R32C/100 Series

Using the E2PROM Emulation Data Flash

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1. Abstract

This document describes the setting method and an application example of the E2PROM emulation data flash (hereafter referred to as E2dataFlash) in the R32C/100 Series.

2. Introduction

The application example described in this document applies to the following microcomputers (MCUs) embedded with E2dataFlash:

- MCUs: R32C/120 Group, R32C/121 Group, R32C/151 Group, R32C/152 Group, R32C/153 Group, R32C/156 Group, R32C/157 Group, R32C/160 Group, and R32C/161 Group

This application note can be used with the above MCUs. Check the user's manuals for any modifications to functions. Careful evaluation is recommended before using the program described in this application note.

3. Overview

The E2dataFlash is a data flash that utilizes the strengths of serial E2PROMs. The units erased are considerably smaller than that of the data flash, and the E2dataFlash can be programmed or erased without stopping the CPU.
Table 3.1 lists the E2dataFlash Specifications.

Table 3.1 E2dataFlash Specifications

Item	Specification	
	ECC disabled	ECC enabled
Memory size	4 Kbytes or 8 Kbytes (1)	2 Kbytes or 4 Kbytes (1)
Block size	32 bytes	16 bytes
Number of blocks	128 blocks or 256 blocks (1)	
Unit to be programmed	2 bytes	1 byte
Unit to be erased	1 block	
How to control program and erase	By software commands	
Software commands	4	
Error correction	None	1-bit error correctable

ECC: Error Check and Correct
Note:
1. Refer to individual hardware user's manuals to check individual E2dataFlash sizes.

3.1 Block Configuration

Memory size of the E2dataFlash is described assumes 4 Kbytes.
When ECC is disabled, the E2dataFlash consists of 32 bytes × 128 blocks of flash memory and 16 bytes × 128 blocks when ECC is enabled.
Figure 3.1 shows the E2dataFlash Memory Configuration.

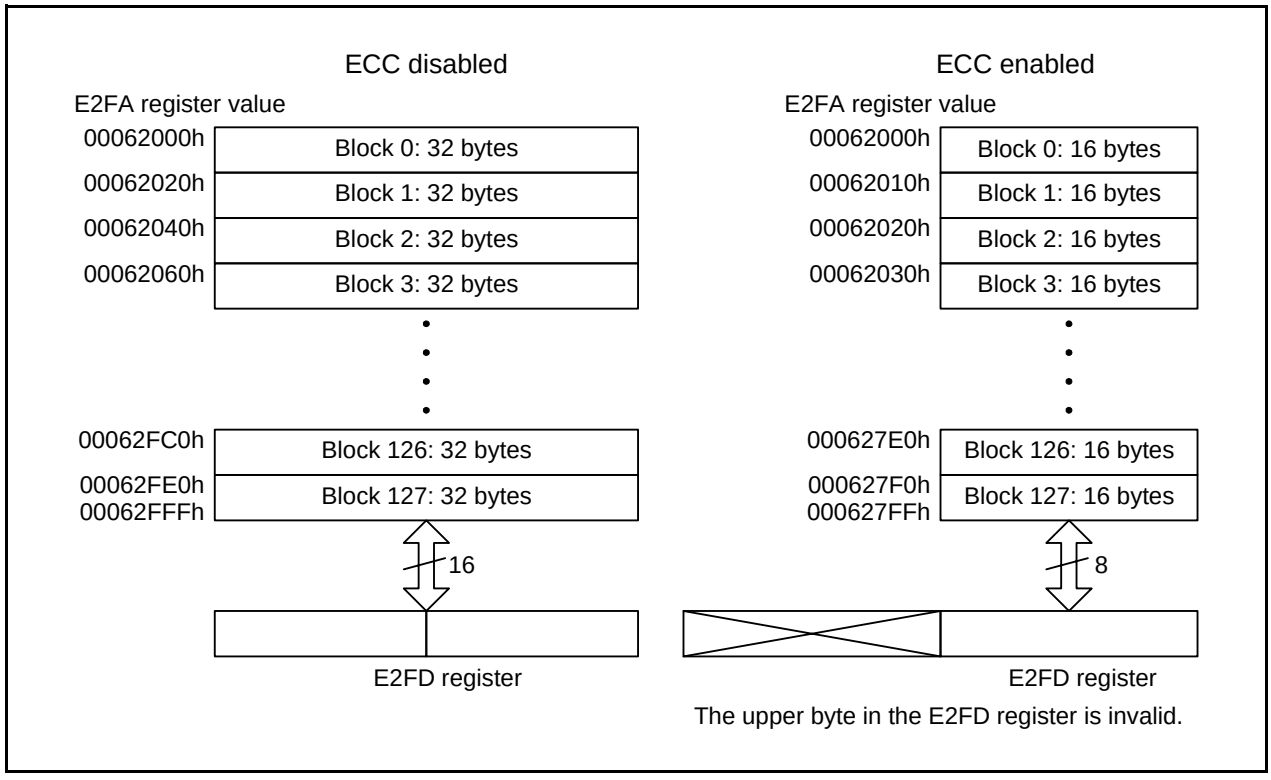
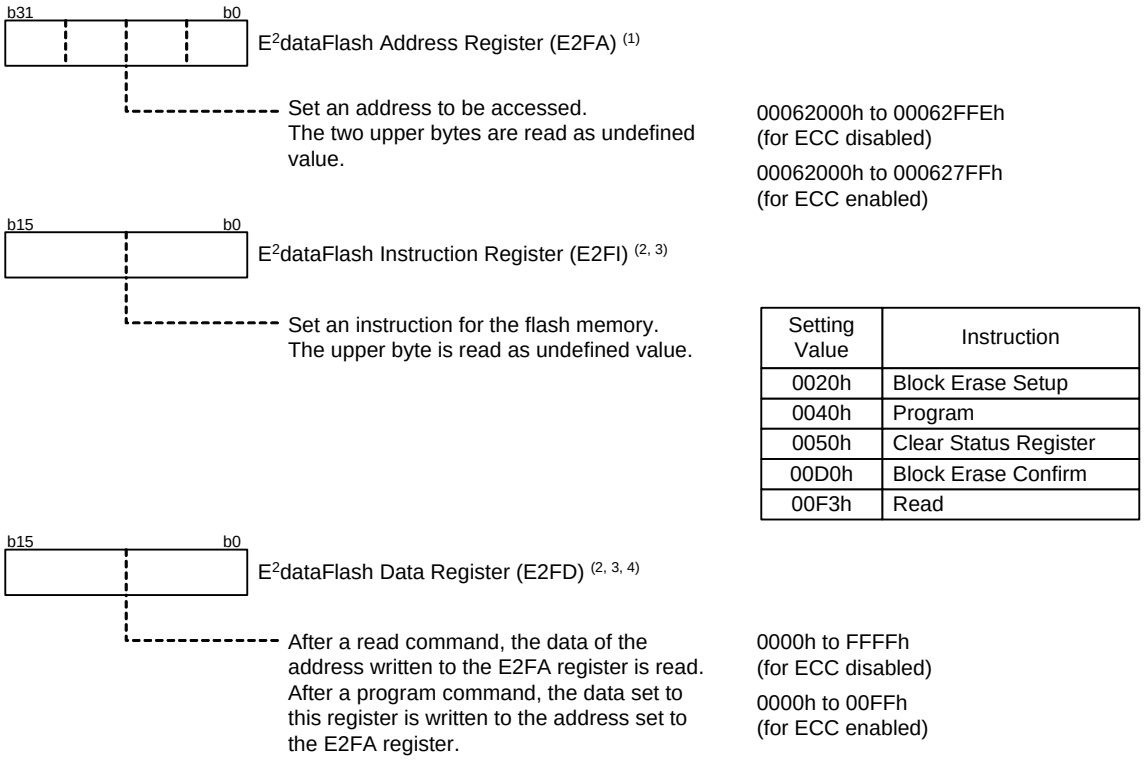


Figure 3.1 E2dataFlash Memory Configuration

3.2 E2dataFlash Access Method

The CPU indirectly accesses the E2dataFlash via registers E2FA, E2FI, and E2FD that are allotted for SFR space. Figure 3.2 shows Registers E2FA, E2FI, and E2FD.



Setting Value	Instruction
0020h	Block Erase Setup
0040h	Program
0050h	Clear Status Register
00D0h	Block Erase Confirm
00F3h	Read

Notes:
1. When the ECC bit in the E2FM register is 0 (ECC disabled), set the E2FA register to an even address (LSB is 0) to write or read the E2dataFlash. When erasing, set the highest-order even address of the corresponding block.
2. A 16-bit write/read access to this register should be performed.
3. Two values need to be written for block erase.
   When writing to the E2FI register, check that the RDY bit in the E2FS0 register is 1.
4. In a program operation, the data should be written after 0040h is set to the E2FI register.

Figure 3.2 Registers E2FA, E2FI, and E2FD

3.3 Operational Procedures

When operating the E2dataFlash, 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 internal ROM (including data area). Do not overwrite data to an address that has already been written.

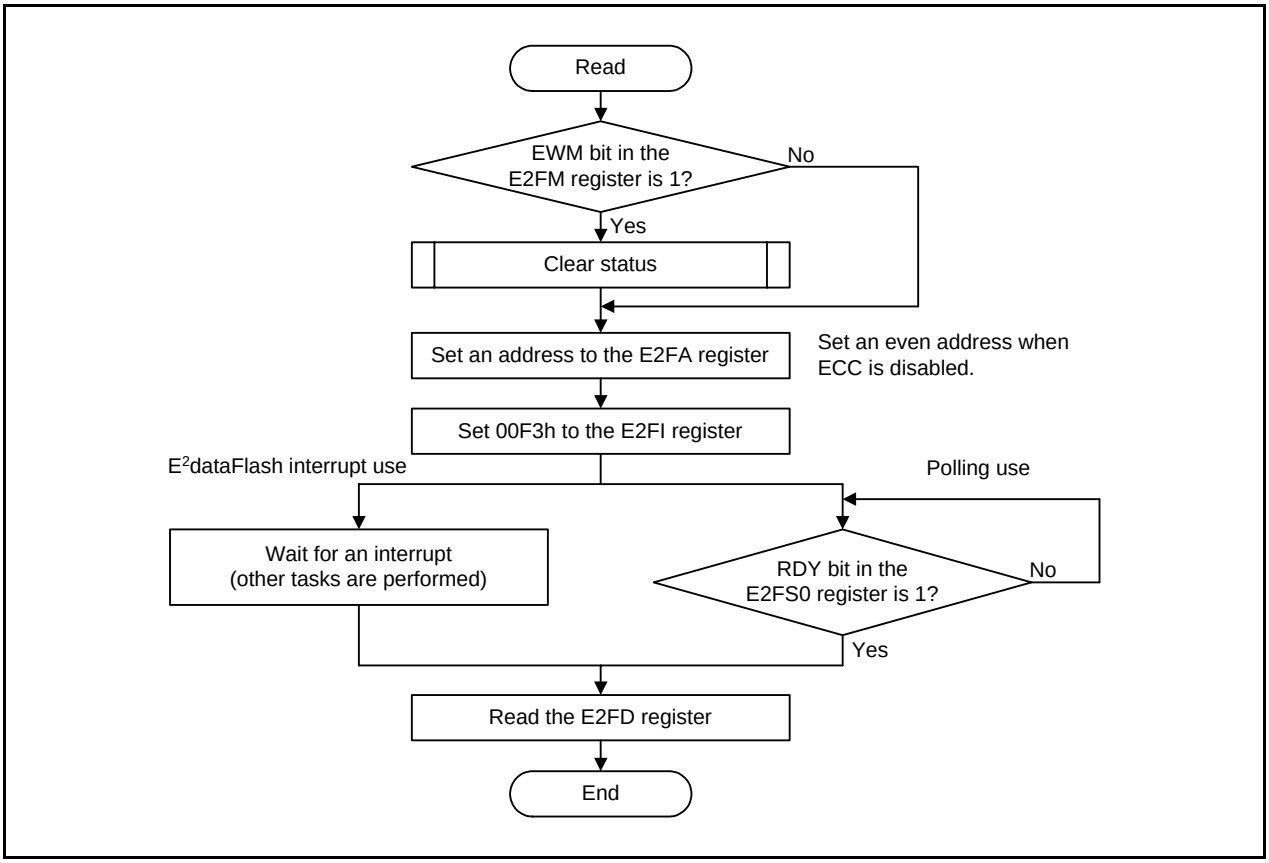


Figure 3.3 Read Operation Example

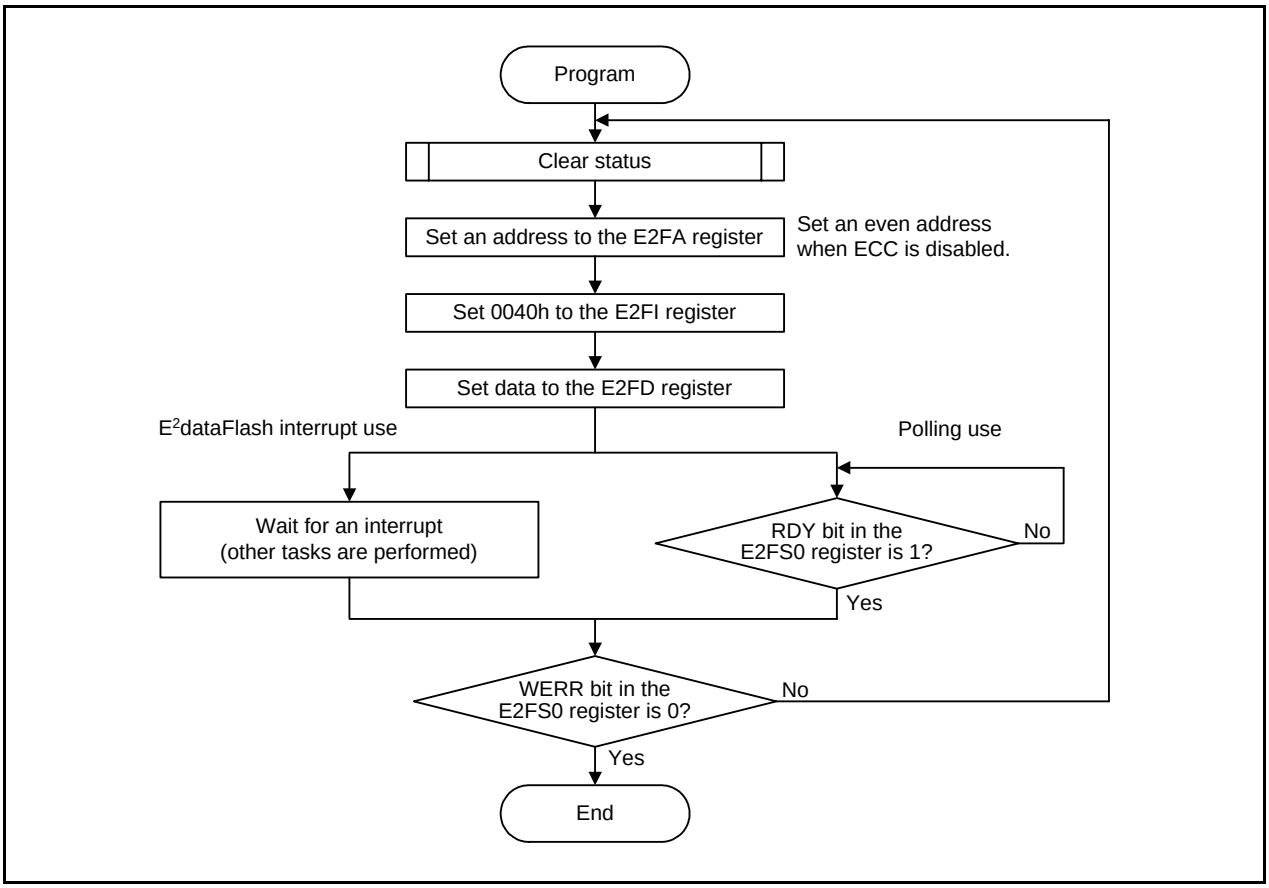


Figure 3.4 Program Operation Example

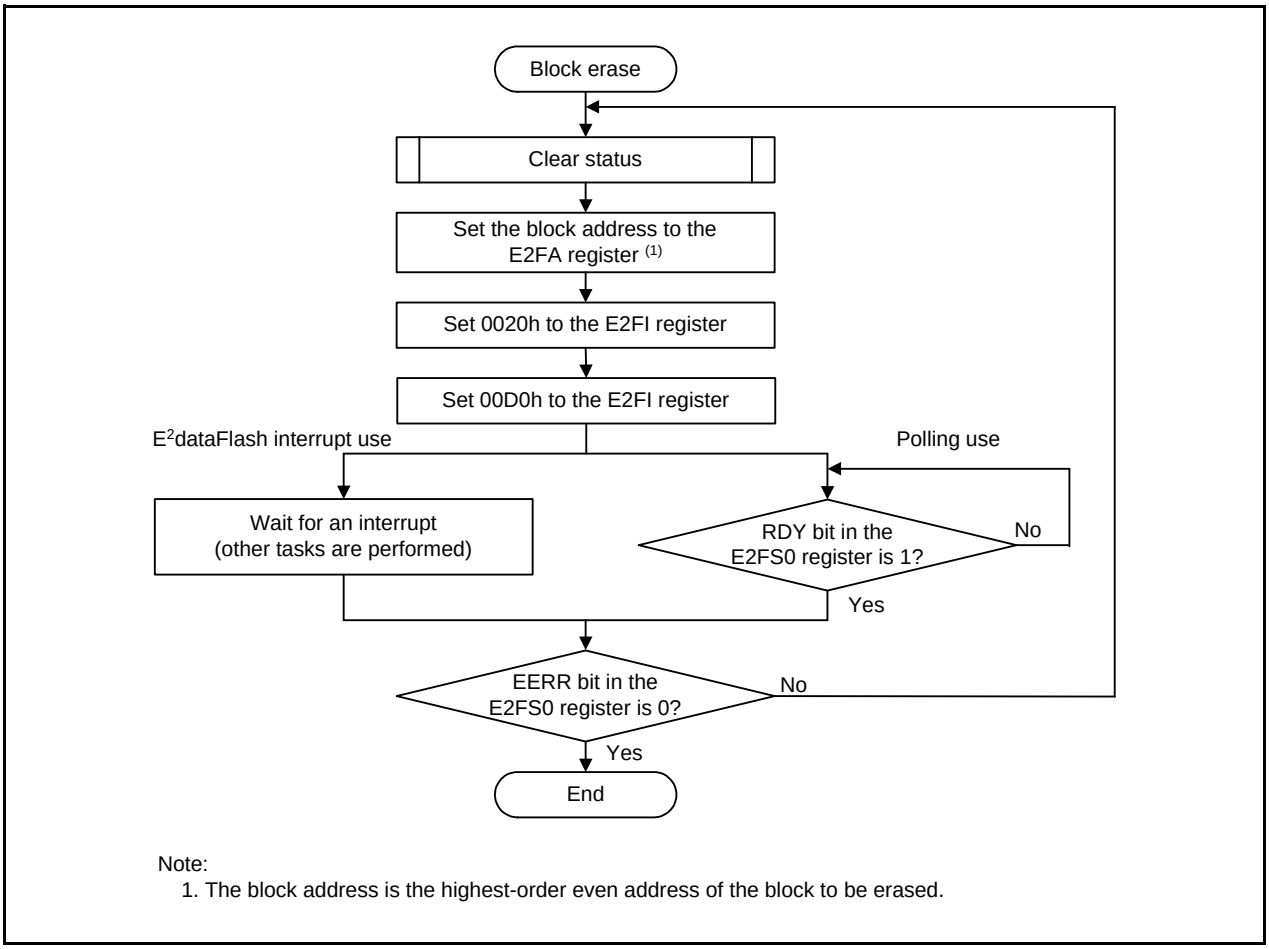


Figure 3.5 Block Erase Operation Example

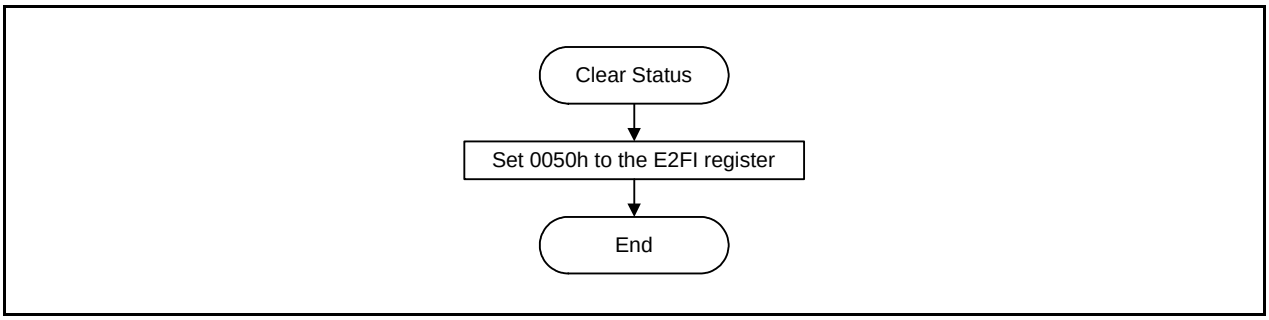


Figure 3.6 Clear Status Operation Example

4. Application Example

The application example below shows E2dataFlash settings and usable area.

ECC: Disabled
Area used: Block 0 (00062000h to 0006201Fh)

4.1 Application Example Outline

The application example outline is as follows:
(1) Initialize the CPU.
(2) Initialize the E2dataFlash (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.

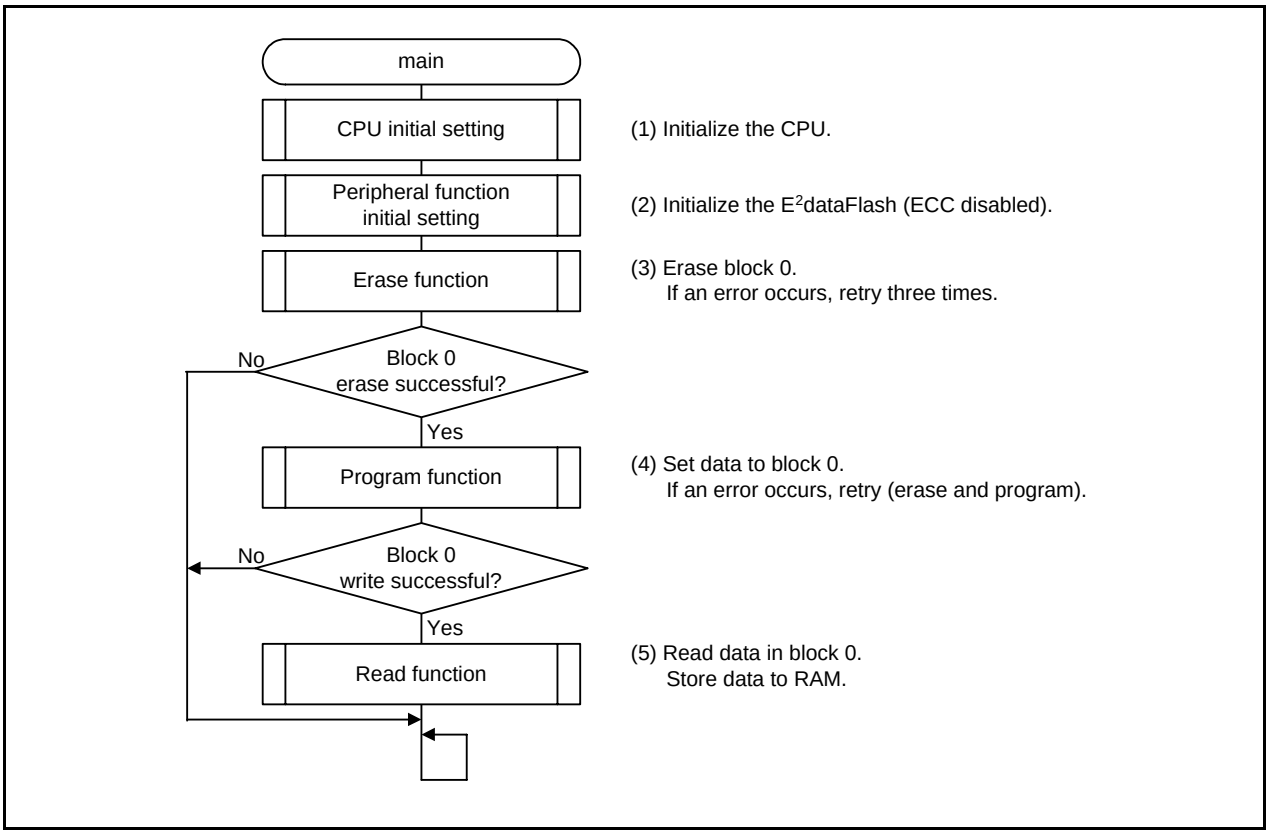


Figure 4.1 Application Example Operation Outline

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 × and 16) data to write to block 0 in the E2dataFlash. 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, checks whether an erase error occurred.		

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 E2dataFlash	
	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, check whether a program error occurred.		

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 E2dataFlash
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.

4.4 Sample Program Flowchart

Figure 4.2 to Figure 4.10 show sample program flowcharts.

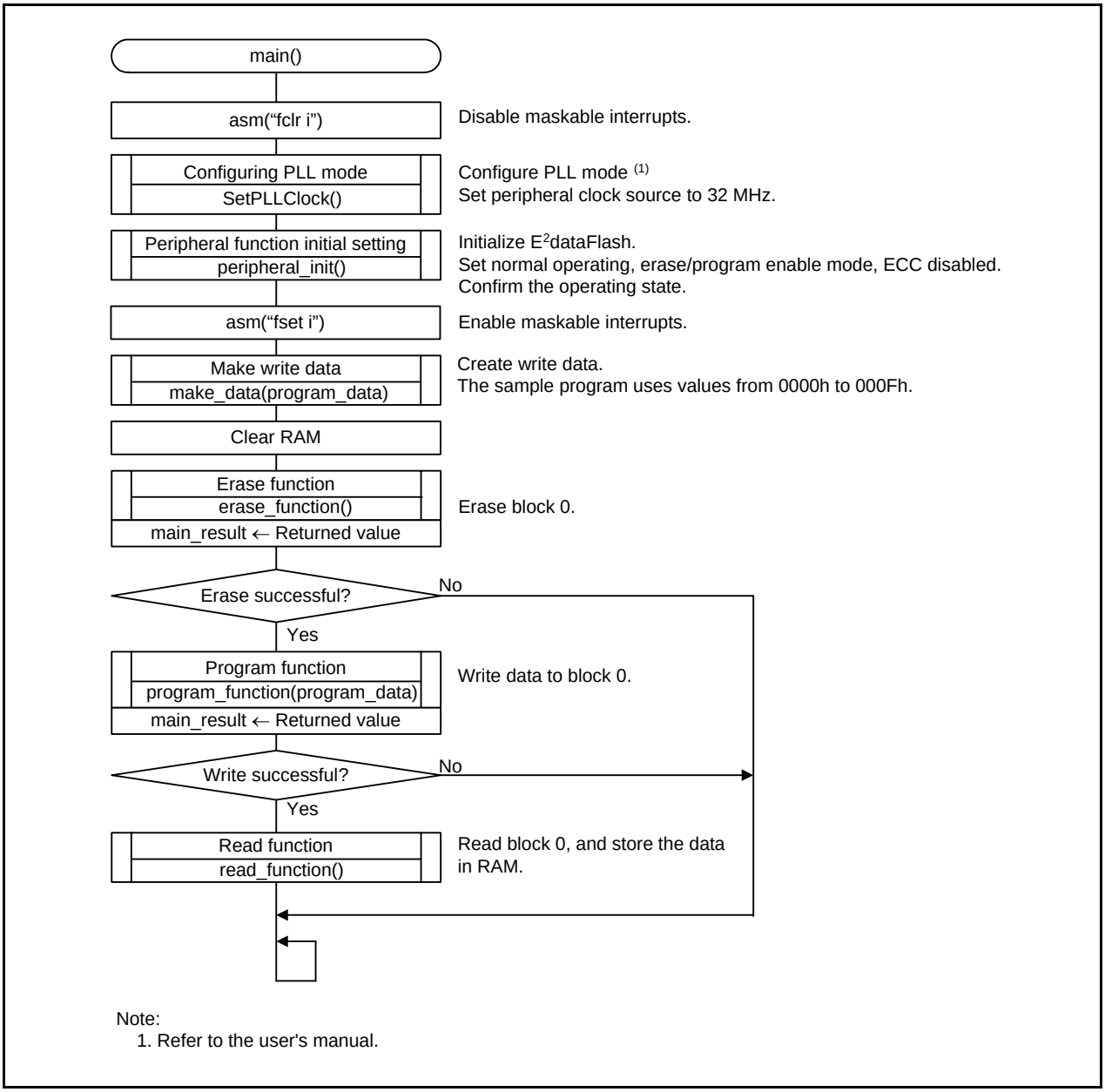


Figure 4.2 Main Program

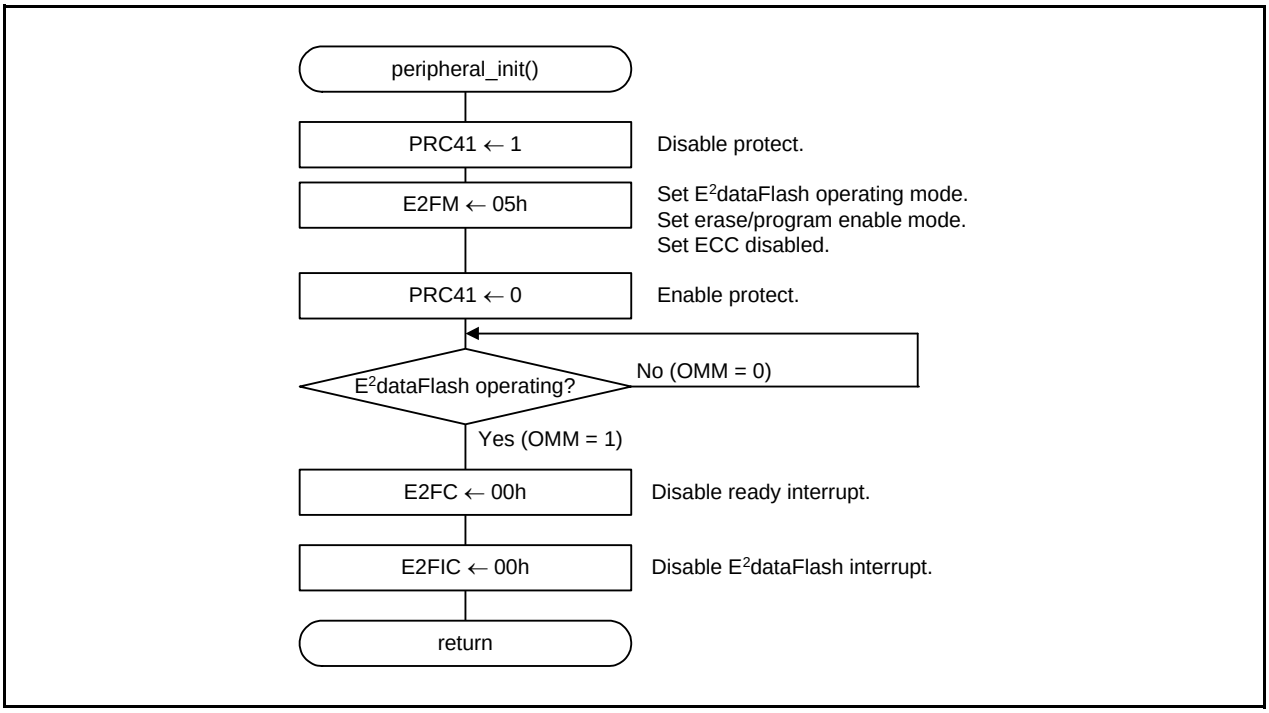


Figure 4.3 Peripheral Function Initial Setting

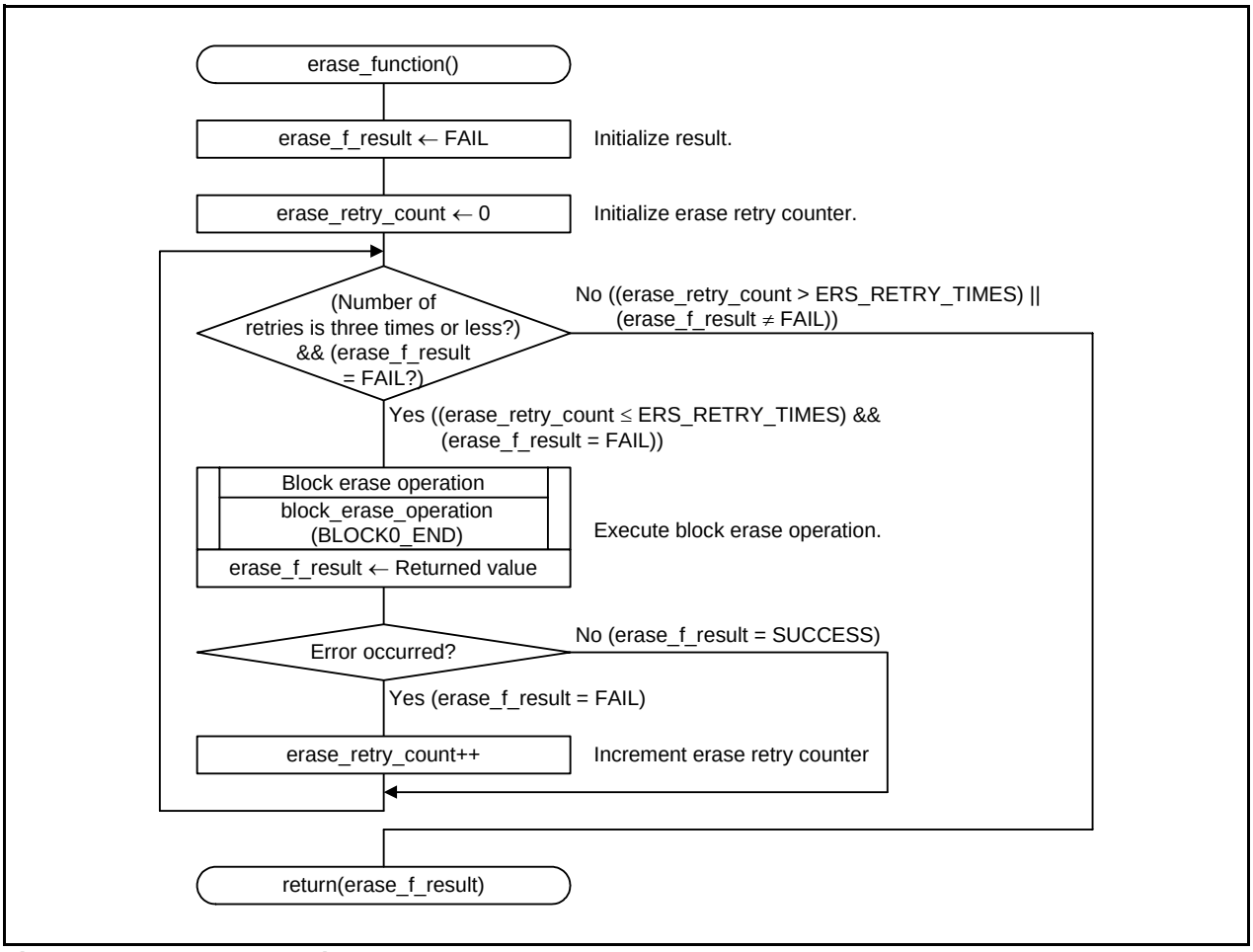


Figure 4.4 Erase Function

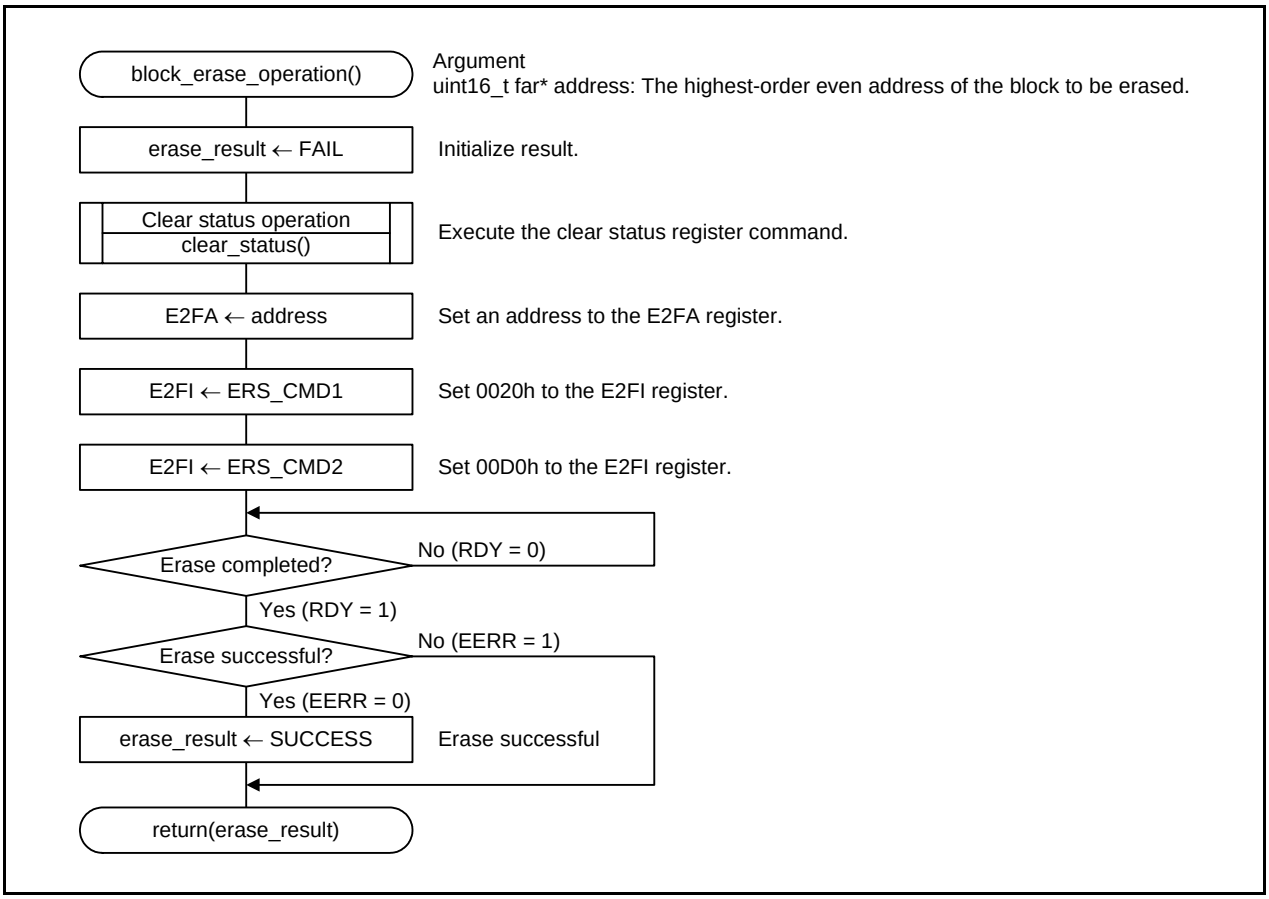


Figure 4.5 Block Erase Operation

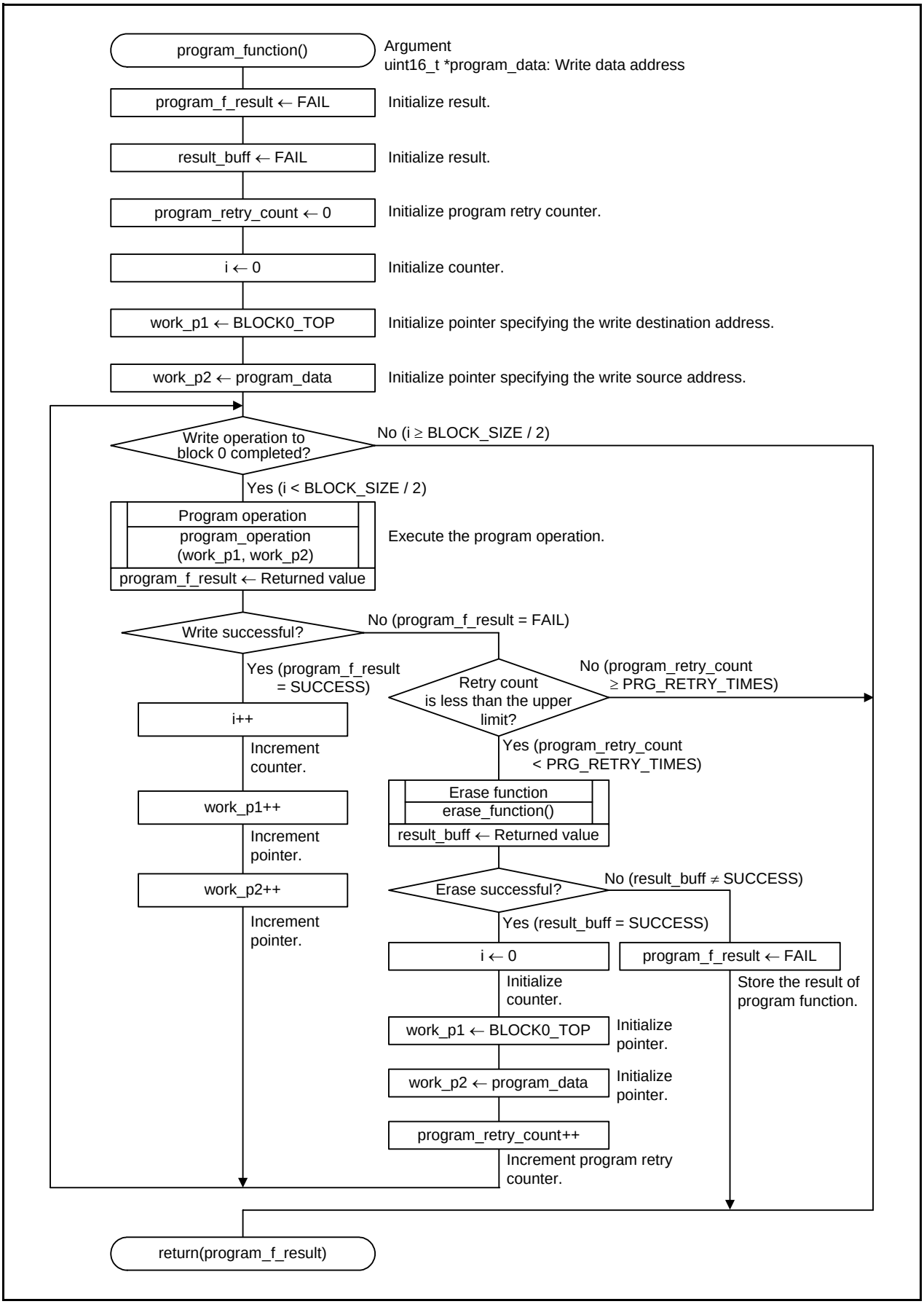


Figure 4.6 Program Function

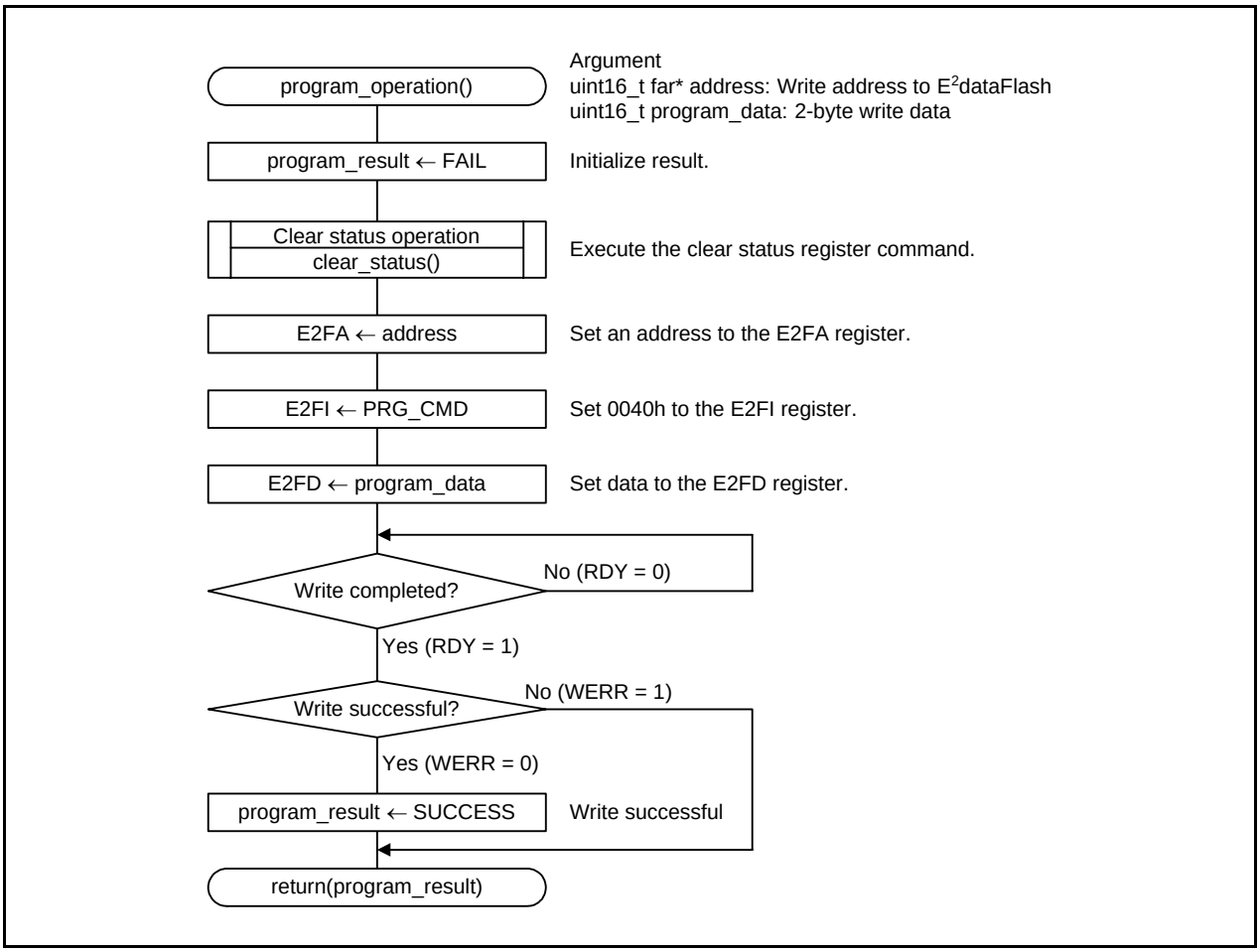


Figure 4.7 Program Operation

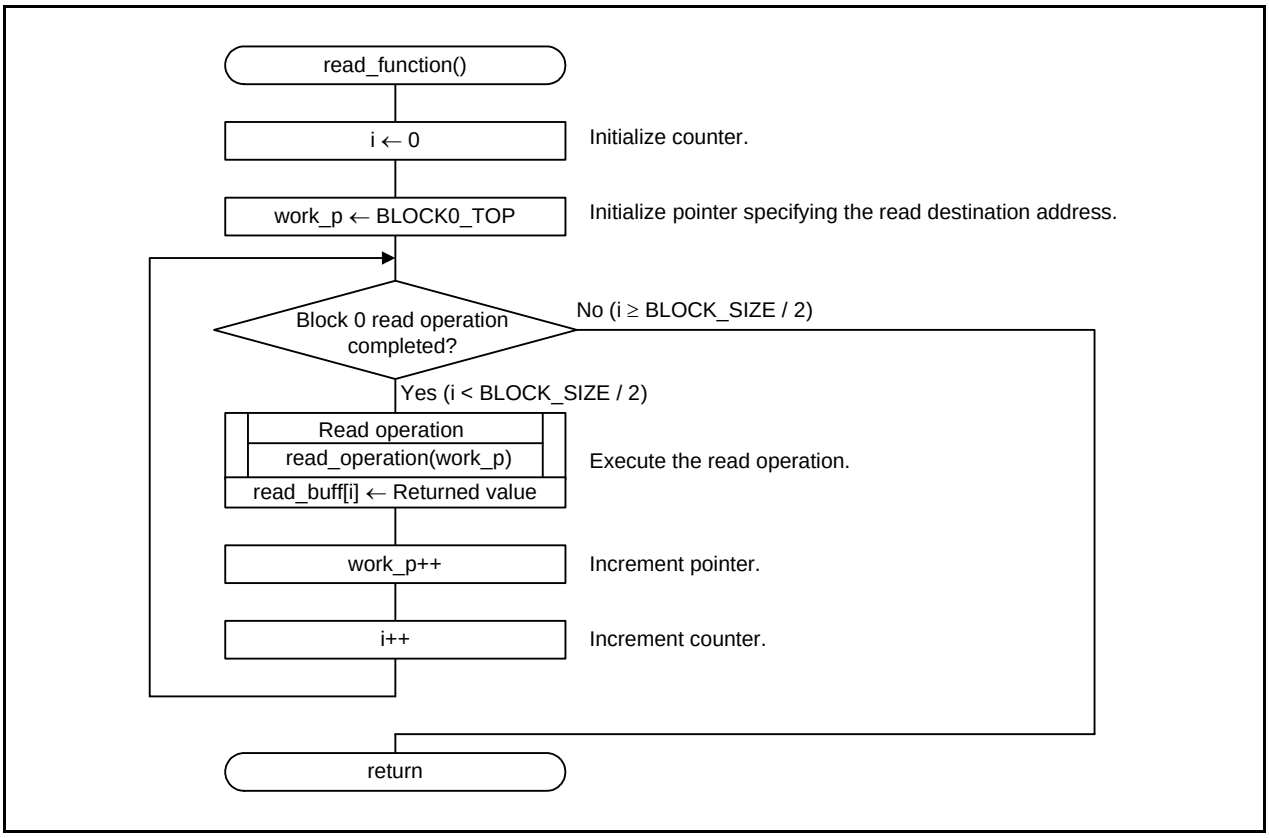


Figure 4.8 Read Function

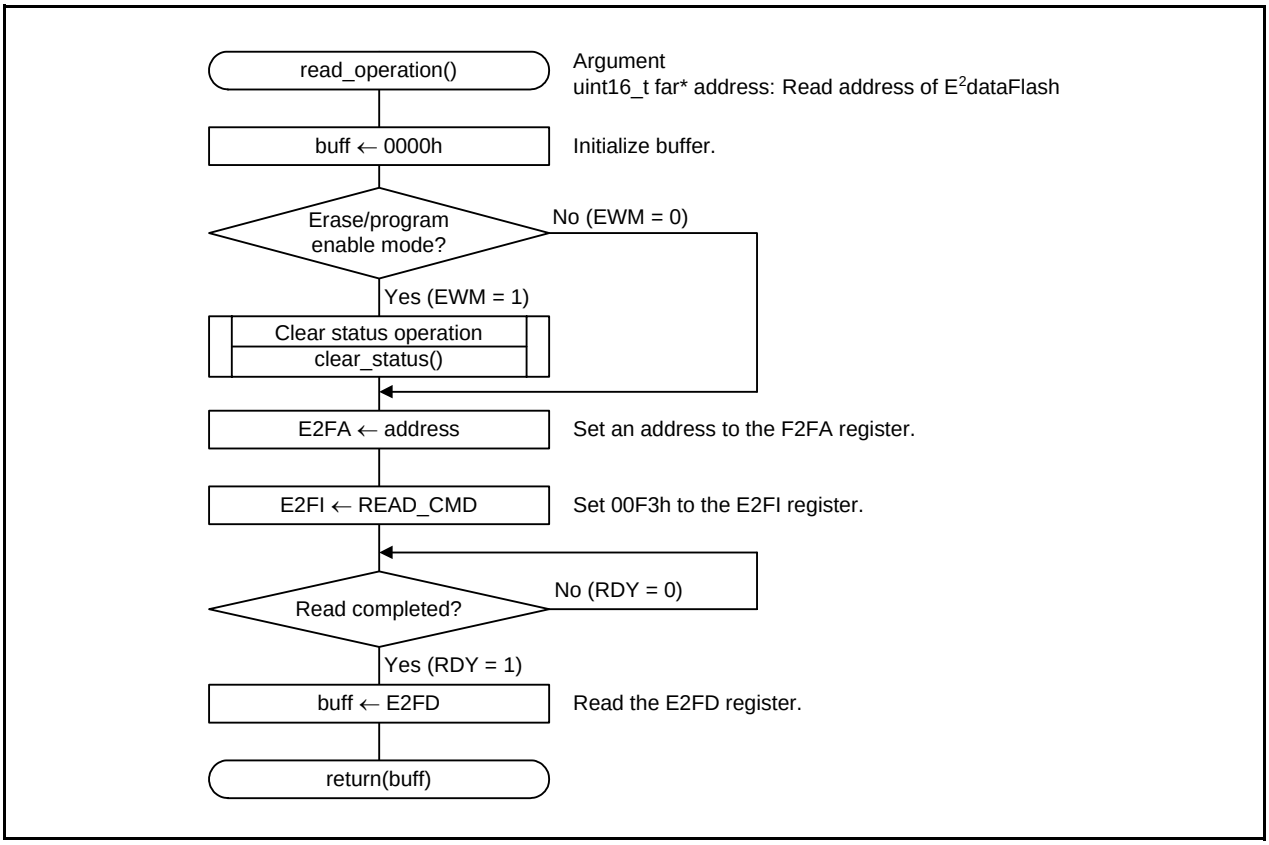


Figure 4.9 Read Operation

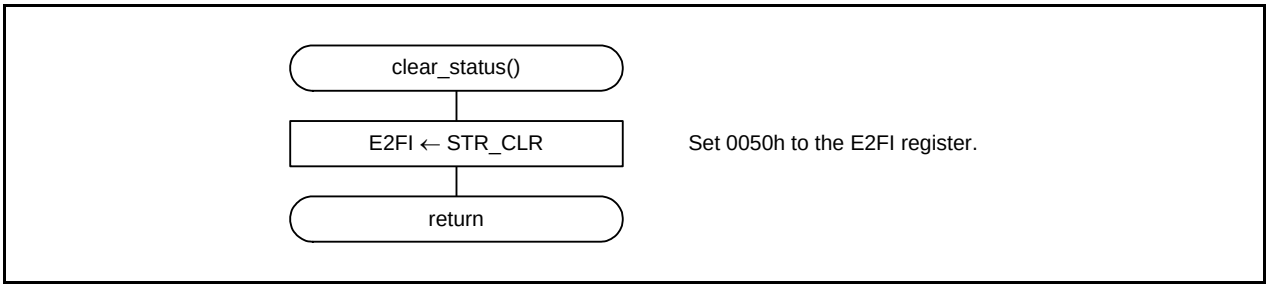


Figure 4.10 Clear Status Operation

5. Sample Program

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

6. Reference Documents

R32C/120 Group User's Manual: Hardware Rev.1.10
R32C/121 Group User's Manual: Hardware Rev.1.10
R32C/151 Group User's Manual: Hardware Rev.1.10
R32C/152 Group User's Manual: Hardware Rev.1.10
R32C/153 Group User's Manual: Hardware Rev.1.10
R32C/156 Group User's Manual: Hardware Rev.1.03
R32C/157 Group User's Manual: Hardware Rev.1.03
R32C/160 Group User's Manual: Hardware Rev.1.02
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Revision History	R32C/100 Series Using the E^{2}PROM Emulation Data Flash

Rev.	Date	Description	
		Page	Summary
1.00	Dec 15, 2010	—	First edition issued

General Precautions in the Handling of MPU/MCU Products

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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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