To our customers,

Old Company Name in Catalogs and Other Documents

On April 1st, 2010, NEC Electronics Corporation merged with Renesas Technology Corporation, and Renesas Electronics Corporation took over all the business of both companies. Therefore, although the old company name remains in this document, it is a valid Renesas Electronics document. We appreciate your understanding.

Renesas Electronics website: http://www.renesas.com

April 1st, 2010
Renesas Electronics Corporation

Issued by: Renesas Electronics Corporation (http://www.renesas.com)
Send any inquiries to http://www.renesas.com/inquiry.
Notice

1. All information included in this document is current as of the date this document is issued. Such information, however, is subject to change without any prior notice. Before purchasing or using any Renesas Electronics products listed herein, please confirm the latest product information with a Renesas Electronics sales office. Also, please pay regular and careful attention to additional and different information to be disclosed by Renesas Electronics such as that disclosed through our website.

2. Renesas Electronics does not assume any liability for infringement of patents, copyrights, or other intellectual property rights of third parties by or arising from the use of Renesas Electronics products or technical information described in this document. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.

3. You should not alter, modify, copy, or otherwise misappropriate any Renesas Electronics product, whether in whole or in part.

4. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation of these circuits, software, and information in the design of your equipment. Renesas Electronics assumes no responsibility for any losses incurred by you or third parties arising from the use of these circuits, software, or information.

5. When exporting the products or technology described in this document, you should comply with the applicable export control laws and regulations and follow the procedures required by such laws and regulations. You should not use Renesas Electronics products or the technology described in this document for any purpose relating to military applications or use by the military, including but not limited to the development of weapons of mass destruction. Renesas Electronics products and technology may not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations.

6. Renesas Electronics has used reasonable care in preparing the information included in this document, but Renesas Electronics does not warrant that such information is error free. Renesas Electronics assumes no liability whatsoever for any damages incurred by you resulting from errors in or omissions from the information included herein.

7. Renesas Electronics products are classified according to the following three quality grades: “Standard”, “High Quality”, and “Specific”. The recommended applications for each Renesas Electronics product depends on the product’s quality grade, as indicated below. You must check the quality grade of each Renesas Electronics product before using it in a particular application. You may not use any Renesas Electronics product for any application categorized as “Specific” without the prior written consent of Renesas Electronics. Further, you may not use any Renesas Electronics product for any application for which it is not intended without the prior written consent of Renesas Electronics. Renesas Electronics shall not be in any way liable for any damages or losses incurred by you or third parties arising from the use of any Renesas Electronics product for an application categorized as “Specific” or for which the product is not intended where you have failed to obtain the prior written consent of Renesas Electronics. The quality grade of each Renesas Electronics product is “Standard” unless otherwise expressly specified in a Renesas Electronics data sheets or data books, etc.

“Standard”: Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; and industrial robots.

“High Quality”: Transportation equipment (automobiles, trains, ships, etc.); traffic control systems; anti-disaster systems; anti-crime systems; safety equipment; and medical equipment not specifically designed for life support.

“Specific”: Aircraft; aerospace equipment; submersible repeaters; nuclear reactor control systems; medical equipment or systems for life support (e.g. artificial life support devices or systems), surgical implantations, or healthcare intervention (e.g. excision, etc.), and any other applications or purposes that pose a direct threat to human life.

8. You should use the Renesas Electronics products described in this document within the range specified by Renesas Electronics, especially with respect to the maximum rating, operating supply voltage range, movement power voltage range, heat radiation characteristics, installation and other product characteristics. Renesas Electronics shall have no liability for malfunctions or damages arising out of the use of Renesas Electronics products beyond such specified ranges.

9. Although Renesas Electronics endeavors to improve the quality and reliability of its products, semiconductor products have specific characteristics such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Further, Renesas Electronics products are not subject to radiation resistance design. Please be sure to implement safety measures to guard them against the possibility of physical injury, and injury or damage caused by fire in the event of the failure of a Renesas Electronics product, such as safety design for hardware and software including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult, please evaluate the safety of the final products or system manufactured by you.

10. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. Please use Renesas Electronics products in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive. Renesas Electronics assumes no liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.

11. This document may not be reproduced or duplicated, in any form, in whole or in part, without prior written consent of Renesas Electronics.

12. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products, or if you have any other inquiries.

(Note 1) “Renesas Electronics” as used in this document means Renesas Electronics Corporation and also includes its majority-owned subsidiaries.

(Note 2) “Renesas Electronics product(s)” means any product developed or manufactured by or for Renesas Electronics.
1. Abstract

This document describes oscillation control of the 3858 Group MCU.

2. Introduction

The application explained in this document applies to the following MCU:

• Applicable MCU: 3858 Group
3. Contents

The 3858 Group MCU can be set to stop the CPU. The CPU can be put on standby using the two power-saving modes listed below:

- Execute the STP instruction to enter stop mode
- Execute the WIT instruction to enter wait mode

3.1 Stop Mode

When the STP instruction is executed, the MCU enters stop mode. In stop mode, the main clock (XIN-XOUT) and sub clock (Xcin - Xcout) oscillations stop. The system clock \( \phi \) stops “H”. The CPU and peripheral functions then stop, and power consumption is reduced.

3.1.1 Status in Stop Mode

Table 3.1 lists the Status in Stop Mode.

<table>
<thead>
<tr>
<th>Item</th>
<th>Function</th>
<th>Pin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oscillation</td>
<td>Stopped</td>
<td>XIN and XOUT: “H”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Xcin and Xcout: High impedance</td>
</tr>
<tr>
<td>CPU</td>
<td>Stopped</td>
<td>–</td>
</tr>
<tr>
<td>System clock ( \phi )</td>
<td>Stopped “H”</td>
<td>–</td>
</tr>
<tr>
<td>I/O ports P0 to P4</td>
<td>The I/O ports are held in their current state when the STP instruction is executed.</td>
<td>The I/O ports are held in the input state or output level when the STP instruction is executed.</td>
</tr>
<tr>
<td>Timers</td>
<td>Stopped (timers 1, 2, X, Y, Z1 and Z2)</td>
<td>Timers are held in the input state or output level when the STP instruction is executed.</td>
</tr>
<tr>
<td></td>
<td>However, timer X, timer Y, timer Z1 and timer Z2 are only active in event counter mode.</td>
<td></td>
</tr>
<tr>
<td>Watchdog timer</td>
<td>Stopped</td>
<td>–</td>
</tr>
<tr>
<td>Serial I/O1 and serial I/O2</td>
<td>Stopped However, serial I/O1 and serial I/O2 are only active when an external clock is selected.</td>
<td>Serial I/O1 and serial I/O2 are held in the input state or output level when the STP instruction is executed.</td>
</tr>
<tr>
<td>A/D converter</td>
<td>Stopped</td>
<td>The A/D converter is held in its current state when the STP instruction is executed.</td>
</tr>
<tr>
<td>PWM</td>
<td>Stopped</td>
<td>PWM is held in the output level when the STP instruction is executed.</td>
</tr>
<tr>
<td>RAM</td>
<td>Held(^{(1)})</td>
<td>–</td>
</tr>
<tr>
<td>CPU register and SFR</td>
<td>Held(^{(2)})</td>
<td>–</td>
</tr>
</tbody>
</table>

NOTES:

1. When voltage supplied to Vcc is more than the RAM hold voltage.
2. When voltage supplied to Vcc is more than the RAM hold voltage. However, the CPU register and SFRs are initialized when the MCU returns by the reset input.
• Example to reduce power consumption
  • Input port: Fix an input port “H” or “L” externally
  • Output port: Fix at the level to which the current does not flow externally
    For example, for a circuit that illuminates an LED when current flows during “L” signal output, an “H” level output is fixed.
  • A/D input pin: Fix the A/D input pin to “H” or “L” externally
  • PWM function enable bit (bit 0 in the PWM control register (address 1D16): “0”
  • Complete an A/D conversion
    Confirm that the AD conversion completion bit (bit 4 in the AD control register (address 3416)) is set to “1”.

3.1.2 Exiting Stop Mode

To exit stop mode, generate an enabled interrupt request or input a reset. The MCU’s return from stop mode differs between the interrupt request being generated and a reset being input.

• Return by interrupt

If an enabled interrupt request is generated during stop mode(1), stop mode is exited and the clock which is oscillating when the STP instruction is executed starts oscillating. As oscillation is unstable when it starts, a certain amount of time is necessary for oscillation to stabilize (oscillation stabilization time). When the MCU returns from stop mode from an interrupt, prescaler 12 and timer 1 generate the standby time for the system clock φ supply to the CPU(2). The count source of prescaler 12 is the clock which is set when the STP instruction is executed and this standby time is allocated for the system clock's oscillation stabilization time(3). The standby time is completed when timer 1 underflows and system clock φ supply to the CPU starts. The generated interrupt request is accepted and the interrupt routine is executed. The watchdog timer does not operate in stop mode, but operates during the standby time. Write to the watchdog timer control register (address 3916) before the STP instruction is executed to prevent underflow during this time(4). Figure 3.1 shows an Operation Example When Returning from Stop Mode Using a Generated INT0 Interrupt Request.

NOTES:
1. The following show the interrupt sources which can be used for returning from stop mode. Enable the interrupt to be used and execute the STP instruction.
  • INTO to INT3
  • CNTR0 to CNTR3
  • Serial I/O1 and serial I/O2 when an external clock is selected
  • Timer X, timer Y, timer Z1 and timer Z2 in event counter mode
2. When the oscillation stabilization time set bit after release of the STP instruction (bit 0 of MISRG (address 3816)) is set to “0”, “FF16” is automatically set to prescaler 12 and “0116” is set to timer 1. When the oscillation stabilization time set bit after release of the STP instruction is set to “1”, set the following to prescaler 12 and timer 1 and execute the STP instruction.
  • Prescaler 12 register and timer 1 register: standby time
    Set the standby time in the following range:
    Oscillation stabilization time < standby time < time until the watchdog timer underflows
  • Timer 1 interrupt enable bit: “0” (interrupt disabled)
Figure 3.1 Operation Example When Returning from Stop Mode Using a Generated INT0 Interrupt Request

NOTES:
1. The prescaler 12 count source is output of a clock for timer 12.
   The timer 1 count source is an underflow signal for prescaler 12.
   m: Prescaler 12 setting value, n: timer 1 setting value

This example shows that the main clock is selected for system clock φ and sub clock oscillation.
XIN and XCIN oscillations depend on the CPU mode register setting.
The rising edge active is set for the INT0 interrupt.
• Return by reset input
  To exit stop mode, the input level to the RESET pin must be “L” in stop mode. All I/O ports are changed to input mode, and main clock (XIN-XOUT) oscillation starts. Divide-by-8 mode is selected for the system clock. Oscillation is unstable when it starts, and a certain amount of time is necessary for oscillation to stabilize (oscillation stabilization time). Hold the RESET pin input level “L” until oscillation is stable. An internal reset occurs when the RESET pin input level is held “L” for 20 cycles or more of the main clock and the MCU operates according to the reset sequence.

3.1.3 Notes on Stop Mode
• The main clock and sub-clock oscillation stabilization time differs. When the MCU is returned from stop mode, clock oscillation which is not selected for system clock $\phi$ may not be stable.
3.2 Wait Mode

The MCU enters wait mode when the WIT instruction is executed. In wait mode, oscillation continues but the system clock $\phi$ stops “H”. The CPU stops, but the peripheral functions are active.

3.2.1 Status in Wait Mode

Table 3.2 lists the Status in Wait Mode.

<table>
<thead>
<tr>
<th>Item</th>
<th>State in Wait Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oscillation</td>
<td>Active</td>
</tr>
<tr>
<td>CPU</td>
<td>Stopped</td>
</tr>
<tr>
<td>System clock $\phi$</td>
<td>Stopped “H”</td>
</tr>
<tr>
<td>I/O ports P0 to P4</td>
<td>Hold the input state or output level when the WIT instruction is executed.</td>
</tr>
<tr>
<td>Timers</td>
<td>Active</td>
</tr>
<tr>
<td>Watchdog timer</td>
<td>Active</td>
</tr>
<tr>
<td>Serial I/O1 and serial I/O2</td>
<td>Active</td>
</tr>
<tr>
<td>A/D converter</td>
<td>Active</td>
</tr>
<tr>
<td>PWM</td>
<td>Active</td>
</tr>
<tr>
<td>RAM</td>
<td>Held(1)</td>
</tr>
<tr>
<td>CPU register and SFR</td>
<td>Held(1)</td>
</tr>
</tbody>
</table>

NOTES:
1. Some SFRs may be changed depending on peripheral function operations. The SFRs are initialized when the MCU returns by the reset input.
3.2.2 Exiting Wait Mode

To exit wait mode, generate an enabled interrupt request or input a reset. The MCU's return from wait mode differs between the interrupt request being generated and a reset being input.

- Return by interrupt

If an enabled interrupt request is generated during wait mode(1), wait mode is exited and the system clock $\phi$ supply to the CPU starts. The generated interrupt request is accepted and its interrupt routine is executed. The watchdog timer is active in wait mode. Write to the watchdog timer control register to prevent underflow. Figure 3.2 shows an Operation When Returning from Wait Mode Using a Generated INT0 Interrupt Request.

NOTE:
All interrupt sources can be used for returning from wait mode. Enable an interrupt and execute the WIT instruction.

---

![Diagram of Wait Mode Exit](image-url)

This example shows that the main clock is selected for system clock $\phi$ and subclock oscillation. $X_{IN}$ and $X_{CIN}$ oscillations depend on the CPU mode register setting. The rising edge active is set for the INT0 interrupt.

Figure 3.2  Operation When Returning from Wait Mode Using a Generated INT0 Interrupt Request
• Return by reset input
  To exit wait mode, the input level to the RESET pin must be “L”. All I/O ports are changed to input mode, sub clock oscillation stops and main clock (XIN - XOUT) oscillation starts. Divide-by-8 mode is selected for the system clock. If the main clock oscillates when the WIT instruction is executed, oscillation continues. An internal reset occurs when the RESET pin is held “L” for 2 μs or more and the MCU operates according to the reset sequence. If the main clock stops when the WIT instruction is executed, time for oscillation to stabilize when oscillation starts is necessary. Hold the RESET pin input level “L” until oscillation is stable. An internal reset occurs when the RESET pin input level is held “L” for 20 cycles or more of the main clock and the MCU operates according to the reset sequence.

3.2.3 Notes on Wait Mode
• Return by reset input
  When the WIT instruction is executed, the sub-clock is selected for the system clock and the main clock stops, sub-clock oscillation stops and main clock oscillation starts by applying “L” input level for the RESET pin. Oscillation is unstable when it starts, and a certain amount of time is necessary for oscillation to stabilize. Hold the RESET pin input level “L” until oscillation is stable. An internal reset occurs when oscillation is stable and the RESET pin input level is held “L” for 20 cycles or more of the main clock.
4. Reference Document

Datasheet
3858 Group Datasheet
Use the most recent version of the document on the Renesas Technology Web site.

Technical News/Technical Update
Use the most recent version of the document on the Renesas Technology Web site.
Web site and Support

Renesas Technology Web site
http://www.renesas.com/

Inquiries
http://www.renesas.com/inquiry
csc@renesas.com

<table>
<thead>
<tr>
<th>Rev.</th>
<th>Date</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.00</td>
<td>Mar 26, 2008</td>
<td>– First Edition issued</td>
</tr>
</tbody>
</table>
Notes regarding these materials

1. This document is provided for reference purposes only so that Renesas customers may select the appropriate Renesas products for their use. Renesas neither makes warranties or representations with respect to the accuracy or completeness of the information contained in this document nor grants any license to any intellectual property rights or any other rights of Renesas or any third party with respect to the information in this document.

2. Renesas shall have no liability for damages or infringement of any intellectual property or other rights arising out of the use of any information in this document, including, but not limited to, product data, diagrams, charts, programs, algorithms, and application circuit examples.

3. You should not use the products or the technology described in this document for the purpose of military applications such as the development of weapons of mass destruction or for the purpose of any other military use. When exporting the products or technology described herein, you should follow the applicable export control laws and regulations, and procedures required by such laws and regulations.

4. All information included in this document such as product data, diagrams, charts, programs, algorithms, and application circuit examples, is current as of the date this document is issued. Such information, however, is subject to change without any prior notice. Before purchasing or using any Renesas products listed in this document, please confirm the latest product information with a Renesas sales office. Also, please pay regular and careful attention to additional and different information to be disclosed by Renesas such as that disclosed through our website. (http://www.renesas.com)

5. Renesas has used reasonable care in compiling the information included in this document, but Renesas assumes no liability whatsoever for any damages incurred as a result of errors or omissions in the information included in this document.

6. You should not use the products or otherwise relying on the information in this document, you should evaluate the information in light of the total system before deciding about the applicability of such information to the intended application. Renesas makes no representations, warranties or guaranties regarding the suitability of its products for any particular application and specifically disclaims any liability arising out of the application and use of the information in this document or Renesas products.

7. With the exception of products specified by Renesas as suitable for automobile applications, Renesas products are not designed, manufactured or tested for applications or otherwise in systems the failure or malfunction of which may cause a direct threat to human life or create a risk of human injury or which require especially high quality and reliability such as safety systems, or equipment or systems for transportation and traffic, healthcare, combustion control, aerospace and aeronautics, nuclear power, or undersea communication transmission. If you are considering the use of our products for such purposes, please contact a Renesas sales office beforehand. Renesas shall have no liability for damages arising out of the uses set forth above.

8. Notwithstanding the preceding paragraph, you should not use Renesas products for the purposes listed below:
   (1) artificial life support devices or systems
   (2) surgical implantations
   (3) healthcare intervention (e.g., excision, administration of medication, etc.)
   (4) any other purposes that pose a direct threat to human life

Renesas shall have no liability for damages arising out of the uses set forth in the above and purchasers who elect to use Renesas products in any of the foregoing applications shall indemnify and hold harmless Renesas Technology Corp., its affiliated companies and their officers, directors, and employees against any and all damages arising out of such applications.

9. You should use the products described herein within the range specified by Renesas, especially with respect to the maximum rating, operating supply voltage range, movement power voltage range, heat radiation characteristics, installation and other product characteristics. Renesas shall have no liability for malfunctions or damages arising out of the use of Renesas products beyond such specified ranges.

10. Although Renesas endeavors to improve the quality and reliability of its products, IC products have specific characteristics such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Please be sure to implement safety measures to guard against the possibility of physical injury, and injury or damage caused by fire in the event of the failure of a Renesas product, such as safety design for hardware and software including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other applicable measures. Among others, since the evaluation of microcomputer software alone is very difficult, please evaluate the safety of the final products or system manufactured by you.

11. In case Renesas products listed in this document are detached from the products to which the Renesas products are attached or affixed, the risk of accident such as swallowing by infants and small children is very high. You should implement safety measures so that Renesas products may not be easily detached from your products. Renesas shall have no liability for damages arising out of such detachment.

12. This document may not be reproduced or duplicated, in any form, in whole or in part, without prior written approval from Renesas.

13. Please contact a Renesas sales office if you have any questions regarding the information contained in this document, Renesas semiconductor products, or if you have any other inquiries.