RX Family

Open Source FAT File System [M3S-TFAT-Tiny] Module Firmware Integration Technology

R20AN0038EJ0304
Rev.3.04
Nov 30, 2018

Introduction

This application note explains about RX Family Open Source FAT Filesystem M3S-TFAT-Tiny (hereafter TFAT Library) using Firmware Integration Technology (FIT).

TFAT Library is no relation to Microsoft Transaction-Safe FAT File System (TFAT).

Library build is needed for TFAT setting changing(ex. Long file name on/off feature).If user needs to change the settings, the library build environment(with source code) is needed. If user needs this one, please contact customer support (http://www.renesas.com/contact/).

Target Device

RX Family

Contents

1. Outline

TFAT Library is FAT File system software library that concerned about low-memory usage.

The TFAT library was made based on FatFs. Please refer to the User's Manual to know the relation about source code version.

What is FatFs?

FatFs is the File system module for the small embedded system. Fat Fs is developed by ChaN Software. FatFs is provided as non-payment for embedded system. Please refer to the Website below for more details.

http://elm-chan.org/fsw/ff/00index_e.html

1.1 Specification of library

1.1.1 Specification of TFAT library

Following are some of the main specifications of the TFAT library.

Table 1.1 Specification of TFAT library

item	specifications
Base program	Fatfs (R0.09b)
Supported FAT Type	FAT16, FAT32
Filename Support	8.3 format (8 lettered filename & 3 lettered extension) s
Filesystem format function	None
Number of drives supported	1
Logical Sector size	512byte

1.1.2 Structure of software stack

Following are structure of software stack of the TFAT library.

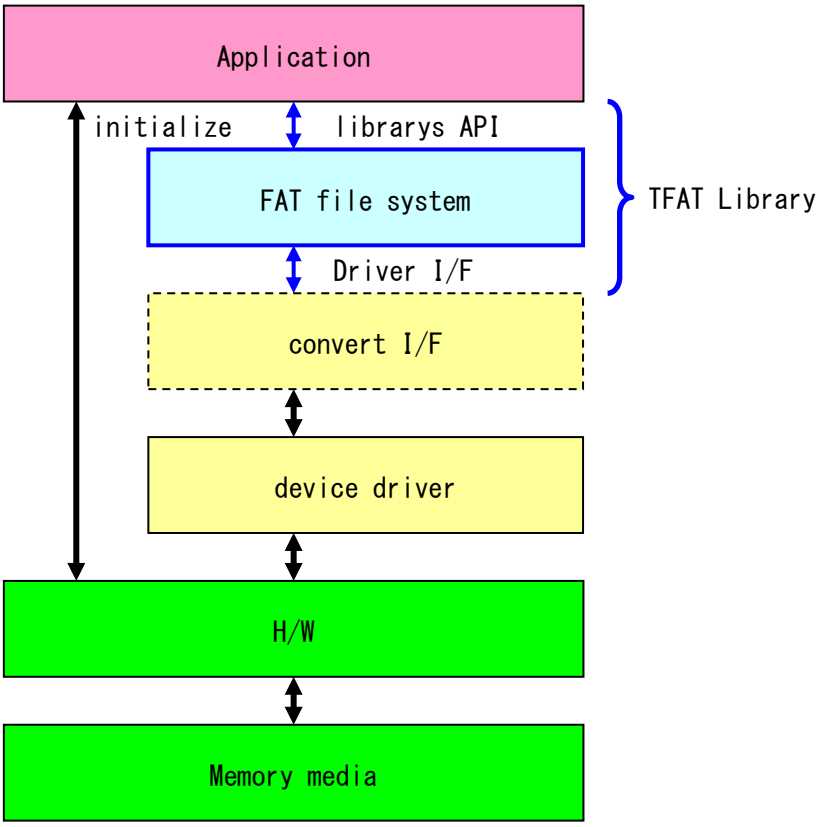

Figure 1-1 structure of software stack of the TFAT library

1.1.3 Compiler option for generating library

Library file is built with the following compiler option.

- TFAT Library file for the RX600 series (big endian)
  -cpu=rx600 -endian=big -include="$(WORKSPDIR)\..\pub_include"
  -output=obj="$(CONFIGDIR)\$(FILELEAF).obj" –nologo

- TFAT Library file for the RX600 series (little endian)
  -cpu=rx600 -include="$(WORKSPDIR)\..\pub_include" -output=obj="$(CONFIGDIR)\$(FILELEAF).obj"
  -nologo

- TFAT Library file for the RX200 series (big endian)
  -cpu=rx200 -endian=big -include="$(WORKSPDIR)\..\pub_include"
  -output=obj="$(CONFIGDIR)\$(FILELEAF).obj" –nologo

- TFAT Library file for the RX200 series (little endian)
  -cpu=rx200 -include="$(WORKSPDIR)\..\pub_include" -output=obj="$(CONFIGDIR)\$(FILELEAF).obj"
  -nologo

1.1.4 Version information

TFAT library has version information as strings. User can access this version information to use extern variable defined in header file.

define: extern const mw_version_t R_tfat_version;

TFAT library has version information showed below.

— RX200 Big endian
- compiler_version = 0x1020100
- library_info = "M3S-TFAT-Tiny version 3.04 for RX200 BIG endian.(Nov 13 2018, 16:51:00)"

— RX200 Little endian
- compiler_version = 0x1020100
- library_info = "M3S-TFAT-Tiny version 3.04 for RX200 LITTLE endian.(Nov 13 2018, 16:50:54)"

— RX600 Big endian
- compiler_version = 0x1020100
- library_info = "M3S-TFAT-Tiny version 3.04 for RX600 BIG endian.(Nov 13 2018, 16:50:48)"

— RX600 Little endian
- compiler_version = 0x1020100
- library_info = "M3S-TFAT-Tiny version 3.04 for RX600 LITTLE endian.(Nov 13 2018, 16:50:41)"

1.1.5 ROM size / RAM size / Stack size

TFAT library requires ROM/RAM/Stack size as below.

Table 1.2 ROM/RAM size

Section (Section name)	size	
	RX600	RX200
ROM (P , C)	About 5.1KB	About 5.1KB
RAM (B)	6byte	6byte

Table 1.3 stack size

API function name	stack size (No memory driver software)[byte]		stack size (with USB driver(*) software)[byte]		stack size (with SD mode SD memory card driver(*) software)[byte]
	RX600	RX200	RX600	RX200	RX600
R_tfat_f_mount	4	4	4	4	4
R_tfat_f_open	204	204	496	424	552
R_tfat_f_close	96	96	352	280	408
R_tfat_f_read	92	92	384	312	440
R_tfat_f_write	112	112	404	332	460
R_tfat_f_lseek	104	104	396	324	452
R_tfat_f_truncate	92	92	384	312	440
R_tfat_f_sync	88	88	344	272	400
R_tfat_f_opendir	160	160	452	380	508
R_tfat_f_readdir	140	140	360	360	488
R_tfat_f_getfree	100	100	392	320	448
R_tfat_f_stat	184	184	476	404	532
R_tfat_f_mkdir	204	204	432	424	552
R_tfat_f_unlink	216	216	508	436	564
R_tfat_f_chmod	184	184	476	404	532
R_tfat_f_utime	180	180	472	400	528
R_tfat_f_rename	240	240	532	460	588
R_tfat_f_forward	88	88	380	308	436

Note: Stack size is dependent on user-defined function.

At least one variable of the structure FATFS is always required for FileSystem Work Area allocation. The FIL and DIR structures will be needed as per the requirement. The number of FIL variables needed is equal to the number of files that will be opened simultaneously by the user. If two files are to be opened simultaneously, then two FIL structure variables will be needed resulting in total memory consumption of 32 x 2 = 64 Bytes. Likewise will be the case with DIR and other structure variables.

Table 1.4 structure size

Structure	Memory for one structure variable [byte]
FATFS	560
FIL	36
DIR	20
FILINFO	24

1.1.6 Performance

The access time that TFAT library reads/write memory card is below.

Table 1.5 Performance

	Test Condition	Time
RX231 (USB)	Time to write 1MByte data file. (File Open , Data write ,File close)	About 2.5 Sec
	Time to read 1MByte data file. (File Open , Data read ,File close)	About 1.1 Sec
RX65N (USB)	Time to write 1MByte data file. (File Open , Data write ,File close)	About 2.5 Sec
	Time to read 1MByte data file. (File Open , Data read ,File close)	About 1.1 Sec
RX65N (SD mode SD card)	Time to write 1MByte data file. (File Open , Data write ,File close)	About 0.22 Sec
	Time to read 1MByte data file. (File Open , Data read ,File close)	About 0.16 Sec

Detail of test condition is below.

Table 1.6 Measurement condition

	Detail of Test Condition	Contents
RX231	CPU Clock(ICLK)	54MHz
	USB Clock(UCLK)	48MHz
	Memory	TAMA ELECTRONICS CORP. 8GB
	FAT type	FAT32
	Driver software	Renesas USB mini driver
	Source data area when data write.	Internal ROM
	Destination data area when data read.	Internal RAM
RX65N (USB)	CPU Clock(ICLK)	120MHz
	USB Clock(UCLK)	48MHz
	Memory	TAMA ELECTRONICS CORP. 8GB
	FAT type	FAT32
	Driver software	Renesas USB driver
	Source data area when data write.	Internal ROM
	Destination data area when data read.	Internal RAM
RX65N (SD mode SD card)	CPU Clock(ICLK)	120MHz
	Peripheral Clock(PCLKB)	40MHz(Default speed: 15MHz)
	Memory	Buffalo CLASSIC2 2GB
	FAT type	FAT32
	Driver software	Renesas SD mode SD memory card driver, Renesas SDHI driver
	Source data area when data write.	Internal ROM
	Destination data area when data read.	Internal RAM

1.2 Usage of Libraries

Please include a library file and a header file in a project.

RX200 series and RX100 series uses TFAT library for RX200. RX600 series and RX700 series uses TFAT library for RX600.

TFAT library does not contain the driver of a memory media (SD card and a USB memory). Please prepare the driver of a memory media by the user side in accordance with the hardware of use.

Please set the driver of a memory media by Memory driver interface of TFAT library. Please refer to a user's manual about Memory driver interface.

2. API Information

2.1 Hardware Requirements

None

2.2 Software Requirements

None

2.3 Supported Toolchains

This library is used the following version or later:
Renesas RX Toolchain V2.04.01

2.4 Limitations

1) When using TFAT Library with Real Time OS, TFAT Library APIs are used in the same thread.

2) TFAT Library is using the following standard function

memset memcmp memcpy

2.5 Header Files

All API calls are accessed by including a single file " r_tfat_lib.h " which is supplied with this software's project code.

Build-time configuration options are selected or defined in the file "r_tfat_rx_config.h"

2.6 Configuration Overview

All configurable options that can be set at build time are located in the file "r_tfat_rx_config.h".

2.7 Adding Library to Your Project

Please refer to the Adding Firmware Integration Technology Modules to Projects (r01an1723eu0111_rx.pdf, for e^2 studio) or the Adding Firmware Integration Technology Modules to CS+ Projects (r01an1826ej0102_rx.pdf).

Lib folder has all TFAT Libraries for RX Family. If user implements using the scheme that is explained in this document, all TFAT Libraries will be linked for building. Please remove the Libraries excluding your needing libraries.

3. API(Library) Functions

TFAT Library uses the following APIs.

Table 3.1 API(Library) Functions

API	Outline
R_tfat_f_mount	Register/Unregister a work area
R_tfat_f_open	Open/Create a file
R_tfat_f_close	Close a file
R_tfat_f_read	Read file
R_tfat_f_write	Write file
R_tfat_f_lseek	Move read/write pointer, Expand file size
R_tfat_f_truncate	Truncate file size
R_tfat_f_sync	Flush cached data
R_tfat_f_opendir	Open a directory
R_tfat_f_readdir	Read a directory item
R_tfat_f_getfree	Get free clusters
R_tfat_f_stat	Get file status
R_tfat_f_mkdir	Create a directory
R_tfat_f_unlink	Remove a file or directory
R_tfat_f_chmod	Change attribute
R_tfat_f_utime	Change timestamp
R_tfat_f_rename	Rename/Move a file or directory
R_tfat_f_forward	Forward file data to the stream directly

Please refer to the User's Manual if you needs datails. (r20uw0078ej0301_tfat.pdf)

4. Sample program

4.1 Outline

The sample program is High-performance Embedded Workshop project that works at the board (hereafter referred to as "CPU board") shown in 6.1Operation Confirmation Environment Development environment. The sample program prepares for two kinds of following projects

- Sample program only using the SD mode SD memory card driver
- Sample program using the USB driver

— Document No. : R01AN3852
— Document Title. : RX Family SDHI Module Using Firmware Integration Technology: Application note

— Document No. : R01AN4233
— Document Title. : RX Family SD mode SD memory Card Firmware Integration Technology: Application note

— Document No. : R01AN2025
— Document Title. : USB Basic Host and Peripheral Driver Firmware Integration Technology: Application note

— Document No. : R01AN2026
— Document Title. : USB Host Mass Storage Class Driver (HMSC) Firmware Integration Technology: Application note

— Document No. : R01AN2166
— Document Title. : USB Basic Mini Host and Peripheral Driver (USB Mini Firmware) Using Firmware Integration Technology: Application note

— Document No. : R01AN2026
— Document Title. : USB Host Mass Storage Class Driver (HMSC) for USB Mini Firmware Integration Technology: Application note

4.2 Sample software execution

4.2.1 The sample program that the SD mode SD memory card driver used

When the program is run, a FAT filesystem work area is registered. A file is created on the memory media and text data of 2 KB is written to the file. The file is then closed. For confirmation of the data that is written, the file is opened again in the read mode. The entire contents of the file are read and they are compared with the write buffer data in the program. Whether the contents of the data are matching or not is indicated on Debug Console(Renesas Virtual Debug Console) on e2studio or CS+.

Table 4.1 Explanation of Debug Console display

Characters	Explanation
Detected attached SD card.	Insertion of the SD card was detected.
Detected detached SD card.	The SD card removal was detected.
!!! Attach SD card. !!!!	Insert the SD card.
!!! Detach SD card. !!!!	Remove the SD card.
Start TFAT sample	Started sample program.
Finished TFAT sample	Finished sample program.
!!!!! TFAT error !!!!!	An error occurred.

The sample data for file read / write is stored in the r_data_file.c. The data is stored in an array of 2048 elements giving a total size of 2 KB (2048 Bytes). The data array consists of the text string "Renesas," written repeatedly. If required, the user can modify this array and the corresponding macro `FILESIZE`.

4.2.2 Flow

Flow of a sample program is shown below.

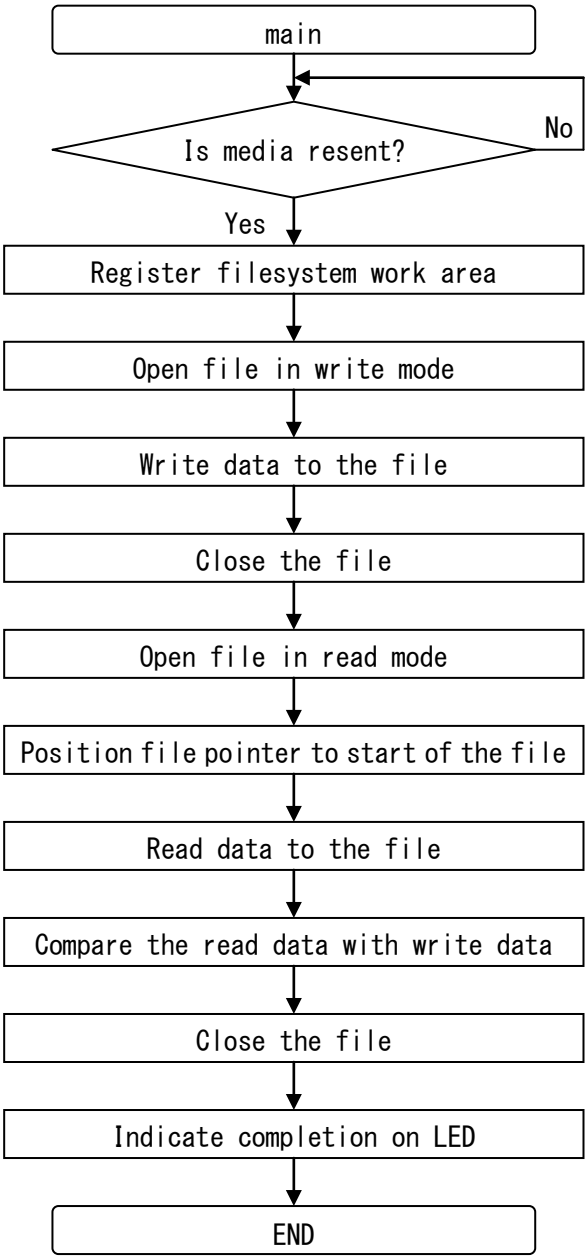

Figure 4-1 Flow of sample program

4.2.3 The sample program that the USB driver used

When the program is run, a FAT filesystem work area is registered. A file is created on the memory media and text data of 2 KB is written to the file. The file is then closed. For confirmation of the data that is written, the file is opened again in the read mode. The entire contents of the file are read and they are compared with the write buffer data in the program. Whether the contents of the data are matching or not is indicated on Debug Console(Renesas Virtual Debug Console) on e2studio or CS+.

Table 4.3 Explanation of Debug Console display

Characters	Explanation
Detected attached USB memory.	Insertion of the USB memory was detected.
Detected detached USB memory.	The USB memory removal was detected.
!!! Attach USB memory. !!!!	Insert the USB memory.
!!! Detach USB memory. !!!!	Remove the USB memory.
Start TFAT sample	Started sample program.
Finished TFAT sample	Finished sample program.
!!!!! TFAT error !!!!!	An error occurred.

The sample data for file read / write is stored in the r_data_file.c. The data is stored in an array of 2048 elements giving a total size of 2 KB (2048 Bytes). The data array consists of the text string "Renesas," written repeatedly. If required, the user can modify this array and the corresponding macro `FILESIZE`.

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Flow of a sample program is shown below.

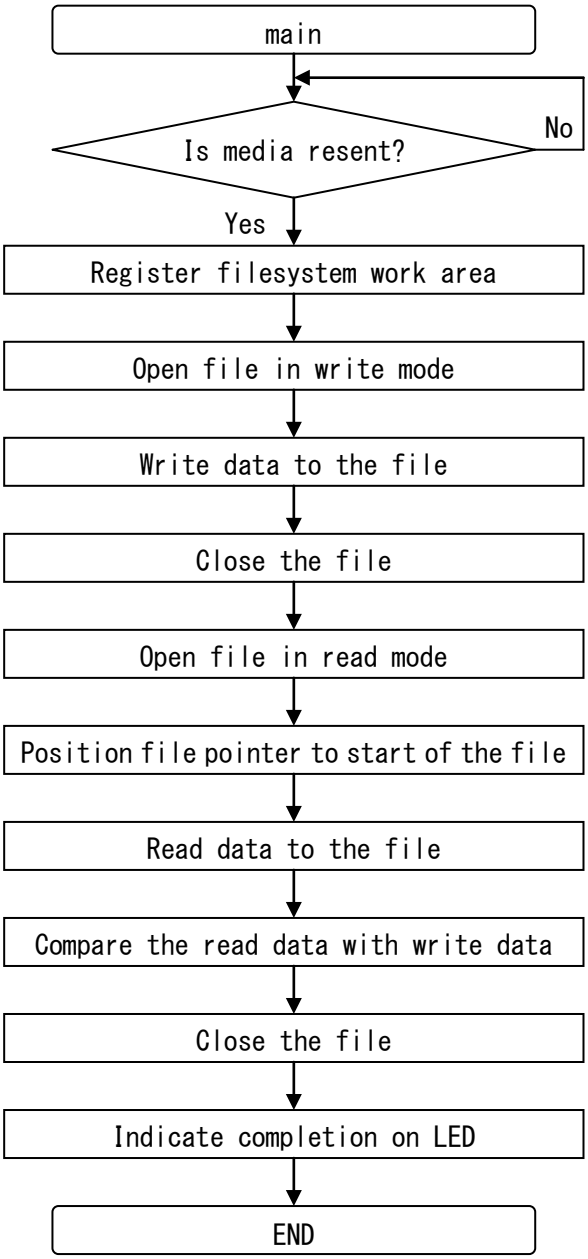

Figure 4-3 Flow of sample program

5. Library version information

Ver	change
3.04	Updated version number with the xml file revision.
3.03	Updated version number with the xml file revision.
3.02	Updated version number.
3.01	Updated version number.
3.00	V.2.00→V.3.00 can use Multidrive feature.

6. Appendices

6.1 Operation Confirmation Environment

This section describes operation confirmation environment for this driver.

Table 6.1 Operation Confirmation Environment

Item	Contents
Integrated development environment	Renesas Electronics e^2 studio V7.1.0
C compiler	Renesas Electronics C/C++ Compiler Package for RX Family V3.00.00
	Compiler option: The following option is added to the default settings of the integrated development environment. -lang = c99
Endian	Little endian
Version of the module	Ver.3.04
Board used	Renesas Starter Kit for RX231 (product No.:R0K505231Sxxxxx) Renesas Starter Kit+ for RX65N-1MB (product No.:RTK500565NSxxxxxxx)

6.2 Troubleshooting

(1) Q: I have added the FIT module to the project and built it. Then I got the error: Could not open source file "platform.h".

A: The FIT module may not be added to the project properly. Check if the method for adding FIT modules is correct with the following documents:

- Using CS+:

  Application note "Adding Firmware Integration Technology Modules to CS+ Projects (R01AN1826)"

- Using e^2 studio:

  Application note "Adding Firmware Integration Technology Modules to Projects (R01AN1723)"

When using this FIT module, the board support package FIT module (BSP module) must also be added to the project. Refer to the application note "Board Support Package Module Using Firmware Integration Technology (R01AN1685)".

(2) Q: I have added the FIT module to the project and built it. Then I got the error: This MCU is not supported by the current r_sdc_sd_rx module.

A: The FIT module you added may not support the target device chosen in your project. Check the supported devices of added FIT modules.

7. Reference Documents

User's Manual: Hardware
The latest versions can be downloaded from the Renesas Electronics website.

Technical Update/Technical News
The latest information can be downloaded from the Renesas Electronics website.

User's Manual: Development Tools
RX Family C/C++ Compiler CC-RX User's Manual (R20UT3248)
The latest version can be downloaded from the Renesas Electronics website.

Website and Support

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Revision History

		Description	
Rev.	**Date**	**Page**	**Summary**
3.04	Nov.30.2018	−	Chapter 2.4, added limitation when using Real Time OS. Chapter 4 and 6 was added Updated the xml file for FIT.
3.03	Oct.01.2016	−	Corresponded to RX family. Updated the xml file for FIT.
3.02	May.01.2015	—	Corresponded to RX231. Updated the xml file for FIT.
3.01	Dec.28.2014	—	Corresponded to RX71M/RX113. Updated the xml file for FIT.
3.00	Apr 01, 2014	—	FIT Module correspondence
1.03	Nov 30, 2013	—	Changed the base version of the open source into V0.09b from V0.06.
1.02	Nov 08, 2013	—	Changed document title Changed the structure of sections Added Fatfs copyright to library source
1.01	Sep 01, 2012	—	RX210 correspondence
1.00	Oct 08, 2010	—	First edition issued

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The following usage notes are applicable to all Microprocessing unit and Microcontroller unit products from Renesas. For detailed usage notes on the products covered by this document, refer to the relevant sections of the document as well as any technical updates that have been issued for the products.

1. Handling of Unused Pins

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

   ¾ 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.

   ¾ 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.

   ¾ 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.

   ¾ 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.

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(Rev.4.0-1 November 2017)

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Colophon 7.2