RL78 Family

MCU Diff Guide for using the IEC60730/60335 Self Test Library

Introduction

The IEC60730/60335 safety standards self test library for RL78 (See the separate application note (R01AN4819)) was created to enable verification of complicity of Renesas RL78 MCUs with the software classes defined in Annex H of the IEC 60730/60335 Class-B standard for functional safety.

Although the self test library has been certified by the VDE Testing and Certification Institute, you need to change the program depending on the MCU and product specifications you want to use.

Therefore, the self test library program is provided as a sample program.

This application note guides the differences in the self test library based on the MCU used.

Target Device

RL78/G13, RL78/G14, RL78/G16, RL78/G22, RL78/G23

Contents

1. Library Functions Based on MCU Variations

The functions used for the self test and the corresponding MCUs are as follows.

Table 1-1 Function Comparison Table (1/2)

Cat.	Function	RL78/G14*	RL78/G13	RL78/G16	RL78/G22	RL78/G23
CPU Register Tests						
	stl_RL78_registertest Tests the AX, HL, DE, and BC registers.	No differences	No differences	No differences	No differences	No differences
	stl_RL78_registertest_psw Tests the PSW register.	No differences	No differences	No differences	No differences	No differences
	stl_RL78_registertest_stack Tests the SP register.	No differences	No differences	No differences	No differences	No differences
	stl_RL78_registertest_cs Tests the CS register.	No differences	No differences	No differences	No differences	No differences
	stl_RL78_registertest_es Tests the ES register.	No differences	No differences	No differences	No differences	No differences
	stl_RL78_registertest_pc Tests the PC register.	No differences	No differences	No differences	No differences	No differences
Software CRC						
	stl_RL78_sw_crc_asm Calculates a CRC value by using software.	No differences	No differences	No differences	No differences	No differences
Hardware CRC						
	stl_RL78_peripheral_crc Calculates a CRC value by using hardware.	No differences	No differences	No differences	No differences	No differences
Variable Memory Test						
	stl_RL78_march_c Tests the RAM by using the March C algorithm.	No differences	No differences	No differences	No differences	No differences
	stl_RL78_march_x Tests the RAM by using the March X algorithm.	No differences	No differences	No differences	No differences	No differences
	stl_RL78_march_c_initial Tests the RAM by using the March C algorithm before the system is initialized.	No differences	No differences	No differences	No differences	No differences
	stl_RL78_march_x_initial Tests the RAM by using the March X algorithm before the system is initialized.	No differences	No differences	No differences	No differences	No differences
	stl_RL78_RamTest_Stacks_c Stack area test (March C).	No differences	No differences	No differences	No differences	No differences
	stl_RL78_RamTest_Stacks_x Stack area test (March X).	No differences	No differences	No differences	No differences	No differences
Testing of the System Clock Verification						
	stl_RL78_hw_clocktest Tests the system clock by using the timer.	TAU0 channel 1	TAU0 channel 5	TAU0 channel 5	TAU0 channel 5	TAU0 channel 5
	stl_RL78_sw_clocktest Tests the clock by measuring a change on the test pin.	No differences	No differences	No differences	No differences	No differences

∗Note: The target microcontroller for the accompanying test harness code.

Table 1-2 Function Comparison Table (2/2)

Cat.	Function	RL78/G14*	RL78/G13	RL78/G16	RL78/G22	RL78/G23
Testing of the A/D converter						
	stl_ADC_Create Initialize ADC.	No differences	No differences	Registers ADM1,ADUL ADLL not present	No differences	No differences
	stl_ADC_Check_TestVoltage Checks that the AD conversion circuit is operating normally.	Selectable reference voltage	Selectable reference voltage	Fixed reference voltage, + side V_{DD} - side V_{ss}	Selectable reference voltage	Selectable reference voltage
GPIO Test						
	stl_RL78_GpioTest Checks that data has been correctly output to the port.	PMS0 must be configured to read the digital output level of the pin.	The value of the Pmn register is read.	The value of the Pmn register is read.	PMS0 must be configured to read the digital output level of the pin.	PMS0 must be configured to read the digital output level of the pin.
Watchdog Timer						
	stl_wdt_Kick Refreshes the watchdog timer count.	No differences	No differences	No differences	No differences	No differences
Voltage						
	stl_VDC_Create Voltage test with low voltage interrupt enabled.	Voltage testing using LVD circuit	Voltage testing using LVD circuit	No LVD circuit, so no low voltage interrupt. (Use SPOR for voltage testing)	Voltage testing using LVD circuit	Voltage testing using LVD circuit

*The target microcontroller for the accompanying test harness code.

2. MCU-Specific Differences Detail

2.1 Testing of the System Clock Verification

The TAU0 channel differs between the RL78/G14 and the others. Change the setting appropriate for the MCU.

2.1.1 For RL78/G14

Measure the pulse width of the input signal on channel 1 of timer array unit 0 (TAU0).

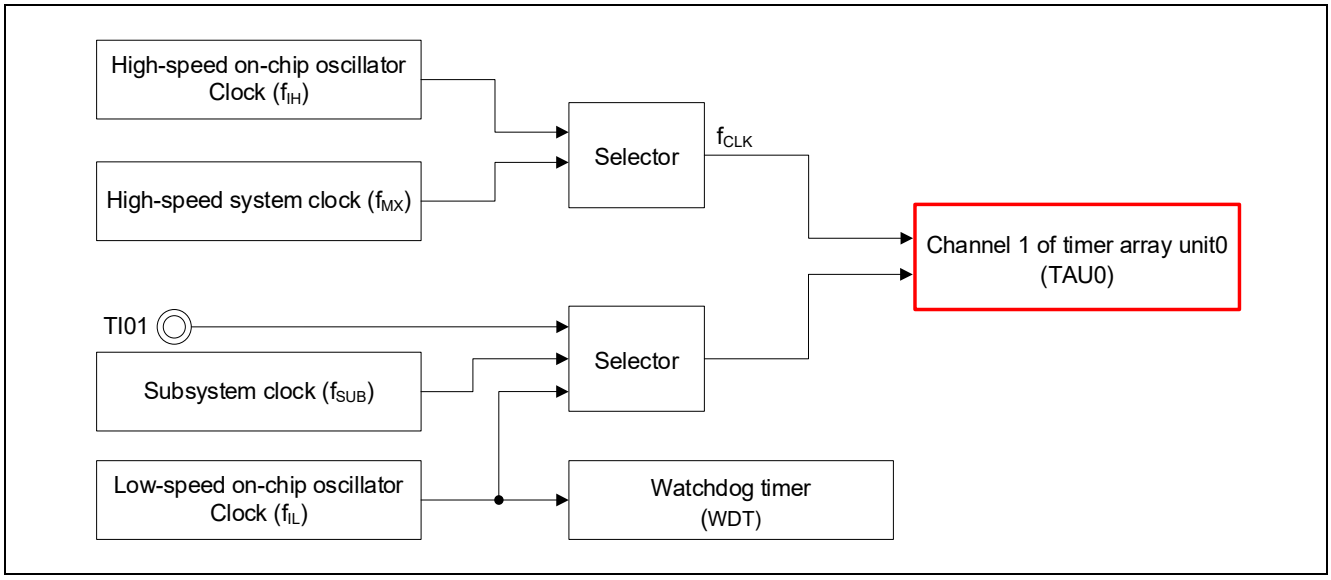

Figure 2-1 Configuration of Frequency Detection Function (RL78/G14)

2.1.2 For RL78/G13, G16, G22, G23

Measure the pulse width of the input signal on channel 5 of timer array unit 0 (TAU0).

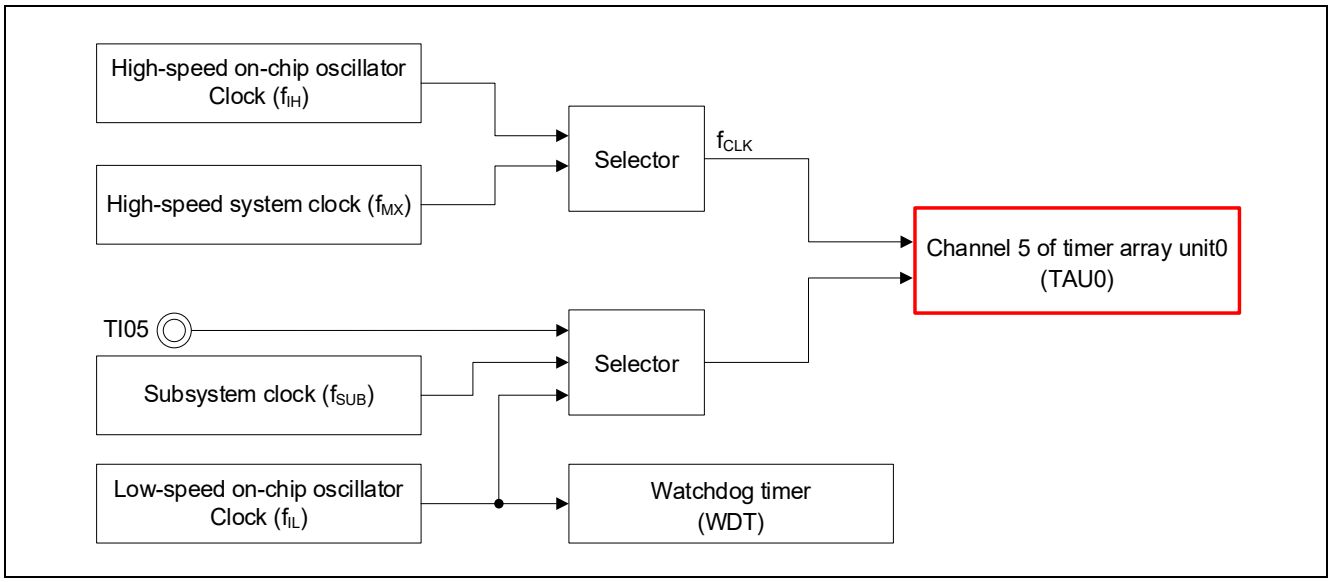

Figure 2-2 Configuration of Frequency Detection Function (RL78/G13, G16)

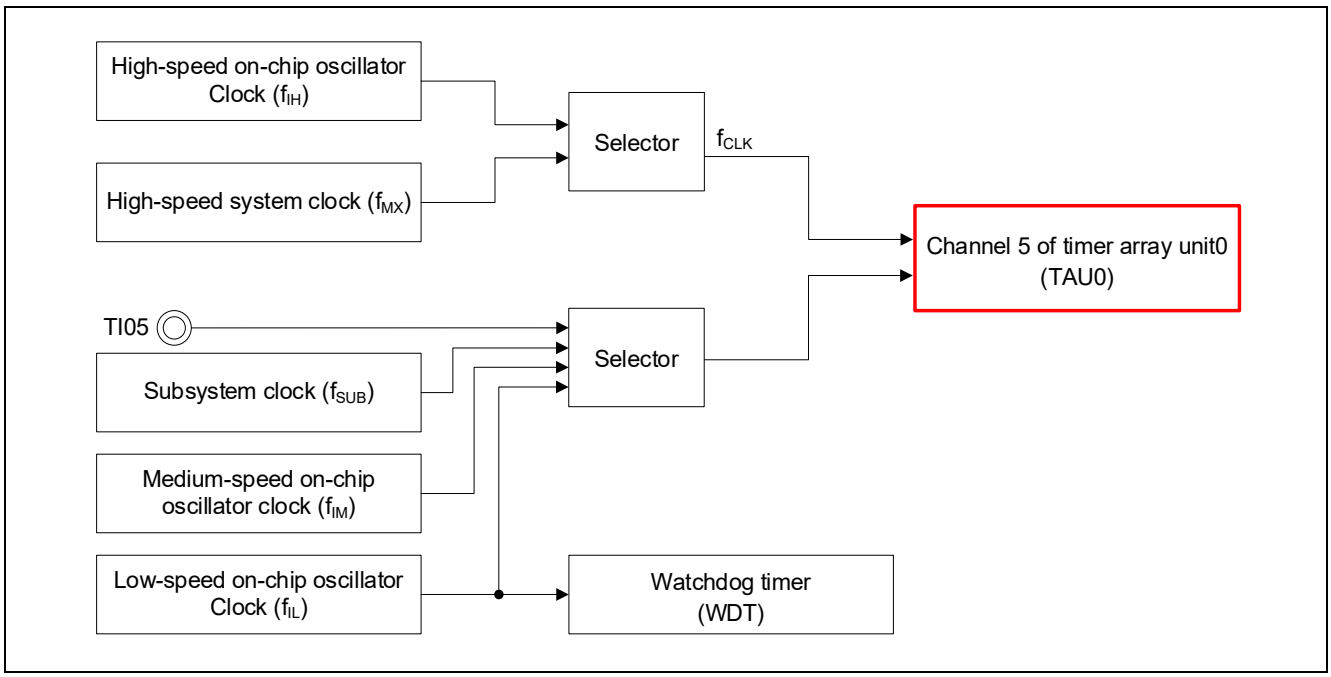

Figure 2-3 Configuration of Frequency Detection Function (RL78/G22, G23)

2.2 Testing of the A/D converter

For all other series except the RL78/G16, both the positive and negative reference voltages can be selected. For the RL78/G16, the positive reference voltage is fixed at V_{DD} and the negative reference voltage is fixed at V_{SS}.

Caution: 1. Since the RL78/G16 does not have registers (ADM1, ADUL, ADLL), remove any register settings when using the self test library.
2. The default setting of the analog input channel specification register (ADS) is "0x81" (internal reference voltage). For the RL78/G16, change it to "0x0D".

2.2.1 For RL78/G13, G14, G22, G23

the target of A/D conversion

- analog input channels (ANIxx)
- temperature sensor output voltage*1
- internal reference voltage*1
- the A/D converter's positive reference voltage
  (selected from AVREFP, the internal reference voltage, and V_{DD})
- A/D converter's negative reference voltage
- (selected from AVREFM and V_{SS})
- TSCAP voltage of the CTSU*2

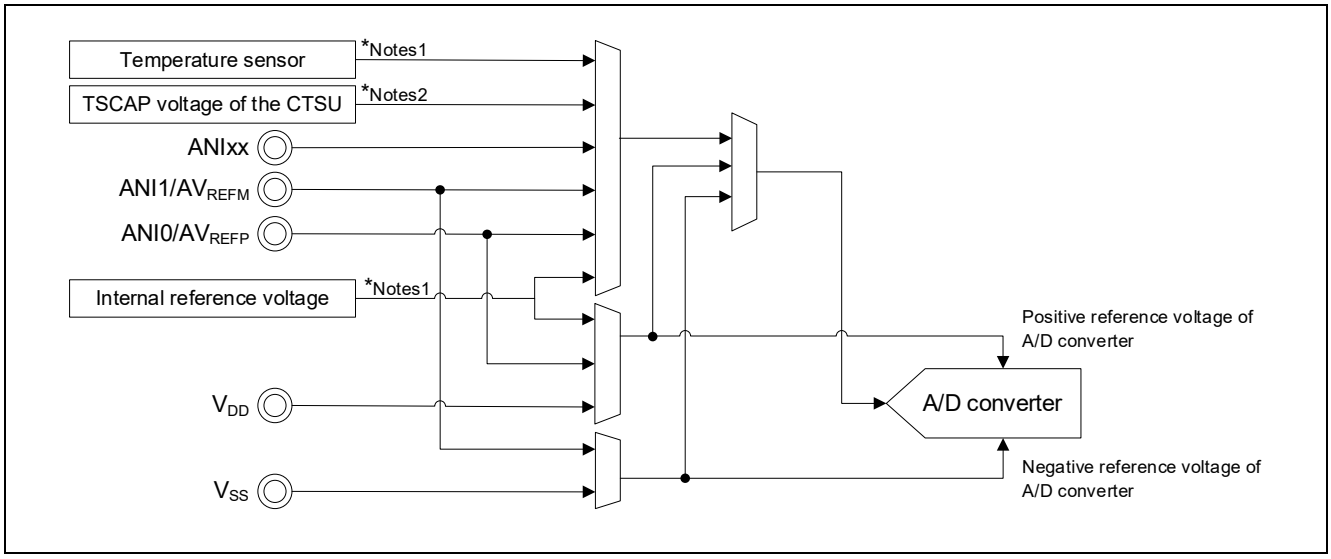

Figure 2-4 Configuration of Testing of the A/D converter (RL78/G13, G14, G22, G23)

*Notes: 1. For RL78/G13 and RL78/G14, Temperature sensor・Internal reference voltage is selectable only in HS (high-speed main) mode.
2. For RL78/G22 and RL78/G23, the CTSUTSCAP voltage can be selected as the A/D conversion target.

2.2.2 For RL78/G16

The target of A/D conversion
- analog input channels (ANIxx)
- temperature sensor output voltage
- internal reference voltage
- the A/D converter's positive reference voltages (V_{DD})
- the A/D converter's negative reference voltages (V_{SS})
- TSCAP voltage of the CTSU

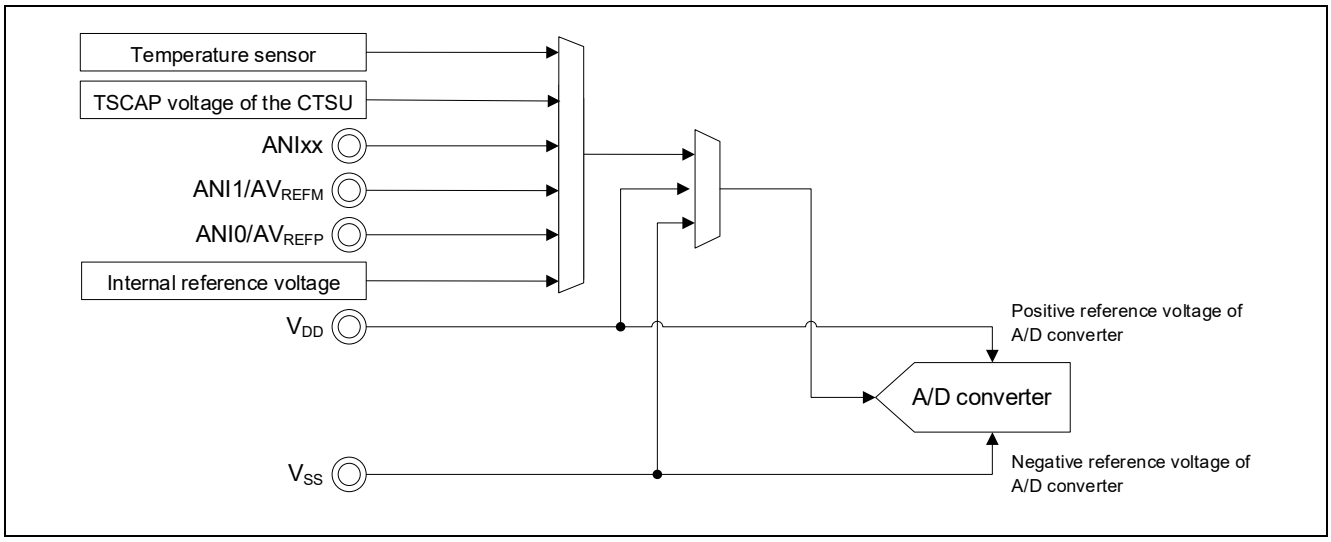

Figure 2-5 Configuration of Testing of the A/D converter (RL78/G16)

2.3 Testing of the GPIO

The differences between RL78/G14, G22, G23 and RL78/G13, G16 are as follows.

2.3.1 For RL78/G14, G22, G23

By using the Port Mode Select (PMS) function, it is possible to verify that the digital output is operating correctly by reading the output level of the terminal.

2.3.2 For RL78/G13, G16

The port mode select register (PMS) function is not provided. When the output port is configured, the output latch value of the port is read.

2.4 Testing of the Voltage

The differences between RL78/G13, G14, G22, G23 and RL78/G16 are as follows.

2.4.1 For RL78/G13, G14, G22, G23

Use the voltage detectors (LVD) to perform voltage testing.

2.4.2 For RL78/G16

As the LVD is not included (instead, the Selectable Power-on Reset (SPOR) circuit is provided), the low voltage detection interrupt cannot be utilized. Therefore, voltage testing should be conducted using the SPOR circuit.

3. Other MCU Changes

The MCU information for using the RL78 IEC60730/60335 Self Test Library (R01AN4819) is as follows:

- MCU : RL78/G14 (R5F104PJ)
- Internal Clock : 32MHz High Speed Oscillator (System Clock 32MHz)
- External Sub Clock : 32kHz
- Memory space : 256K bytes

Refer to the following information and change the self test library program according to the desired MCU and product specifications.

- Change the LED output in the event of an error.
  (The default is #define IDBU_TB specified in globaldefines.h.)
- Change addresses according to memory space.
- Change the selected clock source according to the clocks to be used.

4. Additional Safety Functions

While not certified by VDE, safety features have been added as user support to the RL78 family. The supported MCUs are as follows.

For more details, please refer to each product's user manual.

Table 4-1 Additional Features Compatibility Table

Safety Functions	RL78/G14*	RL78/G13	RL78/G16	RL78/G22	RL78/G23
RAM Memory Parity Generator Checker	○	○	○	○	○
RAM Guard Protection	○	○	○	○	○
Invalid Memory Access Protection	○	○	○	○	○
I/O Port SFR Protection	○	○	○	○	○
Interrupt SFR Protection	○	○	○	○	○
Control Register Protection	○	○	○	○	○
Flash Memory Guard Function	×	×	×	○	○
UART Loopback Function	×	×	×	○	○

*Note: The target microcontroller for the accompanying test harness code.
○: supported
×: not supported

5. Related Application Note

The application note related to this application note is listed below for reference.

- RL78 Family IEC60730/60335 Self Test Library of CCRL78 for RL78 MCU Extended (R01AN4819)
- RL78/G13, RL78/G23 Migration Guide from RL78/G13 to RL78/G23 (R01AN5378)

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Revision Record

Rev.	Date	Description	
		Page	Summary
1.00	Sep.30.24	—	First edition issued

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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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