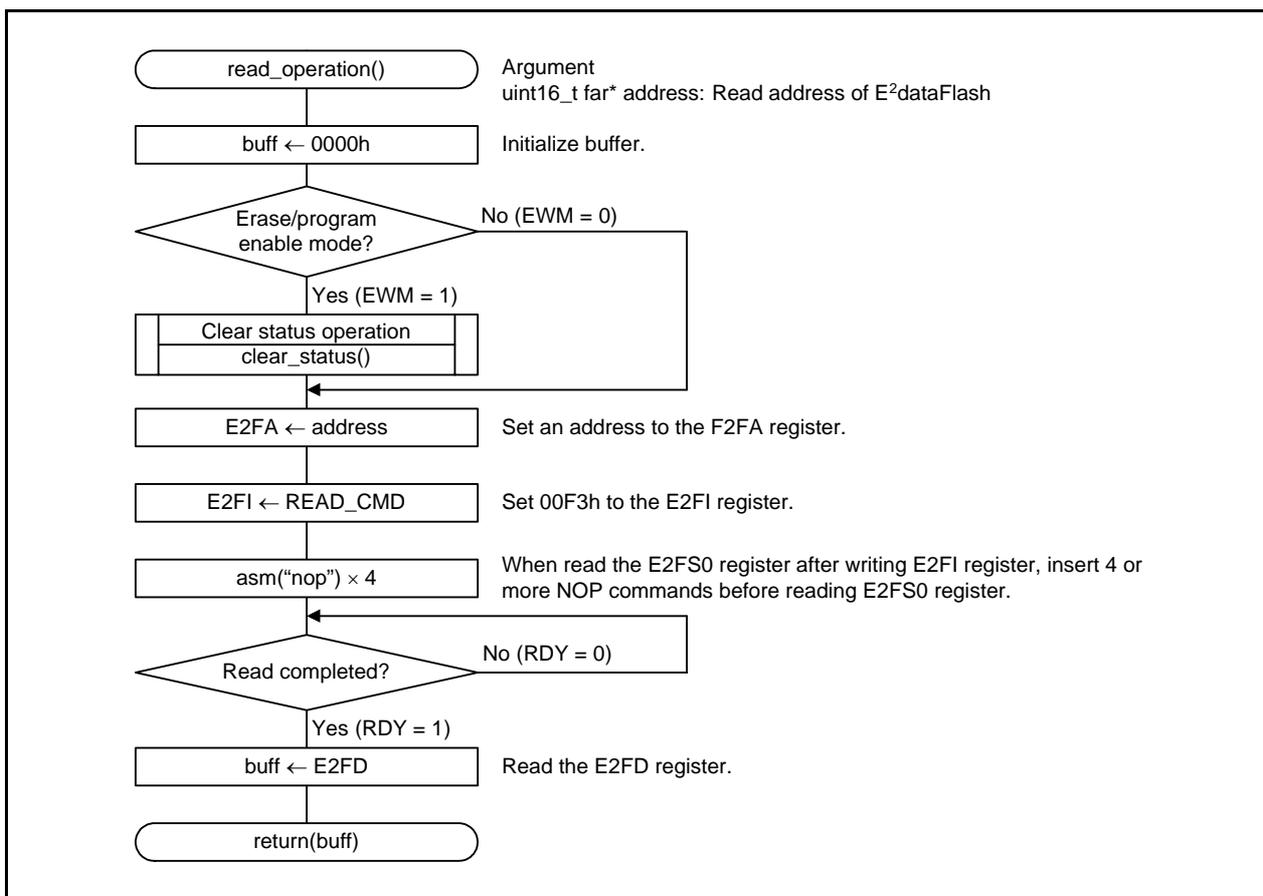


Figure 4.9 Read Operation

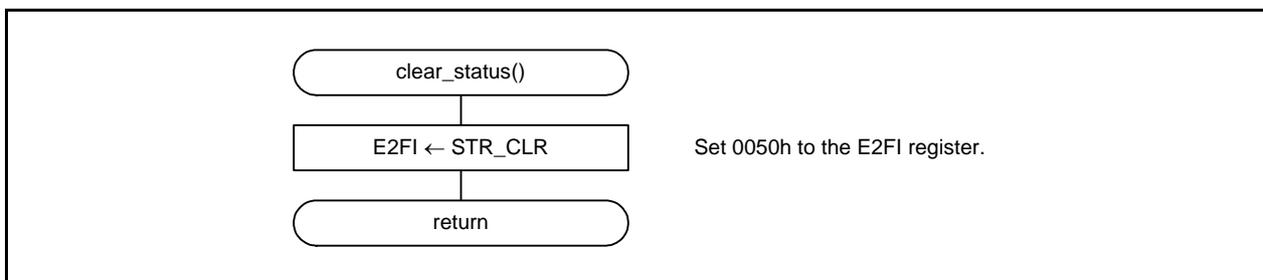


Figure 4.10 Clear Status Operation

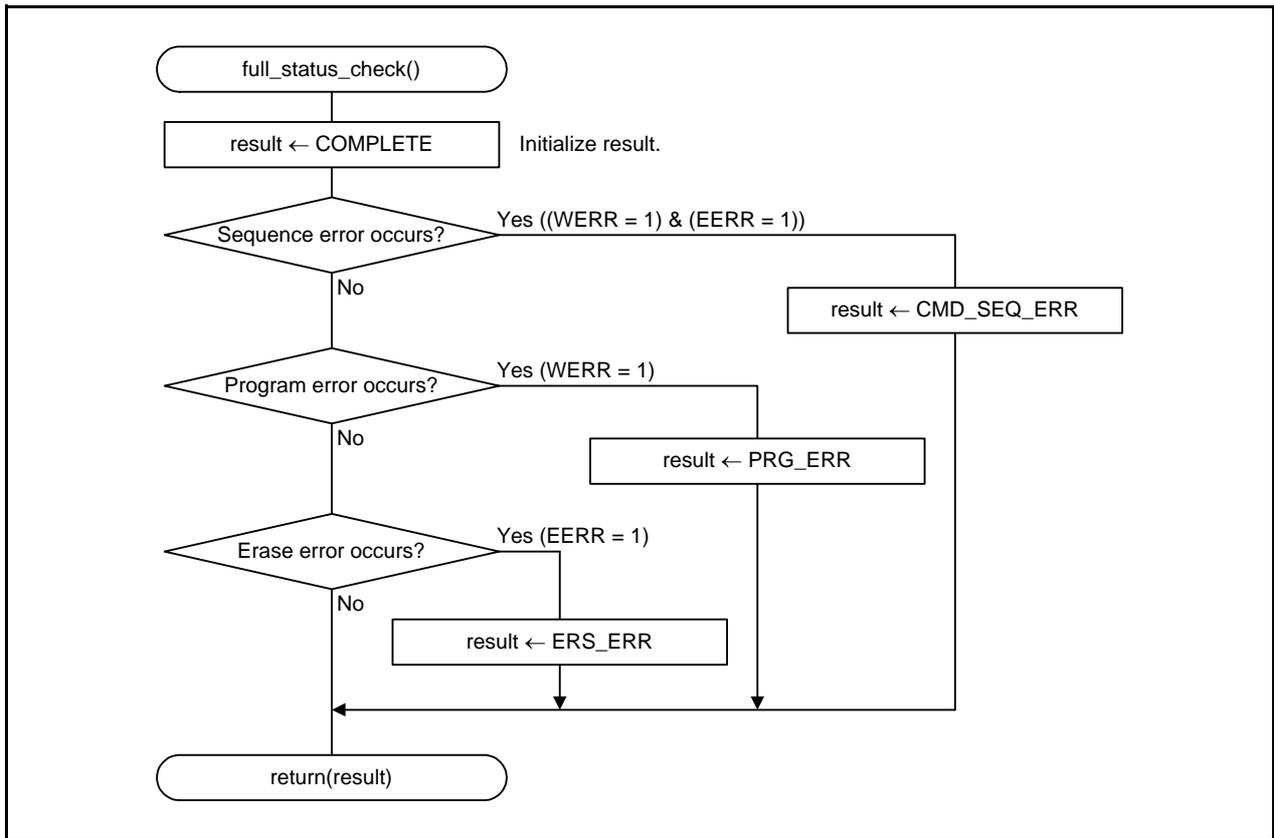


Figure 4.11 Full Status Check

## 5. Sample Program

A sample program can be downloaded from the Renesas Electronics website.

To download, click “Application Notes” in the left-hand side menu of the M16C Family page.

## 6. Reference Documents

Application Note

M16C/5M Group User’s Manual: Hardware Rev.1.01

The latest version can be downloaded from the Renesas Electronics website.

Technical News/Technical Update

The latest information can be downloaded from the Renesas Electronics website.

C Compiler Manual

M16C Series, R8C Family C Compiler Package V.5.45

C Compiler User’s Manual Rev.2.00

The latest version can be downloaded from the Renesas Electronics website.

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Revision History	M16C/5M Group Using the E <sup>2</sup> PROM Emulation Data Flash
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Rev.	Date	Description	
		Page	Summary
1.00	Dec 15, 2010	—	First edition issued

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### 1. Handling of Unused Pins

Handle unused pins in accord with the directions given under Handling of Unused Pins in the manual.

- The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible. Unused pins should be handled as described under Handling of Unused Pins in the manual.

### 2. Processing at Power-on

The state of the product is undefined at the moment when power is supplied.

- The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the moment when power is supplied.

In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the moment when power is supplied until the reset process is completed.

In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the moment when power is supplied until the power reaches the level at which resetting has been specified.

### 3. Prohibition of Access to Reserved Addresses

Access to reserved addresses is prohibited.

- The reserved addresses are provided for the possible future expansion of functions. Do not access these addresses; the correct operation of LSI is not guaranteed if they are accessed.

### 4. Clock Signals

After applying a reset, only release the reset line after the operating clock signal has become stable. When switching the clock signal during program execution, wait until the target clock signal has stabilized.

- When the clock signal is generated with an external resonator (or from an external oscillator) during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Moreover, when switching to a clock signal produced with an external resonator (or by an external oscillator) while program execution is in progress, wait until the target clock signal is stable.

### 5. Differences between Products

Before changing from one product to another, i.e. to one with a different part number, confirm that the change will not lead to problems.

- The characteristics of MPU/MCU in the same group but having different part numbers may differ because of the differences in internal memory capacity and layout pattern. When changing to products of different part numbers, implement a system-evaluation test for each of the products.

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