

# RL78/F23, RL78/F24

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## Porting Guide from RL78/F13, F14 to RL78/F23, F24 Products

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### Introduction

RL78/F23, F24 products are successors of RL78/F13, F14 products and support security, CAN-FD, 12-bit A/D converter and other enhanced peripheral functions.

RL78/F23, F24 products have the same functions of general-timers and serial interfaces as RL78/F13, F14 products. Pin assignments and software of RL78/F23, F24 products are compatible to current products.

This application note provides comparisons between RL78/F13, F14 products and RL78/F23, F24 products, and can be used as a general guide during the migration from RL78/F13, F14 products to RL78/F23, F24 products.

### Target Devices

| Source Devices                            | Destination Devices                   |
|-------------------------------------------|---------------------------------------|
| RL78/F14 (100/80/64/48/32/30-pin)         | <b>RL78/F24 (100/80/64/48/32-pin)</b> |
| RL78/F13 (CAN & LIN) (80/64/48/32/30-pin) | <b>RL78/F24 (100/80/64/48/32-pin)</b> |
| RL78/F13 (LIN) (80/64/48/32/30/20-pin)    | <b>RL78/F23 (80/64/48/32-pin)</b>     |

## Contents

|                                                                               |           |
|-------------------------------------------------------------------------------|-----------|
| <b>1. Overview</b>                                                            | <b>3</b>  |
| 1.1 Product Lineup                                                            | 3         |
| 1.2 Product Feature Comparison                                                | 5         |
| <b>2. Pin Assignment</b>                                                      | <b>7</b>  |
| 2.1 Pin Assignment Comparison                                                 | 7         |
| <b>3. Memory Map</b>                                                          | <b>12</b> |
| 3.1 Memory Size by Products                                                   | 12        |
| 3.2 Memory Map                                                                | 13        |
| <b>4. Port Function</b>                                                       | <b>18</b> |
| 4.1 Port Function Comparison                                                  | 18        |
| <b>5. Clock Generator</b>                                                     | <b>19</b> |
| 5.1 PLL Clock Circuit                                                         | 19        |
| 5.2 High-speed On-chip Oscillator Frequency Selection                         | 20        |
| <b>6. Timer Functions</b>                                                     | <b>21</b> |
| <b>7. Serial Interfaces</b>                                                   | <b>23</b> |
| <b>8. Analog Functions</b>                                                    | <b>24</b> |
| 8.1 A/D Converter                                                             | 24        |
| 8.2 Comparator (RL78/F24 Only)                                                | 25        |
| <b>9. Safety Functions</b>                                                    | <b>26</b> |
| 9.1 Memory Guard Function                                                     | 26        |
| <b>10. Other Features</b>                                                     | <b>27</b> |
| 10.1 ELC (RL78/F24 Only)                                                      | 27        |
| 10.2 AAU (Application Accelerator Unit)                                       | 28        |
| <b>11. Interrupt</b>                                                          | <b>29</b> |
| <b>12. Standby Control</b>                                                    | <b>33</b> |
| <b>13. Flash Memory</b>                                                       | <b>34</b> |
| <b>14. Development Environment</b>                                            | <b>34</b> |
| <b>15. Electrical Specifications</b>                                          | <b>35</b> |
| 15.1 Supply Current Characteristics                                           | 35        |
| 15.2 Pin Current Characteristics                                              | 37        |
| <b>16. Appendix</b>                                                           | <b>38</b> |
| 16.1 SFR Comparison between RL78/F23, F24 Products and RL78/F13, F14 Products | 38        |
| <b>17. References</b>                                                         | <b>42</b> |
| <b>Revision History</b>                                                       | <b>43</b> |

## 1. Overview

This document describes differences between RL78/F23, F24 products and RL78/F13, F14 products, and provides notes when replacing RL78/F13, F14 products with RL78/F23, F24 products.

A thorough evaluation needs to be performed when replacing RL78/F13, F14 products with RL78/F23, F24 products. For details of each product, refer to the hardware user's manuals.

### 1.1 Product Lineup

Tables below show the lineup of RL78/F24 and RL78/F23 products together with corresponding RL78/F14 and RL78/F13 products.

**Table 1-1. RL78/F24 Products Lineup, Compared with RL78/F14**

| Source Devices: RL78/F14 Products |                 |                 |          |             |                  | Destination Devices: RL78/F24 Products |                 |                 |          |             |                  |
|-----------------------------------|-----------------|-----------------|----------|-------------|------------------|----------------------------------------|-----------------|-----------------|----------|-------------|------------------|
| Pin Count                         | Code Flash (KB) | Data Flash (KB) | RAM (KB) | Freq. (MHz) | Temperature (Ta) | Pin Count                              | Code Flash (KB) | Data Flash (KB) | RAM (KB) | Freq. (MHz) | Temperature (Ta) |
| 100QFP                            | 256/192/128     | 8               | 20/16/10 | 32          | -40 to 105       | 100QFP                                 | 256             | 16              | 24       | 40          | -40 to 105       |
|                                   |                 |                 |          | 24          | -40 to 125       |                                        |                 |                 |          |             | -40 to 125       |
|                                   |                 |                 |          | 24          | -40 to 150       |                                        |                 |                 |          |             | -40 to 150       |
|                                   | 96/64           | 4               | 8/6      | 32          | -40 to 105       |                                        |                 |                 |          |             | -40 to 105       |
|                                   |                 |                 |          | 24          | -40 to 125       |                                        |                 |                 |          |             | -40 to 125       |
|                                   |                 |                 |          | 24          | -40 to 150       |                                        |                 |                 |          |             | -40 to 150       |
| 80QFP                             | 256/192/128     | 8               | 20/16/10 | 32          | -40 to 105       | 80QFP                                  | 256             | 16              | 24       | 40          | -40 to 105       |
|                                   |                 |                 |          | 24          | -40 to 125       |                                        |                 |                 |          |             | -40 to 125       |
|                                   |                 |                 |          | 24          | -40 to 150       |                                        |                 |                 |          |             | -40 to 150       |
|                                   | 96/64           | 4               | 8/6      | 32          | -40 to 105       |                                        |                 |                 |          |             | -40 to 105       |
|                                   |                 |                 |          | 24          | -40 to 125       |                                        |                 |                 |          |             | -40 to 125       |
|                                   |                 |                 |          | 24          | -40 to 150       |                                        |                 |                 |          |             | -40 to 150       |
| 64QFP                             | 256/192/128     | 8               | 20/16/10 | 32          | -40 to 105       | 64QFP                                  | 256             | 16              | 24       | 40          | -40 to 105       |
|                                   |                 |                 |          | 24          | -40 to 125       |                                        |                 |                 |          |             | -40 to 125       |
|                                   |                 |                 |          | 24          | -40 to 150       |                                        |                 |                 |          |             | -40 to 150       |
|                                   | 96/64           | 4               | 8/6      | 32          | -40 to 105       |                                        |                 |                 |          |             | -40 to 105       |
|                                   |                 |                 |          | 24          | -40 to 125       |                                        |                 |                 |          |             | -40 to 125       |
|                                   |                 |                 |          | 24          | -40 to 150       |                                        |                 |                 |          |             | -40 to 150       |
| 48QFP<br>48QFN                    | 256/192/128     | 8               | 20/16/10 | 32          | -40 to 105       | 48QFP                                  | 256             | 16              | 24       | 40          | -40 to 105       |
|                                   |                 |                 |          | 24          | -40 to 125       |                                        |                 |                 |          |             | -40 to 125       |
|                                   |                 |                 |          | 24          | -40 to 150       |                                        |                 |                 |          |             | -40 to 150       |
|                                   | 96/64/48        | 4               | 8/6/4    | 32          | -40 to 105       |                                        |                 |                 |          |             | -40 to 105       |
|                                   |                 |                 |          | 24          | -40 to 125       |                                        |                 |                 |          |             | -40 to 125       |
|                                   |                 |                 |          | 24          | -40 to 150       |                                        |                 |                 |          |             | -40 to 150       |
| 32QFN                             | 64/48           | 4               | 6/4      | 32          | -40 to 105       | 32QFN                                  | 256             | 16              | 24       | 40          | -40 to 105       |
|                                   |                 |                 |          | 24          | -40 to 125       |                                        |                 |                 |          |             | -40 to 125       |
|                                   |                 |                 |          | 24          | -40 to 150       |                                        |                 |                 |          |             | -40 to 150       |
| 30SSOP                            | 64/48           | 4               | 6/4      | 32          | -40 to 105       | 32QFN<br>or<br>48QFP                   | 256             | 16              | 24       | 40          | -40 to 105       |
|                                   |                 |                 |          | 24          | -40 to 125       |                                        |                 |                 |          |             | -40 to 125       |
|                                   |                 |                 |          | 24          | -40 to 150       |                                        |                 |                 |          |             | -40 to 150       |

**Table 1-2. RL78/F24 Products Lineup, Compared with RL78/F13 (CAN & LIN)**

| Source Devices: RL78/F13 (CAN & LIN) Products |                     |                 |               |             |                  | Destination Devices: RL78/F24 Products |                 |                 |          |             |                  |
|-----------------------------------------------|---------------------|-----------------|---------------|-------------|------------------|----------------------------------------|-----------------|-----------------|----------|-------------|------------------|
| Pin Count                                     | Code Flash (KB)     | Data Flash (KB) | RAM (KB)      | Freq. (MHz) | Temperature (Ta) | Pin Count                              | Code Flash (KB) | Data Flash (KB) | RAM (KB) | Freq. (MHz) | Temperature (Ta) |
| 80QFP                                         | 128/96/64           | 4               | 8/6/4         | 32          | -40 to 105       | 80QFP                                  | 256             | 16              | 24       | 40          | -40 to 105       |
|                                               |                     |                 |               | 24          | -40 to 125       |                                        |                 |                 |          |             | -40 to 125       |
|                                               |                     |                 |               | 24          | -40 to 150       |                                        |                 |                 |          |             | -40 to 150       |
| 64QFP                                         | 128/96/64/<br>48/32 | 4               | 8/6/4/<br>3/2 | 32          | -40 to 105       | 64QFP                                  | 256             | 16              | 24       | 40          | -40 to 105       |
|                                               |                     |                 |               | 24          | -40 to 125       |                                        |                 |                 |          |             | -40 to 125       |
|                                               |                     |                 |               | 24          | -40 to 150       |                                        |                 |                 |          |             | -40 to 150       |
| 48QFP<br>48QFN                                | 128/96/64/<br>48/32 | 4               | 8/6/4/<br>3/2 | 32          | -40 to 105       | 48QFP                                  | 256             | 16              | 24       | 40          | -40 to 105       |
|                                               |                     |                 |               | 24          | -40 to 125       |                                        |                 |                 |          |             | -40 to 125       |
|                                               |                     |                 |               | 24          | -40 to 150       |                                        |                 |                 |          |             | -40 to 150       |
| 32QFN                                         | 128/96/64/<br>48/32 | 4               | 8/6/4/<br>3/2 | 32          | -40 to 105       | 32QFN                                  | 256             | 16              | 24       | 40          | -40 to 105       |
|                                               |                     |                 |               | 24          | -40 to 125       |                                        |                 |                 |          |             | -40 to 125       |
|                                               |                     |                 |               | 24          | -40 to 150       |                                        |                 |                 |          |             | -40 to 150       |
| 30SSOP                                        | 128/96/64/<br>48/32 | 4               | 8/6/4/<br>3/2 | 32          | -40 to 105       | 32QFN<br>or<br>48QFP                   | 256             | 16              | 24       | 40          | -40 to 105       |
|                                               |                     |                 |               | 24          | -40 to 125       |                                        |                 |                 |          |             | -40 to 125       |
|                                               |                     |                 |               | 24          | -40 to 150       |                                        |                 |                 |          |             | -40 to 150       |

**Table 1-3. RL78/F23 Products Lineup, Compared with RL78/F13 (LIN)**

| Source Devices: RL78/F13 (LIN) Products |                        |                 |                 |             |                  | Destination Devices: RL78/F23 Products |                 |                 |          |             |                  |
|-----------------------------------------|------------------------|-----------------|-----------------|-------------|------------------|----------------------------------------|-----------------|-----------------|----------|-------------|------------------|
| Pin Count                               | Code Flash (KB)        | Data Flash (KB) | RAM (KB)        | Freq. (MHz) | Temperature (Ta) | Pin Count                              | Code Flash (KB) | Data Flash (KB) | RAM (KB) | Freq. (MHz) | Temperature (Ta) |
| 80QFP                                   | 128/96/64              | 4               | 8/6/4           | 32          | -40 to 105       | 80QFP                                  | 128             | 8               | 12       | 40          | -40 to 105       |
|                                         |                        |                 |                 | 24          | -40 to 125       |                                        |                 |                 |          |             | -40 to 125       |
|                                         |                        |                 |                 | 24          | -40 to 150       |                                        |                 |                 |          |             | -40 to 150       |
| 64QFP                                   | 128/96/64/<br>48/32    | 4               | 8/6/4/<br>3/2   | 32          | -40 to 105       | 64QFP                                  | 128             | 8               | 12       | 40          | -40 to 105       |
|                                         |                        |                 |                 | 24          | -40 to 125       |                                        |                 |                 |          |             | -40 to 125       |
|                                         |                        |                 |                 | 24          | -40 to 150       |                                        |                 |                 |          |             | -40 to 150       |
| 48QFP<br>48QFN                          | 128/96/64/<br>48/32/16 | 4               | 8/6/4/<br>3/2/1 | 32          | -40 to 105       | 48QFP                                  | 128             | 8               | 12       | 40          | -40 to 105       |
|                                         |                        |                 |                 | 24          | -40 to 125       |                                        |                 |                 |          |             | -40 to 125       |
|                                         |                        |                 |                 | 24          | -40 to 150       |                                        |                 |                 |          |             | -40 to 150       |
| 32QFN                                   | 64/48/32/16            | 4               | 4/3/2/1         | 32          | -40 to 105       | 32QFN                                  | 128             | 8               | 12       | 40          | -40 to 105       |
|                                         |                        |                 |                 | 24          | -40 to 125       |                                        |                 |                 |          |             | -40 to 125       |
|                                         |                        |                 |                 | 24          | -40 to 150       |                                        |                 |                 |          |             | -40 to 150       |
| 30SSOP                                  | 64/48/32/16            | 4               | 4/3/2/1         | 32          | -40 to 105       | 32QFN<br>or<br>48QFP                   | 128             | 8               | 12       | 40          | -40 to 105       |
|                                         |                        |                 |                 | 24          | -40 to 125       |                                        |                 |                 |          |             | -40 to 125       |
|                                         |                        |                 |                 | 24          | -40 to 150       |                                        |                 |                 |          |             | -40 to 150       |
| 20SSOP                                  | 64/48/32/16            | 4               | 4/3/2/1         | 32          | -40 to 105       | 32QFN<br>or<br>48QFP                   | 128             | 8               | 12       | 40          | -40 to 105       |
|                                         |                        |                 |                 | 24          | -40 to 125       |                                        |                 |                 |          |             | -40 to 125       |
|                                         |                        |                 |                 | 24          | -40 to 150       |                                        |                 |                 |          |             | -40 to 150       |

## 1.2 Product Feature Comparison

Tables below show the feature comparisons between RL78/F23, F24 products and RL78/F13, F14 products. Each function of RL78/F14 product and RL78/F13 (LIN) product shown in the table below is an example of the maximum memory product.

**Table 1-4. Main Features of RL78/F24, Compared with RL78/F14**

| Features <sup>Note 1</sup>                       |                                      | RL78/F24                                                                    |        |        |        |                     | RL78/F14                                                                    |        |        |        |                     | Reference pages <sup>Note 2</sup> |
|--------------------------------------------------|--------------------------------------|-----------------------------------------------------------------------------|--------|--------|--------|---------------------|-----------------------------------------------------------------------------|--------|--------|--------|---------------------|-----------------------------------|
|                                                  |                                      | 100 QFP                                                                     | 80 QFP | 64 QFP | 48 QFP | 32 QFN              | 100 QFP                                                                     | 80 QFP | 64 QFP | 48 QFP | 32 QFN              |                                   |
| CPU                                              |                                      | RL78 CPU Core                                                               |        |        |        |                     | RL78 CPU Core                                                               |        |        |        |                     | -                                 |
| Memory                                           | Code Flash                           | 256KB                                                                       |        |        |        |                     | 48/64/96/128/192/256KB                                                      |        |        |        |                     | P.12                              |
|                                                  | Data Flash                           | 16KB                                                                        |        |        |        |                     | 4/8KB                                                                       |        |        |        |                     |                                   |
|                                                  | RAM                                  | 24KB                                                                        |        |        |        |                     | 4/6/8/10/16/20KB                                                            |        |        |        |                     |                                   |
| Supply Voltage                                   |                                      | 2.7V to 5.5V                                                                |        |        |        |                     | 2.7V to 5.5V                                                                |        |        |        |                     | -                                 |
| Operation Frequency                              |                                      | (max) 40MHz                                                                 |        |        |        |                     | (max) 32MHz, 24MHz@K, Y-grade                                               |        |        |        |                     | P.19                              |
| System Clock                                     | f <sub>X</sub>                       | 2MHz to 20MHz                                                               |        |        |        |                     | 1MHz to 20MHz                                                               |        |        |        |                     |                                   |
|                                                  | f <sub>IH</sub>                      | 40MHz                                                                       |        |        |        |                     | 32MHz, 24MHz@K, Y-grade                                                     |        |        |        |                     |                                   |
|                                                  | f <sub>IL</sub>                      | 15kHz                                                                       |        |        |        |                     | 15kHz                                                                       |        |        |        |                     |                                   |
|                                                  | f <sub>SUB</sub> <sup>Note 4</sup>   | 32.768kHz                                                                   |        |        |        | -                   | 32.768kHz                                                                   |        |        |        | -                   |                                   |
|                                                  | f <sub>PLL</sub>                     | 40MHz                                                                       |        |        |        |                     | 32MHz, 24MHz@K, Y-grade                                                     |        |        |        |                     |                                   |
| Clock for Peripherals                            | f <sub>WDT</sub>                     | 15kHz                                                                       |        |        |        |                     | 15kHz                                                                       |        |        |        |                     |                                   |
|                                                  | f <sub>PLL</sub>                     | 80MHz                                                                       |        |        |        |                     | 64MHz, 48MHz@K, Y-grade                                                     |        |        |        |                     |                                   |
|                                                  | f <sub>IH</sub>                      | 80MHz                                                                       |        |        |        |                     | 64MHz, 48MHz@K, Y-grade                                                     |        |        |        |                     |                                   |
| POR                                              |                                      | Yes                                                                         |        |        |        |                     | Yes                                                                         |        |        |        |                     | -                                 |
| LVD                                              |                                      | Yes                                                                         |        |        |        |                     | Yes                                                                         |        |        |        |                     | -                                 |
| Window Watchdog Timer                            |                                      | Yes                                                                         |        |        |        |                     | Yes                                                                         |        |        |        |                     | -                                 |
| Illegal Instruction Execution Detection Function |                                      | Yes                                                                         |        |        |        |                     | Yes                                                                         |        |        |        |                     | P.26                              |
| Flash Memory CRC Operation Function              |                                      | Yes                                                                         |        |        |        |                     | Yes                                                                         |        |        |        |                     |                                   |
| RAM ECC Detection Function                       |                                      | Yes                                                                         |        |        |        |                     | Yes                                                                         |        |        |        |                     |                                   |
| CAN-FD RAM ECC Detection Function                |                                      | Yes                                                                         |        |        |        |                     | -                                                                           |        |        |        |                     |                                   |
| Code Flash Memory ECC Function                   |                                      | Yes                                                                         |        |        |        |                     | -                                                                           |        |        |        |                     |                                   |
| Invalid Memory Access Detection Function         |                                      | Yes                                                                         |        |        |        |                     | Yes                                                                         |        |        |        |                     |                                   |
| Frequency Detection Function                     |                                      | Yes                                                                         |        |        |        |                     | Yes                                                                         |        |        |        |                     |                                   |
| Clock Monitor Function                           |                                      | Yes                                                                         |        |        |        |                     | Yes                                                                         |        |        |        |                     |                                   |
| Stack Pointer Monitor Function                   |                                      | Yes                                                                         |        |        |        |                     | Yes                                                                         |        |        |        |                     |                                   |
| I/O Port Output Level Detection Function         |                                      | Yes                                                                         |        |        |        |                     | Yes                                                                         |        |        |        |                     |                                   |
| A/D Test Function                                |                                      | Yes                                                                         |        |        |        |                     | Yes                                                                         |        |        |        |                     |                                   |
| I/O Port                                         |                                      | 86ch                                                                        | 68ch   | 52ch   | 38ch   | 25ch                | 86ch                                                                        | 68ch   | 52ch   | 38ch   | 25ch                | P.18                              |
|                                                  | Output Only                          | 1ch                                                                         | 1ch    | 1ch    | 1ch    | -                   | 1ch                                                                         | 1ch    | 1ch    | 1ch    | -                   |                                   |
|                                                  | Input Only                           | 5ch                                                                         | 5ch    | 5ch    | 5ch    | 3ch                 | 5ch                                                                         | 5ch    | 5ch    | 5ch    | 3ch                 |                                   |
| Power Supply Pin                                 | Internal Circuit                     | V <sub>DD</sub> , V <sub>SS</sub> , REGC                                    |        |        |        |                     | V <sub>DD</sub> , V <sub>SS</sub> , REGC                                    |        |        |        |                     |                                   |
|                                                  | I/O Port                             | EV <sub>DD</sub> , EV <sub>SS</sub> <sup>Note 3</sup>                       |        |        |        |                     | EV <sub>DD</sub> , EV <sub>SS</sub> <sup>Note 3</sup>                       |        |        |        |                     |                                   |
|                                                  | Analog                               | V <sub>DD</sub> , V <sub>SS</sub> , AV <sub>REFP</sub> , AV <sub>REFM</sub> |        |        |        |                     | V <sub>DD</sub> , V <sub>SS</sub> , AV <sub>REFP</sub> , AV <sub>REFM</sub> |        |        |        |                     |                                   |
| Interrupt                                        | External                             | 16ch                                                                        | 16ch   | 15ch   | 14ch   | 10ch                | 16ch                                                                        | 16ch   | 15ch   | 14ch   | 9ch                 | P.29                              |
|                                                  | Internal                             | 51ch                                                                        | 51ch   | 51ch   | 51ch   | 51ch                | 48ch                                                                        | 48ch   | 48ch   | 48ch   | 41ch                |                                   |
| Key Return Detection                             |                                      | 8                                                                           | 8      | 8      | 8      | 6                   | 8                                                                           | 8      | 8      | 8      | 6                   | -                                 |
| DTC                                              |                                      | 44                                                                          | 44     | 44     | 44     | 43                  | 44                                                                          | 44     | 44     | 44     | 37                  | -                                 |
| Timer                                            | TAU                                  | 16-bit×16ch                                                                 |        |        |        |                     | 16-bit×16ch                                                                 |        |        |        |                     | P.21                              |
|                                                  | Timer RD                             | 16-bit×2ch<br>(w/ PWMOPA and Dithering/Gate)                                |        |        |        |                     | 16-bit×2ch                                                                  |        |        |        |                     |                                   |
|                                                  | Timer RJ                             | 16-bit×1ch                                                                  |        |        |        |                     | 16-bit×1ch                                                                  |        |        |        |                     |                                   |
|                                                  | RTC                                  | 1ch                                                                         |        |        |        |                     | 1ch                                                                         |        |        |        |                     |                                   |
| Serial I/F                                       | SAU                                  | 4ch/4ch/2ch                                                                 |        |        |        | 3ch/<br>3ch/<br>2ch | 4ch/4ch/2ch                                                                 |        |        |        | 3ch/<br>3ch/<br>2ch | P.23                              |
|                                                  | CSI/simplified I <sup>2</sup> C/UART |                                                                             |        |        |        |                     |                                                                             |        |        |        |                     |                                   |
|                                                  | SPI                                  | Yes                                                                         |        |        |        |                     | Yes                                                                         |        |        |        |                     |                                   |
|                                                  | Multimaster I <sup>2</sup> C         | 1ch                                                                         |        |        |        |                     | 1ch                                                                         |        |        |        |                     |                                   |
|                                                  | LIN/UART module                      | RLIN3: 2ch                                                                  |        |        |        |                     | RLIN3: 2ch                                                                  |        |        |        | 1ch                 |                                   |
| A/D Converter                                    | CAN interface                        | CAN-FD: 1ch                                                                 |        |        |        |                     | CAN: 1ch                                                                    |        |        |        |                     | P.24                              |
|                                                  | Resolution                           | 12-bit                                                                      |        |        |        |                     | 10-bits                                                                     |        |        |        |                     |                                   |
|                                                  | Number of ch                         | 31ch                                                                        | 25ch   | 24ch   | 19ch   | 10ch                | 31ch                                                                        | 25ch   | 20ch   | 18ch   | 10ch                |                                   |
| 8-bit D/A Converter                              |                                      | 1ch                                                                         |        |        |        |                     | 1ch                                                                         |        |        |        |                     | -                                 |
| Comparator                                       |                                      | 1ch                                                                         |        |        |        |                     | 1ch                                                                         |        |        |        |                     | P.25                              |
| Secure Module                                    |                                      | Yes                                                                         |        |        |        |                     | -                                                                           |        |        |        |                     | -                                 |
| ELC                                              |                                      | Yes                                                                         |        |        |        |                     | Yes                                                                         |        |        |        |                     | P.27                              |

**Notes** 1. The table does not list all the features of RL78/F24.

2. Refers to the detail page of each function.

3. 100-pin products: EV<sub>DD0</sub>/EV<sub>DD1</sub> and EV<sub>SS0</sub>/EV<sub>SS1</sub>, 80-/64-pin products: EV<sub>DD0</sub> and EV<sub>SS0</sub>, Others: (Common with V<sub>DD</sub> and V<sub>SS</sub>)

4. Do not use the XT1 and XT2 pin functions in products support Ta = -40 to 150°C.

Table 1-5. Main Features of RL78/F23, Compared with RL78/F13

| Features <sup>Note 1</sup>                       |                                      | RL78/F23                                                                    |        |        |                     | RL78/F13 (LIN)                                                              |        |        |                     | Reference pages <sup>Note 2</sup> |
|--------------------------------------------------|--------------------------------------|-----------------------------------------------------------------------------|--------|--------|---------------------|-----------------------------------------------------------------------------|--------|--------|---------------------|-----------------------------------|
|                                                  |                                      | 80 QFP                                                                      | 64 QFP | 48 QFP | 32 QFN              | 80 QFP                                                                      | 64 QFP | 48 QFP | 32 QFN              |                                   |
| CPU                                              |                                      | RL78 CPU Core                                                               |        |        |                     | RL78 CPU Core                                                               |        |        |                     | -                                 |
| Memory                                           | Code Flash                           | 128KB                                                                       |        |        |                     | 128/96/64/48/32/16KB                                                        |        |        |                     | P.12                              |
|                                                  | Data Flash                           | 8KB                                                                         |        |        |                     | 4KB                                                                         |        |        |                     |                                   |
|                                                  | RAM                                  | 12KB                                                                        |        |        |                     | 8/6/4/3/2/1KB                                                               |        |        |                     |                                   |
| Supply Voltage                                   |                                      | 2.7V to 5.5V                                                                |        |        |                     | 2.7V to 5.5V                                                                |        |        |                     | -                                 |
| Operation Frequency                              |                                      | (max) 40MHz                                                                 |        |        |                     | (max) 32MHz, 24MHz@K, Y-grade                                               |        |        |                     | P.19                              |
| System Clock                                     | f <sub>X</sub>                       | 2MHz to 20MHz                                                               |        |        |                     | 1MHz to 20MHz                                                               |        |        |                     |                                   |
|                                                  | f <sub>IH</sub>                      | 40MHz                                                                       |        |        |                     | 32MHz, 24MHz@K, Y-grade                                                     |        |        |                     |                                   |
|                                                  | f <sub>IL</sub>                      | 15kHz                                                                       |        |        |                     | 15kHz                                                                       |        |        |                     |                                   |
|                                                  | f <sub>SUB</sub> <sup>Note 4</sup>   | 32.768kHz                                                                   |        | -      |                     | 32.768kHz                                                                   |        | -      |                     |                                   |
|                                                  | f <sub>PLL</sub>                     | 40MHz                                                                       |        |        |                     | 32MHz, 24MHz@K, Y-grade                                                     |        |        |                     |                                   |
| Clock for Peripherals                            | f <sub>WDT</sub>                     | 15kHz                                                                       |        |        |                     | 15kHz                                                                       |        |        |                     |                                   |
|                                                  | f <sub>PLL</sub>                     | 80MHz                                                                       |        |        |                     | 64MHz, 48MHz@K, Y-grade                                                     |        |        |                     |                                   |
|                                                  | f <sub>IH</sub>                      | 80MHz                                                                       |        |        |                     | 64MHz, 48MHz@K, Y-grade                                                     |        |        |                     |                                   |
| POR                                              |                                      | Yes                                                                         |        |        |                     | Yes                                                                         |        |        |                     | -                                 |
| LVD                                              |                                      | Yes                                                                         |        |        |                     | Yes                                                                         |        |        |                     | -                                 |
| Window Watchdog Timer                            |                                      | Yes                                                                         |        |        |                     | Yes                                                                         |        |        |                     | -                                 |
| Illegal Instruction Execution Detection Function |                                      | Yes                                                                         |        |        |                     | Yes                                                                         |        |        |                     | P.26                              |
| Flash Memory CRC Operation Function              |                                      | Yes                                                                         |        |        |                     | Yes                                                                         |        |        |                     |                                   |
| RAM ECC Detection Function                       |                                      | Yes                                                                         |        |        |                     | Yes                                                                         |        |        |                     |                                   |
| CAN-FD RAM ECC Detection Function                |                                      | -                                                                           |        |        |                     | -                                                                           |        |        |                     |                                   |
| Code Flash Memory ECC Function                   |                                      | Yes                                                                         |        |        |                     | -                                                                           |        |        |                     |                                   |
| Invalid Memory Access Detection Function         |                                      | Yes                                                                         |        |        |                     | Yes                                                                         |        |        |                     |                                   |
| Frequency Detection Function                     |                                      | Yes                                                                         |        |        |                     | Yes                                                                         |        |        |                     |                                   |
| Clock Monitor Function                           |                                      | Yes                                                                         |        |        |                     | Yes                                                                         |        |        |                     |                                   |
| Stack Pointer Monitor Function                   |                                      | Yes                                                                         |        |        |                     | Yes                                                                         |        |        |                     |                                   |
| I/O Port Output Level Detection Function         |                                      | Yes                                                                         |        |        |                     | Yes                                                                         |        |        |                     |                                   |
| A/D Test Function                                |                                      | Yes                                                                         |        |        |                     | Yes                                                                         |        |        |                     |                                   |
| I/O Port                                         |                                      | 68ch                                                                        | 52ch   | 38ch   | 25ch                | 68ch                                                                        | 52ch   | 38ch   | 25ch                | P.18                              |
|                                                  | Output Only                          | 1ch                                                                         | 1ch    | 1ch    | -                   | 1ch                                                                         | 1ch    | 1ch    | -                   |                                   |
|                                                  | Input Only                           | 5ch                                                                         | 5ch    | 5ch    | 3ch                 | 5ch                                                                         | 5ch    | 5ch    | 3ch                 |                                   |
| Power Supply Pin                                 | Internal Circuit                     | V <sub>DD</sub> , V <sub>SS</sub> , REGC                                    |        |        |                     | V <sub>DD</sub> , V <sub>SS</sub> , REGC                                    |        |        |                     | P.18                              |
|                                                  | I/O Port                             | EV <sub>DD</sub> , EV <sub>SS</sub> <sup>Note 3</sup>                       |        |        |                     | EV <sub>DD</sub> , EV <sub>SS</sub> <sup>Note 3</sup>                       |        |        |                     |                                   |
|                                                  | Analog                               | V <sub>DD</sub> , V <sub>SS</sub> , AV <sub>REFP</sub> , AV <sub>REFM</sub> |        |        |                     | V <sub>DD</sub> , V <sub>SS</sub> , AV <sub>REFP</sub> , AV <sub>REFM</sub> |        |        |                     |                                   |
| Interrupt                                        | External                             | 15ch                                                                        | 14ch   | 12ch   | 8ch                 | 14ch                                                                        | 14ch   | 13ch   | 9ch                 | P.29                              |
|                                                  | Internal                             | 36ch                                                                        | 36ch   | 36ch   | 36ch                | 40ch                                                                        | 40ch   | 40ch   | 40ch                |                                   |
| DTC                                              |                                      | 36                                                                          | 36     | 36     | 35                  | 36                                                                          | 36     | 36     | 29                  | -                                 |
| Timer                                            | TAU                                  | 16-bit×12ch                                                                 |        |        |                     | 16-bit×12ch                                                                 |        |        |                     | P.21                              |
|                                                  | Timer RD                             | 16-bit×2ch<br>(w/ PWMOPA and Dithering/Gate)                                |        |        |                     | 16-bit×2ch                                                                  |        |        |                     |                                   |
|                                                  | Timer RJ                             | 16-bit×1ch                                                                  |        |        |                     | 16-bit×1ch                                                                  |        |        |                     |                                   |
|                                                  | RTC                                  | 1ch                                                                         |        |        |                     | 1ch                                                                         |        |        |                     |                                   |
| Serial I/F                                       | SAU                                  | 4ch/4ch/2ch                                                                 |        |        | 3ch/<br>3ch/<br>2ch | 4ch/4ch/2ch                                                                 |        |        | 3ch/<br>3ch/<br>2ch | P.23                              |
|                                                  | CSI/simplified I <sup>2</sup> C/UART |                                                                             |        |        |                     |                                                                             |        |        |                     |                                   |
|                                                  | SPI                                  | Yes                                                                         |        |        |                     | Yes                                                                         |        |        |                     |                                   |
|                                                  | Multimaster I <sup>2</sup> C         | 1ch                                                                         |        |        |                     | 1ch                                                                         |        |        |                     |                                   |
|                                                  | LIN/UART module                      | RLIN3: 1ch                                                                  |        |        |                     | RLIN3: 1ch                                                                  |        |        |                     |                                   |
| A/D Converter                                    | CAN interface                        | -                                                                           |        |        |                     | -                                                                           |        |        |                     | P.24                              |
|                                                  | Resolution                           | 12-bit                                                                      |        |        |                     | 10-bit                                                                      |        |        |                     |                                   |
|                                                  | Number of ch                         | 25ch                                                                        | 24ch   | 19ch   | 10ch                | 22ch                                                                        | 20ch   | 18ch   | 10ch                |                                   |
| 8-bit D/A Converter                              |                                      | -                                                                           |        |        |                     | -                                                                           |        |        |                     | -                                 |
| Comparator                                       |                                      | -                                                                           |        |        |                     | -                                                                           |        |        |                     | -                                 |
| Secure Module                                    |                                      | Yes                                                                         |        |        |                     | -                                                                           |        |        |                     | -                                 |
| ELC                                              |                                      | -                                                                           |        |        |                     | -                                                                           |        |        |                     | -                                 |

**Notes** 1. The table does not list all the features of RL78/F23.

2. Refers to the detail page of each function.

3. 80-/64-pin products: EV<sub>DD0</sub> and EV<sub>SS0</sub>, Others: (Common with  $V_{DD}$  and  $V_{SS}$ )

4. Do not use the XT1 and XT2 pin functions in products support  $T_a = -40$  to  $150^{\circ}\text{C}$ .

## 2. Pin Assignment

### 2.1 Pin Assignment Comparison

Tables below show the pin functional comparisons and differences between RL78/F24 product and RL78/F14 product, and RL78/F23 product and RL78/F13 product. Each function of RL78/F14 product and RL78/F13 (LIN) product shown in the tables below is an example of the maximum memory product.

**Table 2-1. Port Functions of RL78/F24, Compared with RL78/F14 (1/2)**

| Pin No | Pin No |       |       |       | RL78/F24                                                  | RL78/F14                                        |
|--------|--------|-------|-------|-------|-----------------------------------------------------------|-------------------------------------------------|
|        | 100QFP | 80QFP | 64QFP | 48QFP |                                                           |                                                 |
| 100    | 1      | 1     | 1     | 1     | P120/ANI25/TI07/TO07/TRDIOD0/SO01/(SCK10)/(LTXD1)/INTP4   | P120/ANI25/TI07/TO07/TRDIOD0/SO01/(SCK10)/INTP4 |
| 1      | -      | -     | -     | -     | P153/(SCK11)                                              | P153/(SCK11)                                    |
| 2      | -      | -     | -     | -     | P152/(SI11)                                               | P152/(SI11)                                     |
| 3      | -      | -     | -     | -     | P151/(SO11)                                               | P151/(SO11)                                     |
| 4      | -      | -     | -     | -     | P150/(SSI11)                                              | P150/(SSI11)                                    |
| 5      | 2      | -     | -     | -     | P47/INTP13                                                | P47/INTP13                                      |
| 6      | 3      | -     | -     | -     | P46/(TI12)/(TO12)                                         | P46/(TI12)/(TO12)                               |
| 7      | 4      | -     | -     | -     | P45/(TI10)/(TO10)                                         | P45/(TI10)/(TO10)                               |
| 8      | 5      | -     | -     | -     | P44/(TI07)/(TO07)                                         | P44/(TI07)/(TO07)                               |
| 9      | 6      | 2     | -     | -     | P43/(LRXD0)                                               | P43/(LRXD0)                                     |
| 10     | 7      | 3     | -     | -     | P42/(LTXD0)                                               | P42/(LTXD0)                                     |
| 11     | 8      | 4     | 2     | 2     | P41/TI10/TO10/TRJIO0/TRD0RES/(SI10)/(RXD1)/VCOUT0/SNZOUT2 | P41/TI10/TO10/TRJIO0/VCOUT0/SNZOUT2             |
| 12     | 9      | 5     | 3     | 3     | P40/TOOL0                                                 | P40/TOOL0                                       |
| 13     | 10     | 6     | 4     | 4     | RESET                                                     | RESET                                           |
| 14     | 11     | 7     | 5     | -     | P124/XT2/EXCLKS                                           | P124/XT2/EXCLKS                                 |
| 15     | 12     | 8     | 6     | -     | P123/XT1                                                  | P123/XT1                                        |
| 16     | 13     | 9     | 7     | 5     | P137/INTP0                                                | P137/INTP0                                      |
| 17     | 14     | 10    | 8     | 6     | P122/X2/EXCLK                                             | P122/X2/EXCLK                                   |
| 18     | 15     | 11    | 9     | 7     | P121/X1                                                   | P121/X1                                         |
| 19     | 16     | 12    | 10    | 8     | REGC                                                      | REGC                                            |
| 20     | 17     | 13    | 11    | 9     | VSS                                                       | VSS                                             |
| 21     | 18     | 14    | -     | -     | EVSS0                                                     | EVSS0                                           |
| 22     | 19     | 15    | 12    | 10    | V <sub>DD</sub>                                           | V <sub>DD</sub>                                 |
| 23     | 20     | 16    | -     | -     | EV <sub>DD0</sub>                                         | EV <sub>DD0</sub>                               |
| 24     | 21     | 17    | 13    | 11    | P60/(TO01)/(SCK00)/(SCL00)                                | P60/(SCK00)/(SCL00)                             |
| 25     | 22     | 18    | 14    | 12    | P61/(TO02)/(SI00)/(SDA00)/(RXD0)                          | P61/(SI00)/(SDA00)/(RXD0)                       |
| 26     | 23     | 19    | 15    | 13    | P62/(TO03)/(SO00)/(TXD0)/SCLA0                            | P62/(SO00)/(TXD0)/SCLA0                         |
| 27     | 24     | 20    | 16    | 14    | P63/(TO07)/(SSI00)/SDAA0                                  | P63/(SSI00)/SDAA0                               |
| 28     | 25     | -     | -     | -     | P64/(TI14)/(TO14)/(SNZOUT3)                               | P64/(TI14)/(TO14)/(SNZOUT3)                     |
| 29     | 26     | -     | -     | -     | P65/(TI16)/(TO16)/(SNZOUT2)                               | P65/(TI16)/(TO16)/(SNZOUT2)                     |
| 30     | 27     | -     | -     | -     | P66/(TI00)/(TO00)                                         | P66/(TI00)/(TO00)                               |
| 31     | 28     | -     | -     | -     | P67/(TI02)/(TO02)                                         | P67/(TI02)/(TO02)                               |
| 32     | -      | -     | -     | -     | P154/(SNZOUT7)                                            | P154/(SNZOUT7)                                  |
| 33     | -      | -     | -     | -     | P155/(SNZOUT6)                                            | P155/(SNZOUT6)                                  |
| 34     | 29     | 21    | 17    | -     | P00/(TI05)/(TO05)/INTP9                                   | P00/(TI05)/(TO05)/INTP9                         |
| 35     | -      | -     | -     | -     | P156/(SNZOUT5)                                            | P156/(SNZOUT5)                                  |
| 36     | -      | -     | -     | -     | P157/(SNZOUT4)                                            | P157/(SNZOUT4)                                  |
| 37     | 30     | 22    | 18    | -     | P140/TRD1RES/PCLBUZ0                                      | P140/PCLBUZ0                                    |
| 38     | 31     | 23    | 19    | -     | P130/RESOUT                                               | P130/RESOUT                                     |
| 39     | 32     | 24    | -     | -     | P77/(SSI10)/INTP12                                        | P77/(SSI10)/INTP12                              |
| 40     | 33     | 25    | -     | -     | P76/(SCK10)/INTP12                                        | P76/(SCK10)/INTP12                              |
| 41     | 34     | 26    | -     | -     | P75/(SI10)/(RXD1)                                         | P75/(SI10)/(RXD1)                               |
| 42     | 35     | 27    | -     | -     | P74/ANI30/(SO10)/(TXD1)                                   | P74/ANI30/(SO10)/(TXD1)                         |
| 43     | -      | -     | -     | -     | EVSS1                                                     | EVSS1                                           |
| 44     | 36     | 28    | 20    | -     | P73/ANI29/SSI11/(CRXD0)/SNZOUT7                           | P73/ANI29/SSI11/(CRXD0)/SNZOUT7                 |
| 45     | 37     | 29    | 21    | -     | P72/ANI28/SO11/(CTXD0)/SNZOUT6                            | P72/ANI28/SO11/(CTXD0)/SNZOUT6                  |
| 46     | 38     | 30    | 22    | -     | P71/ANI27/TI17/TO17/SCK11/SCL11/INTP6/SNZOUT5             | P71/ANI27/TI17/TO17/SCK11/SCL11/INTP6/SNZOUT5   |
| 47     | 39     | 31    | 23    | -     | P70/ANI26/TI15/TO15/SI11/SDA11/INTP8/SNZOUT4              | P70/ANI26/TI15/TO15/SI11/SDA11/INTP8/SNZOUT4    |
| 48     | -      | -     | -     | -     | P03/(RTC1HZ)                                              | P03/(RTC1HZ)                                    |
| 49     | 40     | 32    | 24    | -     | P32/TI16/TO16/(SO11)/INTP7                                | P32/TI16/TO16/INTP7                             |

Table 2-1. Port Functions of RL78/F24, Compared with RL78/F14 (2/2)

| Pin No |       |       |       |       | RL78/F24                                                           | RL78/F14                                                           |
|--------|-------|-------|-------|-------|--------------------------------------------------------------------|--------------------------------------------------------------------|
| 100QFP | 80QFP | 64QFP | 48QFP | 32QFN |                                                                    |                                                                    |
| 50     | 41    | 33    | 25    | 15    | P30/TI01/TO01/TRDIOD1/SSI00/INTP2/SNZOUT2                          | P30/TI01/TO01/TRDIOD1/SSI00/INTP2/SNZOUT2                          |
| 51     | 42    | 34    | 26    | 16    | P17/TI00/TO00/TRDI0B1/SCK00/SCL00/INTP3                            | P17/TI00/TO00/TRDI0B1/SCK00/SCL00/INTP3                            |
| 52     | 43    | 35    | 27    | 17    | P16/TI02/TO02/TRDI0C1/SI00/SDA00/RXD0/TOOLRXD                      | P16/TI02/TO02/TRDI0C1/SI00/SDA00/RXD0/TOOLRXD                      |
| 53     | -     | -     | -     | -     | EV <sub>DD1</sub>                                                  | EV <sub>DD1</sub>                                                  |
| 54     | 44    | 36    | 28    | 18    | P15/TI05/TO05/TRDIOA1/(TRDIOA0)/(TRDCLK0)/SO00/TXD0/RTC1HZ/TOOLTxD | P15/TI05/TO05/TRDIOA1/(TRDIOA0)/(TRDCLK0)/SO00/TXD0/RTC1HZ/TOOLTxD |
| 55     | 45    | 37    | 29    | -     | P31/TI14/TO14/(INTP2)/STOPST                                       | P31/TI14/TO14/(INTP2)/STOPST                                       |
| 56     | 46    | 38    | -     | -     | P50/(SSI01)/(INTP3)                                                | P50/(SSI01)/(INTP3)                                                |
| 57     | 47    | 39    | -     | -     | P51/(SO01)/INTP11                                                  | P51/(SO01)/INTP11                                                  |
| 58     | 48    | 40    | -     | -     | P52/(SCK01)/(STOPST)                                               | P52/(SCK01)/(STOPST)                                               |
| 59     | 49    | 41    | -     | -     | P53/(SI01)/INTP10                                                  | P53/(SI01)/INTP10                                                  |
| 60     | 50    | 42    | 30    | 19    | P14/TI06/TO06/TRDI0C0/SCK01/SCL01/LRXD0                            | P14/TI06/TO06/TRDI0C0/SCK01/SCL01/LRXD0                            |
| 61     | 51    | 43    | 31    | 20    | P13/TI04/TO04/TRDIOA0/TRDCLK0/SI01/SDA01/LTXD0                     | P13/TI04/TO04/TRDIOA0/TRDCLK0/SI01/SDA01/LTXD0                     |
| 62     | 52    | 44    | 32    | 21    | P12/TI11/TO11/(TRDI0D0)/SO10/TXD1/INTP5/SNZOUT3                    | P12/TI11/TO11/(TRDI0D0)/SO10/TXD1/INTP5/SNZOUT3                    |
| 63     | 53    | 45    | 33    | 22    | P11/TI13/TO13/TRJO0/SI10/SDA10/RXD1/CRXD0/LRXD1                    | P11/TI13/TO13/TRJO0/SI10/SDA10/RXD1/CRXD0/LRXD1                    |
| 64     | 54    | 46    | 34    | 23    | P10/TI13/TO13/TRJO0/SCK10/SCL10/CXTD0/LTXD1                        | P10/TI13/TO13/TRJO0/SCK10/SCL10/CXTD0/LTXD1                        |
| 65     | 55    | -     | -     | -     | P54/(TI11)/(TO11)/SSI10                                            | P54/(TI11)/(TO11)/SSI10                                            |
| 66     | 56    | -     | -     | -     | P55/(TI13)/(TO13)                                                  | P55/(TI13)/(TO13)                                                  |
| 67     | 57    | -     | -     | -     | P56/(TI15)/(TO15)/(SNZOUT1)                                        | P56/(TI15)/(TO15)/(SNZOUT1)                                        |
| 68     | 58    | -     | -     | -     | P57/(TI17)/(TO17)/(SNZOUT0)                                        | P57/(TI17)/(TO17)/(SNZOUT0)                                        |
| 69     | -     | -     | -     | -     | P107/(LRXD1)                                                       | P107/(LRXD1)                                                       |
| 70     | -     | -     | -     | -     | P106/(LTXD1)                                                       | P106/(LTXD1)                                                       |
| 71     | -     | -     | -     | -     | P105/ANI23                                                         | P105/ANI23                                                         |
| 72     | -     | -     | -     | -     | P104/ANI22                                                         | P104/ANI22                                                         |
| 73     | 59    | 47    | 35    | 24    | P33/AV <sub>REFP</sub> /ANI6                                       | P33/AV <sub>REFP</sub> /ANI0                                       |
| 74     | 60    | 48    | 36    | 25    | P34/AV <sub>REFM</sub> /ANI7                                       | P34/AV <sub>REFM</sub> /ANI1                                       |
| 75     | 61    | 49    | 37    | 26    | P80/ANI0/ANO0                                                      | P80/ANI2/ANO0                                                      |
| 76     | 62    | 50    | 38    | 27    | P81/ANI1                                                           | P81/ANI3/IVCMP00                                                   |
| 77     | 63    | 51    | 39    | 28    | P82/ANI2/IVCMP00                                                   | P82/ANI4/IVCMP01                                                   |
| 78     | 64    | 52    | 40    | 29    | P83/ANI3/IVCMP01                                                   | P83/ANI5/IVCMP02                                                   |
| 79     | 65    | 53    | 41    | 30    | P84/ANI4/IVCMP02                                                   | P84/ANI6/IVCMP03                                                   |
| 80     | 66    | 54    | 42    | 31    | P85/ANI5/IVREF0/IVCMP03                                            | P85/ANI7/IVREF0                                                    |
| 81     | 67    | 55    | 43    | -     | P86/ANI8                                                           | P86/ANI8                                                           |
| 82     | 68    | 56    | 44    | -     | P87/ANI9                                                           | P87/ANI9                                                           |
| 83     | 69    | 57    | 45    | -     | P90/ANI10                                                          | P90/ANI10                                                          |
| 84     | 70    | 58    | 46    | -     | P91/ANI11                                                          | P91/ANI11                                                          |
| 85     | 71    | 59    | 47    | -     | P92/ANI12                                                          | P92/ANI12                                                          |
| 86     | 72    | 60    | -     | -     | P93/ANI13                                                          | P93/ANI13                                                          |
| 87     | 73    | 61    | -     | -     | P94/ANI14                                                          | P94/ANI14                                                          |
| 88     | 74    | 62    | -     | -     | P95/ANI15                                                          | P95/ANI15                                                          |
| 89     | 75    | 63    | -     | -     | P96/ANI16                                                          | P96/ANI16                                                          |
| 90     | 76    | -     | -     | -     | P97/ANI17                                                          | P97/ANI17                                                          |
| 91     | -     | -     | -     | -     | P100/ANI18                                                         | P100/ANI18                                                         |
| 92     | -     | -     | -     | -     | P101/ANI19                                                         | P101/ANI19                                                         |
| 93     | -     | -     | -     | -     | P102/ANI20                                                         | P102/ANI20                                                         |
| 94     | -     | -     | -     | -     | P103/ANI21                                                         | P103/ANI21                                                         |
| 95     | 77    | -     | -     | -     | P02/(TI06)/(TO06)                                                  | P02/(TI06)/(TO06)                                                  |
| 96     | -     | -     | -     | -     | P127/(TI03)/(TO03)                                                 | P127/(TI03)/(TO03)                                                 |
| 97     | 78    | -     | -     | -     | P126/(TI01)/(TO01)                                                 | P126/(TI01)/(TO01)                                                 |
| 98     | 79    | -     | -     | -     | P01/(TI04)/(TO04)                                                  | P01/(TI04)/(TO04)                                                  |
| 99     | 80    | 64    | 48    | 32    | P125/ANI24/TI03/TO03/TRDI0B0/SSI01/(LRXD1)/INTP1/SNZOUT1           | P125/ANI24/TI03/TO03/TRDI0B0/SSI01/INTP1/SNZOUT1                   |

**Remark:** KRx (Key Return) function depends on the product. For details, see “Table 2-3. Pin Assignment for KRx Function”.



Table 2-2. Port Functions of RL78/F23, Compared with RL78/F13 (LIN) (1/2)

| Pin No | Pin No |       |       |       | RL78/F23                                                           | RL78/F13 (LIN)                                                     |
|--------|--------|-------|-------|-------|--------------------------------------------------------------------|--------------------------------------------------------------------|
|        | 100QFP | 80QFP | 64QFP | 48QFP |                                                                    |                                                                    |
| -      | 1      | 1     | 1     | 1     | P120/ANI25/TI07/TO07/TRDIOD0/SO01/(SCK10)/INTP4                    | P120/ANI25/TI07/TO07/TRDIOD0/SO01/(SCK10)/INTP4                    |
| -      | 2      | -     | -     | -     | P47/INTP13                                                         | P47/INTP13                                                         |
| -      | 3      | -     | -     | -     | P46/(TI12)/(TO12)                                                  | P46/(TI12)/(TO12)                                                  |
| -      | 4      | -     | -     | -     | P45/(TI10)/(TO10)                                                  | P45/(TI10)/(TO10)                                                  |
| -      | 5      | -     | -     | -     | P44/(TI07)/(TO07)                                                  | P44/(TI07)/(TO07)                                                  |
| -      | 6      | 2     | -     | -     | P43/(LRXD0)                                                        | P43/(LRXD0)                                                        |
| -      | 7      | 3     | -     | -     | P42/(LTXD0)                                                        | P42/(LTXD0)                                                        |
| -      | 8      | 4     | 2     | 2     | P41/TI10/TO10/TRJIO0/TRD0RES/(SI10)/(RXD1)/SNZOUT2                 | P41/TI10/TO10/TRJIO0/SNZOUT2                                       |
| -      | 9      | 5     | 3     | 3     | P40/TOOL0                                                          | P40/TOOL0                                                          |
| -      | 10     | 6     | 4     | 4     | RESET                                                              | RESET                                                              |
| -      | 11     | 7     | 5     | -     | P124/XT2/EXCLKS                                                    | P124/XT2/EXCLKS                                                    |
| -      | 12     | 8     | 6     | -     | P123/XT1                                                           | P123/XT1                                                           |
| -      | 13     | 9     | 7     | 5     | P137/INTP0                                                         | P137/INTP0                                                         |
| -      | 14     | 10    | 8     | 6     | P122/X2/EXCLK                                                      | P122/X2/EXCLK                                                      |
| -      | 15     | 11    | 9     | 7     | P121/X1                                                            | P121/X1                                                            |
| -      | 16     | 12    | 10    | 8     | REGC                                                               | REGC                                                               |
| -      | 17     | 13    | 11    | 9     | V <sub>SS</sub>                                                    | V <sub>SS</sub>                                                    |
| -      | 18     | 14    | -     | -     | EV <sub>SS0</sub>                                                  | EV <sub>SS0</sub>                                                  |
| -      | 19     | 15    | 12    | 10    | V <sub>DD</sub>                                                    | V <sub>DD</sub>                                                    |
| -      | 20     | 16    | -     | -     | EV <sub>DD0</sub>                                                  | EV <sub>DD0</sub>                                                  |
| -      | 21     | 17    | 13    | 11    | P60/(TO01)/(SCK00)/(SCL00)                                         | P60/(SCK00)/(SCL00)                                                |
| -      | 22     | 18    | 14    | 12    | P61/(TO02)/(SI00)/(SDA00)/(RXD0)                                   | P61/(SI00)/(SDA00)/(RXD0)                                          |
| -      | 23     | 19    | 15    | 13    | P62/(TO03)/(SO00)/(TXD0)/SCLA0                                     | P62/(SO00)/(TXD0)/SCLA0                                            |
| -      | 24     | 20    | 16    | 14    | P63/(TO07)/(SSI00)/SDAA0                                           | P63/(SSI00)/SDAA0                                                  |
| -      | 25     | -     | -     | -     | P64/(SNZOUT3)                                                      | P64/(SNZOUT3)                                                      |
| -      | 26     | -     | -     | -     | P65/(SNZOUT2)                                                      | P65/(SNZOUT2)                                                      |
| -      | 27     | -     | -     | -     | P66/(TI00)/(TO00)                                                  | P66/(TI00)/(TO00)                                                  |
| -      | 28     | -     | -     | -     | P67/(TI02)/(TO02)                                                  | P67/(TI02)/(TO02)                                                  |
| -      | 29     | 21    | 17    | -     | P00/(TI05)/(TO05)/INTP9                                            | P00/(TI05)/(TO05)/INTP9                                            |
| -      | 30     | 22    | 18    | -     | P140/TRD1RES/PCLBUZ0                                               | P140/PCLBUZ0                                                       |
| -      | 31     | 23    | 19    | -     | P130/RESOUT                                                        | P130/RESOUT                                                        |
| -      | 32     | 24    | -     | -     | P77/(SSI10)/INTP12                                                 | P77/(SSI10)/INTP12                                                 |
| -      | 33     | 25    | -     | -     | P76/(SCK10)/INTP12                                                 | P76/(SCK10)/INTP12                                                 |
| -      | 34     | 26    | -     | -     | P75/(SI10)/(RXD1)                                                  | P75/(SI10)/(RXD1)                                                  |
| -      | 35     | 27    | -     | -     | P74/ANI30/(SO10)/(TXD1)                                            | P74/ANI30/(SO10)/(TXD1)                                            |
| -      | 36     | 28    | 20    | -     | P73/ANI29/SSI11/SNZOUT7                                            | P73/ANI29/SSI11/SNZOUT7                                            |
| -      | 37     | 29    | 21    | -     | P72/ANI28/SO11/SNZOUT6                                             | P72/ANI28/SO11/SNZOUT6                                             |
| -      | 38     | 30    | 22    | -     | P71/ANI27/SCK11/SCL11/INTP6/SNZOUT5                                | P71/ANI27/SCK11/SCL11/INTP6/SNZOUT5                                |
| -      | 39     | 31    | 23    | -     | P70/ANI26/SI11/SDA11/INTP8/SNZOUT4                                 | P70/ANI26/SI11/SDA11/INTP8/SNZOUT4                                 |
| -      | 40     | 32    | 24    | -     | P32/(SO11)/INTP7                                                   | P32/INTP7                                                          |
| -      | 41     | 33    | 25    | 15    | P30/TI01/TO01/TRDIOD1/SSI00/INTP2/SNZOUT2                          | P30/TI01/TO01/TRDIOD1/SSI00/INTP2/SNZOUT2                          |
| -      | 42     | 34    | 26    | 16    | P17/TI00/TO00/TRDIOD1/SCK00/SCL00/INTP3                            | P17/TI00/TO00/TRDIOD1/SCK00/SCL00/INTP3                            |
| -      | 43     | 35    | 27    | 17    | P16/TI02/TO02/TRDIOD1/SI00/SDA00/RXD0/TOOLRXD                      | P16/TI02/TO02/TRDIOD1/SI00/SDA00/RXD0/TOOLRXD                      |
| -      | 44     | 36    | 28    | 18    | P15/TI05/TO05/TRDIOA1/(TRDIOA0)/(TRDCLK0)/SO00/TXD0/RTC1HZ/TOOLTXD | P15/TI05/TO05/TRDIOA1/(TRDIOA0)/(TRDCLK0)/SO00/TXD0/RTC1HZ/TOOLTXD |
| -      | 45     | 37    | 29    | -     | P31/(INTP2)/STOPST                                                 | P31/(INTP2)/STOPST                                                 |
| -      | 46     | 38    | -     | -     | P50/(SSI01)/(INTP3)                                                | P50/(SSI01)/(INTP3)                                                |
| -      | 47     | 39    | -     | -     | P51/(SO01)/INTP11                                                  | P51/(SO01)/INTP11                                                  |
| -      | 48     | 40    | -     | -     | P52/(SCK01)/(STOPST)                                               | P52/(SCK01)/(STOPST)                                               |
| -      | 49     | 41    | -     | -     | P53/(SI01)/INTP10                                                  | P53/(SI01)/INTP10                                                  |
| -      | 50     | 42    | 30    | 19    | P14/TI06/TO06/TRDIOD0/SCK01/SCL01/LRXD0                            | P14/TI06/TO06/TRDIOD0/SCK01/SCL01/LRXD0                            |
| -      | 51     | 43    | 31    | 20    | P13/TI04/TO04/TRDIOA0/TRDCLK0/SI01/SDA01/LTXD0                     | P13/TI04/TO04/TRDIOA0/TRDCLK0/SI01/SDA01/LTXD0                     |
| -      | 52     | 44    | 32    | 21    | P12/TI11/TO11/(TRDIOD0)/SO10/TXD1/INTP5/SNZOUT3                    | P12/TI11/TO11/(TRDIOD0)/SO10/TXD1/INTP5/SNZOUT3                    |
| -      | 53     | 45    | 33    | 22    | P11/TI13/TO13/TRJIO0/SI10/SDA10/RXD1                               | P11/TI13/TO13/TRJIO0/SI10/SDA10/RXD1                               |
| -      | 54     | 46    | 34    | 23    | P10/TI13/TO13/TRJIO0/SCK10/SCL10                                   | P10/TI13/TO13/TRJIO0/SCK10/SCL10                                   |
| -      | 55     | -     | -     | -     | P54/(TI11)/(TO11)/SSI10                                            | P54/(TI11)/(TO11)/SSI10                                            |

Table 2-2. Port Functions of RL78/F23, Compared with RL78/F13 (LIN) (2/2)

| Pin No |       |       |       |       | RL78/F23                                         | RL78/F13 (LIN)                                   |
|--------|-------|-------|-------|-------|--------------------------------------------------|--------------------------------------------------|
| 100QFP | 80QFP | 64QFP | 48QFP | 32QFN |                                                  |                                                  |
| -      | 56    | -     | -     | -     | P55/(TI13)/(TO13)                                | P55/(TI13)/(TO13)                                |
| -      | 57    | -     | -     | -     | P56/(SNZOUT1)                                    | P56/(SNZOUT1)                                    |
| -      | 58    | -     | -     | -     | P57/(SNZOUT0)                                    | P57/(SNZOUT0)                                    |
| -      | 59    | 47    | 35    | 24    | P33/AV <sub>REFP</sub> /ANI6                     | P33/AV <sub>REFP</sub> /ANI0                     |
| -      | 60    | 48    | 36    | 25    | P34/AV <sub>REFM</sub> /ANI7                     | P34/AV <sub>REFM</sub> /ANI1                     |
| -      | 61    | 49    | 37    | 26    | P80/ANI0                                         | P80/ANI2                                         |
| -      | 62    | 50    | 38    | 27    | P81/ANI1                                         | P81/ANI3                                         |
| -      | 63    | 51    | 39    | 28    | P82/ANI2                                         | P82/ANI4                                         |
| -      | 64    | 52    | 40    | 29    | P83/ANI3                                         | P83/ANI5                                         |
| -      | 65    | 53    | 41    | 30    | P84/ANI4                                         | P84/ANI6                                         |
| -      | 66    | 54    | 42    | 31    | P85/ANI5                                         | P85/ANI7                                         |
| -      | 67    | 55    | 43    | -     | P86/ANI8                                         | P86/ANI8                                         |
| -      | 68    | 56    | 44    | -     | P87/ANI9                                         | P87/ANI9                                         |
| -      | 69    | 57    | 45    | -     | P90/ANI10                                        | P90/ANI10                                        |
| -      | 70    | 58    | 46    | -     | P91/ANI11                                        | P91/ANI11                                        |
| -      | 71    | 59    | 47    | -     | P92/ANI12                                        | P92/ANI12                                        |
| -      | 72    | 60    | -     | -     | P93/ANI13                                        | P93/ANI13                                        |
| -      | 73    | 61    | -     | -     | P94/ANI14                                        | P94/ANI14                                        |
| -      | 74    | 62    | -     | -     | P95/ANI15                                        | P95/ANI15                                        |
| -      | 75    | 63    | -     | -     | P96/ANI16                                        | P96/ANI16                                        |
| -      | 76    | -     | -     | -     | P97/ANI17                                        | P97/ANI17                                        |
| -      | 77    | -     | -     | -     | P02/(TI06)/(TO06)                                | P02/(TI06)/(TO06)                                |
| -      | 78    | -     | -     | -     | P126/(TI01)/(TO01)                               | P126/(TI01)/(TO01)                               |
| -      | 79    | -     | -     | -     | P01/(TI04)/(TO04)                                | P01/(TI04)/(TO04)                                |
| -      | 80    | 64    | 48    | 32    | P125/ANI24/TI03/TO03/TRDIOB0/SSI01/INTP1/SNZOUT1 | P125/ANI24/TI03/TO03/TRDIOB0/SSI01/INTP1/SNZOUT1 |

**Remark:** KRx (Key Return) function depends on the product. For details, see “Table 2-3. Pin Assignment for KRx Function”.

Table 2-3. Pin Assignment for KRx Function

| Pin Function<br>(Key return) | KRx Assigned Pin (No difference between RL78/F23, F24 products and RL78/F13, F14 products) |          |          |          |          |          |          |          |          |          |
|------------------------------|--------------------------------------------------------------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
|                              | 100QFP                                                                                     |          | 80QFP    |          | 64QFP    |          | 48QFP    |          | 32QFN    |          |
|                              | PIOR50=0                                                                                   | PIOR50=1 | PIOR50=0 | PIOR50=1 | PIOR50=0 | PIOR50=1 | PIOR50=0 | PIOR50=1 | PIOR50=0 | PIOR50=1 |
| KR7                          | P77                                                                                        | -        | P77      | -        | P77      | P96      | -        | P92      | -        | -        |
| KR6                          | P76                                                                                        | -        | P76      | -        | P76      | P95      | -        | P91      | -        | -        |
| KR5                          | P75                                                                                        | -        | P75      | -        | P75      | P94      | -        | P90      | -        | P85      |
| KR4                          | P74                                                                                        | -        | P74      | -        | P74      | P93      | -        | P87      | -        | P84      |
| KR3                          | P73                                                                                        | -        | P73      | -        | P73      | P92      | P73      | P86      | -        | P83      |
| KR2                          | P72                                                                                        | -        | P72      | -        | P72      | P91      | P72      | P85      | -        | P82      |
| KR1                          | P71                                                                                        | -        | P71      | -        | P71      | P90      | P71      | P84      | -        | P81      |
| KR0                          | P70                                                                                        | -        | P70      | -        | P70      | P87      | P70      | P83      | -        | P80      |

The table below shows extended functions on RL78/F23, F24 products.

**Table 2-4. RL78/F23, F24 Pin Function Added from RL78/F13, F14 Products**

| Added Pin Function | Added Purpose                   | Setting to Use                                    |
|--------------------|---------------------------------|---------------------------------------------------|
| P32/(SO11)         | Expanded pin allocation         | PIOR43 = 0, PIOR92 = 1                            |
| P41/TRD0RES        | Expanded the Timer RDe function | - (TRD0 for Timer RDe counter reset signal input) |
| P41/(SI10)/(RXD1)  | Expanded pin allocation         | PIOR42 = 0, PIOR91 = 1                            |
| P60/(TO01)         | Expanded pin allocation         | PIOR11 = 1, PIOR90 = 1                            |
| P61/(TO02)         | Expanded pin allocation         | PIOR12 = 1, PIOR90 = 1                            |
| P62/(TO03)         | Expanded pin allocation         | PIOR13 = 1, PIOR90 = 1                            |
| P63/(TO07)         | Expanded pin allocation         | PIOR17 = 1, PIOR90 = 1                            |
| P120/(LTXD0)       | Expanded pin allocation         | PIOR45 = 1, PIOR93 = 1                            |
| P125/(LRXD0)       | Expanded pin allocation         | PIOR45 = 1, PIOR93 = 1                            |
| P140/TRD1RES       | Expanded the Timer RDe function | - (TRD1 for Timer RDe counter reset signal input) |

**Remarks:** PIOR11, PIOR12, PIOR13, PIOR17: Bit of the PIOR1 register  
PIOR42, PIOR43, PIOR45: Bit of the PIOR4 register  
PIOR90, PIOR91, PIOR92, PIOR93: Bit of the PIOR9 register (This register has been added to the RL78/F23, F24 products.)

The table below shows functions changed on RL78/F23, F24 products.

**Table 2-5. RL78/F23, F24 Pin Function Changed from RL78/F13, F14 Products**

| Pin Function       | Source Device (RL78/F13, F14) | RL78/F23, F24            | Purpose of Change                                                                                                    |
|--------------------|-------------------------------|--------------------------|----------------------------------------------------------------------------------------------------------------------|
| ANI0               | P33                           | P80                      | ANI0 has dedicated-channel S&H circuit, and P33 is assigned AV <sub>REFP</sub> (analog reference voltage (+) input). |
| ANI1               | P34                           | P81                      | ANI1 has dedicated-channel S&H circuit, and P34 is assigned AV <sub>REFM</sub> (analog reference voltage (-) input). |
| ANI2 to ANI7       | P80 to P85                    | P82 to P85, P33, and P34 | Changed ANI0 and ANI1 pin assignment                                                                                 |
| IVCMP00            | P81                           | P82                      | P81 assigned ANI1 function. (ANI1 has dedicated-channel S&H circuit.)                                                |
| IVCMP01 to IVCMP03 | P82 to P84                    | P83 to P85               | Changed IVCMP0x pin assignment                                                                                       |

For details, refer to chapters on functions A/D converter and comparator in this document.

### 3. Memory Map

#### 3.1 Memory Size by Products

RL78/F24 memory sizes are Code Flash: 256 KB, Data Flash: 16 KB, and RAM: 24 KB. Also, RL78/F23 memory sizes are Code Flash: 128 KB, Data Flash: 8 KB, and RAM: 12 KB. The memory size of Data Flash and RAM are expanded from RL78/F13, F14 products.

##### Key Points for Porting:

- **Difference in memory size**

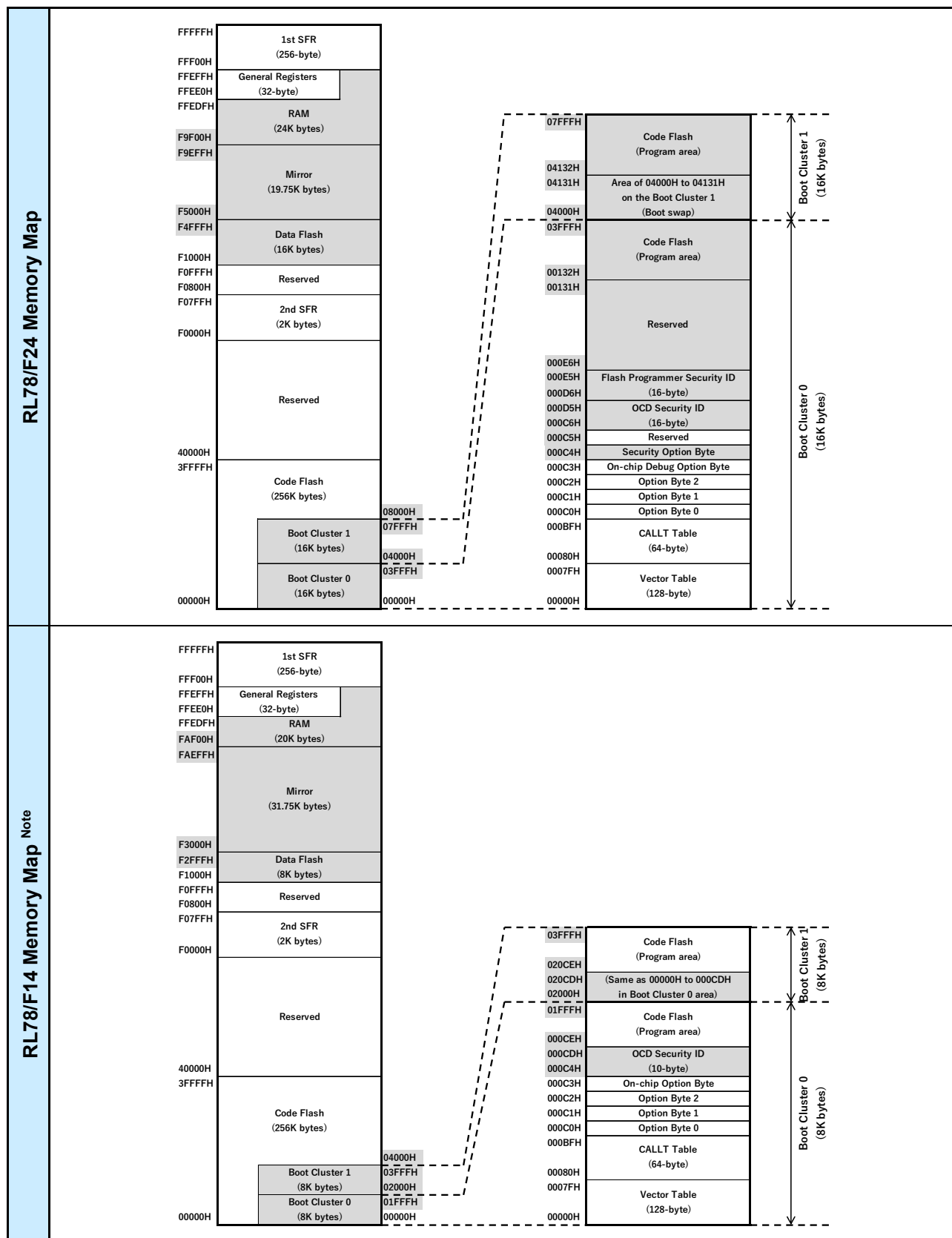
The memory sizes have been expanded from RL78/F14 product to RL78/F24 product, and from RL78/F13 product to RL78/F23 product.

- **Difference in package**

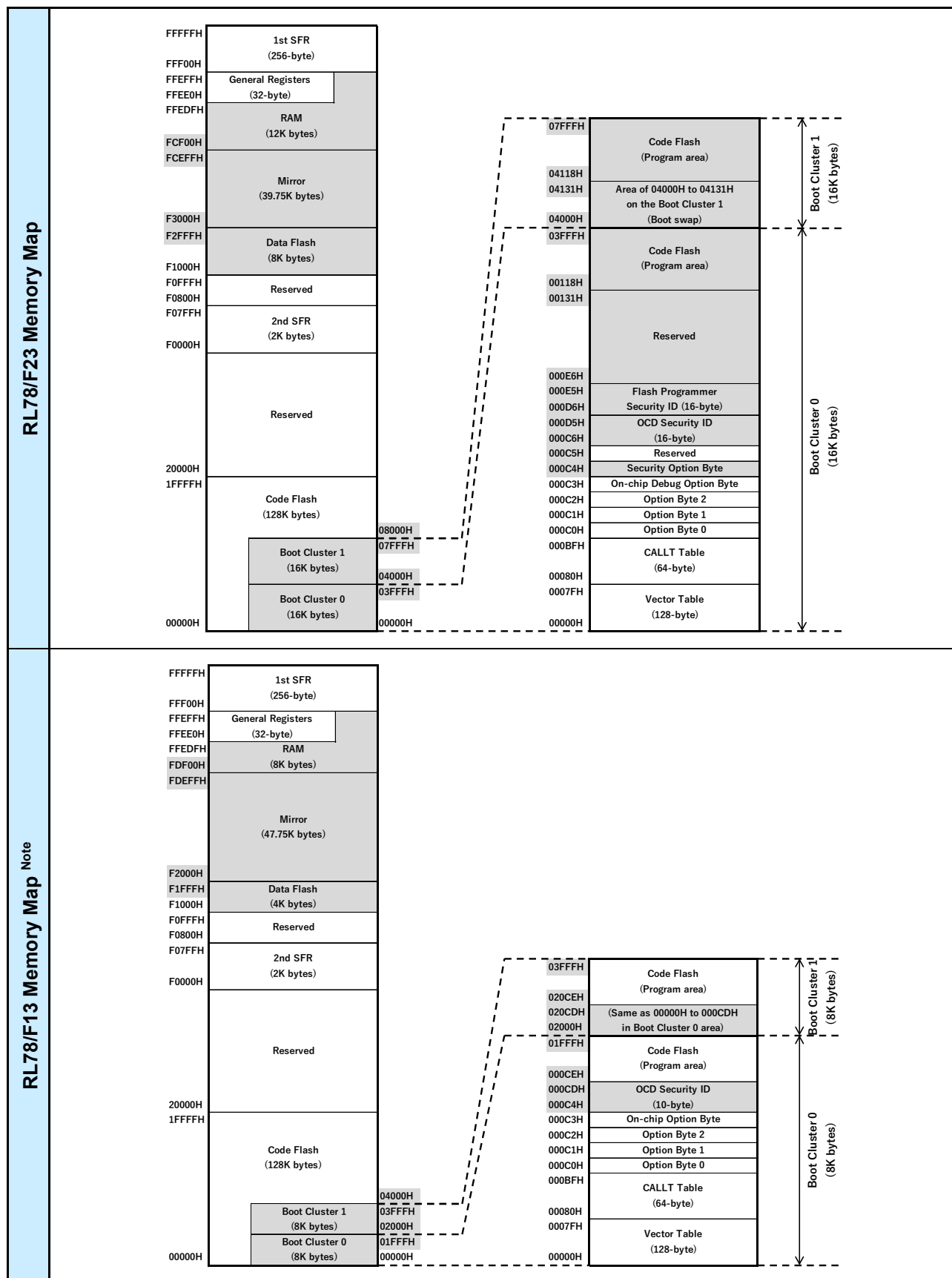
RL78/F23, F24 products do not have a 20-SSOP, 30-SSOP, or a 48-QFN package. Consider 32-QFN or 48-QFP products when migrating from those products.

## 3.2 Memory Map

Figures below show the comparison of memory maps for products of RL78/F24 and RL78/F14 and products of RL78/F23 and RL78/F13.



**Figure 3-1. Memory Map of RL78/F24, Compared with RL78/F14**



**Note.** Illustrate products with maximum memory size.

**Figure 3-2. Memory Map of RL78/F23, Compared with RL78/F13**

The differences in memory map between RL78/F23, F24 products and RL78/F13, F14 products are shown below.

- Added Security Option Byte (000C4H)
- Expanded On-chip Debug Security ID area (000C6H – 000D5H) from 80-bit to 128-bit
- Added Flash Programmer Security ID area (000D6H – 000E5H)
- Expanded Boot Cluster 0/1 memory sizes from 8 KB to 16 KB

The table below shows the difference between option bytes for RL78/F23, F24 products and RL78/F13, F14 products.

**Table 3-1. Option Bytes Area of RL78/F23, F24, Compared with RL78/F13, F14**

| Item                      | RL78/F23, F24                                                                                    | RL78/F13, F14                           |
|---------------------------|--------------------------------------------------------------------------------------------------|-----------------------------------------|
| User Option Byte 0        | WDT control                                                                                      | WDT control                             |
| User Option Byte 1        | LVD, CLM control                                                                                 | LVD, CLM control                        |
| User Option Byte 2        | HOCO frequency setting, RESOUTB control                                                          | HOCO frequency setting, RESOUTB control |
| On-chip Debug Option Byte | OCD, Hot plug-in, <b>Flash programmer</b> control                                                | OCD, Hot plug-in control                |
| Security Option Byte      | <b>Security ID (On-chip debug security ID, and flash programmer security ID) read protection</b> | No features                             |

#### Key Points for Porting:

##### • Difference in memory map

Security option byte, on-chip debug security ID area, and flash programmer security ID area have been expanded with the addition of security features on RL78/F23, F24 products. Set the data according to this specification for security option byte (000C4H) added in RL78/F23, F24 products.

The differences in mirror area for the code flash between RL78/F23, F24 products and RL78/F13, F14 products are shown below.

The RL78/F23 and RL78/F24 products mirror the code flash area of 00000H to 0FFFFH or 10000H to 1FFFFH, to F0000H to FFFFFH (the code flash area to be mirrored is set by the processor mode control register (PMC)), same as RL78/F13 and RL78/F14 products.

The code flash area is not mirrored to the SFR, extended SFR, RAM, data flash memory, and use prohibited areas, so the size of the mirror area varies by product. The figure below shows a comparison of the mirror area for each product.

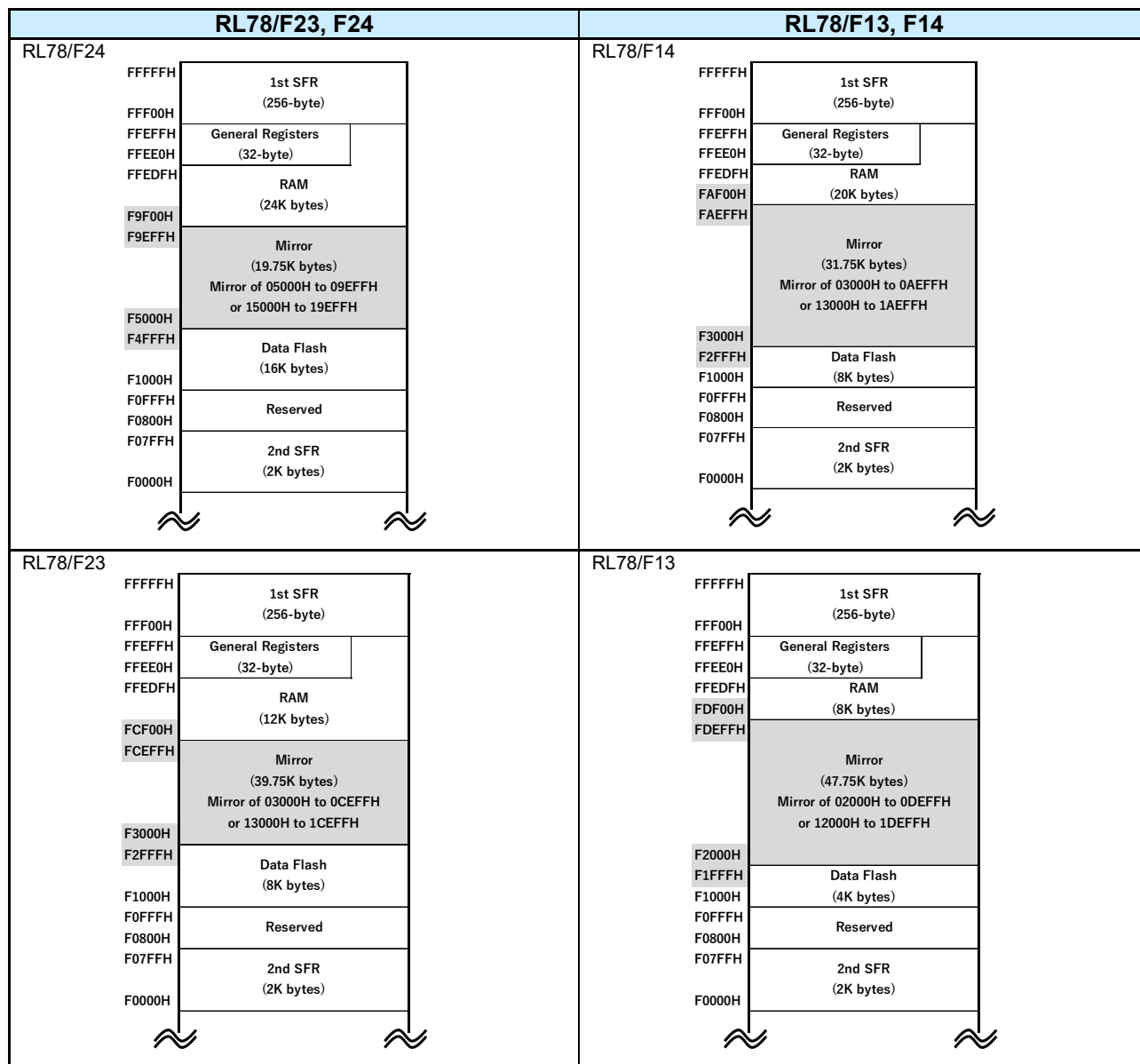


Figure 3-3. Mirror Area of RL78/F23, F24, Compared with RL78/F13, F14

#### Key Points for Porting:

##### • Code flash mirror area

The mirror area (mirror the code flash area of 00000H to 0FFFFH or 10000H to 1FFFFH, to F0000H to FFFFFH) varies by product. When using the mirror area, place the data table used in the mirror area in the code flash area of the corresponding area. See Figure 3-3.

RAM and code flash memory are increased from RL78/F13, F14 products. With this increase, the area available in Mirror area is decreasing. If Mirror area is insufficient, access the code flash memory area directly. Alternatively, copy the data from the code flash memory to the RAM area and access the RAM area.



In RL78/F23, F24 products, the start address of the RAM used can be set to a user-specified value. Set RAMSAR register to the RAM start address (bits 15 to 8; reset value = EFH; valid RAM area = FEF00H to FFEFFH). By using this setting and invalid memory access detection function, writing to an unused RAM area can be guarded.

- MCU reset occurs when writing to an invalid RAM area by using invalid memory access detection function.
- Memory guards writing to the area of 128-/256-/512-byte selected by RAM guard function.

The table below shows an example of the valid area of RAM by RAMSAR register, and the effective area of RAM guard function.

**Table 3-2. RAMSAR Register Setting Example**

| RAMSAR register <sup>Note</sup> | IAWCTL.GRAM[1:0] bits | Valid RAM Area            | RAM Guard Space |
|---------------------------------|-----------------------|---------------------------|-----------------|
| 9FH                             | 01B (128 bytes)       | F9F00H – FFEFFH<br>(24KB) | F9F00H – F9F7FH |
|                                 | 10B (256 bytes)       |                           | F9F00H – F9FFFH |
|                                 | 11B (512 bytes)       |                           | F9F00H – FA0FFH |
| AFH                             | 01B (128 bytes)       | FAF00H – FFEFFH<br>(20KB) | FAF00H – FAF7FH |
|                                 | 10B (256 bytes)       |                           | FAF00H – FAFFFH |
|                                 | 11B (512 bytes)       |                           | FAF00H – FB0FFH |
| CFH                             | 01B (128 bytes)       | FCF00H – FFEFFH<br>(12KB) | FCF00H – FCF7FH |
|                                 | 10B (256 bytes)       |                           | FCF00H – FCFFFH |
|                                 | 11B (512 bytes)       |                           | FCF00H – FD0FFH |
| DFH                             | 01B (128 bytes)       | FDF00H – FFEFFH<br>(8KB)  | FDF00H – FDF7FH |
|                                 | 10B (256 bytes)       |                           | FDF00H – FDFFFH |
|                                 | 11B (512 bytes)       |                           | FDF00H – FE0FFH |
| EFH                             | 01B (128 bytes)       | FEF00H – FFEFFH<br>(4KB)  | FEF00H – FEF7FH |
|                                 | 10B (256 bytes)       |                           | FEF00H – FEFFFH |
|                                 | 11B (512 bytes)       |                           | FEF00H – FF0FFH |

**Note.** Be sure to set it within the memory range of the product to be used.

#### Key Points for Porting:

##### • Difference in RAMSAR register

RL78/F23, F24 products specify the RAM start address by RAMSAR register setting. The reset value of this register is EFH (valid RAM area: FEF00H to FFEFFH, 4 KB). Be sure to set the required value in the start-up program.

##### • Difference in invalid memory access detection function

In RL78/F23, F24 products, the unused area of RAM is expanded to the detection area of invalid memory access detection function.

## 4. Port Function

The number of I/O ports in RL78/F23, F24 products and RL78/F13, F14 products is the same. However, some port related registers that control the function have been changed.

### 4.1 Port Function Comparison

The table below shows the differences between RL78/F23, F24 products and RL78/F13, F14 products port function.

**Table 4-1. I/O Port Register Differences of RL78/F23, F24, Compared with RL78/F13, F14**

| Register | Register Description                                               | RL78/F23, F24                                     |
|----------|--------------------------------------------------------------------|---------------------------------------------------|
| PMx      | Port mode register (Input or output mode setting)                  | Same as RL78/F13, F14                             |
| Px       | Port register (Input or output level)                              | Same as RL78/F13, F14                             |
| PUx      | Pull-up resistor option register (Internal pull-up setting)        | Same as RL78/F13, F14                             |
| PIMx     | Port input mode register (C-MOS or TTL level)                      | Same as RL78/F13, F14                             |
| POMx     | Port output mode register (C-MOS or N-ch open drain)               | Added POM32 bit from RL78/F13, F14                |
| PMCx     | Port mode control register (Digital I/O or analog I/O)             | Added PMC3, 8, 9, 10 registers from RL78/F13, F14 |
| ADPC     | A/D port configuration register (Digital I/O or analog I/O)        | Deleted from RL78/F13, F14 (correspond with PMCx) |
| PITHLx   | Port input threshold control register (Schmitt 1, 3, or TTL level) | Added PITHL41, PITHL120 bits from RL78/F13, F14   |
| PIORx    | Peripheral I/O redirection register                                | Added PIOR9 register from RL78/F13, F14           |
| PSRSEL   | Port output slew rate register (Normal or slow)                    | Same as RL78/F13, F14                             |
| PSNZCNTx | SNOOZE status output control register (Output pun setting)         | Same as RL78/F13, F14                             |
| PMS      | Port mode select register (Read from output pin level)             | Same as RL78/F13, F14                             |

#### Key Points for Porting:

- **Analog port selection**

Select analog input/output port with PMCx register for each pin. If the system is concerned about a short circuit between analog input adjacent pins, an open pin which output low level can be assigned between analog input pin (A) and analog input pin (B).

- **Added PIOR9 register**

In RL78/F23, F24 products, output pin is extended so that PWM output and serial I/F can be used independently. For details, see Table 2-1 and Table 2-2.

## 5. Clock Generator

The table below shows the differences between RL78/F23, F24 products and RL78/F13, F14 products clock generator circuit.

**Table 5-1. Clock Generator of RL78/F23, F24, Compared with RL78/F13, F14**

| Clock Generator       | RL78/F23, F24                | RL78/F13, F14                |
|-----------------------|------------------------------|------------------------------|
| X1 clock              | 2MHz to 20MHz                | 1MHz to 20MHz                |
| XT1 clock             | Same as RL78/F13, F14        | 32.768kHz                    |
| PLL circuit           | Max. output frequency: 80MHz | Max. output frequency: 64MHz |
| High-speed OCO        | 2MHz to 80MHz                | 1MHz to 64MHz                |
| Low-speed OCO         | Same as RL78/F13, F14        | 15kHz                        |
| Low-speed OCO for WDT | Same as RL78/F13, F14        | 15kHz                        |

### 5.1 PLL Clock Circuit

PLL clock circuit of RL78/F23, F24 products is expanded PLL clock frequency to 80 MHz. RL78/F23, F24 products can use up to 80 MHz PLL clock frequency or high-speed on-chip oscillator clock frequency when using RS-CANFD lite module or Timer RDe module.

The table below shows the PLL clock circuit specifications in RL78/F23, F24 products.

**Table 5-2. PLL Clock Settings of RL78/F23, F24**

| X1 Clock | X1 Clock Divider (FMAINDIV) | PLL Multiplier (PLLMULA, PLLMUL) | PLL Divider (PLLDIV0, FPLLDIV) | PLL Frequency |
|----------|-----------------------------|----------------------------------|--------------------------------|---------------|
| 4MHz     | 00B (×1/1)                  | 11B (×20)                        | 01B (×1/1)                     | 80MHz         |
|          | 00B (×1/1)                  | 11B (×20)                        | 00B (×1/2)                     | 40MHz         |
| 8MHz     | 00B (×1/1)                  | 10B (×10)                        | 01B (×1/1)                     | 80MHz         |
|          | 00B (×1/1)                  | 01B (×16)                        | 00B (×1/2)                     | 64MHz         |
|          | 00B (×1/1)                  | 00B (×12)                        | 00B (×1/2)                     | 48MHz         |
|          | 00B (×1/1)                  | 10B (×10)                        | 00B (×1/2)                     | 40MHz         |
|          | 00B (×1/1)                  | 01B (×16)                        | 10B (×1/4)                     | 32MHz         |
|          | 00B (×1/1)                  | 00B (×12)                        | 10B (×1/4)                     | 24MHz         |
| 16MHz    | 10B (×1/2)                  | 10B (×10)                        | 01B (×1/1)                     | 80MHz         |
|          | 10B (×1/2)                  | 01B (×16)                        | 00B (×1/2)                     | 64MHz         |
|          | 10B (×1/2)                  | 00B (×12)                        | 00B (×1/2)                     | 48MHz         |
|          | 10B (×1/2)                  | 10B (×10)                        | 00B (×1/2)                     | 40MHz         |
|          | 10B (×1/2)                  | 01B (×16)                        | 10B (×1/4)                     | 32MHz         |
|          | 10B (×1/2)                  | 00B (×12)                        | 10B (×1/4)                     | 24MHz         |
| 20MHz    | 11B (×1/4)                  | 01B (×16)                        | 01B (×1/1)                     | 80MHz         |
|          | 11B (×1/4)                  | 01B (×16)                        | 00B (×1/2)                     | 40MHz         |

**Caution:** Bit values other than above are prohibited.

**Remarks:** FMAINDIV, FPLLDIV: Bits of the CKSEL register  
PLLMULA, PLLMUL, PLLDIV0: Bits of the PLLCTL register

#### Key Points for Porting:

##### • Using PLL clock circuit

When using PLL clock circuit, be sure to select settings shown in the table.

## 5.2 High-speed On-chip Oscillator Frequency Selection

High-speed on-chip oscillator frequency is selected by user option byte (000C2H) and HOCODIV register. In RL78/F23, F24 products, the frequency of HOCO frequency is also expanded to 80 MHz as the maximum operating frequency is expanded. The table below shows the differences between RL78/F23, F24 products and RL78/F13, F14 products HOCO specifications.

**Table 5-3. High-Speed OCO of RL78/F23, F24, Compared with RL78/F13, F14**

| HOCO<br>DIV2                                  | HOCO<br>DIV1 | HOCO<br>DIV0 | RL78/F23, F24                                        |                |                |                | RL78/F13, F14                                        |                |                |                |
|-----------------------------------------------|--------------|--------------|------------------------------------------------------|----------------|----------------|----------------|------------------------------------------------------|----------------|----------------|----------------|
|                                               |              |              | High-speed on-chip oscillator frequency ( $f_{IH}$ ) |                |                |                | High-speed on-chip oscillator frequency ( $f_{IH}$ ) |                |                |                |
|                                               |              |              | 32 MHz<br>base                                       | 40 MHz<br>base | 64 MHz<br>base | 80 MHz<br>base | 24 MHz<br>base                                       | 32 MHz<br>base | 48 MHz<br>base | 64 MHz<br>base |
|                                               |              |              | FRQSEL4 = 0                                          |                | FRQSEL4 = 1    |                | FRQSEL4 = 0                                          |                | FRQSEL4 = 1    |                |
|                                               |              |              | FRQSEL3<br>= 0                                       | FRQSEL3<br>= 1 | FRQSEL3<br>= 0 | FRQSEL3<br>= 1 | FRQSEL3<br>= 0                                       | FRQSEL3<br>= 1 | FRQSEL3<br>= 0 | FRQSEL3<br>= 1 |
| 0                                             | 0            | 0            | 32 MHz                                               | 40 MHz         | 64 MHz         | 80 MHz         | 24 MHz                                               | 32 MHz         | 48 MHz         | 64 MHz         |
| 0                                             | 0            | 1            | 16 MHz                                               | 20 MHz         | 32 MHz         | 40 MHz         | 12 MHz                                               | 16 MHz         | 24 MHz         | 32 MHz         |
| 0                                             | 1            | 0            | 8 MHz                                                | 10 MHz         | 16 MHz         | 20 MHz         | 6 MHz                                                | 8 MHz          | 12 MHz         | 16 MHz         |
| 0                                             | 1            | 1            | 4 MHz                                                | 5 MHz          | 8 MHz          | 10 MHz         | 3 MHz                                                | 4 MHz          | 6 MHz          | 8 MHz          |
| 1                                             | 0            | 0            | 2 MHz                                                | prohibited     | 4 MHz          | 5 MHz          | prohibited                                           | 2 MHz          | prohibited     | 4 MHz          |
| 1                                             | 0            | 1            | prohibited                                           | prohibited     | prohibited     | prohibited     | prohibited                                           | 1 MHz          | prohibited     | 2 MHz          |
| Settings other than the above are prohibited. |              |              |                                                      |                |                |                |                                                      |                |                |                |

**Remarks:** HOCODIV[2:0]: Bits of the HOCODIV register

FRQSEL4, 3: Bits of the User Option Byte (000C2H/040C2H)

### Key Points for Porting:

#### • HOCO frequency setting

High-speed on-chip oscillator frequency is selected by FRQSEL[4:0] bits of the user option byte (000C2H/040C2H) and HOCODIV register. Set user option byte (000C2H/040C2H) according to the frequency used by the system.

#### • PLL clock setting when FRQSEL3 bit is 0

If the FRQSEL3 bit in the user option byte 2 is set to 0 (HOCO frequency = 64/ 32/ 16/ 8/ 4/ 2 MHz), and moreover the CPU/peripheral hardware clock ( $f_{CLK}$ ) is selected as the PLL clock, the  $f_{CLK}$  must not be set to 40 MHz.

## 6. Timer Functions

Timer functions of RL78/F23, F24 products are extended for the maximum operating frequency. In addition, the Timer RDe extends the PWM output control function in addition to the conventional functions. Tables below show the differences between RL78/F23, F24 products and RL78/F13, F14 products timer functions.

**Table 6-1. Timer Functions of RL78/F24, Compared with RL78/F14**

| Timer Function         | RL78/F24                                                                                      | RL78/F14                                    |
|------------------------|-----------------------------------------------------------------------------------------------|---------------------------------------------|
| Timer Array Unit (TAU) | 16-bit × 16ch<br>Operating frequency: 40MHz                                                   | 16-bit × 16ch<br>Operating frequency: 32MHz |
| Timer RD               | 16-bit × 2ch (Timer RDe)<br>Operating frequency: 80MHz<br>with PWMOPA, Dithering/Gate control | 16-bit × 2ch<br>Operating frequency: 64MHz  |
| Timer RJ               | 16-bit × 1ch<br>Operating frequency: 40MHz                                                    | 16-bit × 1ch<br>Operating frequency: 32MHz  |
| Real-time Clock        | 1ch                                                                                           | 1ch                                         |

**Table 6-2. Timer Functions of RL78/F23, Compared with RL78/F13**

| Timer Function         | RL78/F23                                                                                      | RL78/F13                                    |
|------------------------|-----------------------------------------------------------------------------------------------|---------------------------------------------|
| Timer Array Unit (TAU) | 16-bit × 12ch<br>Operating frequency: 40MHz                                                   | 16-bit × 12ch<br>Operating frequency: 32MHz |
| Timer RD               | 16-bit × 2ch (Timer RDe)<br>Operating frequency: 80MHz<br>with PWMOPA, Dithering/Gate control | 16-bit × 2ch<br>Operating frequency: 64MHz  |
| Timer RJ               | 16-bit × 1ch<br>Operating frequency: 40MHz                                                    | 16-bit × 1ch<br>Operating frequency: 32MHz  |
| Real-time Clock        | 1ch                                                                                           | 1ch                                         |

**Table 6-3. Timer RDe Functions of RL78/F23, F24**

| Timer RDe Features                       |                                        | RL78/F23, F24 Timer RDe                                                                                                                     |
|------------------------------------------|----------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| Input capture function                   |                                        | Same as RL78/F13, F14                                                                                                                       |
| Output compare function                  |                                        | Same as RL78/F13, F14                                                                                                                       |
| PWM function                             | Reset synchronous PWM mode             | Same as RL78/F13, F14                                                                                                                       |
|                                          | Complementary PWM mode                 | Same as RL78/F13, F14                                                                                                                       |
|                                          | PWM3 mode                              | Same as RL78/F13, F14                                                                                                                       |
|                                          | <b>Extended PWM mode</b>               | <b>Dithering function, Gate function, Reset start function</b>                                                                              |
|                                          | <b>Extended complementary PWM mode</b> | <b>Asymmetric PWM pulse control, Interrupt and A/D trigger signal decimation function</b>                                                   |
| <b>PWM output forced cutoff function</b> |                                        | <b>PWMOPA</b>                                                                                                                               |
| A/D trigger                              |                                        | The following A/D trigger signals have been added from RL78/F13, F14.<br>• INTTRD0_IFA, INTTRD1_IFA, INTTRD1_IFB, INTTDR1_UDF, INTTRD_ADTRG |

**Key Points for Porting:**

- **Difference in the number of timer channels**

The number of timer channels is the same for RL78/F23 and RL78/F13, and RL78/F24 product and RL78/F14 product. Set the count register and clock source of each timer as the maximum operating frequency of RL78/F23, F24 products are expanded.

- **Timer RDe extended functionality**

Timer RDe of RL78/F23, F24 products extends the function from Timer RD of RL78/F13, F14 products. Extended complementary PWM mode (synchronous/asynchronous three-phase PWM output), extended PWM mode (with dithering/gate, and counter reset input function), and PWM forced cutoff circuit (PWMOPA) have been added while maintaining the conventional specifications. Moreover, the resolution of a timer is improved by expanding the maximum operating frequency.

## 7. Serial Interfaces

RL78/F24 implements RS-CANFD lite module corresponding to CAN-FD communication. Tables below show the differences between RL78/F23, F24 products and RL78/F13, F14 products serial I/F.

**Table 7-1. Serial I/F of RL78/F24, Compared with RL78/F14**

| Serial I/F                          | RL78/F24                                          | RL78/F14                                          |
|-------------------------------------|---------------------------------------------------|---------------------------------------------------|
| Serial Array Unit (SAU)             | CSI/Simplified-I <sup>2</sup> C/UART: 4ch/4ch/2ch | CSI/Simplified-I <sup>2</sup> C/UART: 4ch/4ch/2ch |
| Multimaster I <sup>2</sup> C (IICA) | 1ch                                               | 1ch                                               |
| LIN/UART module (RLIN3)             | 2ch                                               | 2ch                                               |
| CAN interface                       | RS-CANFD lite: 1ch                                | RS-CAN lite: 1ch                                  |

**Table 7-2. Serial I/F of RL78/F23, Compared with RL78/F13**

| Serial I/F                          | RL78/F23                                          | RL78/F13                                          |
|-------------------------------------|---------------------------------------------------|---------------------------------------------------|
| Serial Array Unit (SAU)             | CSI/Simplified-I <sup>2</sup> C/UART: 4ch/4ch/2ch | CSI/Simplified-I <sup>2</sup> C/UART: 4ch/4ch/2ch |
| Multimaster I <sup>2</sup> C (IICA) | 1ch                                               | 1ch                                               |
| LIN/UART module (RLIN3)             | 1ch                                               | 1ch                                               |
| CAN interface                       | -                                                 | -                                                 |

**Table 7-3. CAN Interface Differences of RL78/F24 Compared with RL78/F14**

| Item                | RL78/F24                                                                                                                                                                                                                                                     | RL78/F14                                                                                                                                                                                         |
|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Module name         | RS-CANFD lite                                                                                                                                                                                                                                                | RS-CAN lite                                                                                                                                                                                      |
| Protocol            | ISO11898-1(2015) compliant<br>Using CAN-FD frames is selectable by switching interface modes.                                                                                                                                                                | ISO11898-1 compliant                                                                                                                                                                             |
| Communication speed | <ul style="list-style-type: none"> <li>Classical CAN only mode<br/>Maximum 1 Mbps</li> <li>CAN-FD mode and CAN-FD only mode<br/>Data bit rate: max.5 Mbps</li> </ul>                                                                                         | <ul style="list-style-type: none"> <li>Classical CAN only mode<br/>Maximum 1 Mbps</li> </ul>                                                                                                     |
| Buffer              | 20 buffers in total <ul style="list-style-type: none"> <li>Individual buffers: 4 buffers<br/>(4 buffers for one channel)</li> <li>Shared buffers: 16 buffers</li> <li>CAN RAM ECC included</li> </ul>                                                        | 20 buffers in total <ul style="list-style-type: none"> <li>Individual buffers: 4 buffers<br/>(4 buffers for one channel)</li> <li>Shared buffers: 16 buffers</li> </ul>                          |
| Interrupt source    | 8 sources <ul style="list-style-type: none"> <li>Global (3 sources)<br/>Added: CAN global RXMB receive interrupt</li> <li>Channel (3 sources/channel)</li> <li>Wakeup detection</li> <li>CAN RAM ECC detection</li> </ul>                                    | 6 sources <ul style="list-style-type: none"> <li>Global (2 sources)</li> <li>Channel (3 sources/channel)</li> <li>Wakeup detection</li> </ul>                                                    |
| CAN clock source    | Selects the clock obtained by frequency- $f_{CLK}$ or the X1 clock ( $f_X$ ).                                                                                                                                                                                | Selects the clock obtained by frequency- $f_{CLK}$ or the X1 clock ( $f_X$ ).                                                                                                                    |
| Test function       | Test function for user evaluation <ul style="list-style-type: none"> <li>Basic test mode</li> <li>Listen-only mode</li> <li>Self-test mode 0 (external loopback)</li> <li>Self-test mode 1 (internal loopback)</li> <li>Restricted operation mode</li> </ul> | Test function for user evaluation <ul style="list-style-type: none"> <li>Listen-only mode</li> <li>Self-test mode 0 (external loopback)</li> <li>Self-test mode 1 (internal loopback)</li> </ul> |

### Key Points for Porting:

#### • Difference in the number of Serial I/F channels

The number of serial I/F channels is the same for RL78/F23 and RL78/F13, and RL78/F24 product and RL78/F14 product. Set the communication baud rate clock of each serial I/F module as the maximum operating frequency of RL78/F23, F24 products are expanded.

#### • CAN-FD module

When using RS-CANFD lite function, be sure to set the clock to the " $f_{MP}/2 = f_{CLK} \geq f_{CAN}$ " condition (Setting example:  $f_{MP} = 80\text{MHz}$ ,  $f_{CLK} = 40\text{MHz}$ ,  $f_{CAN} = 40\text{MHz}$ ). In RS-CANFD lite module, the register is window type because it corresponds to 64 payloads. Select a window to access the corresponding register.

## 8. Analog Functions

RL78/F23, F24 products implement A/D converter, D/A converter, and comparator as analog functions. D/A converter has no difference between RL78/F24 and RL78/F14. This section describes the differences between RL78/F23, F24 products and RL78/F13, F14 products for A/D converter and comparator. Note that D/A converter and comparator are implemented only for RL78/F24 and RL78/F14.

### 8.1 A/D Converter

The table below shows differences between RL78/F23, F24 products and RL78/F13, F14 products A/D converter.

**Table 8-1. A/D Converter of RL78/F23, F24, Compared with RL78/F13, F14**

| A/D Converter Features   | RL78/F23, F24                                                                                           | RL78/F13, F14                                                               |
|--------------------------|---------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------|
| Resolution               | 12 bits                                                                                                 | 10 bits                                                                     |
| Analog input channels    | 31ch/25ch/24ch/19ch/10ch<br>High-speed channels: ANI0 to ANI15<br>Normal-speed channels: ANI16 to ANI30 | 31ch/25ch/20ch/18ch/10ch                                                    |
| Expansion input channels | • Internal reference voltage ( $V_{BGR}$ )                                                              | • Internal reference voltage ( $V_{BGR}$ )<br>• Internal temperature sensor |
| Operating modes          | • Single scan mode<br>• Continuous scan mode<br>• Group scan mode (group A and B)                       | • One-shot conversion mode<br>• Sequential conversion mode                  |
| A/D trigger              | • Software trigger<br>• Hardware trigger                                                                | • Software trigger<br>• Hardware trigger (no-wait or wait mode)             |
| Interrupt                | • INTAD (A/D conversion end)<br>• INTADGB (group B A/D conversion end)                                  | • INTAD (A/D conversion end)                                                |
| Others                   | Channel-dedicated S&H circuit (ANI1, ANI2)                                                              | -                                                                           |
|                          | Sampling state cycle setting for each channel                                                           | -                                                                           |
|                          | Self-diagnosis mode ( $ANin=V_{ref}$ , $V_{ref}/2$ , 0)                                                 | Self-diagnosis mode ( $ANin=V_{ref}$ , 0)                                   |
|                          | Addition/Average operation mode                                                                         | -                                                                           |
|                          | Disconnection detection assist function                                                                 | Self-diagnosis mode                                                         |

#### Key Points for Porting:

##### • Difference in the number of analog input channels

The number of analog input channels is the same or extended for RL78/F23 and RL78/F13, and RL78/F24 and RL78/F14, respectively. In addition, ANI1 and ANI2 implement channel dedicated sample & hold circuit and can be sampled at the same time by hardware trigger input. Use ANI0 to ANI15 analog input channels when fast A/D conversion time and high accuracy are required.

##### • A/D data register

RL78/F23, F24 products A/D data registers (stores A/D conversion result) are implemented for each channel. In addition, the A/D data register can be right-aligned (store in bits 0 to 11) or left-aligned (store in bits 4 to 15) when storing the A / D conversion result.

##### • A/D-related register

In RL78/F23, F24 A/D module, the register is window type. Select a window to access the corresponding register. A/D data register from ANI0 to ANI7 can be accessed as mirror register without setting the window. Software processing can be reduced by preferentially using the ANI0 to ANI7 inputs.



## 8.2 Comparator (RL78/F24 Only)

The table below shows the differences between RL78/F24 and RL78/F14 comparator.

**Table 8-2. Comparator Function Differences of RL78/F24, Compared with RL78/F14**

| Function              |         | RL78/F24                      | RL78/F14             |
|-----------------------|---------|-------------------------------|----------------------|
| Port Control Register |         | PMC8                          | ADPC                 |
| Comparator Input Port | IVCMP00 | P82 / ANI2 / IVCMP00          | P81 / ANI3 / IVCMP00 |
|                       | IVCMP01 | P83 / ANI3 / IVCMP01          | P82 / ANI4 / IVCMP01 |
|                       | IVCMP02 | P84 / ANI4 / IVCMP02          | P83 / ANI5 / IVCMP02 |
|                       | IVCMP03 | P85 / ANI5 / IVCMP03 / IVREF0 | P84 / ANI6 / IVCMP03 |
|                       | IVREF0  |                               | P85 / ANI7 / IVREF0  |

### Key Points for Porting:

- **Difference in the comparator input pins**

RL78/F24 does not implement the comparator input on P81 pin. Also, when P85/IVREF0 input is used, the input of IVCMP03 cannot be used at the same time. Be caution of pin assignments when using comparator function.

## 9. Safety Functions

The table below shows the differences between RL78/F23, F24 products and RL78/F13, F14 products safety functions.

**Table 9-1. Safety Function Differences of RL78/F23, F24, Compared with RL78/F13, F14**

| Safety Features                                     | RL78/F23, F24                                                                                                   | RL78/F13, F14                                                                                               |
|-----------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|
| Window watchdog timer                               | Same as RL78/F13, F14                                                                                           | with WWDT                                                                                                   |
| Illegal instruction execution detection function    | Same as RL78/F13, F14                                                                                           | with illegal instruction detection                                                                          |
| Flash memory CRC operation function                 | Same as RL78/F13, F14                                                                                           | with Flash memory CRC                                                                                       |
| General-purpose CRC function                        | Same as RL78/F13, F14                                                                                           | with general-purpose CRC                                                                                    |
| RAM ECC (1-bit correction/ 2-bit detection)         | Same as RL78/F13, F14                                                                                           | with RAM ECC                                                                                                |
| Invalid memory access detection function            | Same as RL78/F13, F14, added RAM start address setting register                                                 | with invalid memory access detection                                                                        |
| Frequency detection function                        | Same as RL78/F13, F14                                                                                           | with frequency detection                                                                                    |
| Clock monitor function                              | Added self-diagnosis mode from RL78/F13, F14                                                                    | with clock monitor function                                                                                 |
| Stack pointer monitor function                      | Same as RL78/F13, F14                                                                                           | with stack pointer monitor                                                                                  |
| I/O port output level detection function            | Same as RL78/F13, F14                                                                                           | with output port monitoring function                                                                        |
| A/D test function                                   | Disconnection assist<br>(pre-charge/discharge → Target pin A/D conversion)<br>Self-diagnosis (VREF, VREF/2, 0V) | Disconnection assist<br>(VREFL A/D conversion → Target pin A/D conversion)<br>Self-diagnosis (VREFH, VREFL) |
| SFR, RAM guard function                             | Same as RL78/F13, F14, added RAM start address setting register                                                 | with memory guard function                                                                                  |
| Code Flash memory ECC function                      | Yes (1-bit correction, bit error detection, accumulation error detection)                                       | No                                                                                                          |
| CAN RAM ECC<br>(1-bit correction / 2-bit detection) | Yes (only RL78/F24 product)                                                                                     | No                                                                                                          |

### 9.1 Memory Guard Function

The table below shows the differences between RL78/F23, F24 products and RL78/F13, F14 products memory guard function.

**Table 9-2. SFR Guard Function of RL78/F23, F24, Compared with RL78/F13, F14**

| SFR Guard Function                                             | RL78/F23, F24                                                                                                                | RL78/F13, F14                                                                                               |
|----------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|
|                                                                | Guarded SFRs                                                                                                                 | Guarded SFRs                                                                                                |
| Port function SFR guard controlled by IAWCTL.GPORT bit         | PMxx, PUxx, PIMxx, POMxx, PMCxx, PITHLxx, PIORx <sup>Note</sup>                                                              | PMxx, PUxx, PIMxx, POMxx, PMCxx, PITHLxx, PIORx <sup>Note</sup><br>ADPC                                     |
| Interrupt function SFR guard controlled by IAWCTL.GINT bit     | IFxx, MKxx, PRxx, EGPx, EGNx                                                                                                 | IFxx, MKxx, PRxx, EGPx, EGNx                                                                                |
| Clock control function SFR guard controlled by IAWCTL.GCSC bit | CMC, CSC, OSTS, CKC, PERx, OSMC, LVIM, LVIS, CANCKSEL, LINCKSEL, CKSEL, PLLCTL, MDIV, RTCCL, POCRES, STPSTC<br>CLMTES, ADCKS | CMC, CSC, OSTS, CKC, PERx, OSMC, LVIM, LVIS, CANCKSEL, LINCKSEL, CKSEL, PLLCTL, MDIV, RTCCL, POCRES, STPSTC |

**Note.** Pxx (Port register) is not guarded.

#### Key Points for Porting:

- **Difference in SFR guard function**

As shown in the table above, some registers have been added and some have been deleted.

## 10. Other Features

### 10.1 ELC (RL78/F24 Only)

Tables below show the differences between RL78/F24 and RL78/F14 ELC function.

**Table 10-1. ELC Functions of RL78/F24, Compared with RL78/F14**

| Event   | Event Source Trigger                  | Trigger Control Register | RL78/F24 | RL78/F14 |
|---------|---------------------------------------|--------------------------|----------|----------|
| INTP0   | INTP0 (Pin edge detection)            | ELSELR00                 | ○        | ○        |
| INTP1   | INTP1 (Pin edge detection)            | ELSELR01                 | ○        | ○        |
| INTP2   | INTP2 (Pin edge detection)            | ELSELR02                 | ○        | ○        |
| INTP3   | INTP3 (Pin edge detection)            | ELSELR03                 | ○        | ○        |
| INTP4   | INTP4 (Pin edge detection)            | ELSELR04                 | ○        | ○        |
| INTP5   | INTP5 (Pin edge detection)            | ELSELR05                 | ○        | ○        |
| INTKR   | INTKR (Key return function interrupt) | ELSELR06                 | ○        | ○        |
| INTRTC  | INTRTC (RTC function interrupt)       | ELSELR07                 | ○        | ○        |
| INTTRD0 | INTTRD0_IFA (Timer RD0 interrupt)     | ELSELR08                 | ○        | ○        |
| INTTRD0 | INTTRD0_IFB (Timer RD0 interrupt)     | ELSELR09                 | ○        | ○        |
| INTTRD1 | INTTRD1_IFA (Timer RD1 interrupt)     | ELSELR10                 | ○        | ○        |
| INTTRD1 | INTTRD1_IFB (Timer RD1 interrupt)     | ELSELR11                 | ○        | ○        |
| INTTRD1 | INTTRD1_UDF (Timer RD1 interrupt)     | ELSELR12                 | ○        | ○        |
| INTTRJ0 | INTTRJ0 (Timer RJ0 interrupt)         | ELSELR13                 | ○        | ○        |
| INTTM00 | INTTM00 (TAU0 ch0 interrupt)          | ELSELR14                 | ○        | ○        |
| INTTM01 | INTTM01 (TAU0 ch1 interrupt)          | ELSELR15                 | ○        | ○        |
| INTTM02 | INTTM02 (TAU0 ch2 interrupt)          | ELSELR16                 | ○        | ○        |
| INTTM03 | INTTM03 (TAU0 ch3 interrupt)          | ELSELR17                 | ○        | ○        |
| INTTM04 | INTTM04 (TAU0 ch4 interrupt)          | ELSELR18                 | ○        | ○        |
| INTCMP0 | INTCMP0 (Comparator detection)        | ELSELR19                 | ○        | ○        |
| INTTM05 | INTTM05 (TAU0 ch5 interrupt)          | ELSELR20                 | ○        | ○        |
| INTTM06 | INTTM06 (TAU0 ch6 interrupt)          | ELSELR21                 | ○        | ○        |
| INTTM07 | INTTM07 (TAU0 ch7 interrupt)          | ELSELR22                 | ○        | ○        |
| INTTM10 | INTTM10 (TAU1 ch0 interrupt)          | ELSELR23                 | ○        | ○        |
| INTTM11 | INTTM11 (TAU1 ch1 interrupt)          | ELSELR24                 | ○        | ○        |
| INTTM12 | INTTM12 (TAU1 ch2 interrupt)          | ELSELR25                 | ○        | ○        |

**Table 10-2. ELC Functions of RL78/F24, Compared with RL78/F14 (Link Destination)**

| Link Destination Function | Operation                                        | ELSELRn[3:0] | RL78/F24 | RL78/F14 |
|---------------------------|--------------------------------------------------|--------------|----------|----------|
| A/D Converter             | A/D conversion starts                            | 0001B        | ○        | ○        |
| TAU0 channel.0            | Delay counter. Input pulse interval measurement. | 0010B        | ○        | ○        |
| TAU0 channel.1            | Delay counter. Input pulse interval measurement. | 0011B        | ○        | ○        |
| Timer RJ                  | Count source for Timer RJ                        | 0100B        | ○        | ○        |
| Timer RD 0                | TRDIOD0 input capture. Pulse output cutoff       | 0101B        | ○        | ○        |
| Timer RD 1                | TRDIOD1 input capture. Pulse output cutoff       | 0110B        | ○        | ○        |
| D/A Converter             | DA0 real-time output                             | 0111B        | ○        | ○        |
| TAU0 channel.2            | Delay counter. Input pulse interval measurement. | 1000B        | ○        | ○        |
| TAU0 channel.3            | Delay counter. Input pulse interval measurement. | 1001B        | ○        | ○        |
| PWMOPA                    | Pulse output cutoff                              | 1010B        | ○        | -        |

#### Key Points for Porting:

- **Difference in ELC function**

PWMOPA (Timer RDe PWM pulse forced cutoff function) has been added to link destination function.

## 10.2 AAU (Application Accelerator Unit)

The table below describes the AAU function added in RL78/F23, F24 products.

**Table 10-3. AAU Functions of RL78/F23, F24**

| No. | AAU Algorithm Mode                                                                            | Data Type                                            | Execution Time <sup>Note 1</sup> | RL78/<br>F23, F24 | RL78/<br>F13, F14 |
|-----|-----------------------------------------------------------------------------------------------|------------------------------------------------------|----------------------------------|-------------------|-------------------|
| 1   | Sine operation                                                                                | Input, Output: 16-bit (integer)                      | 1 clock                          | ○                 | -                 |
| 2   | Cosine operation                                                                              | Input, Output: 16-bit (integer)                      | 1 clock                          | ○                 | -                 |
| 3   | Clarke and Park transformation<br>(for FOC controls) <sup>Note 2</sup>                        | Input, Output: 16-bit (integer)                      | 7 clocks                         | ○                 | -                 |
| 4   | Inverse Park (I-Park) transformation<br>(for FOC controls)                                    | Input, Output: 16-bit (integer)                      | 6 clocks                         | ○                 | -                 |
| 5   | Inverse Clarke (I-Clarke) transformation<br>(for FOC controls) <sup>Note 2</sup>              | Input, Output: 16-bit (integer)                      | 5 clocks                         | ○                 | -                 |
| 6   | PI control for motor (for FOC controls)                                                       | Input, Output: 16-bit (integer)                      | 15 clocks                        | ○                 | -                 |
| 7   | Clarke & Park transformation and PI control for<br>motor (for FOC controls) <sup>Note 2</sup> | Input, Output: 16-bit (integer)                      | 22 clocks                        | ○                 | -                 |
| 8   | I-Park & I-Clarke transformation<br>(for FOC controls) <sup>Note 2</sup>                      | Input, Output: 16-bit (integer)                      | 11 clocks                        | ○                 | -                 |
| 9   | PI control for DC/DC control                                                                  | Input, Output: 16-bit (integer)                      | 6 clocks / ch                    | ○                 | -                 |
| 10  | Multiply: 32-bit × 32-bit = 64-bit                                                            | Input: 32-bit (integer),<br>Output: 64-bit (integer) | 5 clocks                         | ○                 | -                 |

**Notes** 1. If STM=1 (Software trigger), the execution time is added by 1 cycle.

2. The AAU supports both algorithms, power invariant transformation and amplitude invariant transformation.

### Key Points for Porting:

#### • AAU function

AAU is a new function added in RL78/F23, F24 products. By using this function, software processing such as 32-bit multiplication can execute faster than RL78/F13, F14 products.

## 11. Interrupt

RL78/F23, F24 products add some interrupt sources compared to RL78/F13, F14 product. Tables below show the differences between RL78/F23, F24 products and RL78/F13, F14 products interrupt source.

**Table 11-1. Interrupt Functions of RL78/F24, Compared with RL78/F14 (1/2)**

| Vector Address | Interrupt Factor                              | RL78/F24 |        |        |        |        | RL78/F14 |        |        |        |        |
|----------------|-----------------------------------------------|----------|--------|--------|--------|--------|----------|--------|--------|--------|--------|
|                |                                               | 100 QFP  | 80 QFP | 64 QFP | 48 QFP | 32 QFN | 100 QFP  | 80 QFP | 64 QFP | 48 QFP | 32 QFN |
| 0000H          | RESET/POR/LVD/WDT/TRAP/IAW/CLM                | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 0002H          | Reserved                                      | -        | -      | -      | -      | -      | -        | -      | -      | -      | -      |
| 0004H          | INTWDTI (Watchdog timer interval)             | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 0006H          | INTLVI (Voltage detection)                    | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 0008H          | INTP0 (Pin edge detection)                    | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 000AH          | INTP1 (Pin edge detection)                    | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 000CH          | INTP2 (Pin edge detection)                    | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 000EH          | INTP3 (Pin edge detection)                    | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 0010H          | INTP4 (Pin edge detection)                    | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
|                | INTSPM (Stack pointer overflow / underflow)   | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 0012H          | INTP5 (Pin edge detection)                    | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
|                | INTCMP0 (Comparator detection)                | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 0014H          | INTP13 (Pin edge detection)                   | ○        | ○      | -      | -      | -      | ○        | ○      | -      | -      | -      |
|                | INTCLM (PLL clock stop detection)             | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 0016H          | INTST0/INTCSI00/INTIIC00 (SAU0 ch0 interrupt) | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 0018H          | INTSR0/INTCSI01/INTIIC01 (SAU0 ch1 interrupt) | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 001AH          | INTTRD0 (Timer RD0 interrupt)                 | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 001CH          | INTTRD1 (Timer RD1 interrupt)                 | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 001EH          | INTTRJ0 (Timer RJ0 interrupt)                 | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 0020H          | INTRAM (RAM ECC detection)                    | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 0022H          | INTLIN0TRM (LIN0 transmission)                | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 0024H          | INTLIN0RVC (LIN0 reception)                   | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 0026H          | INTLIN0STA/INTLIN0 (LIN0 interrupt)           | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 0028H          | INTIICA0 (Multimaster I2C interrupt)          | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 002AH          | INTP8 (Pin edge detection)                    | ○        | ○      | ○      | ○      | -      | ○        | ○      | ○      | ○      | -      |
|                | INTRTC (RTC interrupt)                        | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 002CH          | INTTM00 (TAU0 ch0 interrupt)                  | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 002EH          | INTTM01 (TAU0 ch1 interrupt)                  | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 0030H          | INTTM02 (TAU0 ch2 interrupt)                  | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 0032H          | INTTM03 (TAU0 ch3 interrupt)                  | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 0034H          | INTAD (A/D interrupt)                         | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 0036H          | INTP6 (Pin edge detection)                    | ○        | ○      | ○      | ○      | -      | ○        | ○      | ○      | ○      | -      |
|                | INTTM11H (TAU1 ch1 8-bit timer interrupt)     | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 0038H          | INTP7 (Pin edge detection)                    | ○        | ○      | ○      | ○      | -      | ○        | ○      | ○      | ○      | -      |
|                | INTTM13H (TAU1 ch3 8-bit timer interrupt)     | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 003AH          | INTP9 (Pin edge detection)                    | ○        | ○      | ○      | ○      | -      | ○        | ○      | ○      | ○      | -      |
|                | INTTM01H (TAU0 ch1 8-bit timer interrupt)     | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 003CH          | INTP10 (Pin edge detection)                   | ○        | ○      | ○      | -      | -      | ○        | ○      | ○      | -      | -      |
|                | INTTM03H (TAU0 ch3 8-bit timer interrupt)     | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 003EH          | INTST1/INTCSI10/INTIIC10 (SAU1 ch0 interrupt) | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |

Table 11-1. Interrupt Functions of RL78/F24, Compared with RL78/F14 (2/2)

| Vector Address | Interrupt Factor                                                  | RL78/F24 |        |        |        |        | RL78/F14 |        |        |        |        |
|----------------|-------------------------------------------------------------------|----------|--------|--------|--------|--------|----------|--------|--------|--------|--------|
|                |                                                                   | 100 QFP  | 80 QFP | 64 QFP | 48 QFP | 32 QFN | 100 QFP  | 80 QFP | 64 QFP | 48 QFP | 32 QFN |
| 0040H          | INTSR1 (SAU1 UART reception interrupt)                            | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
|                | INTCSI11/INTIIC11 (SAU1 ch1 interrupt)                            | ○        | ○      | ○      | ○      | -      | ○        | ○      | ○      | ○      | -      |
| 0042H          | INTTM04 (TAU0 ch4 interrupt)                                      | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 0044H          | INTTM05 (TAU0 ch5 interrupt)                                      | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 0046H          | INTTM06 (TAU0 ch6 interrupt)                                      | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 0048H          | INTTM07 (TAU0 ch7 interrupt)                                      | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 004AH          | INTP11 (Pin edge detection)                                       | ○        | ○      | ○      | -      | -      | ○        | ○      | ○      | -      | -      |
|                | INTLIN0WUP (LIN0 wakeup interrupt)                                | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 004CH          | INTKR (Key return function interrupt)                             | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
|                | INTRCAN0RVC (CAN0 channel receive interrupt)                      | ○        | ○      | ○      | ○      | ○      | -        | -      | -      | -      | -      |
| 004EH          | INTRCAN0ERR (CAN0 channel error interrupt)                        | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 0050H          | INTRCAN0WUP (CAN0 wakeup interrupt)                               | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 0052H          | INTRCAN0CFR (CAN0 transmit/ receive FIFO receive interrupt)       | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 0054H          | INTRCAN0TRM (CAN0 channel transmit interrupt)                     | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 0056H          | INTRCAN0RFR (CAN0 global receive FIFO interrupt)                  | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 0058H          | INTRCAN0ERR (CAN0 global error interrupt)                         | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 005AH          | INTTM10 (TAU1 ch0 interrupt)                                      | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 005CH          | INTTM11 (TAU1 ch1 interrupt)                                      | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 005EH          | INTTM12 (TAU1 ch2 interrupt)                                      | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 0060H          | INTTM13 (TAU1 ch3 interrupt)                                      | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 0062H          | Reserved                                                          | -        | -      | -      | -      | -      | -        | -      | -      | -      | -      |
| 0064H          | INTP12 (Pin edge detection)                                       | ○        | ○      | ○      | -      | -      | ○        | ○      | ○      | -      | -      |
|                | INTLIN1WUP (LIN1 wakeup interrupt)                                | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 0066H          | INTLIN1TRM (LIN1 transmission interrupt)                          | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 0068H          | INTLIN1RVC (LIN1 reception interrupt)                             | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 006AH          | INTLIN1STA/INTLIN1 (LIN1 interrupt)                               | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 006CH          | INTTM14 (TAU1 ch4 interrupt)                                      | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 006EH          | INTTM15 (TAU1 ch5 interrupt)                                      | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 0070H          | INTTM16 (TAU1 ch6 interrupt)                                      | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 0072H          | INTTM17 (TAU1 ch7 interrupt)                                      | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |
| 0074H          | Reserved                                                          | -        | -      | -      | -      | -      | -        | -      | -      | -      | -      |
| 0076H          | Reserved                                                          | -        | -      | -      | -      | -      | -        | -      | -      | -      | -      |
| 0078H          | INTADGB (A/D (group-B) interrupt)                                 | ○        | ○      | ○      | ○      | ○      | -        | -      | -      | -      | -      |
| 007AH          | INTGRAM (RAM for RS-CANFD lite ECC 1-bit / 2-bit error detection) | ○        | ○      | ○      | ○      | ○      | -        | -      | -      | -      | -      |
| 007CH          | INTROM (Code Flash bit error detection)                           | ○        | ○      | ○      | ○      | ○      | -        | -      | -      | -      | -      |
| 007EH          | BRK (BRK instruction interrupt)                                   | ○        | ○      | ○      | ○      | ○      | ○        | ○      | ○      | ○      | ○      |

Table 11-2. Interrupt Functions of RL78/F23, Compared with RL78/F13 (1/2)

| Vector Address | Interrupt Factor                              | RL78/F23 |        |        |        | RL78/F13 |        |        |        |
|----------------|-----------------------------------------------|----------|--------|--------|--------|----------|--------|--------|--------|
|                |                                               | 80 QFP   | 64 QFP | 48 QFP | 32 QFN | 80 QFP   | 64 QFP | 48 QFP | 32 QFN |
| 0000H          | RESET/POR/LVD/WDT/TRAP/IAW/CLM                | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |
| 0002H          | Reserved                                      | -        | -      | -      | -      | -        | -      | -      | -      |
| 0004H          | INTWDTI (Watchdog timer interval)             | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |
| 0006H          | INTLVI (Voltage detection)                    | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |
| 0008H          | INTP0 (Pin edge detection)                    | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |
| 000AH          | INTP1 (Pin edge detection)                    | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |
| 000CH          | INTP2 (Pin edge detection)                    | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |
| 000EH          | INTP3 (Pin edge detection)                    | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |
| 0010H          | INTP4 (Pin edge detection)                    | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |
|                | INTSPM (Stack pointer overflow / underflow)   | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |
| 0012H          | INTP5 (Pin edge detection)                    | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |
|                | INTCMP0 (Comparator detection)                | -        | -      | -      | -      | -        | -      | -      | -      |
| 0014H          | INTP13 (Pin edge detection)                   | ○        | -      | -      | -      | ○        | -      | -      | -      |
|                | INTCLM (PLL clock stop detection)             | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |
| 0016H          | INTST0/INTCSI00/INTIIC00 (SAU0 ch0 interrupt) | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |
| 0018H          | INTSR0/INTCSI01/INTIIC01 (SAU0 ch1 interrupt) | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |
| 001AH          | INTTRD0 (Timer RD0 interrupt)                 | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |
| 001CH          | INTTRD1 (Timer RD1 interrupt)                 | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |
| 001EH          | INTTRJ0 (Timer RJ0 interrupt)                 | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |
| 0020H          | INTRAM (RAM ECC detection)                    | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |
| 0022H          | INTLIN0TRM (LIN0 transmission)                | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |
| 0024H          | INTLIN0RVC (LIN0 reception)                   | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |
| 0026H          | INTLIN0STA/INTLIN0 (LIN0 interrupt)           | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |
| 0028H          | INTIICA0 (Multimaster I2C interrupt)          | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |
| 002AH          | INTP8 (Pin edge detection)                    | ○        | ○      | ○      | -      | ○        | ○      | ○      | -      |
|                | INTRTC (RTC interrupt)                        | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |
| 002CH          | INTTM00 (TAU0 ch0 interrupt)                  | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |
| 002EH          | INTTM01 (TAU0 ch1 interrupt)                  | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |
| 0030H          | INTTM02 (TAU0 ch2 interrupt)                  | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |
| 0032H          | INTTM03 (TAU0 ch3 interrupt)                  | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |
| 0034H          | INTAD (A/D interrupt)                         | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |
| 0036H          | INTP6 (Pin edge detection)                    | ○        | ○      | ○      | -      | ○        | ○      | ○      | -      |
|                | INTTM11H (TAU1 ch1 8-bit timer interrupt)     | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |
| 0038H          | INTP7 (Pin edge detection)                    | ○        | ○      | ○      | -      | ○        | ○      | ○      | -      |
|                | INTTM13H (TAU1 ch3 8-bit timer interrupt)     | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |
| 003AH          | INTP9 (Pin edge detection)                    | ○        | ○      | ○      | -      | ○        | ○      | ○      | -      |
|                | INTTM01H (TAU0 ch1 8-bit timer interrupt)     | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |
| 003CH          | INTP10 (Pin edge detection)                   | ○        | ○      | -      | -      | ○        | ○      | -      | -      |
|                | INTTM03H (TAU0 ch3 8-bit timer interrupt)     | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |
| 003EH          | INTST1/INTCSI10/INTIIC10 (SAU1 ch0 interrupt) | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |

Table 11-2. Interrupt Functions of RL78/F23, Compared with RL78/F13 (2/2)

| Vector Address | Interrupt Factor                                                  | RL78/F23 |        |        |        | RL78/F13 |        |        |        |
|----------------|-------------------------------------------------------------------|----------|--------|--------|--------|----------|--------|--------|--------|
|                |                                                                   | 80 QFP   | 64 QFP | 48 QFP | 32 QFN | 80 QFP   | 64 QFP | 48 QFP | 32 QFN |
| 0040H          | INTSR1 (SAU1 UART reception interrupt)                            | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |
|                | INTCSI11/INTIIC11 (SAU1 ch1 interrupt)                            | ○        | ○      | ○      | -      | ○        | ○      | ○      | -      |
| 0042H          | INTTM04 (TAU0 ch4 interrupt)                                      | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |
| 0044H          | INTTM05 (TAU0 ch5 interrupt)                                      | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |
| 0046H          | INTTM06 (TAU0 ch6 interrupt)                                      | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |
| 0048H          | INTTM07 (TAU0 ch7 interrupt)                                      | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |
| 004AH          | INTP11 (Pin edge detection)                                       | ○        | ○      | -      | -      | ○        | ○      | -      | -      |
|                | INTLIN0WUP (LIN0 wakeup interrupt)                                | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |
| 004CH          | INTKR (Key return function interrupt)                             | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |
|                | INTRCAN0RVC (CAN0 channel receive interrupt)                      | -        | -      | -      | -      | -        | -      | -      | -      |
| 004EH          | INTRCAN0ERR (CAN0 channel error interrupt)                        | -        | -      | -      | -      | -        | -      | -      | -      |
| 0050H          | INTRCAN0WUP (CAN0 wakeup interrupt)                               | -        | -      | -      | -      | -        | -      | -      | -      |
| 0052H          | INTRCAN0CFR (CAN0 transmit/ receive FIFO receive interrupt)       | -        | -      | -      | -      | -        | -      | -      | -      |
| 0054H          | INTRCAN0TRM (CAN0 channel transmit interrupt)                     | -        | -      | -      | -      | -        | -      | -      | -      |
| 0056H          | INTRCAN0RFR (CAN0 global receive FIFO interrupt)                  | -        | -      | -      | -      | -        | -      | -      | -      |
| 0058H          | INTRCANGERR (CAN0 global error interrupt)                         | -        | -      | -      | -      | -        | -      | -      | -      |
| 005AH          | INTTM10 (TAU1 ch0 interrupt)                                      | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |
| 005CH          | INTTM11 (TAU1 ch1 interrupt)                                      | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |
| 005EH          | INTTM12 (TAU1 ch2 interrupt)                                      | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |
| 0060H          | INTTM13 (TAU1 ch3 interrupt)                                      | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |
| 0062H          | Reserved                                                          | -        | -      | -      | -      | -        | -      | -      | -      |
| 0064H          | INTP12 (Pin edge detection)                                       | ○        | ○      | -      | -      | ○        | ○      | -      | -      |
|                | INTLIN1WUP (LIN1 wakeup interrupt)                                | -        | -      | -      | -      | -        | -      | -      | -      |
| 0066H          | INTLIN1TRM (LIN1 transmission interrupt)                          | -        | -      | -      | -      | -        | -      | -      | -      |
| 0068H          | INTLIN1RVC (LIN1 reception interrupt)                             | -        | -      | -      | -      | -        | -      | -      | -      |
| 006AH          | INTLIN1STA/INTLIN1 (LIN1 interrupt)                               | -        | -      | -      | -      | -        | -      | -      | -      |
| 006CH          | INTTM14 (TAU1 ch4 interrupt)                                      | -        | -      | -      | -      | -        | -      | -      | -      |
| 006EH          | INTTM15 (TAU1 ch5 interrupt)                                      | -        | -      | -      | -      | -        | -      | -      | -      |
| 0070H          | INTTM16 (TAU1 ch6 interrupt)                                      | -        | -      | -      | -      | -        | -      | -      | -      |
| 0072H          | INTTM17 (TAU1 ch7 interrupt)                                      | -        | -      | -      | -      | -        | -      | -      | -      |
| 0074H          | Reserved                                                          | -        | -      | -      | -      | -        | -      | -      | -      |
| 0076H          | Reserved                                                          | -        | -      | -      | -      | -        | -      | -      | -      |
| 0078H          | INTADGB (A/D (group-B) interrupt)                                 | ○        | ○      | ○      | ○      | -        | -      | -      | -      |
| 007AH          | INTGRAM (RAM for RS-CANFD lite ECC 1-bit / 2-bit error detection) | -        | -      | -      | -      | -        | -      | -      | -      |
| 007CH          | INTROM (Code Flash bit error detection)                           | ○        | ○      | ○      | ○      | -        | -      | -      | -      |
| 007EH          | BRK (BRK instruction interrupt)                                   | ○        | ○      | ○      | ○      | ○        | ○      | ○      | ○      |

**Key Points for Porting:****• Difference in interrupt functions**

RL78/F23, F24 products add some sources from RL78/F13, F14 products. With the addition of these functions, the related registers (IFxx, MKxx, and PRxx) have also been expanded. When using the additional interrupt, set the interrupt vector and the register related to that interrupt.



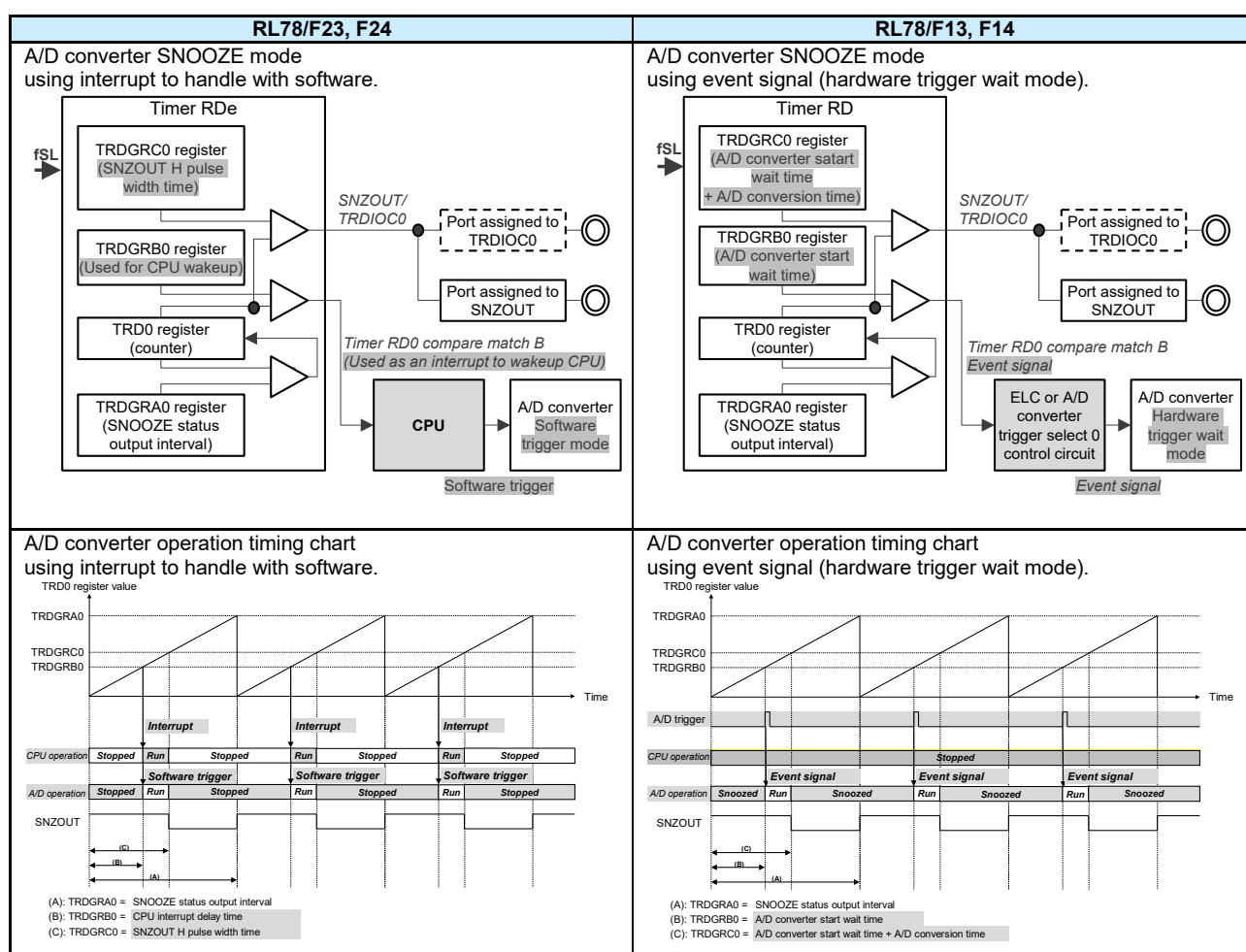
## 12. Standby Control

The table below shows the differences between RL78/F23, F24 products and RL78/F13, F14 products standby control.

**Table 12-1. Stand-by Functions of RL78/F23, F24, Compared with RL78/F13, F14**

| Item                    | RL78/F23, F24                                                              | RL78/F13, F14 |
|-------------------------|----------------------------------------------------------------------------|---------------|
| HALT mode               | Yes                                                                        | Yes           |
| STOP mode               | Yes                                                                        | Yes           |
| SNOOZE mode             |                                                                            |               |
| LIN/UART module (RLIN3) | Yes                                                                        | Yes           |
| A/D converter           | No<br>Use interrupt to handle with software<br>(refer to the figure below) | Yes           |
| DTC                     | Yes                                                                        | Yes           |

RL78/F23, F24 products do not support A/D converter in the SNOOZE mode. However, the same measures are possible as shown in the figure below.



**Figure 12-1. A/D Converter SNOOZE Mode of RL78/F23, F24, Compared with RL78/F13, F14**

### Key Points for Porting:

- A/D conversion in SNOOZE mode**

RL78/F23, F24 products do not support A/D conversion in the SNOOZE mode. Refer to the figure shown above when performing the same process as A/D conversion in SNOOZE mode on RL78/F23, F24 products.

### 13. Flash Memory

RL78/F13, F14 product used FSL (Flash Self Library) and FDL, EEL (Data Flash Library) to rewrite Flash Memory (Code/ Data Flash), but RL78/F23, F24 products use user software. The flash memory control software (RFD: Renesas Flash Drivers) will be provided in the same way as conventional products.

#### Key Points for Porting:

- **Flash memory rewriting**

The flash memory control software (RFD: Renesas Flash Drivers) is provided as source code.

### 14. Development Environment

The table below shows the differences between RL78/F23, F24 products and RL78/F13, F14 products software development environment.

**Table 14-1. Software Development Environment of RL78/F23, F24, Compared with RL78/F13, F14**

| Item                                          | RL78/F23, F24                      | RL78/F13, F14                               |
|-----------------------------------------------|------------------------------------|---------------------------------------------|
| Integrated Development Environment / Compiler | CS+, e <sup>2</sup> studio / CC-RL | CS+, e <sup>2</sup> studio / CC-RL, CA78K0R |
|                                               | Embedded Workbench / IAR Compiler  | Embedded Workbench / IAR Compiler           |
| Emulator                                      | E2, E2 Lite                        | IECUBE<br>E1, E2, E2 Lite                   |

## 15. Electrical Specifications

Comparisons of the electrical characteristics of RL78/F23, F24 and RL78/F13, F14 are shown below. For details, refer to the user's manual of the target product.

### 15.1 Supply Current Characteristics

Shown below is comparison of supply current consumptions in each operation mode between RL78/F24 and RL78/F14, and RL78/F23 and RL78/F13.

**Table 15-1. Supply Current Characteristics of RL78/F24, Compared with RL78/F14**

| Mode           | RL78/F24                                                                                  |                                                                                                                                                                                                    | RL78/F14                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|----------------|-------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                | Conditions                                                                                | Supply Current Specifications                                                                                                                                                                      | Conditions                                                                               | Supply Current Specifications                                                                                                                                                                                                                                                                                                                                                                                                             |
| Operation Mode | $f_{CLK} = 40 \text{ MHz}$ ,<br>$f_{PLL} = 80 \text{ MHz}$ ,<br>$f_{MX} = 20 \text{ MHz}$ | Grade-3: (TYP.) 10.6 mA, (MAX.) 20.0 mA<br>Grade-4: (TYP.) 10.6 mA, (MAX.) 20.0 mA<br>Grade-5: (TYP.) 10.6 mA, (MAX.) 21.0 mA                                                                      | $f_{CLK} = 32 \text{ MHz}$ ,<br>$f_{PLL} = 64 \text{ MHz}$ ,<br>$f_{MX} = 8 \text{ MHz}$ | L-grade: (TYP.) 6.4 mA, (MAX.) 14.0 mA                                                                                                                                                                                                                                                                                                                                                                                                    |
|                |                                                                                           |                                                                                                                                                                                                    | $f_{CLK} = 24 \text{ MHz}$ ,<br>$f_{PLL} = 48 \text{ MHz}$ ,<br>$f_{MX} = 8 \text{ MHz}$ | K-grade: (TYP.) 5.0 mA, (MAX.) 12.0 mA<br>Y-grade: (TYP.) 5.0 mA, (MAX.) 12.5 mA                                                                                                                                                                                                                                                                                                                                                          |
| HALT Mode      | $f_{CLK} = 40 \text{ MHz}$ ,<br>$f_{PLL} = 80 \text{ MHz}$ ,<br>$f_{MX} = 20 \text{ MHz}$ | Grade-3: (TYP.) 3.2 mA, (MAX.) 12.0 mA<br>Grade-4: (TYP.) 3.2 mA, (MAX.) 12.0 mA<br>Grade-5: (TYP.) 3.2 mA, (MAX.) 13.0 mA                                                                         | $f_{CLK} = 32 \text{ MHz}$ ,<br>$f_{PLL} = 64 \text{ MHz}$ ,<br>$f_{MX} = 8 \text{ MHz}$ | L-grade: (TYP.) 1.1 mA, (MAX.) 10.0 mA                                                                                                                                                                                                                                                                                                                                                                                                    |
|                |                                                                                           |                                                                                                                                                                                                    | $f_{CLK} = 24 \text{ MHz}$ ,<br>$f_{PLL} = 48 \text{ MHz}$ ,<br>$f_{MX} = 8 \text{ MHz}$ | K-grade: (TYP.) 0.9 mA, (MAX.) 8.0 mA<br>Y-grade: (TYP.) 0.9 mA, (MAX.) 8.5 mA                                                                                                                                                                                                                                                                                                                                                            |
| STOP Mode      | -                                                                                         | Grade-3: (TYP.) 0.6 $\mu\text{A}$ , (MAX.) 115.0 $\mu\text{A}$<br>Grade-4: (TYP.) 0.6 $\mu\text{A}$ , (MAX.) 270.0 $\mu\text{A}$<br>Grade-5: (TYP.) 0.6 $\mu\text{A}$ , (MAX.) 700.0 $\mu\text{A}$ | -                                                                                        | L-grade:<br>Group D: (TYP.) 0.5 $\mu\text{A}$ , (MAX.) 30.0 $\mu\text{A}$<br>Group E: (TYP.) 0.5 $\mu\text{A}$ , (MAX.) 50.0 $\mu\text{A}$<br>K-grade:<br>Group D: (TYP.) 0.5 $\mu\text{A}$ , (MAX.) 60.0 $\mu\text{A}$<br>Group E: (TYP.) 0.5 $\mu\text{A}$ , (MAX.) 100.0 $\mu\text{A}$<br>Y-grade:<br>Group D: (TYP.) 0.5 $\mu\text{A}$ , (MAX.) 150.0 $\mu\text{A}$<br>Group E: (TYP.) 0.5 $\mu\text{A}$ , (MAX.) 200.0 $\mu\text{A}$ |

**Remarks:** Group D products: RL78/F14 products with 30, 32, 48, 64, or 80 pins and products with 96 KB or less code flash memory.

Group E products: RL78/F14 products with 100 pins and products with 128 KB or more code flash memory.

**Table 15-2. Supply Current Characteristics of RL78/F23, Compared with RL78/F13**

| Mode           | RL78/F23                                                                                  |                                                                                                                                                                                                   | RL78/F13                                                                                 |                                                                                                                                                                                                  |
|----------------|-------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                | Conditions                                                                                | Supply Current Specifications                                                                                                                                                                     | Conditions                                                                               | Supply Current Specifications                                                                                                                                                                    |
| Operation Mode | $f_{CLK} = 40 \text{ MHz}$ ,<br>$f_{PLL} = 80 \text{ MHz}$ ,<br>$f_{MX} = 20 \text{ MHz}$ | Grade-3: (TYP.) 9.2 mA, (MAX.) 17.0 mA<br>Grade-4: (TYP.) 9.2 mA, (MAX.) 17.0 mA<br>Grade-5: (TYP.) 9.2 mA, (MAX.) 18.0 mA                                                                        | $f_{CLK} = 32 \text{ MHz}$ ,<br>$f_{PLL} = 64 \text{ MHz}$ ,<br>$f_{MX} = 8 \text{ MHz}$ | L-grade: (TYP.) 6.4 mA, (MAX.) 14.0 mA                                                                                                                                                           |
|                |                                                                                           |                                                                                                                                                                                                   | $f_{CLK} = 24 \text{ MHz}$ ,<br>$f_{PLL} = 48 \text{ MHz}$ ,<br>$f_{MX} = 8 \text{ MHz}$ | K-grade: (TYP.) 5.0 mA, (MAX.) 12.0 mA<br>Y-grade: (TYP.) 5.0 mA, (MAX.) 12.5 mA                                                                                                                 |
| HALT Mode      | $f_{CLK} = 40 \text{ MHz}$ ,<br>$f_{PLL} = 80 \text{ MHz}$ ,<br>$f_{MX} = 20 \text{ MHz}$ | Grade-3: (TYP.) 3.1 mA, (MAX.) 11.0 mA<br>Grade-4: (TYP.) 3.1 mA, (MAX.) 11.0 mA<br>Grade-5: (TYP.) 3.1 mA, (MAX.) 12.0 mA                                                                        | $f_{CLK} = 32 \text{ MHz}$ ,<br>$f_{PLL} = 64 \text{ MHz}$ ,<br>$f_{MX} = 8 \text{ MHz}$ | L-grade: (TYP.) 1.1 mA, (MAX.) 10.0 mA                                                                                                                                                           |
|                |                                                                                           |                                                                                                                                                                                                   | $f_{CLK} = 24 \text{ MHz}$ ,<br>$f_{PLL} = 48 \text{ MHz}$ ,<br>$f_{MX} = 8 \text{ MHz}$ | K-grade: (TYP.) 0.9 mA, (MAX.) 8.0 mA<br>Y-grade: (TYP.) 0.9 mA, (MAX.) 8.5 mA                                                                                                                   |
| STOP Mode      | -                                                                                         | Grade-3: (TYP.) 0.5 $\mu\text{A}$ , (MAX.) 51.0 $\mu\text{A}$<br>Grade-4: (TYP.) 0.5 $\mu\text{A}$ , (MAX.) 110.0 $\mu\text{A}$<br>Grade-5: (TYP.) 0.5 $\mu\text{A}$ , (MAX.) 300.0 $\mu\text{A}$ | -                                                                                        | L-grade: (TYP.) 0.5 $\mu\text{A}$ , (MAX.) 30.0 $\mu\text{A}$<br>K-grade: (TYP.) 0.5 $\mu\text{A}$ , (MAX.) 60.0 $\mu\text{A}$<br>Y-grade: (TYP.) 0.5 $\mu\text{A}$ , (MAX.) 150.0 $\mu\text{A}$ |

**Table 15-3. Operation Current Characteristics of RL78/F23, F24, Compared with RL78/F13, F14**

| Mode           | RL78/F23, F24                                                          |                                                                                  | RL78/F13, F14                        |                                                                                  |
|----------------|------------------------------------------------------------------------|----------------------------------------------------------------------------------|--------------------------------------|----------------------------------------------------------------------------------|
|                | Conditions                                                             | Supply Current Specifications                                                    | Conditions                           | Supply Current Specifications                                                    |
| Watchdog timer | $f_{WDT} = 15 \text{ kHz}$                                             | Grade-3, Grade-4, Grade-5:<br>(TYP.) $0.3 \mu\text{A}$                           | $f_{WDT} = 15 \text{ kHz}$           | L-grade, K-grade, Y-grade:<br>(TYP.) $0.22 \mu\text{A}$                          |
| A/D converter  | During conversion                                                      | Grade-3, Grade-4, Grade-5:<br>(TYP.) $1.3 \text{ mA}$ , (MAX.) $1.7 \text{ mA}$  | During conversion                    | L-grade, K-grade, Y-grade:<br>(TYP.) $1.3 \text{ mA}$ , (MAX.) $1.7 \text{ mA}$  |
|                | Added current<br>$AV_{REF} = V_{DD}$                                   | Grade-3, Grade-4, Grade-5:<br>(TYP.) $75.0 \mu\text{A}$                          | Added current<br>$AV_{REF} = V_{DD}$ | L-grade, K-grade, Y-grade:<br>(TYP.) $75.0 \mu\text{A}$                          |
|                | Added current<br>$AV_{REF} = AV_{REFP}$ ,<br>$AV_{REFP} = 5.0\text{V}$ | Grade-3, Grade-4, Grade-5:<br>(TYP.) $65.0 \mu\text{A}$                          | -                                    | -                                                                                |
|                | Added current<br>Sample-and-hold<br>circuit operation                  | Grade-3, Grade-4, Grade-5:<br>(TYP.) $0.8 \text{ mA}$ , (MAX.) $1.2 \text{ mA}$  | -                                    | -                                                                                |
| LVD operation  | -                                                                      | Grade-3, Grade-4, Grade-5:<br>(TYP.) $0.08 \mu\text{A}$                          | -                                    | L-grade, K-grade, Y-grade:<br>(TYP.) $0.08 \mu\text{A}$                          |
| D/A converter  | -                                                                      | Grade-3, Grade-4, Grade-5:<br>(TYP.) $0.8 \text{ mA}$ , (MAX.) $1.5 \text{ mA}$  | -                                    | L-grade, K-grade, Y-grade:<br>(TYP.) $0.8 \text{ mA}$ , (MAX.) $1.5 \text{ mA}$  |
| Comparator     | -                                                                      | Grade-3, Grade-4, Grade-5:<br>(TYP.) $50.0 \mu\text{A}$                          | -                                    | L-grade, K-grade, Y-grade:<br>(TYP.) $50.0 \mu\text{A}$                          |
| BGO operation  | -                                                                      | Grade-3, Grade-4, Grade-5:<br>(TYP.) $2.5 \text{ mA}$ , (MAX.) $12.2 \text{ mA}$ | -                                    | L-grade, K-grade, Y-grade:<br>(TYP.) $2.5 \text{ mA}$ , (MAX.) $12.2 \text{ mA}$ |

**Key Points for Porting:**

- **Supply current characteristics**

Please design the power supply of the target system according to the power supply current specifications of the product to be used.

## 15.2 Pin Current Characteristics

Shown below is comparison of pin current characteristics in each parameter of RL78/F23, F24 and RL78/F13, F14.

**Table 15-4. Pin Current Characteristics of RL78/F23, F24, Compared with RL78/F13, F14**

| Mode                            | RL78/F23, F24                 |                                                                                                                                                                                                                   | RL78/F13, F14                 |                                                                                                                                                                                                                   |
|---------------------------------|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                 | Conditions                    | Pin Current Specifications                                                                                                                                                                                        | Conditions                    | Pin Current Specifications                                                                                                                                                                                        |
| Pin output current: High (IOH1) | $4.0V \leq EV_{DD} \leq 5.5V$ | Grade-3:<br>(MAX.) -5.0 mA / pin<br>(MAX.) -50.0 mA / total of pins<br>Grade-4:<br>(MAX.) -5.0 mA / pin<br>(MAX.) -42.0 mA / total of pins<br>Grade-5:<br>(MAX.) -5.0 mA / pin<br>(MAX.) -32.0 mA / total of pins | $4.0V \leq EV_{DD} \leq 5.5V$ | L-grade:<br>(MAX.) -5.0 mA / pin<br>(MAX.) -50.0 mA / total of pins<br>K-grade:<br>(MAX.) -5.0 mA / pin<br>(MAX.) -42.0 mA / total of pins<br>Y-grade:<br>(MAX.) -5.0 mA / pin<br>(MAX.) -32.0 mA / total of pins |
|                                 | $2.7V \leq EV_{DD} < 4.0V$    | Grade-3, Grade-4, Grade-5:<br>(MAX.) -3.0 mA / pin<br>(MAX.) -29.0 mA / total of pins                                                                                                                             | $2.7V \leq EV_{DD} < 4.0V$    | L-grade, K-grade, Y-grade:<br>(MAX.) -3.0 mA / pin<br>(MAX.) -29.0 mA / total of pins                                                                                                                             |
| Pin output current: Low (IOL1)  | $4.0V \leq EV_{DD} \leq 5.5V$ | Grade-3, Grade-4:<br>(MAX.) 8.5 mA / pin<br>(MAX.) 65.0 mA / total of pins<br>Grade-5:<br>(MAX.) 8.5 mA / pin<br>(MAX.) 55.0 mA / total of pins                                                                   | $4.0V \leq EV_{DD} \leq 5.5V$ | L-grade, K-grade:<br>(MAX.) 8.5 mA / pin<br>(MAX.) 65.0 mA / total of pins<br>Y-grade:<br>(MAX.) 8.5 mA / pin<br>(MAX.) 55.0 mA / total of pins                                                                   |
|                                 | $2.7V \leq EV_{DD} < 4.0V$    | Grade-3, Grade-4:<br>(MAX.) 4.0 mA / pin<br>(MAX.) 50.0 mA / total of pins<br>Grade-5:<br>(MAX.) 4.0 mA / pin<br>(MAX.) 45.0 mA / total of pins                                                                   | $2.7V \leq EV_{DD} < 4.0V$    | L-grade, K-grade:<br>(MAX.) 4.0 mA / pin<br>(MAX.) 50.0 mA / total of pins<br>Y-grade:<br>(MAX.) 4.0 mA / pin<br>(MAX.) 45.0 mA / total of pins                                                                   |
| Pin output current: High (IOH2) | $2.7V \leq V_{DD} \leq 5.5V$  | Grade-3, Grade-4, Grade-5:<br>(MAX.) -0.1 mA / pin<br>(MAX.) -2.0 mA / total of pins                                                                                                                              | $2.7V \leq V_{DD} \leq 5.5V$  | L-grade, K-grade, Y-grade:<br>(MAX.) -0.1 mA / pin<br>(MAX.) -2.0 mA / total of pins                                                                                                                              |
| Pin output current: Low (IOL2)  | $2.7V \leq V_{DD} \leq 5.5V$  | Grade-3, Grade-4, Grade-5:<br>(MAX.) 0.4 mA / pin<br>(MAX.) 5.0 mA / total of pins                                                                                                                                | $2.7V \leq V_{DD} \leq 5.5V$  | L-grade, K-grade, Y-grade:<br>(MAX.) 0.4 mA / pin<br>(MAX.) 5.0 mA / total of pins                                                                                                                                |

### Key Points for Porting:

- Pin current characteristics

Pin specifications vary depending on the pin block of the product. Please refer the user's manual for details.

## 16. Appendix

### 16.1 SFR Comparison between RL78/F23, F24 Products and RL78/F13, F14 Products

This section shows SFR (Special Function Registers) comparison between RL78/F23, F24 products and RL78/F13, F14 products. For details on each register and bit, refer to the User's Manual: Hardware.

References to item in the Table 16-2 and Table 16-3, refer to chapters in the RL78/F23, F24 User's Manual: Hardware. Also, refer to "RL78/F23, F24 List of Special Function Registers (R01AN6253)" for a list by product.

This table does not show differences in operating clocks or electrical characteristics. See the User's Manual: Hardware for details on these.

**Table 16-1. SFRs Newly Added in RL78/F23, F24 Products**

| Newly Added Features                                                                                                                  | Added SFR                                                                                                                                                                                                                                                                                                                                                                         |
|---------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| RAM start addresses setting function                                                                                                  | RAMSAR (F0076H)<br>Changed bit specifications for GRAM[1:0] of the IAWCTL register.                                                                                                                                                                                                                                                                                               |
| Port function<br>Analog I/O selection<br>Expanded peripheral function pin assignment                                                  | PMC3 (F0063H),<br>PMC8, PMC9 (bits 0 to 5), PMC10 (F0068H, F0069H, F006AH)<br>PIOR9 (F001FH),<br>Added bits PITHL4.1, PITHL12.0, and POM3.2.                                                                                                                                                                                                                                      |
| Clock generator<br>HOCO (supports 40/80 MHz)<br>PLL (supports 40/80 MHz)                                                              | HOCODIV (bits 0 to 2) (F00A8H)<br>CKSEL (bits 5 to 7) (F02C4H),<br>PLLCTL (bits 1, 3, 5 to 7) (F02C5H)                                                                                                                                                                                                                                                                            |
| Flash memory control                                                                                                                  | FLPMC, ..., FLWH (F00C0H to F00CFH),<br>FLSEC, ..., FLWE (FFF0H to FFFC6H)                                                                                                                                                                                                                                                                                                        |
| Timer RDe<br>Added modes (Extended PWM mode, Extended complementary PWM mode)<br>Added function (PWMOPA, TRDMBK)                      | TRDCMPD0, ..., TRDDGCR1 (FFF60H to FFF6FH),<br>TRDCMPB0, ..., TRDEMR1 (F0280H to F029BH)<br>OPCTL0, ..., OPSR (F0248H to F024CH),<br>TRDMBKCTL, TRDMBKCOMP (F024EH, F024FH),<br>Added bits EPWM and CPSS of the TRDFCR register.<br>Added the UDS bit of the TRDSR1 register.<br>Added the PWMOPEN bit of the PER1 register.                                                      |
| 12-bit A/D Converter                                                                                                                  | ADDR0M, ..., ADDR7M (F06A0H to F06AFH),<br>ADC window registers (F06B0H to F06BFH),<br>ADWINR (FFF30H),<br>ADCKS (F00E0H),<br>Added bit specification for GCSC bit of the IAWCTL register.                                                                                                                                                                                        |
| CAN interface (RS-CANFD lite)                                                                                                         | C0NCFG, ..., C0FDCRCH (F0300H to F0413H),<br>CAN0 window registers (F0420H to F067FH)                                                                                                                                                                                                                                                                                             |
| LIN/UART module (RLIN3)<br>Added function (Break/Sync field detection, Dominant level detection in response space)                    | LBSS0/1, LRSS0/1 (F06ECH, F06EEH)                                                                                                                                                                                                                                                                                                                                                 |
| Application Accelerator Unit (AAU)                                                                                                    | AAU window registers (F02B0H to F02BFH),<br>AAUWINR (FFF32H),<br>Added the AAUEN bit of the PER2 register                                                                                                                                                                                                                                                                         |
| Event Link Controller (ELC)<br>Added PWMOPA (PWM output cutoff) as a link destination function                                        | ELSELR00 to ELSELR25 (F0780H to F0799H)                                                                                                                                                                                                                                                                                                                                           |
| Functional Safety<br>• Code flash memory ECC function<br>• CAN RAM ECC function<br>• Clock monitor (test function)                    | • CFERRCTL, ..., ERRADRH (F00B8H to F00BDH)<br>• CFDECTL, ..., CFDECEAD (F07C0H to F07D1H)<br>• CLMTES (F02CCH)                                                                                                                                                                                                                                                                   |
| Interrupt function<br>Added interruption (Code flash ECC function, CAN RAM ECC function, 12-bit ADC function, RS-CANFD lite function) | IF3H, MK3H, PR03H, PR13H (FFFD3H, FFFD6H, FFFDBH, FFFDFH)<br>Added bits of INTRCANGRCV to registers IF2L, MK2L, PR02L, and PR12L.<br>Changed the bit names of INTRCAN0ERR, INTRCAN0WUP, INTRCAN0CFR, INTRCAN0TRM, INTRCANGRR, and INTRCANGERR (registers IF2L, IF2H, MK2L, MK2H, PR02L, PR02H, PR12L, and PR12H).<br>Added bit specification for GINT bit of the IAWCTL register. |
| Security function                                                                                                                     | <b>Note.</b> A contract is required for the details of security function.                                                                                                                                                                                                                                                                                                         |

Table 16-2. List of SFR Differences Between RL78/F23, F24 and RL78/F13, F14

| Address         | RL78/F23, F24 SFR                                                      | Difference from RL78/F13, F14 product                                                                                                                                                                                                                                                        | References       |
|-----------------|------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| FFF00H – FFF0FH | Port related registers (P0 to P15)                                     | No difference                                                                                                                                                                                                                                                                                | 4.3              |
| FFF10H – FFF13H | SAU0 related registers (SDR00, SDR01)                                  | No difference                                                                                                                                                                                                                                                                                | 15.2             |
| FFF18H – FFF1BH | TAU0 related registers (TDR00, TDR01)                                  | No difference                                                                                                                                                                                                                                                                                | 6.2              |
| FFF1EH, FFF1FH  | –                                                                      | (Deleted the ADCR register.)                                                                                                                                                                                                                                                                 | –                |
| FFF20H – FFF2FH | Port related registers (PM0 to PM15)                                   | No difference                                                                                                                                                                                                                                                                                | 4.3              |
| FFF30H          | ADC related register ( <b>ADWINR</b> )                                 | <b>New</b> , (Deleted the ADM0 register.)                                                                                                                                                                                                                                                    | 12.2             |
| FFF31H          | –                                                                      | (Deleted the ADS register.)                                                                                                                                                                                                                                                                  | –                |
| FFF32H          | AAU related register ( <b>AAUWINR</b> )                                | <b>New</b> , (Deleted the ADM1 register.)                                                                                                                                                                                                                                                    | 27.2             |
| FFF34H, FFF36H  | DAC related registers (DACS0, DAM)                                     | No difference                                                                                                                                                                                                                                                                                | 13.3             |
| FFF37H          | Key return related register (KRM)                                      | No difference                                                                                                                                                                                                                                                                                | 22.3             |
| FFF38H – FFF3BH | External interrupt pin related registers (EGP0, EGN0, EGP1, EGN1)      | No difference                                                                                                                                                                                                                                                                                | 21.3             |
| FFF48H – FFF4BH | SAU1 related registers (SDR10, SDR11)                                  | No difference                                                                                                                                                                                                                                                                                | 15.2             |
| FFF50H – FFF52H | IICA0 related registers (IICA0, IICS0, IICF0)                          | No difference                                                                                                                                                                                                                                                                                | 16.2<br>16.3     |
| FFF54H, FFF55H  | RTC related register (SUBCUDW)                                         | No difference                                                                                                                                                                                                                                                                                | 9.3              |
| FFF58H – FFF5FH | Timer RDe related registers (TRDGRC0, TRDGRD0, TRDGRC1, TRDGRD1)       | No difference (Timer RD registers). Each register has additional specifications for extended PWM mode and extended complementary PWM mode.                                                                                                                                                   | 8.2              |
| FFF60H – FFF6FH | Timer RDe related registers ( <b>TRDCMPD0</b> , ..., <b>TRDDGCR1</b> ) | <b>New</b> , (Moved TAU0 related registers (TDR02 to TDR07).)                                                                                                                                                                                                                                | 8.2              |
| FFF70H – FFF73H | –                                                                      | (Moved TAU1 related registers (TDR10, TDR11).)                                                                                                                                                                                                                                               | –                |
| FFF74H – FFF7FH | TAU0 related registers (TDR02 to TDR07)                                | (Moved TAU1 related registers (TDR12 to TDR17).)                                                                                                                                                                                                                                             | 6.2              |
| FFF80H – FFF8FH | TAU1 related registers (TDR10 to TDR17)                                | (No register in these addresses.)                                                                                                                                                                                                                                                            | 6.2              |
| FFF92H – FFF9EH | RTC related registers (SEC, ..., RTCC1)                                | No difference                                                                                                                                                                                                                                                                                | 9.3              |
| FFFA0H – FFFA4H | OSC related registers (CMC, ..., CKC)                                  | No difference                                                                                                                                                                                                                                                                                | 5.3              |
| FFFA5H          | Clock/Buzzer output related register (CKS0)                            | No difference                                                                                                                                                                                                                                                                                | 10.3             |
| FFFA8H          | RESET related register (RESF)                                          | No difference                                                                                                                                                                                                                                                                                | 24.1             |
| FFFA9H, FFFAAH  | LVD related registers (LVIM, LVIS)                                     | No difference                                                                                                                                                                                                                                                                                | 26.3             |
| FFFABH          | WWDT related register (WDTE)                                           | No difference                                                                                                                                                                                                                                                                                | 11.3             |
| FFFACH          | General purpose CRC related register (CRCIN)                           | No difference                                                                                                                                                                                                                                                                                | 28.3.2           |
| FFFB0H – FFFC6H | Flash memory related registers ( <b>FLSEC</b> , ..., <b>FLWE</b> )     | <b>New</b>                                                                                                                                                                                                                                                                                   | 28.3.5<br>32.7.2 |
| FFFD0H – FFFE7H | Interrupt related registers (IF2L, ..., PR11H)                         | Added registers <b>IF3H</b> , <b>MK3H</b> , <b>PR03H</b> , and <b>PR13H</b> .<br>Added bits related to <b>INTRCANGRVC</b> (IF2L, MK2L, PR02L, and PR12L).<br>Changed bit names related to INTRCAN0ERR, INTRCAN0WUP, INTRCAN0CFR, INTRCAN0TRM, INTRCANGRFR, and INTRCANGERR of RS-CANFD lite. | 21.3             |
| FFFF0H – FFFF3H | MAC instruction related registers (MACRL, MACRH)                       | No difference                                                                                                                                                                                                                                                                                | 35.1.5           |
| FFFFEH          | Processor related register (PMC)                                       | No difference                                                                                                                                                                                                                                                                                | 3.5              |

**Table 16-3. List of 2nd SFR Differences Between RL78/F23, F24 and RL78/F13, F14 (1/2)**

| Address         | RL78/F23, F24 SFR                                                           | Difference from RL78/F13, F14 product                                                                       | References          |
|-----------------|-----------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------|---------------------|
| F0010H – F0013H | –                                                                           | (Deleted ADC related registers (ADM2, ADUL, ADLL, ADTES).)                                                  | –                   |
| F0016H – F001EH | Port related registers (PIOR0 to PIOR8)                                     | No difference                                                                                               | 4.3                 |
| F001FH          | Port related register ( <b>PIOR9</b> )                                      | <b>New</b>                                                                                                  | 4.3                 |
| F0021H – F002FH | Port related registers (PITHL1, ..., PITHL15)                               | Added <b>PITHL4.1</b> and <b>PITHL12.0</b> bits.                                                            | 4.3                 |
| F0030H – F003FH | Port related registers (PU0, ..., PU15)                                     | (Deleted the PU9 register.)                                                                                 | 4.3                 |
| F0041H – F004CH | Port related registers (PIM1, ..., PIM12)                                   | No difference                                                                                               | 4.3                 |
| F0051H – F005CH | Port related registers (POM1, ..., POM12)                                   | Added the <b>POM3.2</b> bit.                                                                                | 4.3                 |
| F0063H – F006CH | Port related registers (PMC3, ..., PMC12)                                   | Added registers <b>PMC3</b> , <b>PMC8</b> and <b>PMC10</b> .<br>Added bits <b>PMC9.0</b> to <b>PMC9.5</b> . | 4.3                 |
| F0070H – F0072H | Noise filter registers (NFEN0, NFEN1, NFEN2)                                | No difference                                                                                               | 15.3<br>6.3         |
| F0073H – F0075H | Input signals select registers (ISC, TIS0, TIS1)                            | No difference                                                                                               | 15.3<br>17.2<br>6.3 |
| F0076H          | RAM address selects register ( <b>RAMSAR</b> )                              | <b>New</b>                                                                                                  | 3.5                 |
| F0077H          | Port related register (PMS)                                                 | No difference                                                                                               | 4.3                 |
| F0078H          | Safety functions related register (IAWCTL)                                  | Changed bit specifications for <b>GRAM[1:0]</b> , <b>GPORT</b> , <b>GINT</b> , and <b>GCSC</b> bits.        | 3.5<br>28.3.8       |
| F0079H          | Interrupt related register (INTFLG0)                                        | No difference                                                                                               | 21.3                |
| F007AH          | Input signals select register (TIS2)                                        | No difference                                                                                               | 6.3<br>9.3          |
| F007BH          | RLIN3 related register (LCHSEL)                                             | No difference                                                                                               | 17.2                |
| F007CH          | Interrupt related register (INTMSK)                                         | No difference                                                                                               | 21.3                |
| F0090H          | Data flash memory related register (DFLCTL)                                 | No difference                                                                                               | 32.7.2              |
| F00A0H          | HOCO related register (HIOTRM)                                              | No difference                                                                                               | 5.3                 |
| F00A8H          | HOCO related register (HOCODIV)                                             | Changed bit specifications for <b>HOCODIV[2:0]</b> bits.                                                    | 5.3                 |
| F00B8H – F00BDH | Code flash ECC related registers ( <b>CFERRCTLR</b> , ..., <b>ERRADRH</b> ) | <b>New</b>                                                                                                  | 28.3.5              |
| F00C0H – F00CFH | Flash memory related registers ( <b>FLPMC</b> , ..., <b>FLWH</b> )          | <b>New</b>                                                                                                  | 28.3.5<br>32.7.2    |
| F00D8H – F00DDH | Stack pointer monitor related registers (SPMCTRL, SPOFR, SPUFR)             | No difference                                                                                               | 28.3.6              |
| F00E0H          | ADC related register ( <b>ADCKS</b> )                                       | <b>New</b>                                                                                                  | 12.2                |
| F00F0H, F00F3H  | Clock related register (PER0, OSMC)                                         | No difference                                                                                               | 5.3                 |
| F00FEH          | BCD related register (BCDADJ)                                               | No difference                                                                                               | 34.2                |
| F0100H – F0123H | SAU0 related registers (SSR00, ..., SSE0)                                   | No difference                                                                                               | 15.3                |
| F0140H – F0163H | SAU1 related registers (SSR10, ..., SSE1)                                   | No difference                                                                                               | 15.3                |
| F0180H – F01BFH | TAU0 related registers (TCR00, ..., TOM0)                                   | No difference                                                                                               | 6.2<br>6.3          |
| F01C0H – F01FFH | TAU1 related registers (TCR10, ..., TOM1)                                   | No difference                                                                                               | 6.2<br>6.3          |
| F0200H – F0207H | RAM ECC related registers (ERADR, ..., ECCDWRVR)                            | No difference                                                                                               | 28.3.3              |
| F0220H          | Port related register (PSRSEL)                                              | No difference                                                                                               | 4.3                 |
| F0222H – F0225H | SNOOZE status registers (PSNZCNT0 to PSNZCNT3)                              | No difference                                                                                               | 4.3                 |
| F0227H          | DAC related register (DAM2)                                                 | No difference                                                                                               | 13.3                |



**Table 16-3. List of 2nd SFR Differences Between RL78/F23, F24 and RL78/F13, F14 (2/2)**

| Address         | RL78/F23, F24 SFR                                                        | Difference from RL78/F13, F14 product                                                                                                                                                                                                                                                               | References   |
|-----------------|--------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| F0228H – F022DH | PWM delay control registers (PWMDLY0, PWMDLY1, PWMDLY2)                  | No difference                                                                                                                                                                                                                                                                                       | 6.3<br>8.2   |
| F0230H – F0234H | IICA0 related registers (IICCTL00, ..., SVA0)                            | No difference                                                                                                                                                                                                                                                                                       | 16.2<br>16.3 |
| F0240H – F0243H | Timer RJ0 related registers (TRJCR0, ..., TRJISR0)                       | No difference                                                                                                                                                                                                                                                                                       | 7.3          |
| F0248H – F024CH | PWMOPA related registers ( <b>OPCTL0</b> , ..., <b>OPSR</b> )            | <b>New</b>                                                                                                                                                                                                                                                                                          | 8.6.2        |
| F024EH, F024FH  | TRDMBK related registers ( <b>TRDMBKCTL</b> , <b>TRDMBKCOMP</b> )        | <b>New</b>                                                                                                                                                                                                                                                                                          | 8.7.2        |
| F0250H – F027BH | Timer RDe related registers (TRDEL0, ..., TRDGRB1)                       | (Timer RD related registers moved from address (F0260H to F028BH).)<br>Added bits <b>EPWM</b> and <b>CPSS</b> of the TRDFCR register.<br>Added the <b>UDS</b> bit of the TRDSR1 register.<br>Each register has additional specifications for extended PWM mode and extended complementary PWM mode. | 8.2          |
| F0280H – F029BH | Timer RDe related registers ( <b>TRDCMPB0</b> , ..., <b>TRDEMR1</b> )    | <b>New</b>                                                                                                                                                                                                                                                                                          | 8.2          |
| F02A0H – F02A2H | Comparator related registers (CMPCTL, CMPSEL, CMPMON)                    | No difference (Different pin assignments)                                                                                                                                                                                                                                                           | 14.2         |
| F02B0H – F02BFH | <b>AAU related registers</b>                                             | <b>New</b>                                                                                                                                                                                                                                                                                          | 27.2         |
| F02C0H          | Clock related register (PER1)                                            | Added the <b>PWMOPEN</b> bit.                                                                                                                                                                                                                                                                       | 5.3          |
| F02C1H          | Clock related register (PER2)                                            | Added the <b>AAUEN</b> bit.                                                                                                                                                                                                                                                                         | 5.3          |
| F02C2H, F02C3H  | Clock related register (CANCKSEL, LINCKSEL)                              | No difference                                                                                                                                                                                                                                                                                       | 5.3          |
| F02C4H          | Clock related register (CKSEL)                                           | Added bits <b>FPLLDIV</b> and <b>FMAINDIV[1:0]</b> .                                                                                                                                                                                                                                                | 5.3          |
| F02C5H          | Clock related register (PLLCTL)                                          | Changed bit specifications for <b>LCKSEL[1:0]</b> , <b>PLLDIV1</b> , and <b>PLLMUL</b> bits.<br>Added the <b>PLLMULA</b> bit.                                                                                                                                                                       | 5.3          |
| F02C6H, F02C7H  | Clock related registers (PLLSTS, MDIV)                                   | No difference                                                                                                                                                                                                                                                                                       | 5.3          |
| F02C8H          | RTC related register (RTCCL)                                             | No difference                                                                                                                                                                                                                                                                                       | 9.3          |
| F02C9H          | RESET related register (POCRES)                                          | No difference                                                                                                                                                                                                                                                                                       | 24.1         |
| F02CAH          | STOP status related register (STPSTC)                                    | No difference                                                                                                                                                                                                                                                                                       | 23.2         |
| F02CCH          | Clock monitor related register ( <b>CLMTES</b> )                         | <b>New</b>                                                                                                                                                                                                                                                                                          | 28.3.7       |
| F02D0H – F02EDH | DTC related registers (HDTCCR0, ..., DTCEN5)                             | No difference                                                                                                                                                                                                                                                                                       | 19.2         |
| F02F0H – F02F3H | Flash memory CRC related registers (CRC0CTL, PGCRCCL)                    | No difference                                                                                                                                                                                                                                                                                       | 28.3.1       |
| F02F9H – F02FBH | General purpose CRC related registers (CRCMD, CRCD)                      | No difference                                                                                                                                                                                                                                                                                       | 28.3.2       |
| F0300H – F067FH | <b>RS-CANFD lite related registers</b>                                   | <b>New</b> , (Changed from RS-CAN lite SFRs (address: F0300H to F0681H).)                                                                                                                                                                                                                           | 18.3         |
| F06A0H – F06BFH | <b>12-bit ADC related registers</b>                                      | <b>New</b>                                                                                                                                                                                                                                                                                          | 12.2         |
| F06C1H – F06E9H | RLIN3 related registers (LWBR0/1, ..., LUWTDRO/1)                        | No difference                                                                                                                                                                                                                                                                                       | 17.2         |
| F06ECH, F06EEH  | RLIN3 related register ( <b>LBSS0/1</b> , <b>LRSS0/1</b> )               | <b>New</b>                                                                                                                                                                                                                                                                                          | 17.2.2       |
| F06F0H, F06F1H  | Timer RJ0 related register (TRJ0)                                        | No difference                                                                                                                                                                                                                                                                                       | 7.3          |
| F0780H – F0799H | ELC related registers (ELSELR00 to ELSELR25)                             | Added bit specifications of <b>ELSELRn[3:0]</b> bits.                                                                                                                                                                                                                                               | 20.2         |
| F07C0H – F07D1H | CAN RAM ECC related registers ( <b>CFDECCTL</b> , ..., <b>CFDECEAD</b> ) | <b>New</b>                                                                                                                                                                                                                                                                                          | 28.3.4       |

## 17. References

Documents referenced in this application note are shown below. When referring to these documents, make sure to obtain the latest version of each document from Renesas Electronics website.

- RL78/ F23, F24 User's Manual: Hardware Rev. 1.00
- RL78/ F13, F14 User's Manual: Hardware Rev. 2.10
- RL78 Family User's Manual: Software Rev. 2.30

**Revision History**

| Rev. | Date       | Description |                                                                                                                     |
|------|------------|-------------|---------------------------------------------------------------------------------------------------------------------|
|      |            | Page        | Summary                                                                                                             |
| 0.50 | 2022.02.15 | -           | Provisional edition issued.                                                                                         |
| 1.00 | 2022.09.30 |             | First edition issued.                                                                                               |
|      |            | P.16        | Revised key points of porting for the mirror area.                                                                  |
|      |            | P.23        | Revised key points of porting for the CAN-FD.                                                                       |
|      |            | P.27        | Revised tables (10-1 and 10-2) for the ELC.                                                                         |
|      |            | P.35-37     | Added new tables (15-1 to 15-4) for the electrical specifications.                                                  |
| 1.10 | 2023. 7.30 | P.38-41     | Added the description of "SFR comparison between RL78/F23, F24 products and RL78/F13, F14 products" as an appendix. |
|      |            |             |                                                                                                                     |

# 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. Precaution against Electrostatic Discharge (ESD)

A strong electrical field, when exposed to a CMOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop the generation of static electricity as much as possible, and quickly dissipate it when it occurs. Environmental control must be adequate. When it is dry, a humidifier should be used. This is recommended to avoid using insulators that can easily build up static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors must be grounded. The operator must also be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions must be taken for printed circuit boards with mounted semiconductor devices.

## 2. Processing at power-on

The state of the product is undefined at the time 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 time 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 time 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 time when power is supplied until the power reaches the level at which resetting is specified.

## 3. Input of signal during power-off state

Do not input signals or an I/O pull-up power supply while the device is powered off. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements. Follow the guideline for input signal during power-off state as described in your product documentation.

## 4. 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 the 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.

## 5. Clock signals

After applying a reset, only release the reset line after the operating clock signal becomes stable. When switching the clock signal during program execution, wait until the target clock signal is 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. Additionally, 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.

## 6. Voltage application waveform at input pin

Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between  $V_{IL}$  (Max.) and  $V_{IH}$  (Min.) due to noise, for example, the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between  $V_{IL}$  (Max.) and  $V_{IH}$  (Min.).

## 7. Prohibition of access to reserved addresses

Access to reserved addresses is prohibited. The reserved addresses are provided for possible future expansion of functions. Do not access these addresses as the correct operation of the LSI is not guaranteed.

## 8. Differences between products

Before changing from one product to another, for example to a product with a different part number, confirm that the change will not lead to problems. The characteristics of a microprocessing unit or microcontroller unit products in the same group but having a different part number might differ in terms of 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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