RL78 Family

FFT Library: Introduction Guide

R20AN0150EJ0103
Rev.1.03
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Introduction

This document explains FFT Library V.1.01 Release 00 (hereafter referred to as “FFT library"). FFT library will differ depending on the MCUs. Fast Fourier Transform (FFT) is the fast algorithm for efficient implementation of the discrete Fourier transform (DFT). As is well known, the development of FFT by Cooley and Tukey in 1965 has led to phenomenal grown in its applications in digital signal processing.

The FFT library for the Renesas Microcomputer is written in optimized assembler.

Please refer to the User’s Manual to understand how to use the software library.

Target Device

RL78/G13, RL78/G14

Contents

1. Structure of This Product

This product is consists of the following components:

1. FFT Library V.1.01 Release 00
2. FFT Library V.1.01 Release 00 Introduction Guide（r20an0150ej0103_rl78_fft.pdf）
   part number of this product : R0M7800LF0010RRC

Table 1 FFT library product files

name	Description
r20an0150ej0103_rl78_fft.pdf	Introduction Guide (this document)
workspace(workspace)	
Document (doc)	
English(en)	
r20uw0099ej0102_fft.pdf	User's Manual
r20an0150ej0103_rl78_fft.pdf	Introduction Guide (this document)
Japanese(ja)	
r20uw0099jj0102_fft.pdf	User's Manual
r20an0150jj0103_rl78_fft.pdf	Introduction Guide
For CS+ for CA, CX(CS+ for CA)	
FFT Library (lib)	
libfft_rl78g13.lib	Assembler-tuned (16-bit fixed-point) FFT library for RL78/G13 version 1.01
libfft_rl78g14.lib	Assembler-tuned (16-bit fixed-point) FFT library for RL78/G14 version 1.01
r_fft_int16.h	FFT library header file
r_stdint.h	Standard integer typedefs
Sample program (sample)	
rl78g14_fft	Sample CS+ for CA project(RL78/G14)
For CS+ for CC(CS+ for CC)	
FFT Library (lib)	
libfft_rl78g13.lib	Assembler-tuned (16-bit fixed-point) FFT library for RL78/G13 version 1.01
libfft_rl78g14.lib	Assembler-tuned (16-bit fixed-point) FFT library for RL78/G14 version 1.01
r_fft_int16.h	FFT library header file
r_stdint.h	Standard integer typedefs
Sample program (sample)	
rl78g14_fft_ccrl	Sample CS+ for CC project(RL78/G14)
For IAR Embedded Workbench(IAR)	
FFT Library (lib)	
libfft_rl78g13.a	Assembler-tuned (16-bit fixed-point) FFT library for RL78/G13 version 1.01
libfft_rl78g14.a	Assembler-tuned (16-bit fixed-point) FFT library for RL78/G14 version 1.01
r_fft_int16.h	FFT library header file
r_stdint.h	Standard integer typedefs
Sample program (sample)	
rl78g14_fft_iar	Sample IAR IDE Workspace project(RL78/G14)

2. Library Functions

FFT Library supports the following library functions (API)

API	Outline
R_rfft64_int16	16-bit fixed-point real FFT (64 points)
R_rfft128_int16	16-bit fixed-point real FFT (128 points)
R_rfft256_int16	16-bit fixed-point real FFT (256 points)

3. For CS+ for CA, CX

3.1 Limitations

Since RL78/G13 FFT utilizes the multiplier and divider/multiply-accumulator for multiply–accumulate operations, the application must not change the values of the following registers in its user interrupt functions:

- Registers:
  - Multiplication/division data register A (L) (MDAL)
  - Multiplication/division data register A (H) (MDAH)
  - Multiplication/division data register B (L) (MDBL)
  - Multiplication/division data register B (H) (MDBH)
  - Multiplication/division data register C (L) (MDCL)
  - Multiplication/division data register C (H) (MDCH)
- Control Register:
  - Multiplication/division control register (MDUC)

For further information, please consult Chapter 14 Multiplier and Divider/Multiply-Accumulator, *RL78/G13 User's Manual: Hardware*

3.2 Corresponding MCU

This product is specifically built with the following compiler options:

```
-qx2 –common –mm –mi0 –ng
```

3.3 Development Environment

Renesas Toolchain Requirements

Please use the same or a later version of the toolchain listed below:

- Integrated Development Environment:
  - CS+ for CA, CX V3.00.01
- C compiler:
  - CA78K0R V1.71
- Debugger:
  - RL78 Simulator; Debugger Library V3.00.00

3.4 ROM / RAM / Stack Size

The ROM, RAM, and stack footprints of each FFT library functions (API) are shown below (in bytes):

FFT Library for RL78/G13:

API	ROM	RAM	Stack
R_rfft64_int16	1261	0	66
R_rfft128_int16	1513	0	66
R_rfft256_int16	2019	0	66

FFT Library for RL78/G14:

API	ROM	RAM	Stack
R_rfft64_int16	1225	0	66
R_rfft128_int16	1477	0	66
R_rfft256_int16	1983	0	66

3.5 Section Information

The following table shows program sections (segments) used in each FFT library.

Section name	Contents	Section Attributes
@@CODEL	program code	CSEG
@@CNST	constant data	CSEG MIRRORP

3.6 Performance

The following table shows FFT library's performance. The processing speeds are indicated in processing time per function call.

FFT Library for RL78/G13:

API	time(system clock = 32MHz)
R_rfft64_int16	About 0.4ms
R_rfft128_int16	About 0.9ms
R_rfft256_int16	About 1.9ms

FFT Library for RL78/G14:

API	time(system clock = 32MHz)
R_rfft64_int16	About 0.4ms
R_rfft128_int16	About 0.9ms
R_rfft256_int16	About 1.9ms

3.7 Version Information

The application may refer the following version string of FFT library via the global variable `r_fft_a_version`:

```
extern const char r_fft_a_version[];
```

And the data that is included in this package is below.

FFT Library for RL78/G13:

```
const char r_fft_a_version[] =
“FFT Library version 1.01 for RL78 Family (RL78G13) (Dec 07 2015, 17:29:14)”;
```

FFT Library for RL78/G14:

```
const char r_fft_a_version[] =
“FFT Library version 1.01 for RL78 Family (RL78G14) (Dec 07 2015, 17:28:57)”;
```

4. For CS+ for CC

4.1 Limitations

Since RL78/G13 FFT utilizes the multiplier and divider/multiply-accumulator for multiply–accumulate operations, the application must not change the values of the following registers in its user interrupt functions:

- Registers:
  - Multiplication/division data register A (L) (MDAL)
  - Multiplication/division data register A (H) (MDAH)
  - Multiplication/division data register B (L) (MDBL)
  - Multiplication/division data register B (H) (MDBH)
  - Multiplication/division data register C (L) (MDCL)
  - Multiplication/division data register C (H) (MDCH)
- Control Register:
  - Multiplication/division control register (MDUC)

For further information, please consult Chapter 14 Multiplier and Divider/Multiply-Accumulator, *RL78/G13 User's Manual: Hardware*

4.2 Corresponding MCU

This product is specifically built with the following compiler options:

-asmopt=-mirror_source=common -memory_model=medium

4.3 Development Environment

Renesas Toolchain Requirements

Please use the same or a later version of the toolchain listed below:

- Integrated Development Environment:
  - CS+ for CC V3.01.00
- C compiler:
  - CCRL V1.01
- Debugger:
  - RL78 Simulator
    - Device V3.01.00
    - DeviceRl78 V3.01.00
    - ConfigurationRl78Simulator V3.01.00
    - EngineManager V3.01.00
    - EngineManagerExec V3.01.00
    - RL78 Asm/Disasm V3.01.00
    - DBEvaluatorManager V3.01.00
    - LoadModuleManager V3.01.00

4.4 ROM / RAM / Stack Size

The ROM, RAM, and stack footprints of each FFT library functions (API) are shown below (in bytes):

FFT Library for RL78/G13:

API	ROM	RAM	Stack
R_rfft64_int16	1260	0	68
R_rfft128_int16	1512	0	68
R_rfft256_int16	2018	0	68

FFT Library for RL78/G14:

API	ROM	RAM	Stack
R_rfft64_int16	1224	0	68
R_rfft128_int16	1476	0	68
R_rfft256_int16	1982	0	68

4.5 Section Information

The following table shows program sections (segments) used in each FFT library.

Section name	**Contents**	**Section Attributes**
.textf	program code	.CSEG TEXTF
.const	constant data	.CSEG CONST

4.6 Performance

The following table shows FFT library's performance. The processing speeds are indicated in processing time per function call.

FFT Library for RL78/G13:

API	**time(system clock = 32MHz)**
R_rfft64_int16	About 0.4ms
R_rfft128_int16	About 0.9ms
R_rfft256_int16	About 1.9ms

FFT Library for RL78/G14:

API	**time(system clock = 32MHz)**
R_rfft64_int16	About 0.4ms
R_rfft128_int16	About 0.9ms
R_rfft256_int16	About 1.9ms

4.7 Version Information

The application may refer the following version string of FFT library via the global variable `r_fft_a_version`:

```
extern const char r_fft_a_version[];
```

And the data that is included in this package is below.

FFT Library for RL78/G13:

```
const char r_fft_a_version[] =
“FFT Library version 1.01 for RL78 Family (RL78G13) (Dec  7 2015, 17:30:04)”;
```

FFT Library for RL78/G14:

```
const char r_fft_a_version[] =
“FFT Library version 1.01 for RL78 Family (RL78G14) (Dec  7 2015, 17:29:42)”;
```

5. For IAR Embedded Workbench

5.1 Limitations

Since RL78/G13 FFT utilizes the multiplier and divider/multiply-accumulator for multiply–accumulate operations, the application must not change the values of the following registers in its user interrupt functions:

- Registers:
  Multiplication/division data register A (L) (MDAL)
  Multiplication/division data register A (H) (MDAH)
  Multiplication/division data register B (L) (MDBL)
  Multiplication/division data register B (H) (MDBH)
  Multiplication/division data register C (L) (MDCL)
  Multiplication/division data register C (H) (MDCH)
- Control Register:
  Multiplication/division control register (MDUC)

For further information, please consult Chapter 14 Multiplier and Divider/Multiply-Accumulator, *RL78/G13 User's Manual: Hardware*

5.2 Corresponding MCU

This product is specifically built with the following compiler options:

FFT Library for RL78/G13:

```
--core rl78_1 –code_model far –data_model near
--near_const_location rom0 –e –Oh –library_module
```

FFT Library for RL78/G14:

```
--core rl78_2 –code_model far –data_model near
--near_const_location rom0 –e –Oh –library_module
```

5.3 Development Environment

Renesas Toolchain Requirements

Please use the same or a later version of the toolchain listed below:

- Integrated Development Environment:
  IAR Embedded Workbench for Renesas RL78 V2.10.1
- C compiler:
  IAR C/C++ Compiler for Renesas RL78 V2.10.1.1362
- Debugger:
  IAR C-SPY Debugger Kernel V7.2.2.3718

5.4 ROM/ RAM / Stack Size

The ROM, RAM, and stack footprints of each FFT library functions (API) are shown below (in bytes):

FFT Library for RL78/G13:

API	ROM	RAM	stack
R_rfft64_int16	1262	0	68
R_rfft128_int16	1514	0	68
R_rfft256_int16	2020	0	68

FFT Library for RL78/G14:

API	ROM	RAM	stack
R_rfft64_int16	1226	0	68
R_rfft128_int16	1478	0	68
R_rfft256_int16	1984	0	68

5.5 Section Information

The following table shows program sections (segments) used in FFT library.

Section name	Contents
.textf	program code
.const	constant data

5.6 Performance

The following table shows FFT library's performance. The processing speeds are indicated in processing time per function call.

FFT Library for RL78/G13:

API	time(system clock = 32MHz)
R_rfft64_int16	About 0.4ms
R_rfft128_int16	About 0.9ms
R_rfft256_int16	About 1.9ms

FFT Library for RL78/G14:

API	time(system clock = 32MHz)
R_rfft64_int16	About 0.4ms
R_rfft128_int16	About 0.9ms
R_rfft256_int16	About 1.9ms

5.7 Version Information

The application may refer the following version string of FFT library via the global variable `r_fft_a_version`:

```
extern const char r_fft_a_version[];
```

And the data that is included in this package is below.

FFT Library for RL78/G13:

```
const char r_fft_a_version[] =
“FFT Library version 1.01 for RL78 Family (RL78G13) (Dec  7 2015, 17:32:09)”;
```

FFT Library for RL78/G14:

```
const char r_fft_a_version[] =
“FFT Library version 1.01 for RL78 Family (RL78G14) (Dec  7 2015, 17:31:03)”;
```

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Revision History

		Description	
Rev.	**Date**	**Page**	**Summary**
1.03	Oct 01, 2015	**—**	Changed CubeSuite+ to CS+ for CA,CX Supported CS+ for CC.
1.02	Apr 01, 2015	P2	Updated “Structure of This Product” section for package version V.1.00 Release 02.
1.01	Apr 01, 2014	—	Updated “Structure of This Product” section for package version V.1.00 Release 01. Added support IAR Embedded Workbench
1.00	Mar 31, 2012	—	First edition issued

General Precautions in the Handling of Microprocessing Unit and Microcontroller Unit Products

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.

   — 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 a product with a different part number, confirm that the change will not lead to problems.

   — The characteristics of Microprocessing unit or Microcontroller unit products in the same group but having a different part number may differ in terms of the internal memory capacity, layout pattern, and other factors, which can affect the ranges of electrical characteristics, such as characteristic values, operating margins, immunity to noise, and amount of radiated noise. When changing to a product with a different part number, implement a system-evaluation test for the given product.

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Colophon 5.0