

# RA2L1 Group

## Self-Capacitance Waterproof Demo Hardware Manual

### Introduction

This application note describes how to use the Self-Capacitance Waterproof Demo.

Make sure to read this before using this demo set.

### Target Device

RA2L1(R7FA2L1AB2DFP)

### Contents

1. Overview.....	2
2. Hardware Specifications.....	2
2.1 External View and Part Names .....	2
2.2 Internal Configuration .....	3
3. Demo Controls.....	4
3.1 Opening/Closing Cover .....	4
3.2 Battery .....	5
3.3 Power Source.....	5
3.4 Demonstration and Evaluation .....	6
3.5 CPU Reset.....	6
3.6 Caution .....	7
3.7 Troubleshooting.....	7
4. Customize.....	8
4.1 Cover Removal.....	8
4.2 Battery Replacement.....	8
4.3 Capacitive Touch Button Tuning .....	8
4.4 CPU Board Replacement.....	9
4.5 Electrode Board Replacement .....	9
5. Specifications .....	10
Revision History .....	11

## 1. Overview

This demo set demonstrates and evaluates the waterproof self-capacitance touch buttons with an application example of the active shield function supported by CTSU2. The demo set is equipped with ground shield buttons and active shield buttons. The difference between the two shield methods allows the user to compare the waterproof characteristics. As the board and mobile battery power source are enclosed in a waterproof box, you can pour water on the demo set and confirm controls and operations.

This application note is based on use of the standard hardware specifications of the RA2L1 CPU board and self-capacitance button electrode board.

## 2. Hardware Specifications

### 2.1 External View and Part Names

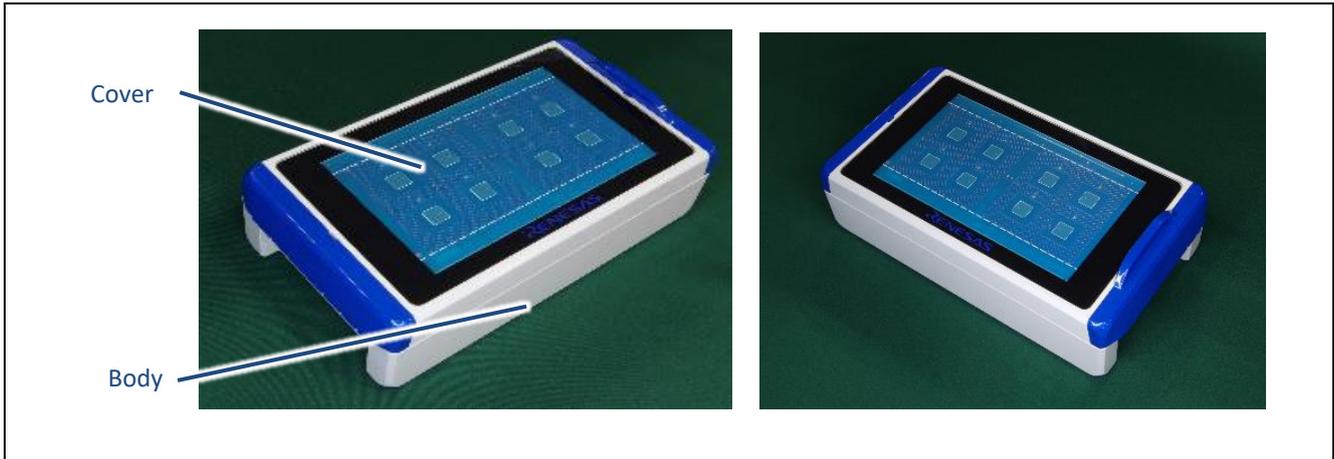


Figure 2-1 Demo Set External View

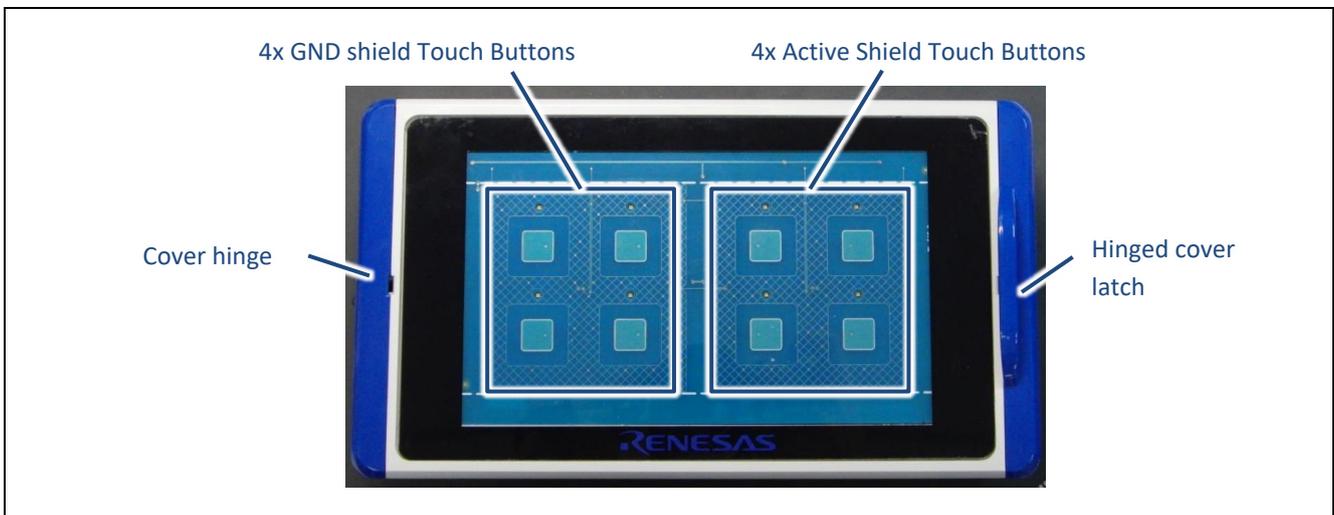


Figure 2-2 Control Panel

**GND Shield Touch Button:** A button shielded in the GND pattern. Turns on corresponding LED when touched. All buttons work independently.

**Active Shield Touch Button:** Active Shield Guard button. The active shield is a shield guard that drives at the same potential as the touch buttons. Turns on corresponding LED when touched. If pressed at the same time, the input of one of the buttons pressed earlier is enabled.

**Cover fixing hinge:** Supports the cover when opened/closed.

**Latched hinge:** Latch for opening/closing the cover.

## 2.2 Internal Configuration

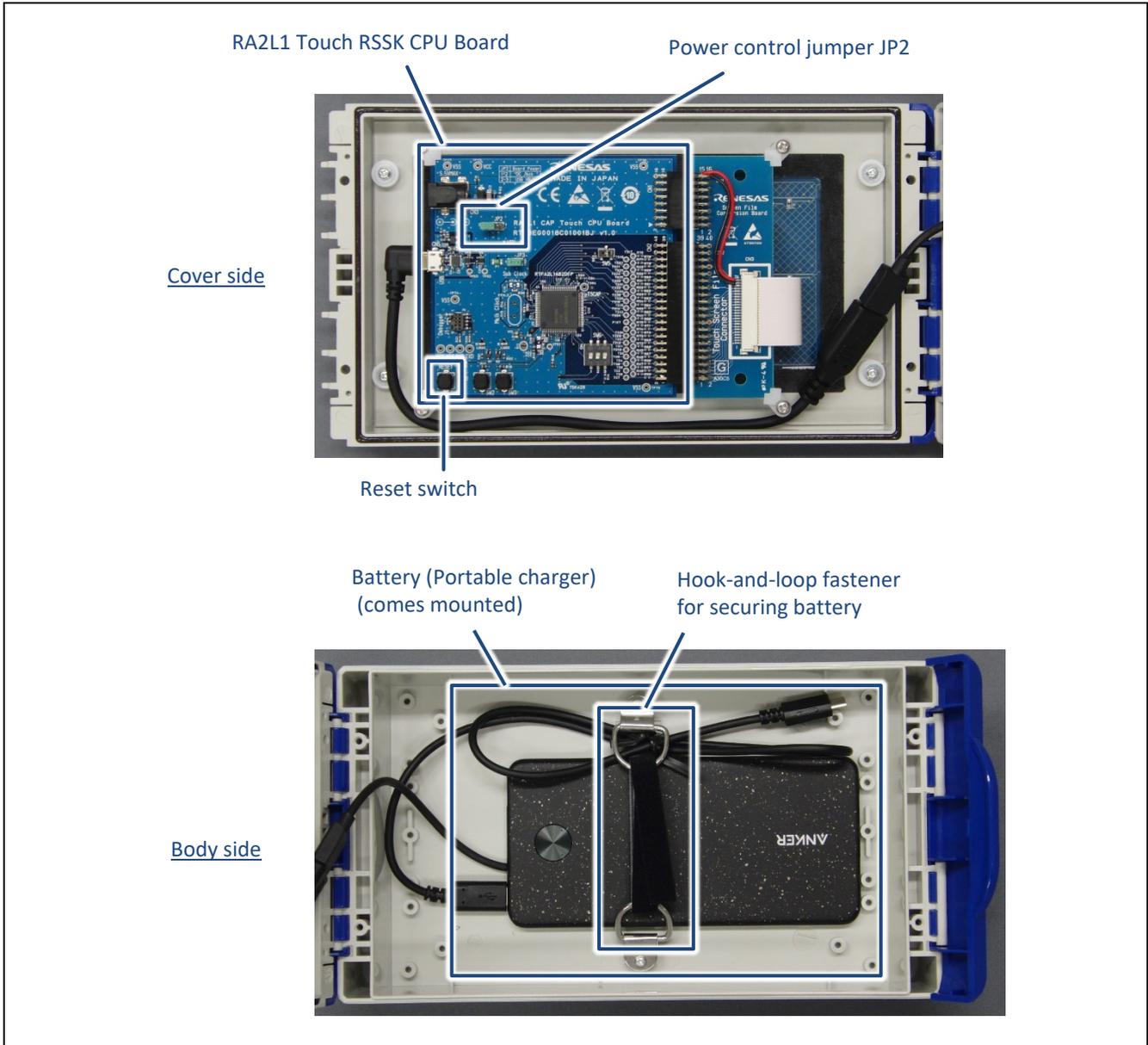


Figure 2-3. Internal Configuration

### 3. Demo Controls

#### 3.1 Opening/Closing Cover

Pull the hinged cover latch away from the unit to release and open the cover. Open the cover slowly and carefully so as not to displace the cable that reaches from the battery to the board. Also note that the weight of the cover may cause the demo set to fall over and incur damage. When opening or closing the unit, always support the cover with one hand.

When closing the cover, make sure the battery cable does not get caught between the cover and the board. Press down on the cover with one hand while closing the latch with the other.

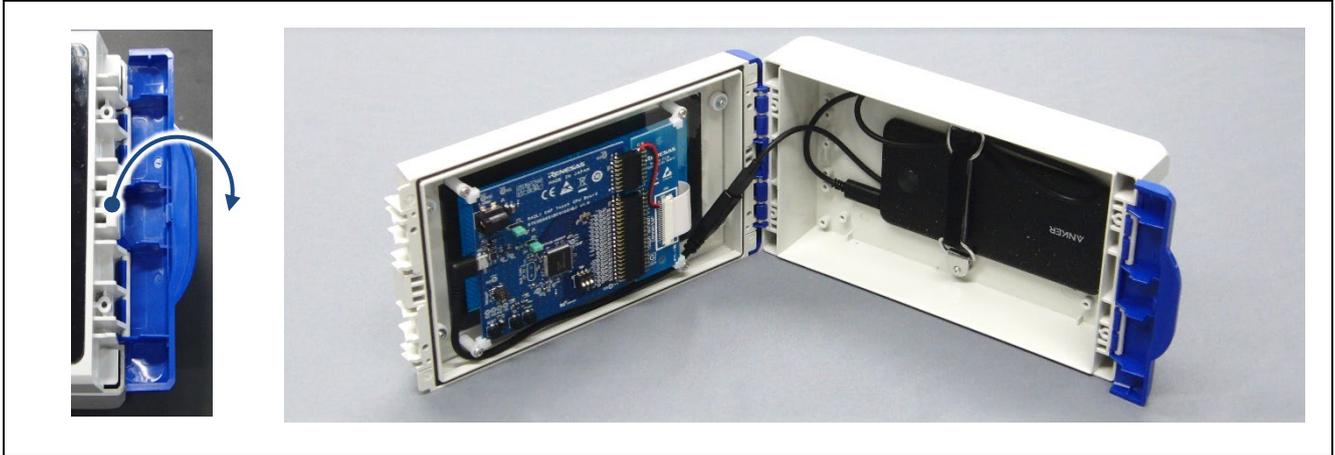


Figure 3-1. How to Open the Cover

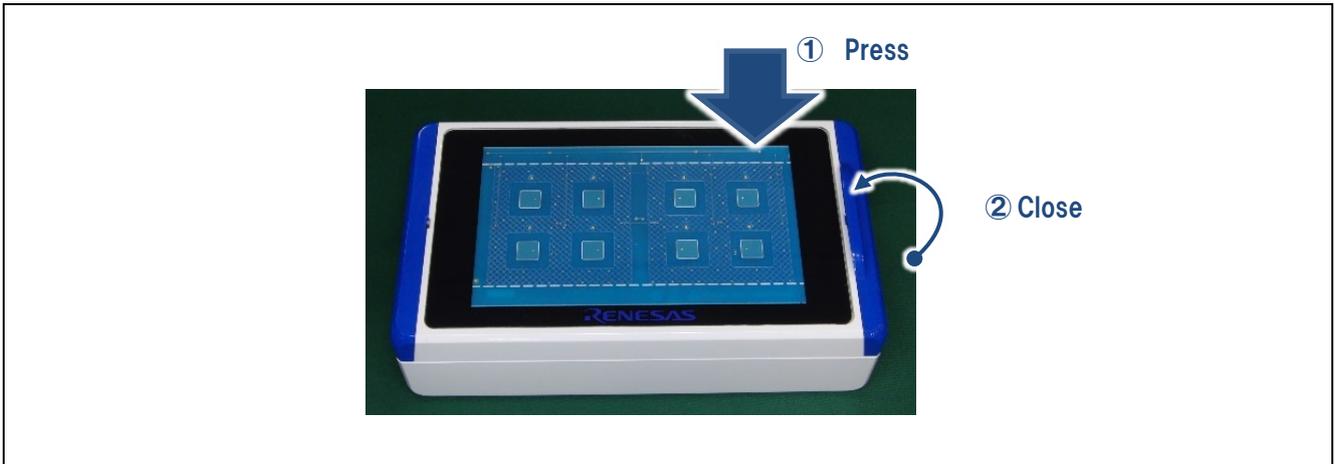


Figure 3-2. How to Close the Cover

### 3.2 Battery

The battery is secured with a hook-and-loop fastener. To remove the battery, please remove the cable from the battery first, then open the fastener. When securing the battery to the body of the demo set, take care to protect the connectors, then close the hook-and-loop fastener.

The button on the battery is the battery status indicator, not the ON/OFF switch.

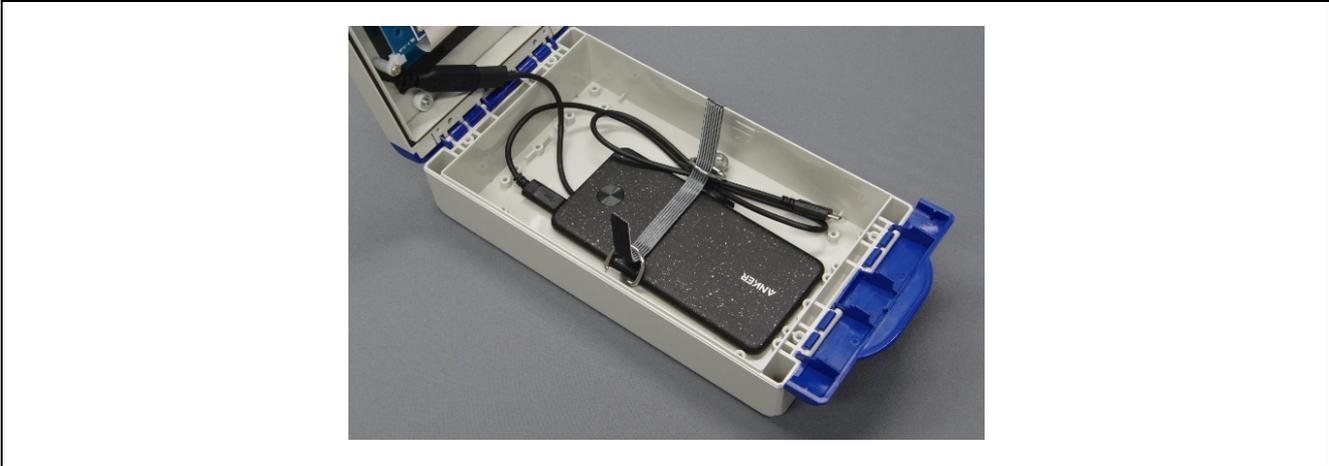


Figure 3-3. How to Remove the Battery

### 3.3 Power Source

Control the power source by switching the power source jumper on the CPU board or disconnecting the USB cable intermediate connector.

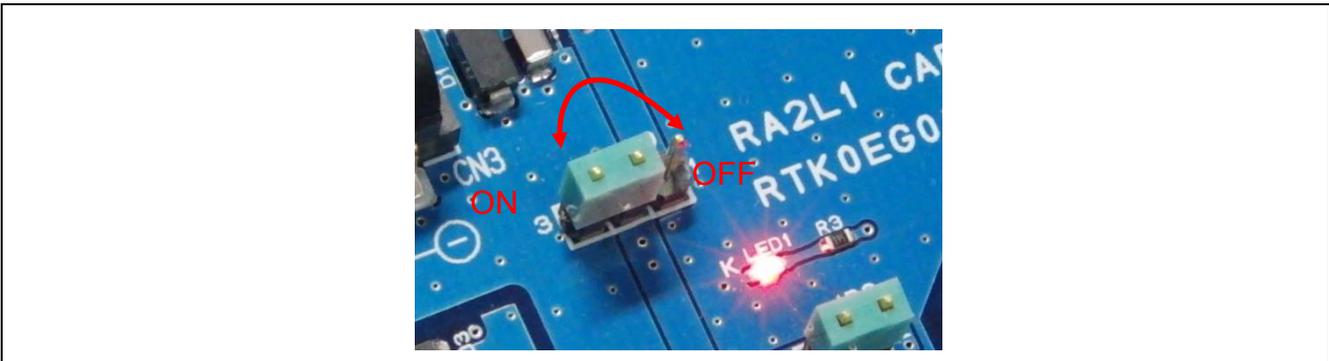


Figure 3-4. Jumper Power Control on CPU Board

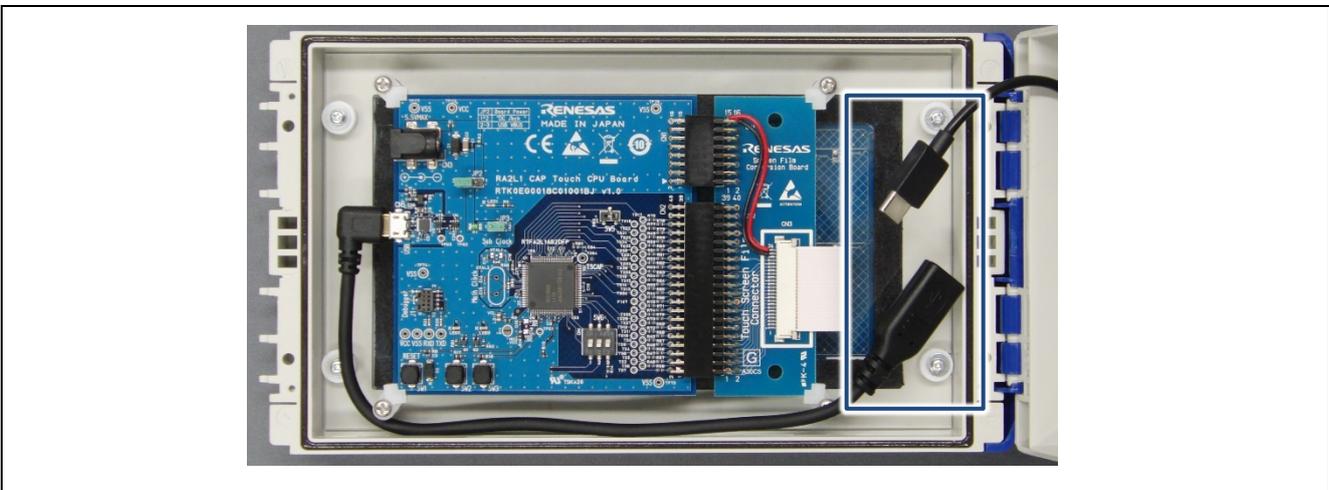


Figure 3-5. Power Source Control via USB Cable Intermediate Connector

### 3.4 Demonstration and Evaluation

After confirming that the cover is firmly closed, pour water over the demo set and try the button controls. The corresponding LED lights up when a button is touched or when a malfunction is caused due to water. GND shield buttons are configured for independent input control. Active shield buttons are pressed at the same time, the input of one of the buttons pressed earlier is enabled.

When conducting an evaluation, make sure the water does not cross over into neighboring shield. Bridging the active shield and buttons with the GND shield, may cause button malfunction.

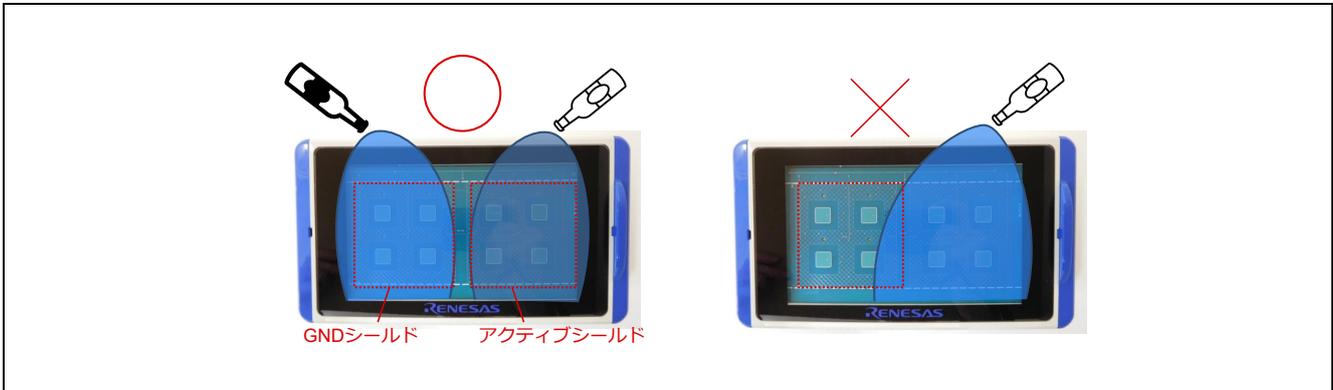


Figure 3-6. How to Pour Water on the Demo Set

Table 3-1. Operating Specifications

Button	Water exposure (Note 1)	GND Shield Button Operation	Active Shield Button Operation
No-touch	No	✓	✓
Touch	No	✓	✓
No-touch	Yes	-	✓
Touch	Yes	-	✓ (Note 2)

✓ : operable - : inoperable (malfunction, false reaction, cause simultaneous push)

Note 1: Tilt the unit about 30° and pour enough water to cover the 4 buttons protected by either the GND shield or the active shield.

Note 2: If pressed at the same time, the input of one of the buttons pressed earlier is enabled.

### 3.5 CPU Reset

Push the reset switch on the CPU board to reset the CPU.

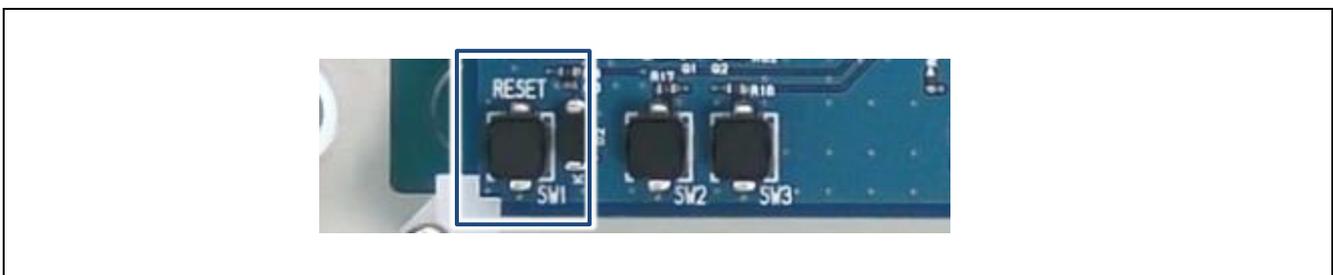


Figure 3-7. Reset Button

### 3.6 Caution

Take extra care to ensure that the cover is securely closed before conducting an evaluation with water. Although the box is waterproof, the set cannot be evaluated when fully immersed in water.

After you have completed the demonstration and evaluation, make sure you stop the power supply according to the instructions provided in section 3.3 Power Source.

Note that leakage may occur if the acrylic panel starts peeling from the cover. Take care not to shake the demo set excessively or apply too much stress on the acrylic panel.

### 3.7 Troubleshooting

**Table 3-2 Troubleshooting**

<b>Problem</b>	<b>Countermeasure</b>
Water leakage	Immediately stop using the demo set, disconnect the power source, remove the boards, battery and related accessories from the cover and dry them.
Button malfunction immediately after closing cover	This may mean the USB cable is touching the board or FFC cable. Recheck the internal wiring, reset the CPU, then close the cover.
Button malfunction during demo or when not using control buttons	Reset the CPU (see 3.5 CPU).
Malfunction occurs regardless of now water exposure and no touch.	
No power supply	Check the mobile battery status. You may need to charge the battery.
Power cuts off during operations	Connecting the USB TypeC – MicroB cable to the mobile battery. The standard specification includes a cable that is set to allow current to flow all the time. Some types of mobile batteries automatically turn off if the output current is too low.

## 4. Customize

### 4.1 Cover Removal

To customize the set, you will need to remove the screws on the cover and/or body. When customizing, remove the 2 hinges (cover and latch), and separate the cover and body. Remove the cover hinge by removing the minus driver.



Figure 4-1. How to Remove the Cover Hinge

### 4.2 Battery Replacement

When using a mobile battery other than the one included in the standard parts, make sure the battery dimensions, including the attached cable, meet the specifications shown below.

- LxWxH = 82x180x16(mm)

Some mobile batteries cut off output when power consumption is low, so always confirm operations before using the demo set with a replacement battery. If the battery you choose does cut off output, introduce a dummy load somewhere on the power supply cable as a workaround.

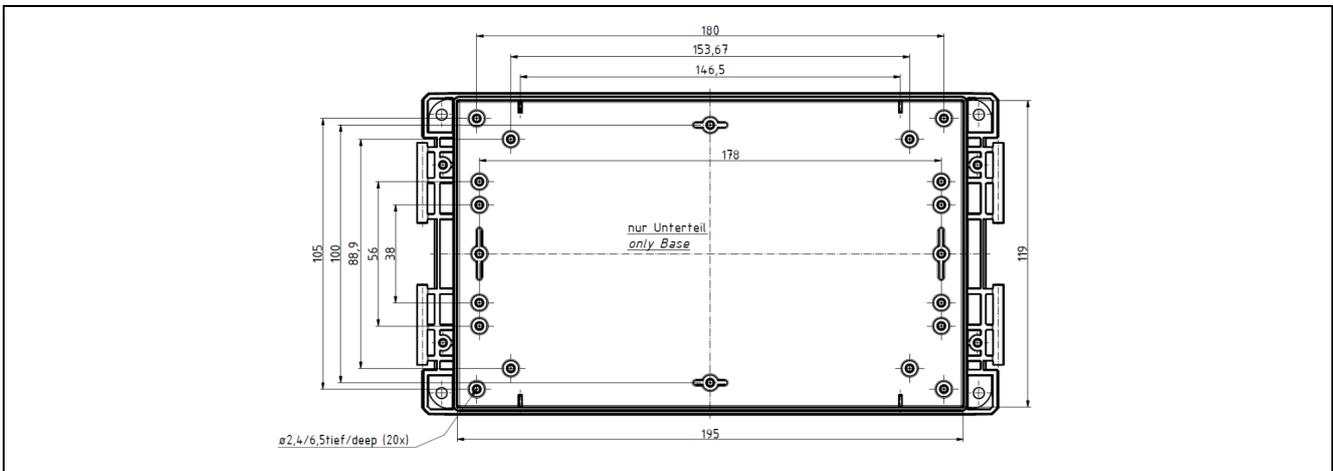


Figure 4-2. Internal Body Dimensions

### 4.3 Capacitive Touch Button Tuning

To re-tune the electrodes, first remove the cover and then attach the debugger cables to the boards. Do not close the cover while the debugger cables are connected as that may cut off the cables and cause shorting and other damage.

### 4.4 CPU Board Replacement

The CPU board can be replaced with the CPU board that comes with the Renesas Electronics Capacitive Touch Evaluation System. To replace the CPU board, remove the cover before removing any of the fixed parts. Take care not to cut or bend the flat cable.

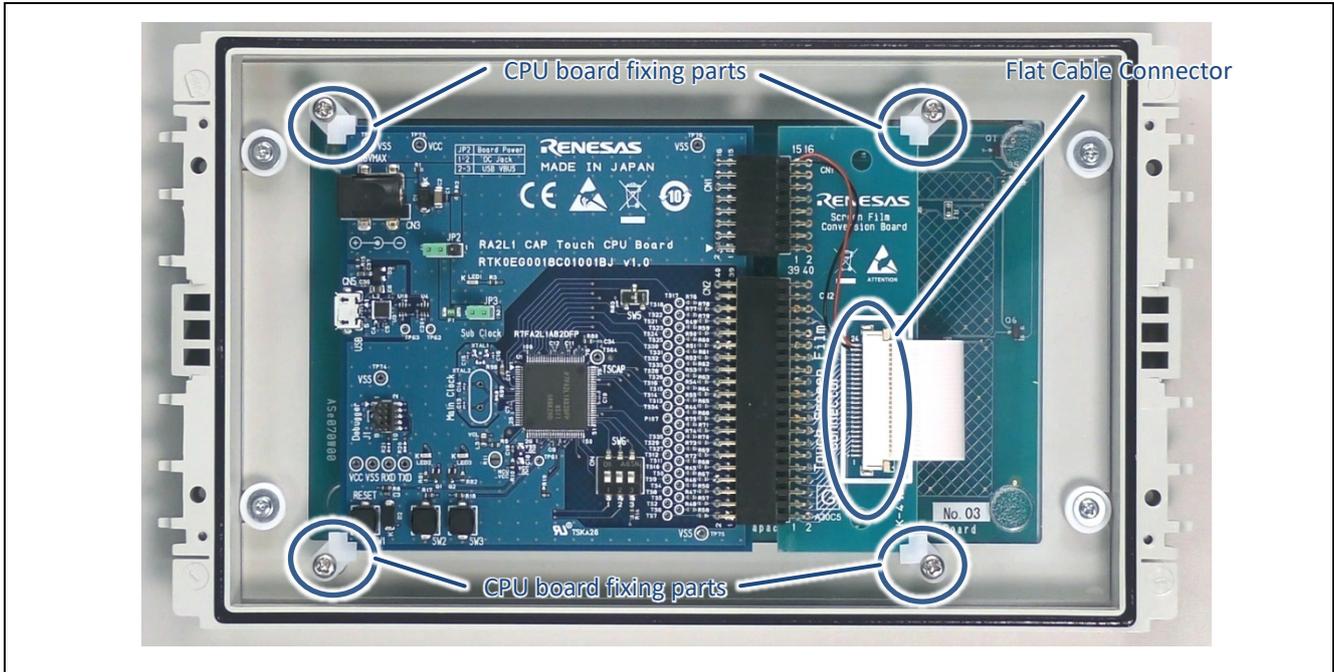


Figure 4-3. How to replace the CPU board

### 4.5 Electrode Board Replacement

To replace the electrode board, remove the cover before removing any of the fixed parts. Take care not to cut or bend the flat cable.

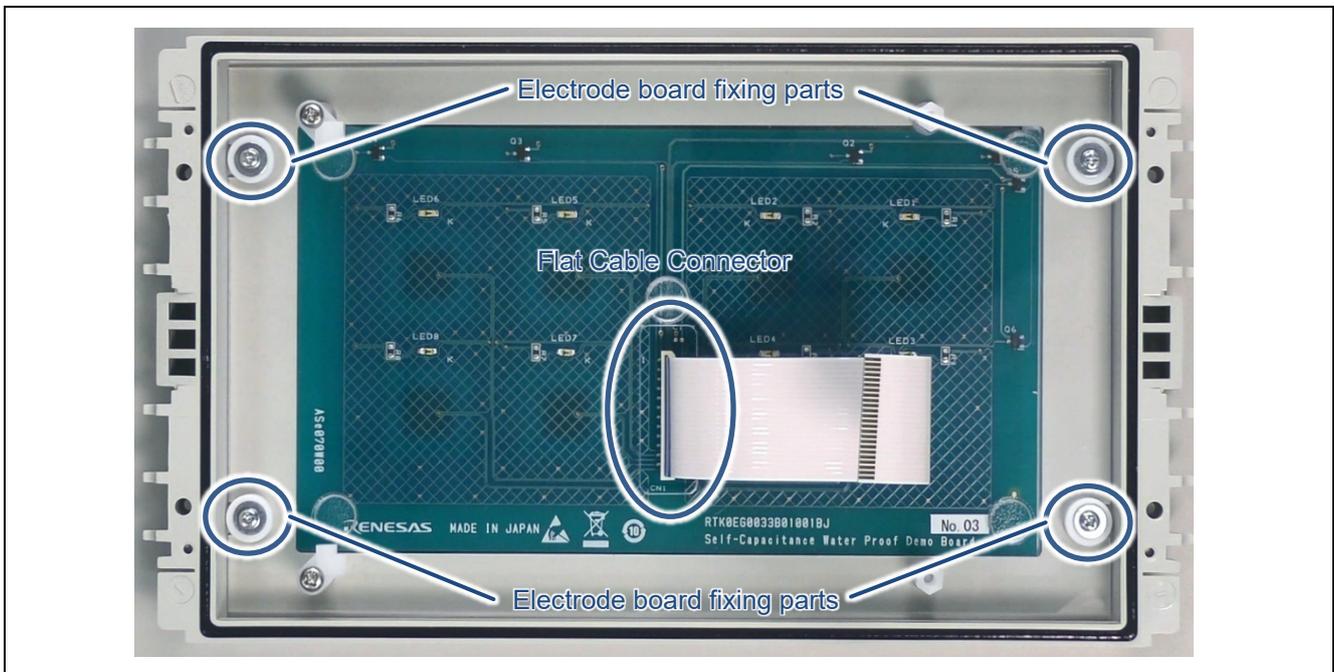


Figure 4-4. How to replace the electrode board

## 5. Specifications

**Table 5-1 Hardware Specifications**

Item	Specifications
MCU	Model No.: RA2L1 (R7FA2L1AB2DFP)
Control panel	Self-capacitance touch buttons: 8 <ul style="list-style-type: none"> <li>• GND shield buttons: 4</li> <li>• Active shield buttons: 4</li> </ul> LEDs: 8 Acrylic panel thickness: 2mm
Power supply	5V USB power supply (internal mobile battery power supply)
Internal devices	<p>CPU board</p> <ul style="list-style-type: none"> <li>• RA2L1 Cap Touch CPU Board (RTK0EG0018C01001BJ) Renesas Electronics Capacitive Touch Evaluation System for RA2L1 (RTK0EG0022S01001BJ) Accessories</li> </ul> <p>Electrode board</p> <ul style="list-style-type: none"> <li>• Self-capacitance Waterproof Demo Board</li> <li>• FFC Conversion Board for Capacitive Touch Evaluation System — FFC cable: molex 150390405</li> </ul> <p>Mobile battery</p> <ul style="list-style-type: none"> <li>• Anker PowerCore III Slim 5000 with Built-in USB-C Cable (A1218011)</li> </ul> <p>USB cable</p> <ul style="list-style-type: none"> <li>• USB Type C female to Micro USB male L-shape 90-degree angle right-facing conversion adapter</li> <li>• ELECOM USB Type-C micro-B cable (U2C-CMB05NBK)</li> </ul>
Dimensions (W x D x H)	125 x 231 x 60(mm) (excluding the protruding cover handle)
Weight	524g (excluding battery)
Current consumption	500mA or less
Operating Temperature Range	When operating: 10 to 35°C, in storage: -10 to 50°C (no condensation)

**Revision History**

Rev.	Date	Description	
		Page	Summary
1.0	Sep.30.2021	-	First Edition issued

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

The following usage notes are applicable to all Microprocessing unit and Microcontroller unit products from Renesas. For detailed usage notes on the products covered by this document, refer to the relevant sections of the document as well as any technical updates that have been issued for the products.

## 1. 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.

## 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 or any other use of the circuits, software, and information in the design of your product or system. Renesas Electronics disclaims any and all liability for any losses and damages incurred by you or third parties arising from the use of these circuits, software, or information.
2. Renesas Electronics hereby expressly disclaims any warranties against and liability for infringement or any other claims involving 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, including but not limited to, the product data, drawings, charts, programs, algorithms, and application examples.
3. 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 shall be responsible for determining what licenses are required from any third parties, and obtaining such licenses for the lawful import, export, manufacture, sales, utilization, distribution or other disposal of any products incorporating Renesas Electronics products, if required.
5. You shall not alter, modify, copy, or reverse engineer any Renesas Electronics product, whether in whole or in part. Renesas Electronics disclaims any and all liability for any losses or damages incurred by you or third parties arising from such alteration, modification, copying or reverse engineering.
6. Renesas Electronics products are classified according to the following two quality grades: "Standard" and "High Quality". The intended 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; industrial robots; etc.
  - "High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control (traffic lights); large-scale communication equipment; key financial terminal systems; safety control equipment; etc.Unless expressly designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not intended or 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 damage (space system; undersea repeaters; nuclear power control systems; aircraft control systems; key plant systems; military equipment; etc.). Renesas Electronics disclaims any and all liability for any damages or losses incurred by you or any third parties arising from the use of any Renesas Electronics product that is inconsistent with any Renesas Electronics data sheet, user's manual or other Renesas Electronics document.
7. No semiconductor product is absolutely secure. Notwithstanding any security measures or features that may be implemented in Renesas Electronics hardware or software products, Renesas Electronics shall have absolutely no liability arising out of any vulnerability or security breach, including but not limited to any unauthorized access to or use of a Renesas Electronics product or a system that uses a Renesas Electronics product. RENESAS ELECTRONICS DOES NOT WARRANT OR GUARANTEE THAT RENESAS ELECTRONICS PRODUCTS, OR ANY SYSTEMS CREATED USING RENESAS ELECTRONICS PRODUCTS WILL BE INVULNERABLE OR FREE FROM CORRUPTION, ATTACK, VIRUSES, INTERFERENCE, HACKING, DATA LOSS OR THEFT, OR OTHER SECURITY INTRUSION ("Vulnerability Issues"). RENESAS ELECTRONICS DISCLAIMS ANY AND ALL RESPONSIBILITY OR LIABILITY ARISING FROM OR RELATED TO ANY VULNERABILITY ISSUES. FURTHERMORE, TO THE EXTENT PERMITTED BY APPLICABLE LAW, RENESAS ELECTRONICS DISCLAIMS ANY AND ALL WARRANTIES, EXPRESS OR IMPLIED, WITH RESPECT TO THIS DOCUMENT AND ANY RELATED OR ACCOMPANYING SOFTWARE OR HARDWARE, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY, OR FITNESS FOR A PARTICULAR PURPOSE.
8. When using Renesas Electronics products, refer to the latest product information (data sheets, user's manuals, application notes, "General Notes for Handling and Using Semiconductor Devices" in the reliability handbook, etc.), and ensure that usage conditions are within the ranges specified by Renesas Electronics with respect to maximum ratings, operating power supply voltage range, heat dissipation characteristics, installation, etc. Renesas Electronics disclaims any and all liability for any malfunctions, failure or accident arising out of the use of Renesas Electronics products outside of such specified ranges.
9. Although Renesas Electronics endeavors to improve the quality and reliability of Renesas Electronics products, semiconductor products have specific characteristics, such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Unless designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not subject to radiation resistance design. You are responsible for implementing safety measures to guard against the possibility of bodily injury, injury or damage caused by fire, and/or danger to the public in the event of a failure or malfunction of Renesas Electronics products, 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 and impractical, you are responsible for evaluating the safety of the final products or systems 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. You are responsible for carefully and sufficiently investigating applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive, and using Renesas Electronics products in compliance with all these applicable laws and regulations. Renesas Electronics disclaims any and all liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
11. Renesas Electronics products and technologies shall 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 shall comply with any applicable export control laws and regulations promulgated and administered by the governments of any countries asserting jurisdiction over the parties or transactions.
12. It is the responsibility of the buyer or distributor of Renesas Electronics products, or any other party who distributes, disposes of, or otherwise sells or transfers the product to a third party, to notify such third party in advance of the contents and conditions set forth in this document.
13. This document shall not be reprinted, reproduced or duplicated in any form, in whole or in part, without prior written consent of Renesas Electronics.
14. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products.

(Note1) "Renesas Electronics" as used in this document means Renesas Electronics Corporation and also includes its directly or indirectly controlled subsidiaries.

(Note2) "Renesas Electronics product(s)" means any product developed or manufactured by or for Renesas Electronics.

(Rev.5.0-1 October 2020)

## Corporate Headquarters

TOYOSU FORESIA, 3-2-24 Toyosu,  
Koto-ku, Tokyo 135-0061, Japan

[www.renesas.com](http://www.renesas.com)

## Trademarks

Renesas and the Renesas logo are trademarks of Renesas Electronics Corporation. All trademarks and registered trademarks are the property of their respective owners.

## Contact information

For further information on a product, technology, the most up-to-date version of a document, or your nearest sales office, please visit:

[www.renesas.com/contact/](http://www.renesas.com/contact/).