M16C/63,64,64A,64C,65,65C,6C,5LD,56D,5L,56,5M,57 Group
Rewriting Flash Memory (EW1 Mode)

R01AN0395EJ0101
Rev. 1.01
Dec. 28, 2010

1. Abstract

This document describes the method for rewriting the data flash in EW1 mode.

2. Introduction

The application example described in this document applies to the following microcomputers (MCUs).

- MCUs: M16C/63 Group
  M16C/64 Group
  M16C/64A Group
  M16C/64C Group
  M16C/65 Group (Only in a product with program ROM 1 that is 512 KB or less)
  M16C/65C Group
  M16C/6C Group
  M16C/5LD Group
  M16C/56D Group
  M16C/5L Group
  M16C/56 Group
  M16C/5M Group
  M16C/57 Group

The sample program in this application note can be used with other R8C Family MCUs which have the same special function registers (SFRs) as the above groups. Check the manual for any modifications to functions. Careful evaluation is recommended before using this application note.

3. Application Example

This application note describes an example method for rewriting the flash memory in EW1 mode.

3.1 CPU Rewrite Mode

In CPU rewrite mode, the flash memory can be rewritten when the CPU executes software commands. CPU rewrite mode consists of erase-write mode 0 (EW0 mode) and erase-write mode 1 (EW1 mode).

Table 3.1 shows the difference between EW0 Mode and EW1 Mode.

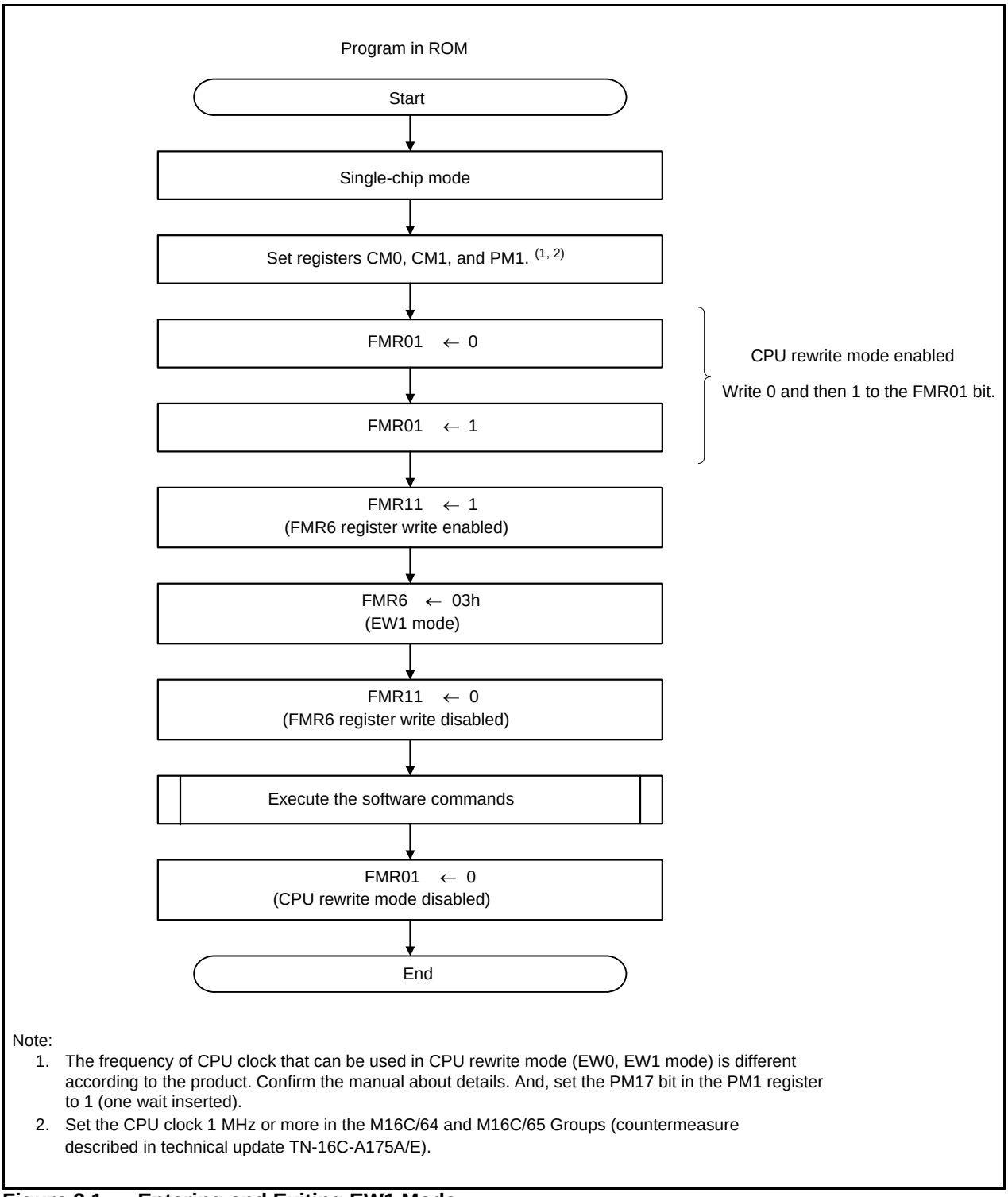
Table 3.1 EW0 Mode and EW1 Mode

Item	EW0 Mode	EW1 Mode
Operating modes	• Single-chip mode • Memory expansion mode	Single-chip mode
Rewrite control program allocatable areas	• Program ROM 1 • Program ROM 2 • External area	• Program ROM 1 • Program ROM 2
Rewrite control program executable areas	The rewrite control program must be transferred to an area other than the flash memory (e.g., RAM) before being executed.	The rewrite control program can be executed in program ROM 1 and program ROM 2.
Rewritable areas	• Program ROM 1 • Program ROM 2 • Data flash	• Program ROM 1 • Program ROM 2 • Data flash Excluding blocks with the rewrite control program
Software command restrictions	None	• Program and block erase commands: Do not execute these commands in a block with the rewrite control program. • Read status register command: Do not execute this command.
Mode after program or erase	Read status register mode	Read array mode
State during auto write and auto erase	Hold state is not maintained.	Hold state is maintained (I/O ports maintains the state before the command execution).
Flash memory status detection	• Read bits FMR00, FMR06, and FMR07 in the FMR0 register. • Execute the read status register command, and then read bits SR7, SR5, and SR4 in the status register.	Read bits FMR00, FMR06, and FMR07 in the FMR0 register.

3.2 EW1 Mode

EW1 mode is selected by setting the FMR60 bit in the FMR6 register to 1 after setting the FMR01 bit in the FMR0 register to 1.
The FMR0 register indicates whether a program or erase operation is completed. This status register can not be read while in EW1 mode.
When a program or erase operation is initiated, the CPU halts all program execution until the operation is completed.

Figure 3.1 shows the Entering and Exiting EW1 Mode.



Note:
1. The frequency of CPU clock that can be used in CPU rewrite mode (EW0, EW1 mode) is different according to the product. Confirm the manual about details. And, set the PM17 bit in the PM1 register to 1 (one wait inserted).
2. Set the CPU clock 1 MHz or more in the M16C/64 and M16C/65 Groups (countermeasure described in technical update TN-16C-A175A/E).

Figure 3.1 Entering and Exiting EW1 Mode

3.3 Program Command

The program command is used to write two words (4 bytes) of data to the flash memory.
By writing xx41h in the first bus cycle and data to the write address in the second and third bus cycles, auto-program operation (data program and verify) is started. Set the end of the write address to 0h, 4h, 8h, or Ch.
The FMR00 bit in the FMR0 register indicates whether the auto-program operation has been completed. The FMR00 bit is 0 (busy) during the auto-program operation, and 1 (ready) after the auto-program operation is completed. Do not execute other commands while the FMR00 bit is 0.
After the auto-program operation is completed, the FMR06 bit in the FMR0 register indicates whether or not the auto-program operation has been completed as expected.
Do not rewrite the addresses already programmed. Figure 3.2 shows the Program Command.

The lock bit protects individual blocks from being programmed inadvertently.
In EW1 mode, do not execute this command on a block to which the rewrite control program is allocated.

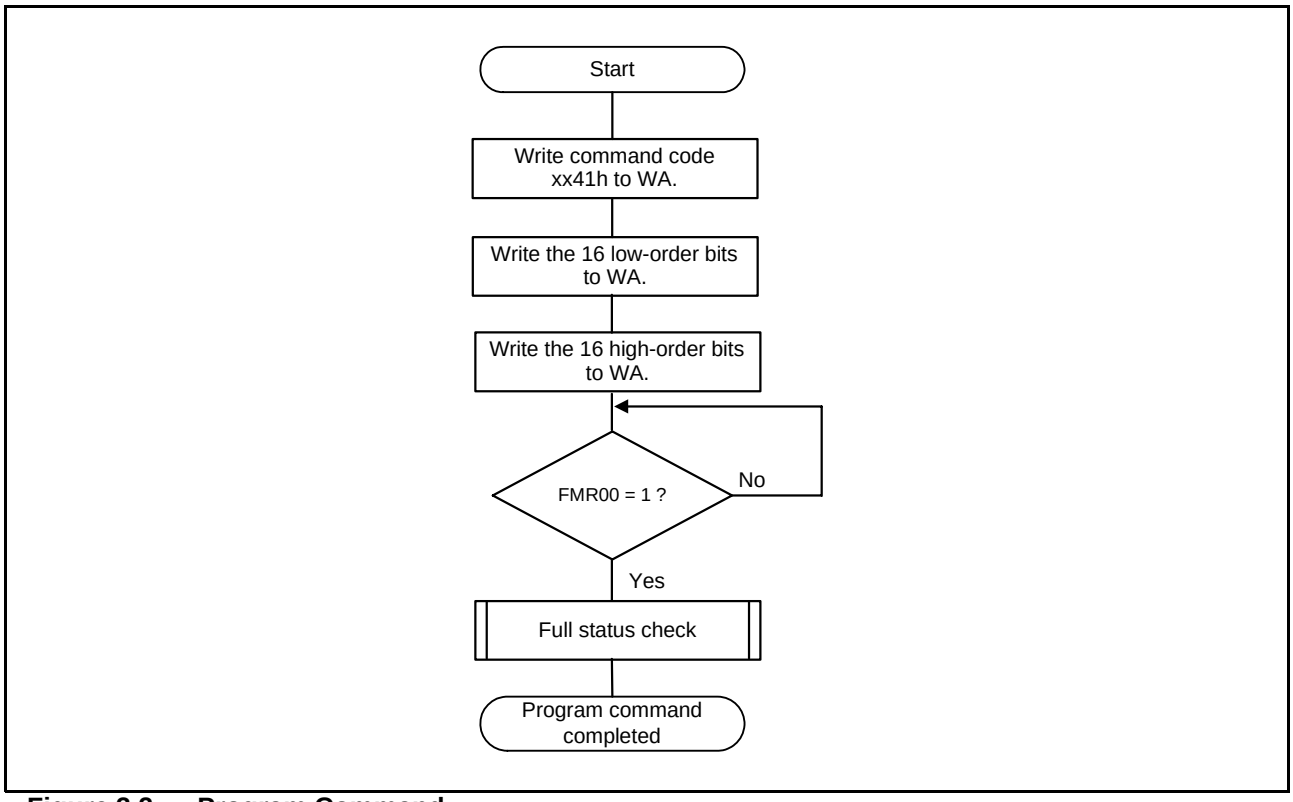


Figure 3.2 Program Command

3.4 Block Erase Command

By writing xx20h in the first bus cycle and xxD0h to the highest-order even address of a block in the second bus cycle, an auto-erase operation (erase and verify) is started on the specified block.
The FMR00 bit in the FMR0 register indicates whether the auto-erase operation has been completed.
The FMR00 bit is 0 (busy) during the auto-erase operation, and 1 (ready) when the auto-erase operation is completed. Do not execute other commands while the FMR00 bit is 0.
After the auto erase operation is completed, the FMR07 bit in the FMR0 register indicates whether or not the auto erase operation has been completed as expected.
Figure 3.3 shows the Flow Chart of the Block Erase Command Programming.
The lock bit protects individual blocks from being erased inadvertently.
In EW1 mode, do not execute this command on the block to which the rewrite control program is allocated.

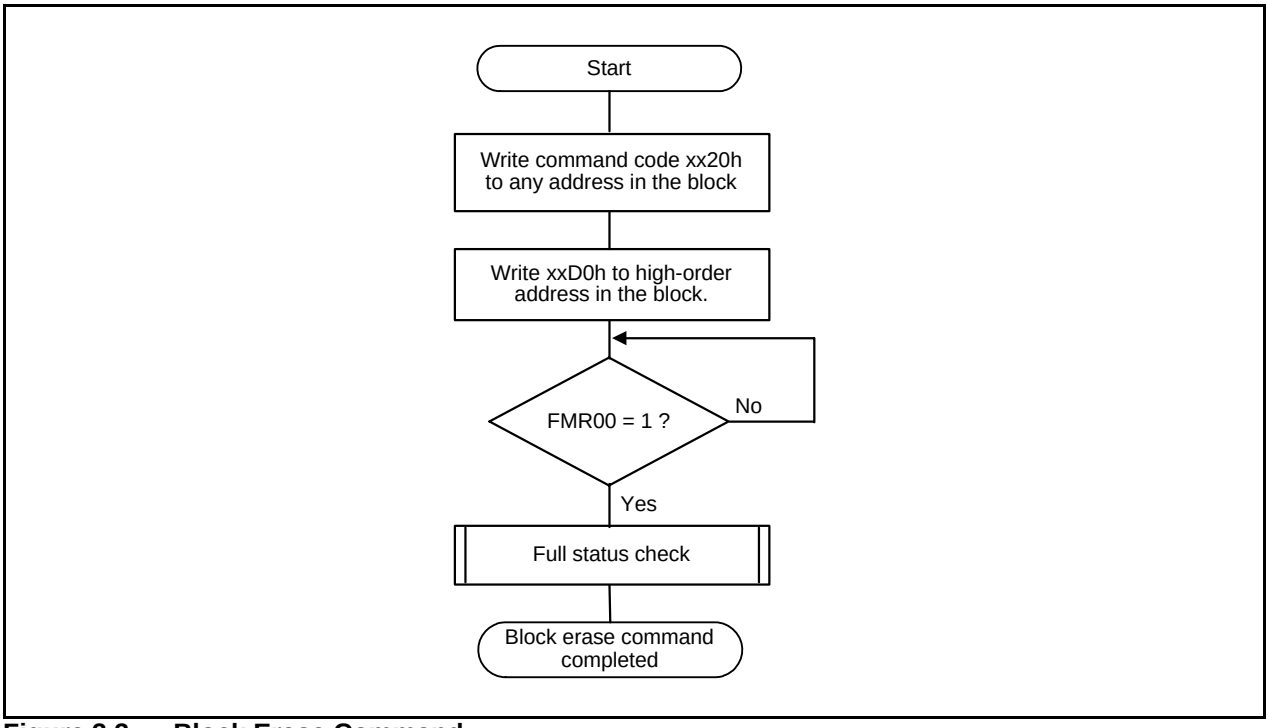


Figure 3.3 Block Erase Command

3.5 Clear Status Register Command

The clear status register command is used to clear the status register.
By writing the command code xx50h, bits FMR07 and FMR06 in the FMR0 register (SR5 and SR4 in the status register) become 00b.

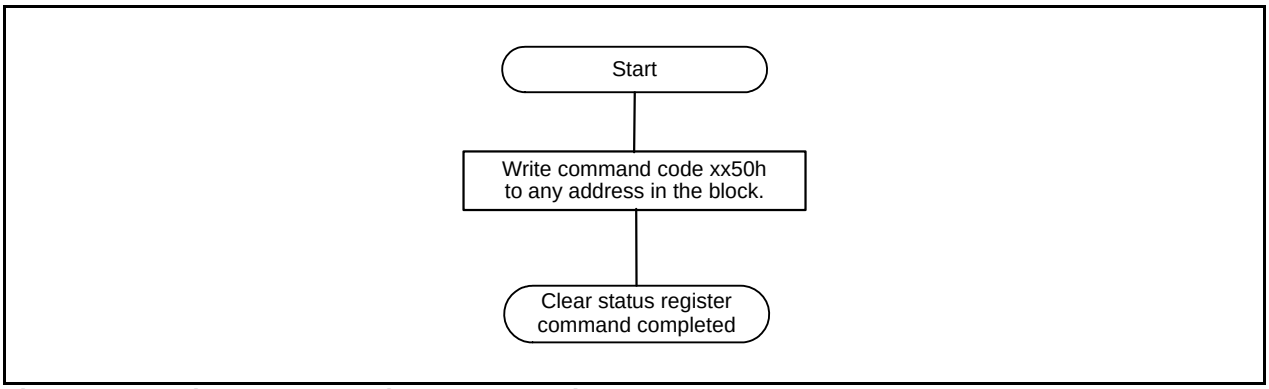


Figure 3.4 Clear Status Register Command

4. Description of Reference Program

4.1 Write Data to the Data Flash Area

This application note assumes that one record is 64 bytes. These records are divided into two blocks (A and B) wherein the block A has 0E000h to 0EFFFh and the block B has 0F000h to 0FFFFh, and each blocks contains 16 records, 0 to 63.

Figure 4.1 shows the Relationship between Data Flash and Records.

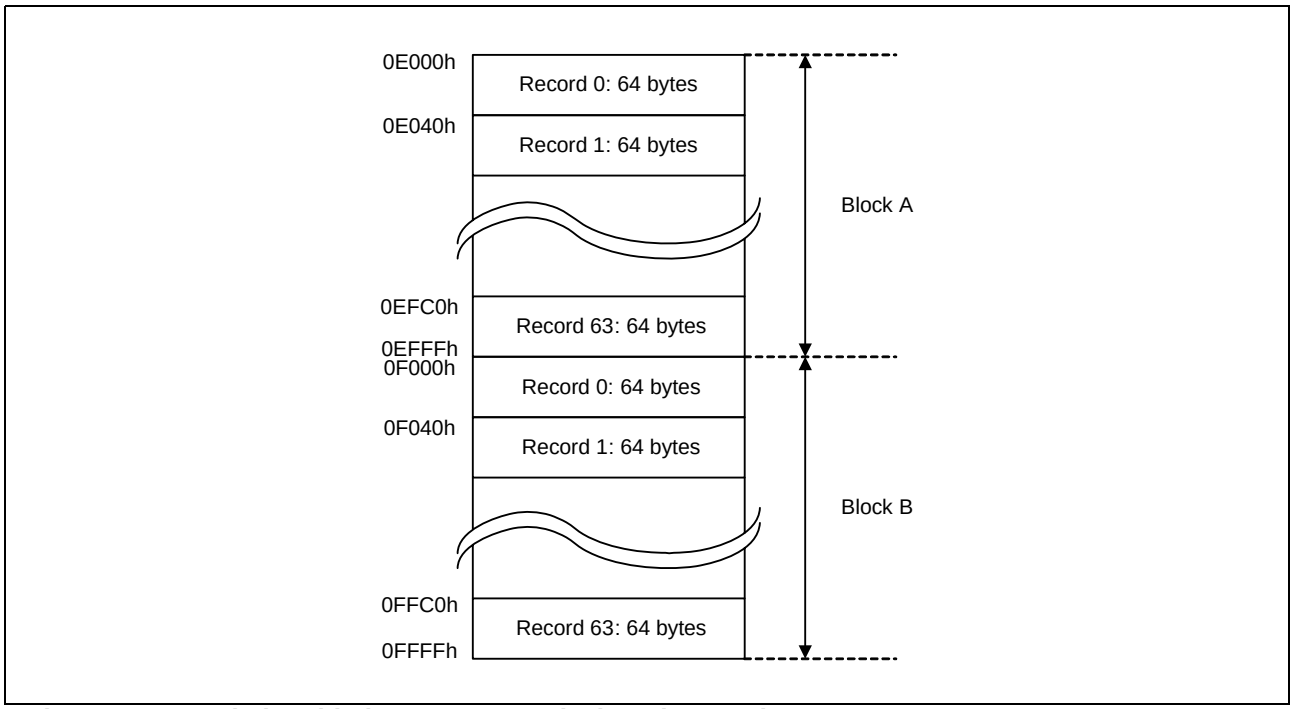


Figure 4.1 Relationship between Data Flash and Records

When writing data, write in record units starting from record 0 in block A. After writing to record 63, erase all contents (block erase) of block B. When writing the next data, start from record 0 in block B. In the same way, after writing to record 63 in block B, erase all content in block A. When writing the next data, start writing from record 0 in block A.

4.2 Error Processing

This application note does not include any error processing when accessing data flash.
Perform error processing if an error occurs.

4.3 Function Tables

Declaration	void write_record_init(void)		
Outline	Initialize write record		
Argument	Argument name		Meaning
	None		None
Variable (global)	Variable name		Content
	unsigned short write_record		Initial setting
	unsigned char block_select		Initial setting
Returned value	Type	Value	Meaning
	None	None	None
Function	Clear the data flash area, and initialize the block used (block_select) and the write record number (write_record).		

Declaration	unsigned char flash_write(unsigned short *data)		
Outline	Data write control		
Argument	Argument name		Meaning
	unsigned short *data		Table starting address of write data
Variable (global)	Variable name		Content
	unsigned short write_record		Referring/Setting
	unsigned char block_select		Referring/Setting
Returned value	Type	Value	Meaning
	unsigned char	COMPLETE	Completed successfully (0x00)
		DATA_PROGRAM_ERR	Data write error (0x01)
		ERASE_ERR	Data erase error (0x02)
Function	Write the record data before updating the write record number (write_record). When writing data to the last record (record 63), erase unused blocks and clear the record write information (writing_info) to change used block. When a write failure or an erase failure occurs, the returned value becomes DATA_PROGRAM_ERR + ERASE_ERR (0x03)		

Declaration	unsigned char block_erase(unsigned short *ers_addr)		
Outline	Block erase		
Argument	Argument name		Meaning
	unsigned short *ers_addr		Table starting address of erase block
Variable (global)	Variable name		Content
	None		None
Returned value	Type	Value	Meaning
	unsigned char	COMPLETE	Completed successfully
		ERASE_ERR	Erase error
Function	Erase the specified block in EW1 mode.		

Declaration	unsigned char data_write(unsigned short *write_data)		
Outline	Data write		
Argument	Argument name		Meaning
	unsigned short *write_data		Table starting address of write data
Variable (global)	Variable name		Content
	unsigned short write_record		Referring
	unsigned char block_select		Referring
Returned value	Type	Value	Meaning
	unsigned char	COMPLETE	Completed successfully
		DATA_PROGRAM_ERR	Writing error
Function	Write data to the write record (write_record) of the block used (block_select) in EW1 mode.		

Declaration	void make_data(unsigned short *data)		
Outline	Creating write data		
Argument	Argument name		Meaning
	unsigned short *data		Table starting address of write data
Variable (global)	Variable name		Content
	None		None
Returned value	Type	Value	Meaning
	None	None	None
Function	Create write record data for data flash. As dummy data, values from 0000h to 001FH are generated in this application note.		

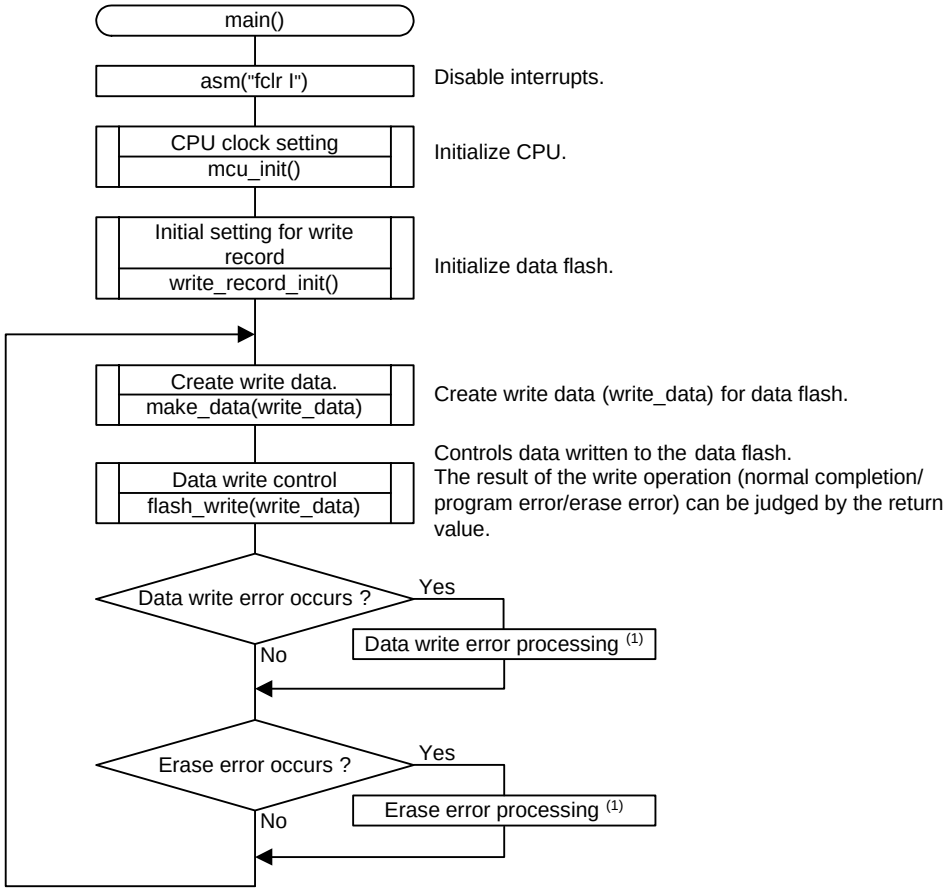
Declaration	void cpu_slow(void)		
Outline	System clock slow down		
Argument	Argument name		Meaning
	None		None
Variable (global)	Variable name		Content
	None		None
Returned value	Type	Value	Meaning
	None	None	None
Function	Set the CPU clock divisor to CM06 = 0, CM17 to CM16 = 01b (divide-by-2), PM17 = 1 (one wait inserted).		

Declaration	void cpu_fast(void)		
Outline	System clock speed up		
Argument	Argument name		Meaning
	None		None
Variable (global)	Variable name		Content
	None		None
Returned value	Type	Value	Meaning
	None	None	None
Function	Set the CPU clock divisor to CM06 = 0, CM17 to CM16 = 01b (not divided), PM17 = 0 (no wait inserted).		

Declaration	void command_write(unsigned short *addr, unsigned short *data)		
Outline	Program command issue		
Argument	Argument name		Meaning
	unsigned short *addr		Table starting address of data flash for writing data
	unsigned short *data		Table starting address of write data
Variable (global)	Variable name		Content
	None		None
Returned value	Type	Value	Meaning
	None	None	None
Function	Issue program command and write data to data flash.		

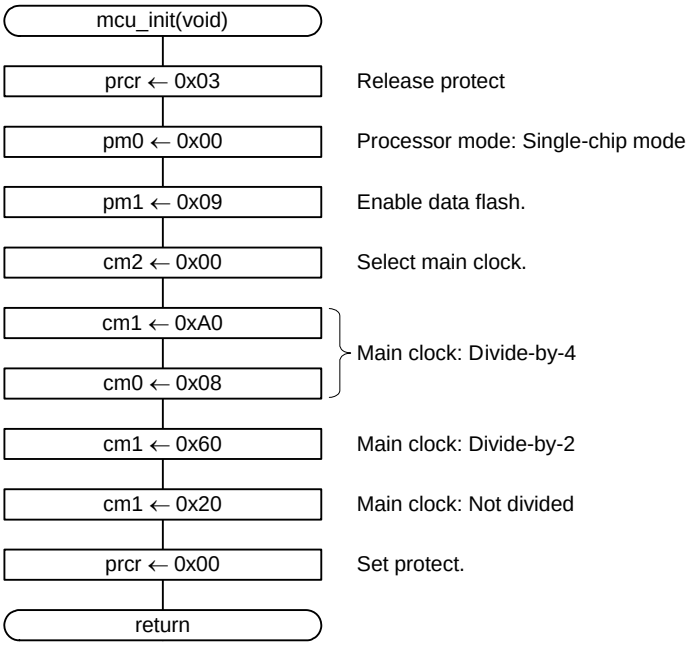
4.4 Flowcharts

4.4.1 Main Function

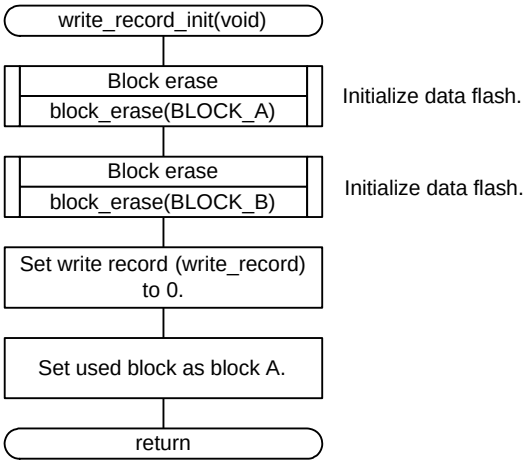


Note:
1. This application note does not include any error processing when accessing data flash. Perform error processing if an error occurs.

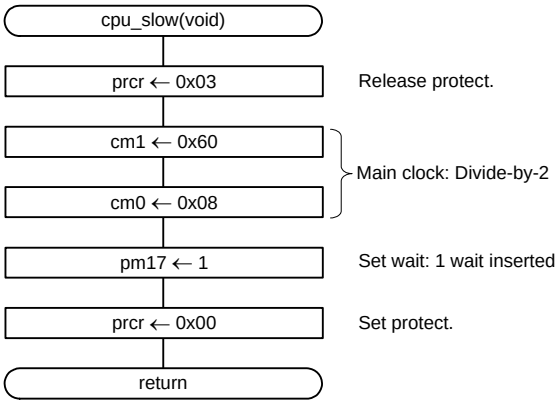
4.4.2 CPU Initialization



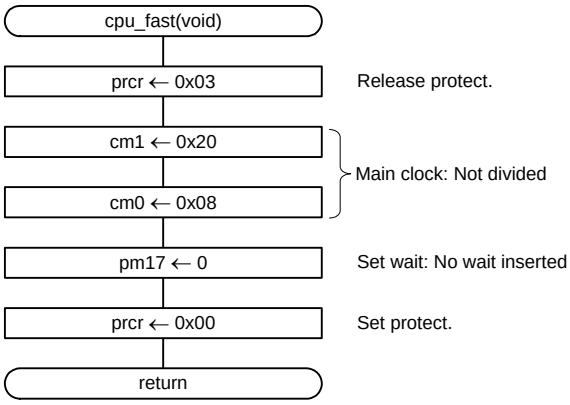
4.4.3 Write Record Initialization



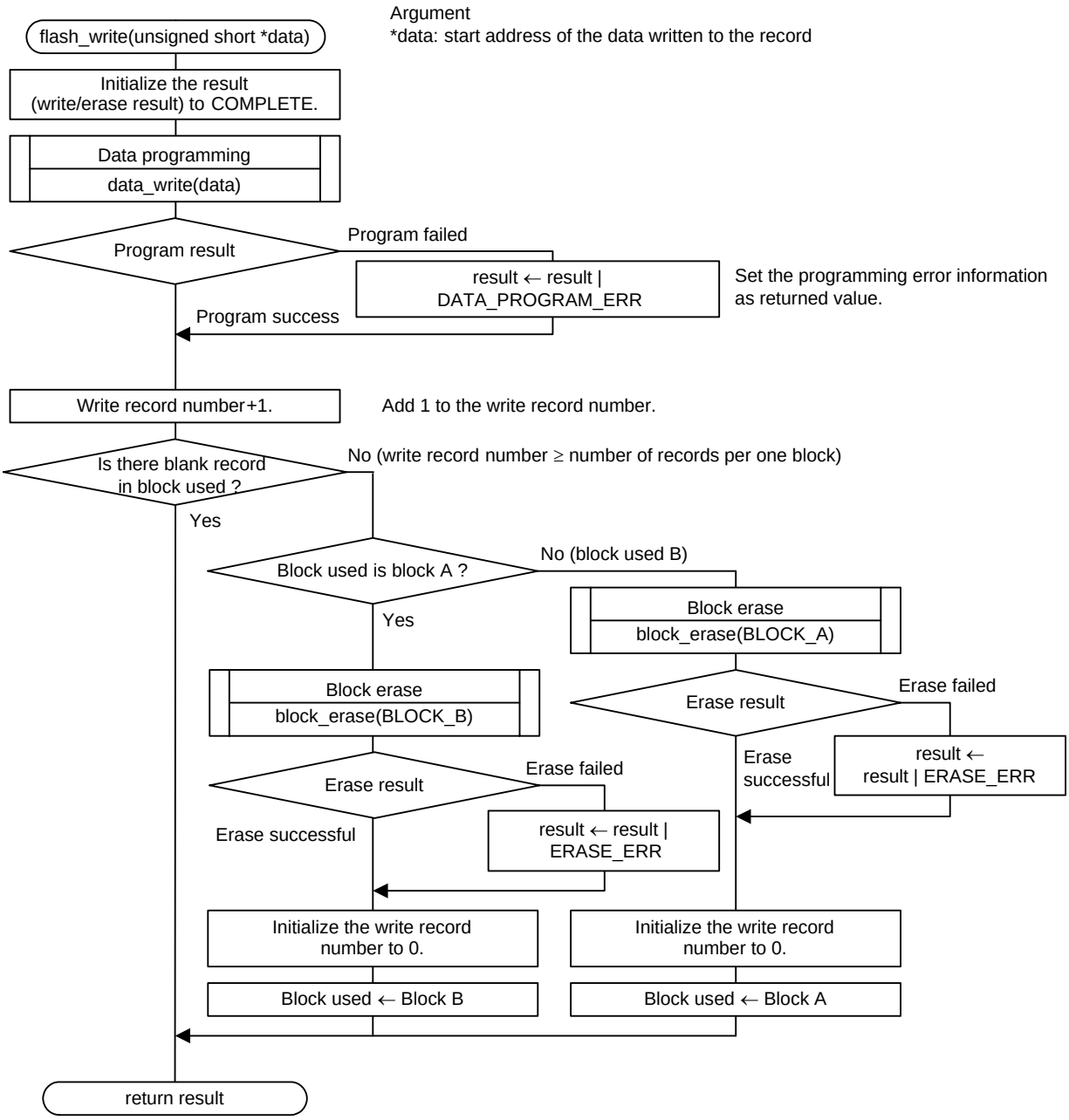
4.4.4 System Clock Slow Down



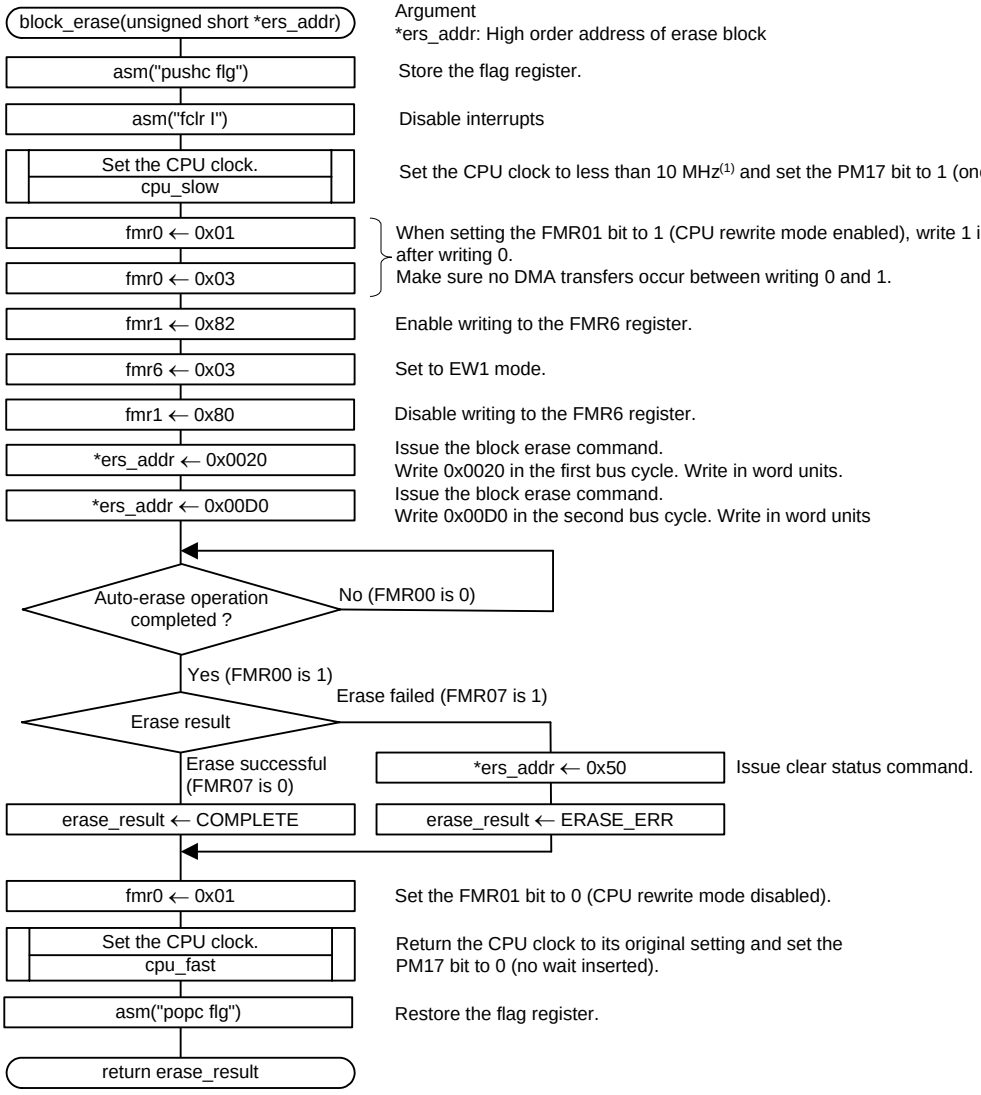
4.4.5 System Clock Speed Up



4.4.6 Data Write Control

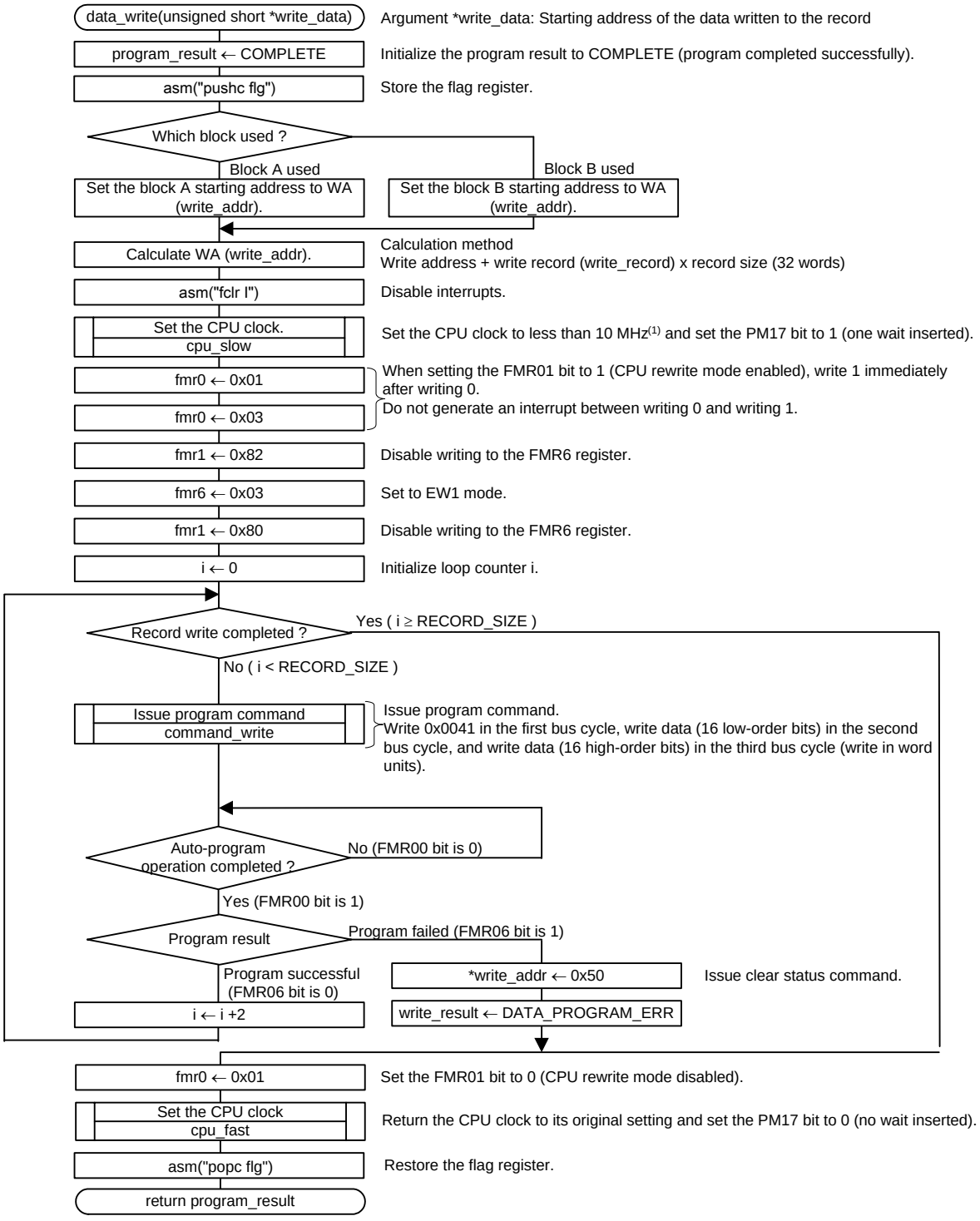


4.4.7 Block Erase



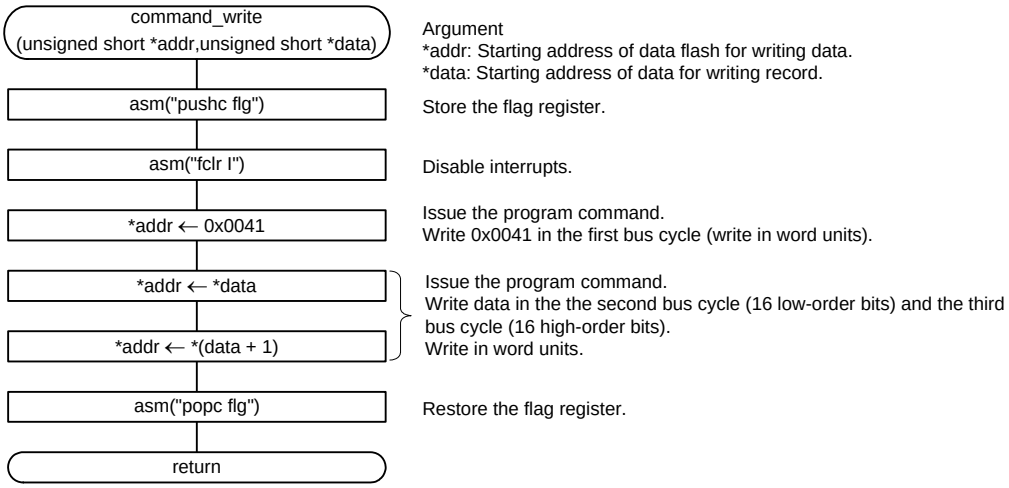
Note:
1. The frequency of CPU clock that can be used in CPU rewrite mode (EW0, EW1 mode) is different according to the product. Confirm the manual about details.

4.4.8 Record Write



Note:
1. The frequency of CPU clock that can be used in CPU rewrite mode (EW0, EW1 mode) is different according to the product. Confirm the manual about details.

4.4.9 Issue Program Command



5. Sample Code

Sample code can be downloaded from the Renesas Electronics website.

6. Reference Documents

M16C/63 Group User's Manual: Hardware Rev.1 .00
M16C/64 Group User's Manual: Hardware Rev.1 .05
M16C/64A Group User's Manual: Hardware Rev.1 .10
M16C/64C Group User's Manual: Hardware Rev.0 .10
M16C/65 Group User's Manual: Hardware Rev.1 .10
M16C/65C Group User's Manual: Hardware Rev.0 .10
M16C/6C Group User's Manual: Hardware Rev.1 .00
M16C/5LD Group, M16C/56D Group User's Manual: Hardware Rev.1 .10
M16C/5L Group, M16C/56 Group User's Manual: Hardware Rev.1 .00
M16C/5M Group, M16C/57 Group User's Manual: Hardware Rev.1 .01
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Revision History	M16C/63,64,64A,64C,65,65C,6C,5LD,56D,5L,56,5M,57 Group Rewriting Flash Memory (EW1 Mode)

Rev.	Date	Description	
		Page	Summary
1.00	Oct. 30, 2009	—	First edition issued
1.01	Dec. 28, 2010	—	Add M16C/64, M16C/64C, M16C/65C, M16C/5LD, M16C/56D, M16C/5L, M16C/56, M16C/5M, M16C/57
		3	Corrected note 1 of figure 3.1
		15	"4.4.7 Block Erase" was added note 1
		16	"4.4.8 Record Write" was added note 1

General Precautions in the Handling of MPU/MCU Products

The following usage notes are applicable to all MPU/MCU products from Renesas. For detailed usage notes on the products covered by this manual, refer to the relevant sections of the manual. If the descriptions under General Precautions in the Handling of MPU/MCU Products and in the body of the manual differ from each other, the description in the body of the manual takes precedence.

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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