

R8C/38T-A Group

R01AN1213EJ0100

Rev.1.00

Application of Capacitive touch technology to a metal panel

May 23, 2013

Abstract

The MCU for touch panel, R8C/38T-A Group, incorporates touch sensor control unit hardware (hereinafter called TSCU) which determines whether an electrode is being touched or not by measuring the floating capacitance between the touch electrode and a human body.

This application note explains how to use switches on a metal panel created by applying electrostatic capacitance touch technology.

Target Device

R8C/38T-A Group

Contents

1. Overview	2
2. Configuration Example of Metal Panel Button	3
3. Appendix. Application to Proximity Sensor	10

1. Overview

With an electrostatic capacitance type touch switch, whether the switch is turned on or off can be detected by measuring the electrostatic capacitance between touch electrode and human body (finger). Basically, this switch works even in structure which has a changing distance between a conductive substance and the electrode, if the change in the electrostatic capacitance can be detected. Figure 1-1 shows an example of a button formed with a metal panel. As shown in this figure, pushing the convex-shape metal part close to the electrode works as a switch.

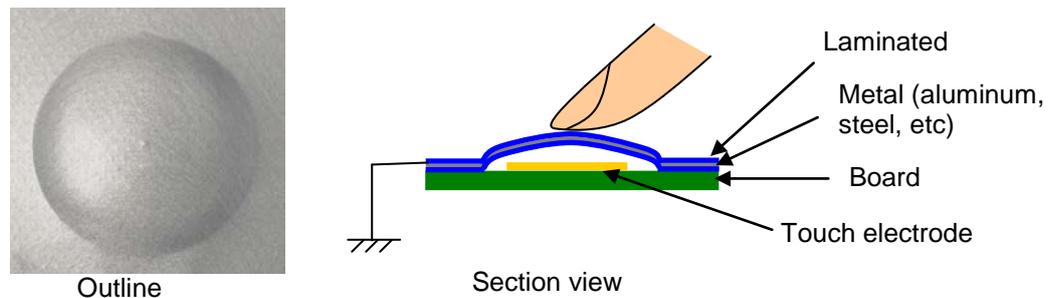


Figure 1-1 Example of Metal Panel Button

Combining a metal panel and electrostatic capacitance method offers potential benefits as follows.

- A front panel may consist of metallic materials such as aluminum, stainless, and etc.
- No need for mechanical contact switches, leading to cost saving.
- The electrostatic capacitance method provides 'touch' feeling.
- The metal panel covering the electrode functions as a noise shield, so resistance to RF noise which is a weakness of the electrostatic capacitance method may be increased.

In the following pages, an example of switch with combination of the metal panel and electrostatic capacitance detection method is described.

2. Configuration Example of Metal Panel Button

2.1 Evaluation Set Configuration

Figure 2-1 illustrates the configuration of evaluation set for metallic panel buttons. Specifically, this evaluation set consists of a metal panel with convex-shape buttons each having different height, a touch MCU R8C/36T-A evaluation board, an emulator debugger E1, and a PC for integrated environment HEW and touch evaluation tool Workbench. On the back side of the panel, touch electrodes are allocated and connected to channels for measurement of the touch MCU. To avoid misjudgment of touch detection from parts other than buttons, the metal panel itself is connected to GND.

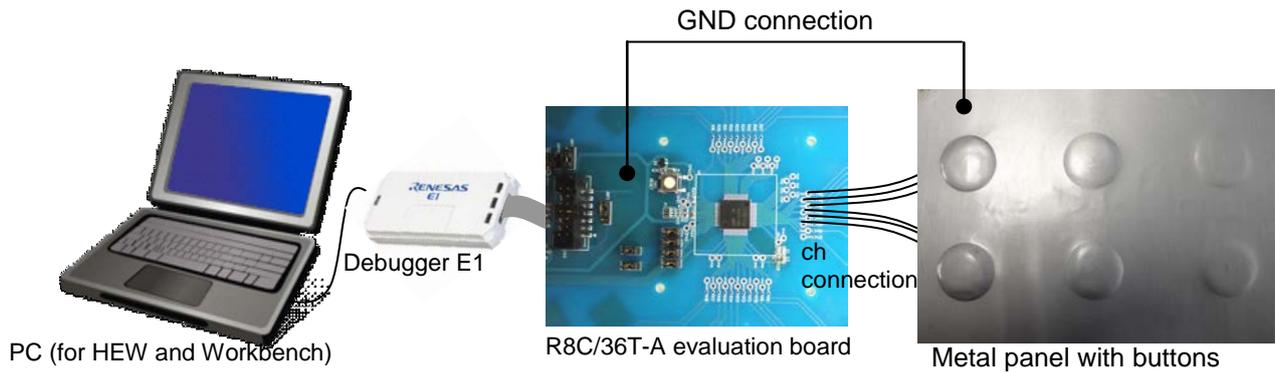


Figure 2-1 Configuration of Evaluation Set for Metallic Panel Buttons

2.2 Metal Panel Buttons

Figure 2-2 shows an example of structure of a metal panel button. This button has four layers. From the top, an aluminum board of which both sides are laminated, a double-sided adhesive sheet, a touch electrode, and a glass epoxy board form this button. Pushing the convex-shape aluminum board by a finger brings the metal connected to GND closer to the touch electrode and increases electrostatic capacitance. This increase in electrostatic capacitance is measured by the touch MCU and ON or OFF to the button is detected.

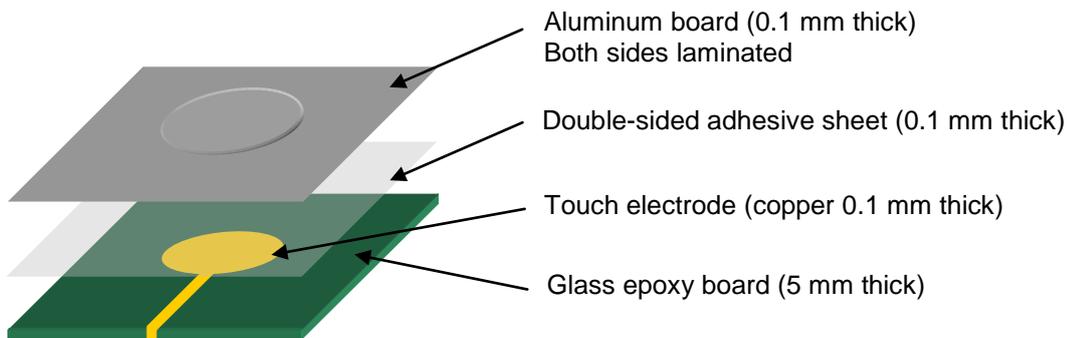


Figure 2-2 Structure of a Metal Panel Button

Note that electrode wiring is set directly below the metal panel in this evaluation set where the touch electrodes are located on a single-side single-layer board. To control parasitic capacitance against the metal panel, it is recommended to use a double layer board where wiring is set on the back side via a through-hole when applying to practical use for products.

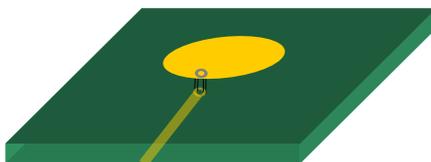


Figure 2-3 Touch Electrode on Double Layer Board

R8C/38T-A Group R8C38T-A Group Application of Capacitive touch technology to a metal panel

Based on the assumption that the buttons are used for various applications, several sizes of buttons and touch electrodes are provided. Table 2-1 shows each size of buttons used for this evaluation set.

Table 2-1 Size of Buttons

	Convex part of the aluminum board		Touch electrode		
	Height (mm)	Diameter (mm)	Diameter (mm)	Wiring line width (mm)	Wiring length between CH and electrode (mm)
Button 1	0.025	17	15	0.3	100
Button 2	0.05				
Button 3	0.1				
Button 4	0.025		10		
Button 5	0.05				
Button 6	0.1				
Legends					

2.3 TSCU Settings and External Circuit Constants for R8C/36T-A

TSCU settings of R8C/36T-A used for this evaluation are as follows. As for meaning of each register, refer to R8C/36T-A hardware manual.

DF_TSCUCR0	0x0006	// TSCU Control Register 0 F=1/1(20MHz)
DF_TSCUCR1	0x0010	// TSCU Control Register 1
DF_TSCUMR	0x0000	// TSCU Mode Register soft trigger
DF_TSCUTCRA	0x0300	// TSCU Timing Control Register 0A charge max
DF_TSCUTCROB	0x0300	// TSCU Timing Control Register 0B charge max
DF_TSCUTCRI	0x0307	// TSCU Timing Control Register 1 Larea 2cyc
DF_TSCUTCRI2	0x8000	// TSCU Timing Control Register 2
DF_TSCUTCRI3	0x0000	// TSCU Timing Control Register 3
DF_TSCUHC	(0x0080+MAX_CH-1)	// TSCU Channel Control Register 22ch up-down scan
DF_TSCUFR	0x0000	// TSCU Flag Register
DF_TSCUSCS	0x0020	// TSCU Secondary Counter Set Register 7count
DF_TSCURVR0	0x0000	// TSCU random Register 0
DF_TSCURVR1	0x0000	// TSCU random Register 1
DF_TSCURVR2	0x0000	// TSCU random Register 2
DF_TSCURVR3	0x0000	// TSCU random Register 3

External circuit constants of the R8C/36T-A evaluation board are as follows.

Cc: 0.1 μ F

Rc: 2.7 K Ω

Cr: 27 pF (with CHxA0 side used)

Rr: 1 K Ω

2.4 Measurement Method

Regarding the buttons 1 to 6, touch measurement values (count values) when each of the buttons is not pushed and pushed using a 10 mm ϕ cylindrical metal bar with approximately 600 g weighted are measured on the Workbench status monitor. Figure 2-4 is a picture showing a button pushed with the metal bar. In this evaluation set, the metal panel part is connected to GND. Therefore there is no need to take into consideration influence of electrical resistance or capacitance from a human body and the metal bar as evaluation conditions.



Figure 2-4 A Button Pushed with a Metal Bar

Other conditions of measurement:

- MCU supply voltage 5.00 V
- Temperature (room temperature) 25 °C
- Humidity 30 %
- Workbench4 Ver. 4.60.02

2.5 Measurement Result

Table 2-1 shows touch measurement count values when each button is pushed/not pushed. Note that the count values are measured on the status monitor of Workbench and the values measured four times are added to be defined as a measurement result.

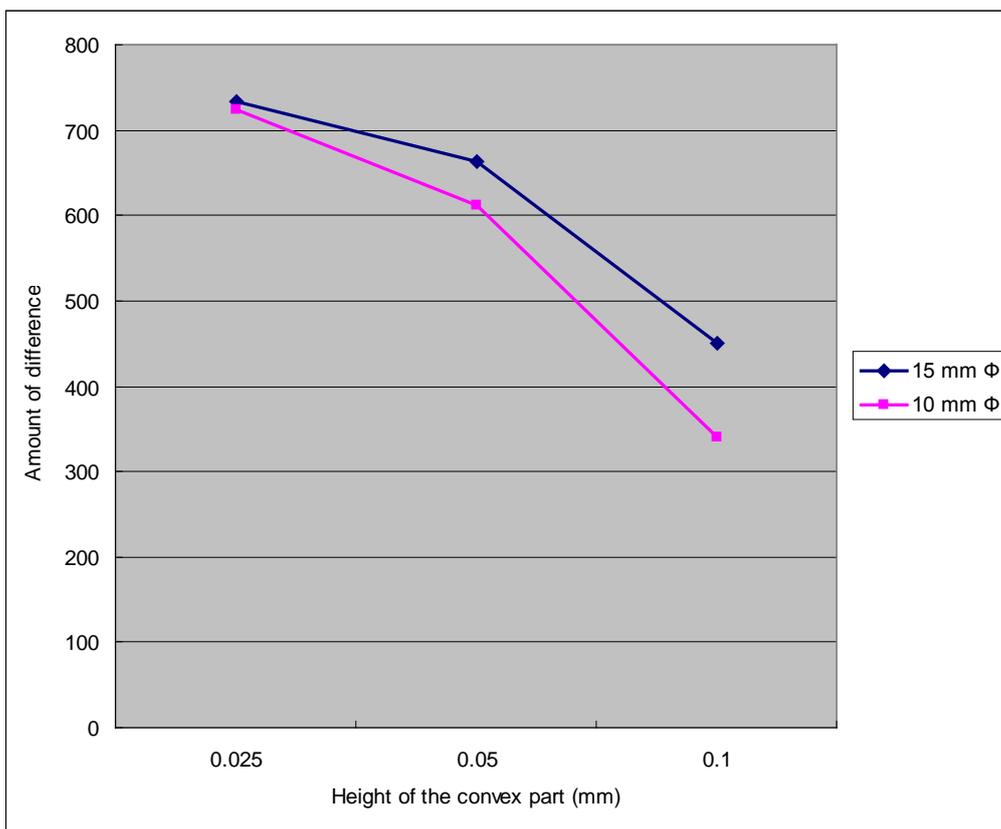
Table 2-2 Measurement Result

	Sizes of buttons		Measurement result (count values added four times)		
	Height of convex part (mm)	Touch electrode diameter (mm)	When not pushed	When pushed	Difference
Button 1	0.025	15	1154	420	734
Button 2	0.05		1234	570	664
Button 3	0.1		1290	840	450
Button 4	0.025	10	1508	784	724
Button 5	0.05		1575	964	611
Button 6	0.1		1580	1240	340

2.6 Consideration

As shown in the result, each button operates properly as a switch because there is enough difference to determine ON or OFF.

Figure 2-5 shows a relationship between the shape of button and difference in measurement result. As shown in this graph, the higher the convex part, the less difference observed. This is because contact area to the electrode when the button is pushed is smaller.



Figure

Relationship between Button Shape and Difference in Measurement Result

2-5

It is a logical conclusion that the smaller electrode has the less difference in measurement result. In addition, the difference based on the size of electrode varies depending on the height of convex part of button. The graph shows the difference observed between two lines ■ (with 10 mm ϕ electrode) and ◆ (with 15 mm ϕ electrode) is greater when the convex part is higher.

R8C/38T-A Group R8C38T-A Group Application of Capacitive touch technology to a metal panel

This is because how much the convex part changes in shape when the button is pushed varies depending on the height of the convex part. Figure 2-6 shows a relationship between height of the convex part and contact area to the touch electrode. When the convex part is high, only the center part of the button changes in shape and the contact area to the electrode is relatively small.

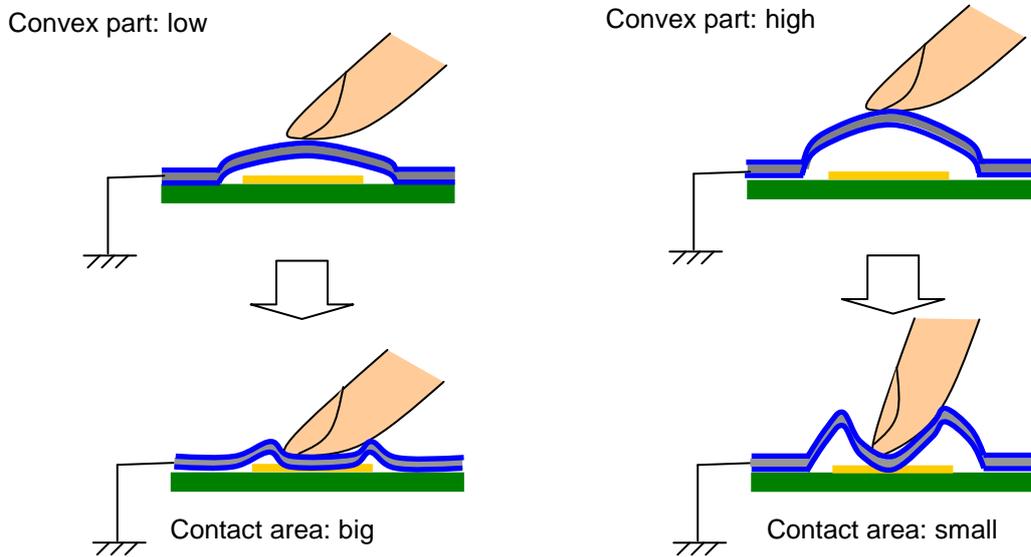


Figure 2-6 Relationship Between Height of the Convex Part and Contact Area

3. Appendix. Application to Proximity Sensor

Applications of buttons using the metal panel include a proximity sensor in which the metal panel itself is used as the touch electrode. Specifically, the following application is feasible.

- (1) When power is OFF, the product is in low power consumption state and can detect only proximity of a human body with the metal panel used as electrodes.
- (2) When the proximity of a human body is detected, the metal panel stops the detection and the convex parts of the metal panel are activated as switches.
- (3) The metal panel is connected to GND via MCU pins.
- (4) When there is no operation in a certain period of time or a user turns power off, the product enters low power consumption state and the procedure returns to (1).

Distance in order for the metal panel operating as a proximity sensor to detect an approach of a human body is evaluated in the below environment. Figure 3-1 shows the evaluation environment for the proximity sensor. Other conditions such as TSCU settings and external circuit constants are the same as those for evaluating buttons.

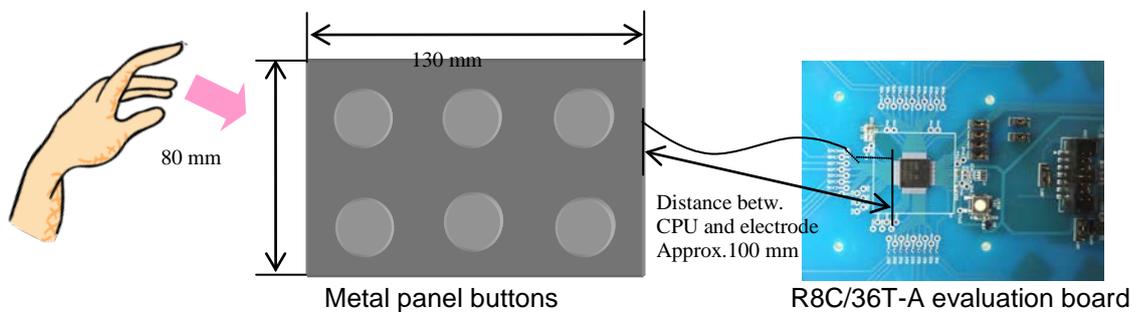


Figure 3-1 Proximity Sensor Evaluation Environment

R8C/38T-A Group R8C38T-A Group Application of Capacitive touch technology to a metal panel

Figure 3-2 is a graph showing the result of evaluation. As shown in this graph, the panel starts to detect an approach of a hand about 100 mm from it, and the count value decreases in an asymptotic line curve till the distance becomes 0 mm. Although an actual measurement result depends on margin setting against malfunction caused by noise, the evaluation result shows that detecting an approach of a hand within approximately 50 mm is considered possible in this evaluation environment.

Distance from the panel and hand (mm)	200	175	150	125	100	75	50	25	0
Count value	640	638	637	633	630	623	600	520	280

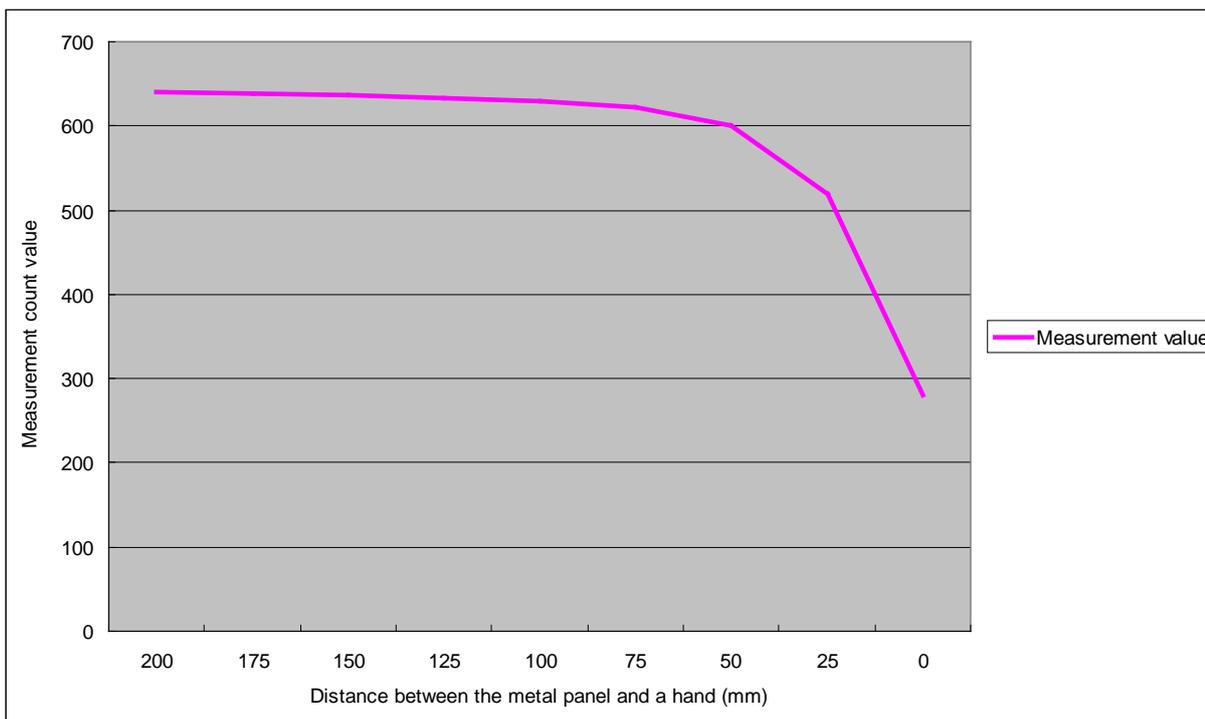


Figure 3-2 Measurement Count Value and Approach of a Hand

Website and Support

Renesas Electronics Website

<http://www.renesas.com/>

Inquiries

<http://www.renesas.com/contact/>

All trademarks and registered trademarks are the property of their respective owners.

Revision Record

Rev.	Date	Description	
		Page	Summary
1.00	May 23, 2013	-	Numbering change(Content is as same as R01AN1214EJ0100)

General Precautions in the Handling of MPU/MCU Products

The following usage notes are applicable to all MPU/MCU products from Renesas. For detailed usage notes on the products covered by this manual, refer to the relevant sections of the manual. If the descriptions under General Precautions in the Handling of MPU/MCU Products and in the body of the manual differ from each other, the description in the body of the manual takes precedence.

1. Handling of Unused Pins

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

- The input pins of CMOS products are generally in the high-impedance state. In operation with an unused pin in the open-circuit state, extra electromagnetic noise is induced in the vicinity of LSI, an associated shoot-through current flows internally, and malfunctions occur due to the false recognition of the pin state as an input signal become possible. Unused pins should be handled as described under Handling of Unused Pins in the manual.

2. Processing at Power-on

The state of the product is undefined at the moment when power is supplied.

- The states of internal circuits in the LSI are indeterminate and the states of register settings and pins are undefined at the moment when power is supplied.

In a finished product where the reset signal is applied to the external reset pin, the states of pins are not guaranteed from the moment when power is supplied until the reset process is completed.

In a similar way, the states of pins in a product that is reset by an on-chip power-on reset function are not guaranteed from the moment when power is supplied until the power reaches the level at which resetting has been specified.

3. Prohibition of Access to Reserved Addresses

Access to reserved addresses is prohibited.

- The reserved addresses are provided for the possible future expansion of functions. Do not access these addresses; the correct operation of LSI is not guaranteed if they are accessed.

4. Clock Signals

After applying a reset, only release the reset line after the operating clock signal has become stable.

When switching the clock signal during program execution, wait until the target clock signal has stabilized.

- When the clock signal is generated with an external resonator (or from an external oscillator) during a reset, ensure that the reset line is only released after full stabilization of the clock signal. Moreover, when switching to a clock signal produced with an external resonator (or by an external oscillator) while program execution is in progress, wait until the target clock signal is stable.

5. Differences between Products

Before changing from one product to another, i.e. to one with a different type number, confirm that the change will not lead to problems.

- The characteristics of MPU/MCU in the same group but having different type numbers may differ because of the differences in internal memory capacity and layout pattern. When changing to products of different type numbers, implement a system-evaluation test for each of the products.

Notice

1. 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.
 2. 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.
 3. 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.
 4. You should not alter, modify, copy, or otherwise misappropriate any Renesas Electronics product, whether in whole or in part. Renesas Electronics assumes no responsibility for any losses incurred by you or third parties arising from such alteration, modification, copy or otherwise misappropriation of Renesas Electronics product.
 5. Renesas Electronics products are classified according to the following two quality grades: "Standard" and "High Quality". The recommended applications for each Renesas Electronics product depends on the product's quality grade, as indicated below.
"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 etc.
"High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control systems; anti-disaster systems; anti-crime systems; and safety equipment etc.
Renesas Electronics products are neither intended nor authorized for use in products or systems that may pose a direct threat to human life or bodily injury (artificial life support devices or systems, surgical implantations etc.), or may cause serious property damages (nuclear reactor control systems, military equipment etc.). 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 for which it is not intended. 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 which the product is not intended by Renesas Electronics.
 6. 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.
 7. 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 systems manufactured by you.
 8. 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.
 9. 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. You should not use Renesas Electronics products or 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. When exporting the Renesas Electronics 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.
 10. It is the responsibility of the buyer or distributor of Renesas Electronics products, who distributes, disposes of, or otherwise places the product with a third party, to notify such third party in advance of the contents and conditions set forth in this document, Renesas Electronics assumes no responsibility for any losses incurred by you or third parties as a result of unauthorized use of Renesas Electronics products.
 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.



SALES OFFICES

Renesas Electronics Corporation

<http://www.renesas.com>

Refer to "<http://www.renesas.com/>" for the latest and detailed information.

Renesas Electronics America Inc.
2880 Scott Boulevard Santa Clara, CA 95050-2554, U.S.A.
Tel: +1-408-588-6000, Fax: +1-408-588-6130

Renesas Electronics Canada Limited
1101 Nicholson Road, Newmarket, Ontario L3Y 9C3, Canada
Tel: +1-905-898-5441, Fax: +1-905-898-3220

Renesas Electronics Europe Limited
Dukes Meadow, Millboard Road, Bourne End, Buckinghamshire, SL8 5FH, U.K
Tel: +44-1628-651-700, Fax: +44-1628-651-804

Renesas Electronics Europe GmbH
Arcadiastrasse 10, 40472 Düsseldorf, Germany
Tel: +49-211-65030, Fax: +49-211-6503-1327

Renesas Electronics (China) Co., Ltd.
7th Floor, Quantum Plaza, No.27 ZhiChunLu Haidian District, Beijing 100083, P.R.China
Tel: +86-10-8235-1155, Fax: +86-10-8235-7679

Renesas Electronics (Shanghai) Co., Ltd.
Unit 204, 205, AZIA Center, No.1233 Lujiazui Ring Rd., Pudong District, Shanghai 200120, China
Tel: +86-21-5877-1818, Fax: +86-21-6887-7858 / -7898

Renesas Electronics Hong Kong Limited
Unit 1601-1613, 16/F., Tower 2, Grand Century Place, 193 Prince Edward Road West, Mongkok, Kowloon, Hong Kong
Tel: +852-2886-9318, Fax: +852 2886-9022/9044

Renesas Electronics Taiwan Co., Ltd.
13F, No. 363, Fu Shing North Road, Taipei, Taiwan
Tel: +886-2-8175-9600, Fax: +886 2-8175-9670

Renesas Electronics Singapore Pte. Ltd.
80 Bendemeer Road, Unit #06-02 Hyflux Innovation Centre Singapore 339949
Tel: +65-6213-0200, Fax: +65-6213-0300

Renesas Electronics Malaysia Sdn.Bhd.
Unit 906, Block B, Menara Amcorp, Amcorp Trade Centre, No. 18, Jln Persiaran Barat, 46050 Petaling Jaya, Selangor Darul Ehsan, Malaysia
Tel: +60-3-7955-9390, Fax: +60-3-7955-9510

Renesas Electronics Korea Co., Ltd.
11F., Samik Lavied' or Bldg., 720-2 Yeoksam-Dong, Kangnam-Ku, Seoul 135-080, Korea
Tel: +82-2-558-3737, Fax: +82-2-558-5141