Cap Touch and 3D gesture solution

New Capacitive Touch IP

Renesas Electronics Corporation

18th May 2018

What is Capacitive Touch?

Roughly, method of the touch panel has
“Capacitive touch switch” and “Projection-capacitive touch”

Touch panel

- Projection-capacitive touch (Touch Screen)
- Capacitive touch Switch

	Capacitive touch Screen	Capacitive touch Switch
Features	・High degree of freedom for operation (Two-dimensional) ・Using expensive components such as liquid crystal display	・Low degree of freedom for operation (One-dimensional) ・Few components
Main components	Liquid crystal display, ITO electrode, Cover panel	Cover panel
Cost	High	**Low**
Adopted product	・Smart Phone, Tablet ・Game machine etc.	・Home Appliance (Refrigerator, MWO, Rice Cooker) ・Health care products (Blood Pressure Meter, Body Composition Meter) etc.

Reference: Comparison of Switch

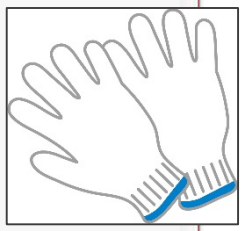
	Mechanical Switch	Membrane Switch		Capacitive touch
		Normal type 	Film type 	
Freedom of Design	×	×	△	○
Cost	×	△	×	○
water-proof/dust-proof	×	×	○	○
Endurance	△	×	×	○
Freedom of Material	×	×	×	○
Feeling of press	○	△	△	×
Easy-to press	△	×	×	○
Example of use				

THE CONTENTS

Feature of Renesas Capacitive Touch

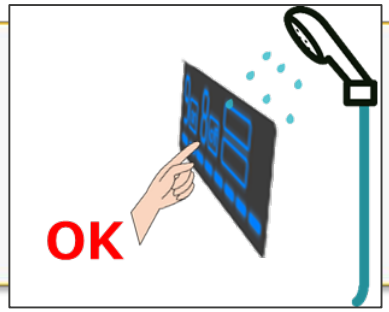
1. High sensitivity & High Noise Immunity

- Sensing of thick acrylic material, wooden material and wear the glove
- Realizing 300mm-proximity sensing
- Noise Immunity, which passed the IEC61000 4-3/4-6 Level 3



2. Compatible with both Self/Mutual capacitance method

- Enhance water resistance (Mutual)
- Increase cap touch key channels by matrix (Mutual)

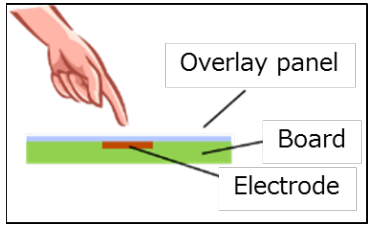


3. Easy Development

- Development tool realizes sensitivity auto-tuning
- Short R&D time by development tool

1. High Sensitivity & High Noise Immunity
- High Sensitivity -

■ Existing Touch



Overlay material	Relative permittivity
Glass	5.4 - 9.9
Acryl	2.7 - 4.5
Wood (Dried)	2.0 - 6.0
Air	1.0

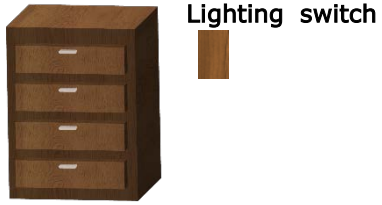
Easy

Difficult

■ Renesas New Touch

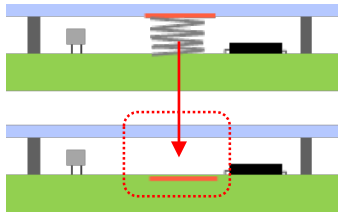
Material Free

Good Design!

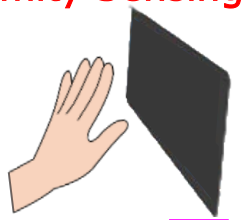


Cost Reduction

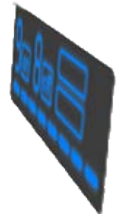
Reducing spring!



Proximity Sensing

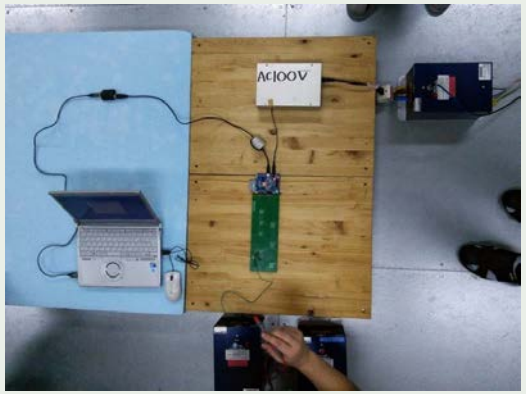


Futuristic Design!



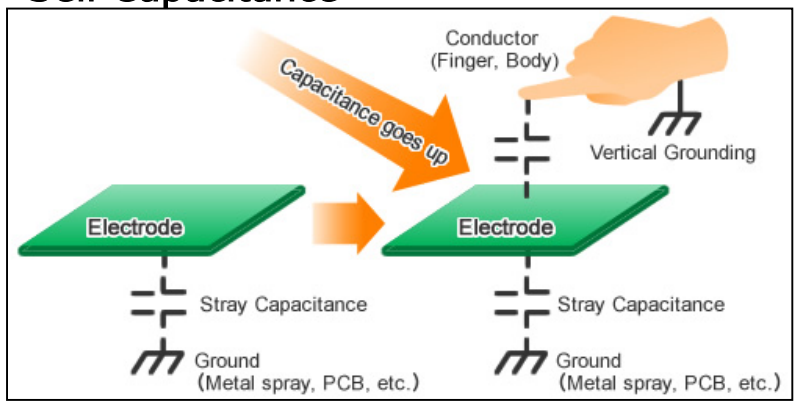
1. High Sensitivity & High Noise Immunity
- High Noise Immunity -

Renesas CTSU **passed the industrial standard of "IEC61000 4-3/4-6 level 3".**

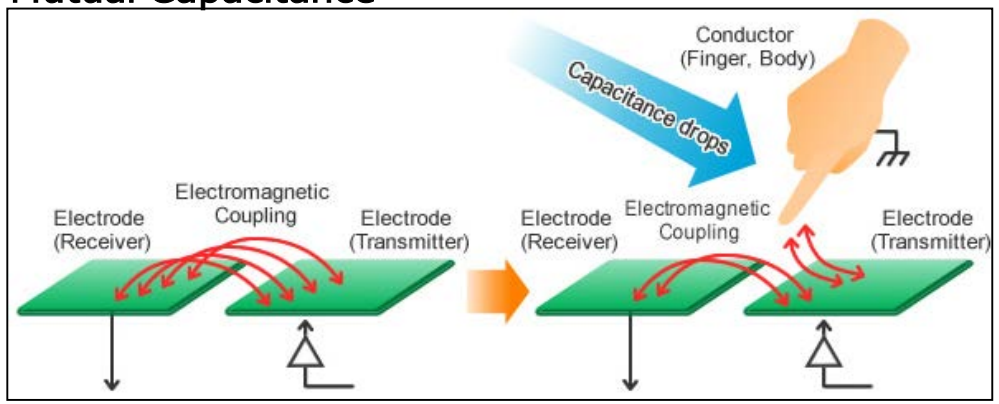
	IEC61000 4-3	IEC61000 4-6
Overview	Radiated, radio-frequency, electromagnetic field immunity test	Immunity to conducted disturbances, induced by radio-frequency fields
Frequency range	80MHz-1GHz	150KHz-80MHz
Noise Test Environment		

2. Compatible with both Self/Mutual capacitance method

Self Capacitance



Mutual Capacitance



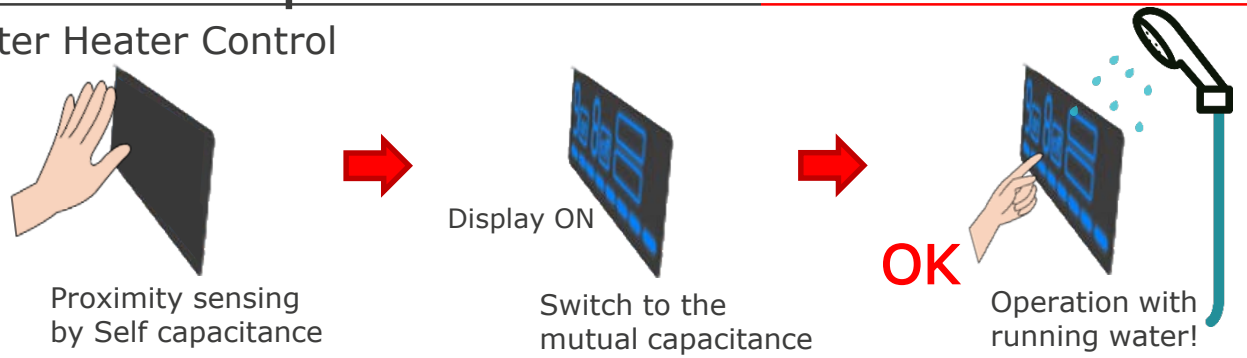
Feature of Self/Mutual capacitance method

	Self Capacitance	Mutual Capacitance
Layout	○ Easy	△ Some Limitation
Proximity sensing	○ Easy	△ Harder than self
Water resistance	△ Not strong	○ Strong
Matrix	△ Some Limitation	○ Avl.

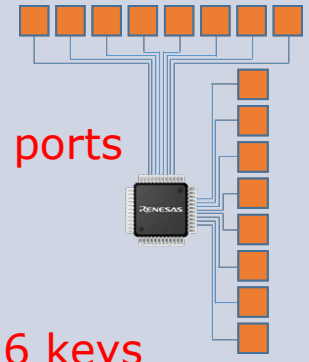
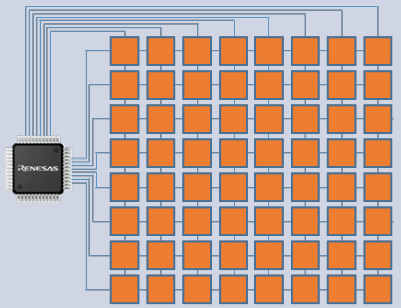
2. Compatible with both Self/Mutual capacitance method
- Merit of Mutual capacitance method -

Renesas new Cap Touch can offer both “Self” and “Mutual” method.

(Ex.) Water Heater Control



Increase cap touch key channels by matrix

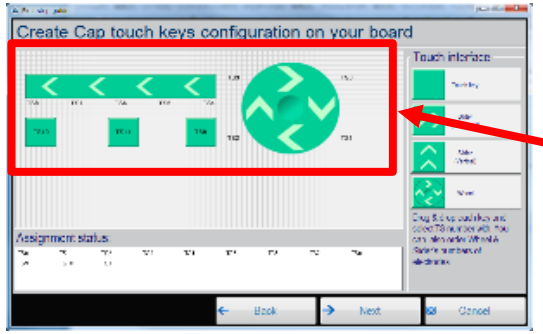
Self capacitance method	Mutual capacitance method
 16 ports 16 ports → 16 keys	 16 ports 8 ports x 8ports → 64 keys

3. Easy Development

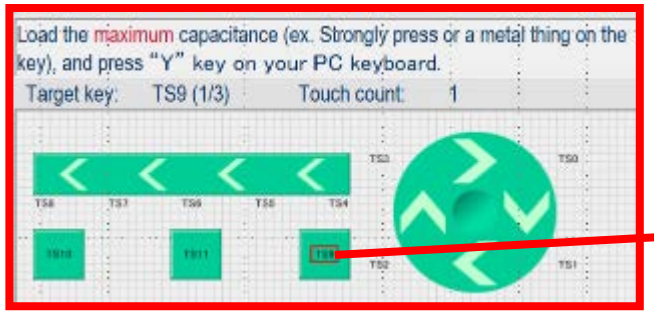
Workbench6 ⟷ **IDE「CS+」or「e2 studio」**

Touch Auto Tuning & Code Generate

Step1. Just drug & drop keys into the design box



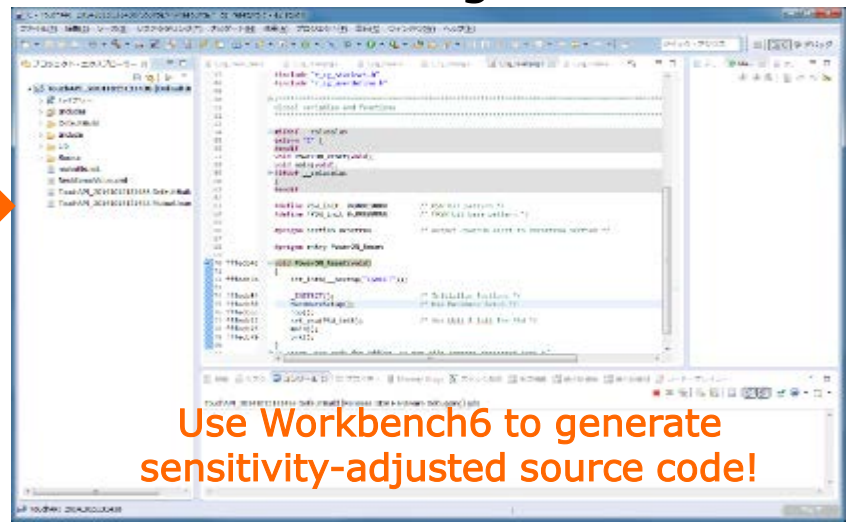
Step 2. Touch the electrode to determine each key's sensitivity



Touch

Bridge

Debug



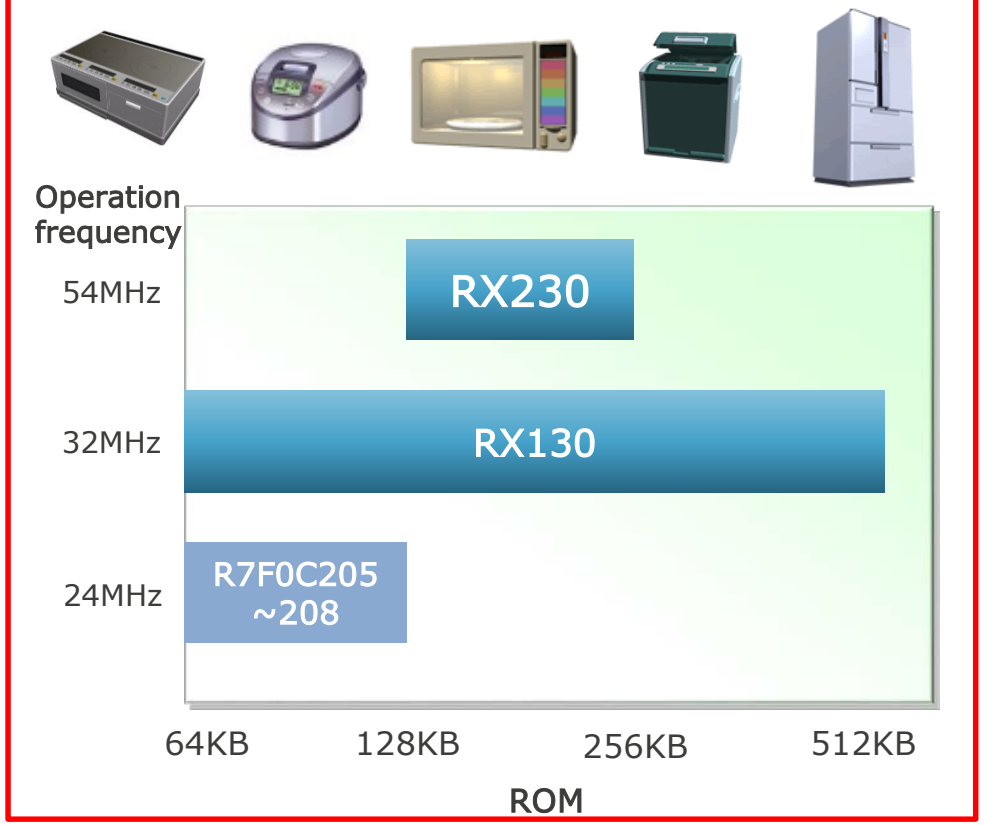
Use Workbench6 to generate sensitivity-adjusted source code!

- Even beginners can develop easily!
- Greatly reduce development man-hours and speed up development schedule!

(Reference) See the features of Workbench6 !
https://www.renesas.com/en-us/solutions/key-technology/human-interface/touch-sensor-system2.html

Renesas Touch MCUs Lineup

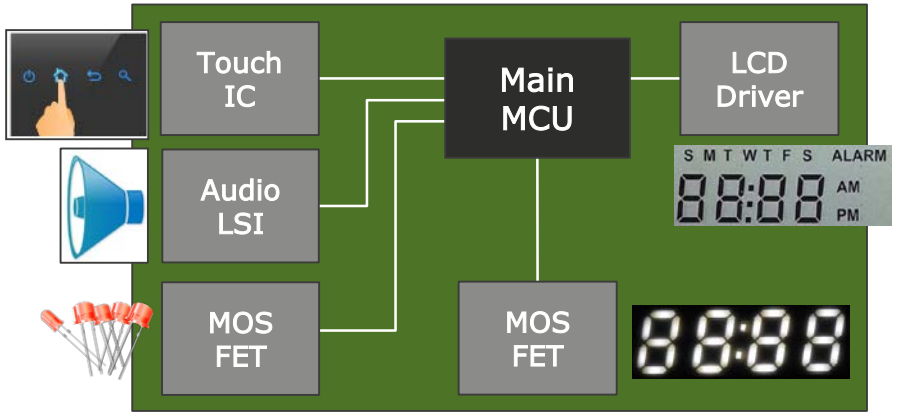
Devices	Basic Specifications	Features	Applications
RX113	- RX-v1 Core (32MHz) - Power supply voltage: 1.8-3.6V - Pin: 100pin - ROM: 128-512KB	- Cap touch: 12ch - Segment LCD driver - USB (Host/Function)	Healthcare 
RX231	- RX-v2 Core (54MHz) - Power supply voltage: 1.8-5.5V - Pin: 48, 64, 100pin - ROM: 128-512KB	- Cap touch: 24ch (max) - USB (Host/Function) - Security function - CAN/SDHI	Industry
RX230	- RX-v2 Core (54MHz) - Power supply voltage: 1.8-5.5V - Pin: 48, 64, 100pin - ROM: 128-256KB	- Cap touch: 24ch (max)	- Consumer (High-end) - General purpose
RX130	- RX-v1 Core (32MHz) - Power supply voltage: 1.8-5.5V - Pin: 48, 64, 80pin → 100pin (Under development) - ROM: 64-128KB → ~512KB (Under development)	- Cap touch: 36ch (max) - 0.8mm-pitch QFP PKG	- Consumer - Housing equipment - General purpose
R7F0C 205~208	- RL78 Core (24MHz) - Pin: 64, 80pin - ROM: 64-128KB	- Cap touch: 24ch (max) - Segment LCD driver - High current I/O - 0.65mm-pitch QFP PKG	- Consumer - Housing equipment - General purpose



Reduce BOM cost by system integration
- ex. R7F0C205~208 -

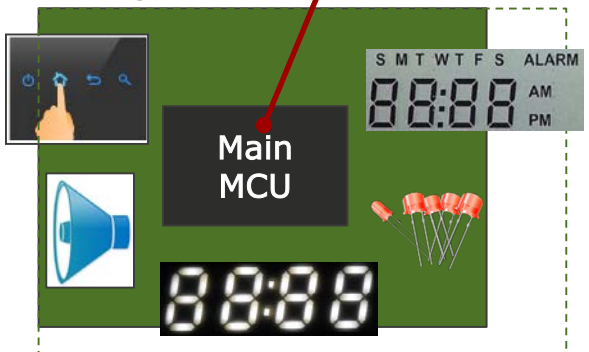
[Function]
Touch: CTSU
LED : I/O
Seg-LCD: LCD driver
7Seg-LED: High current I/O
Audio: ADPCM

■ Existing Model



Reduce the board

■ Renesas Proposal



Prices are for image only.

Function	Existing Model	Renesas estimation (Ex.)
Main MCU	$ 1.0	$ 1.5
Motor MCU	$ 1.0	Unnecessary (Using "M3S-S2-Tiny" Middleware)
Touch IC	$ 0.5	Unnecessary
Audio LSI	$ 1.0	Unnecessary
LCD Driver	$ 0.5	Unnecessary
MOSFET	$ 0.1	Unnecessary
BCB	$ x	$ x – $ 0.1
Total	**$ 4.1 + x**	**$ 2.0 + ($ x – $ 0.1)**

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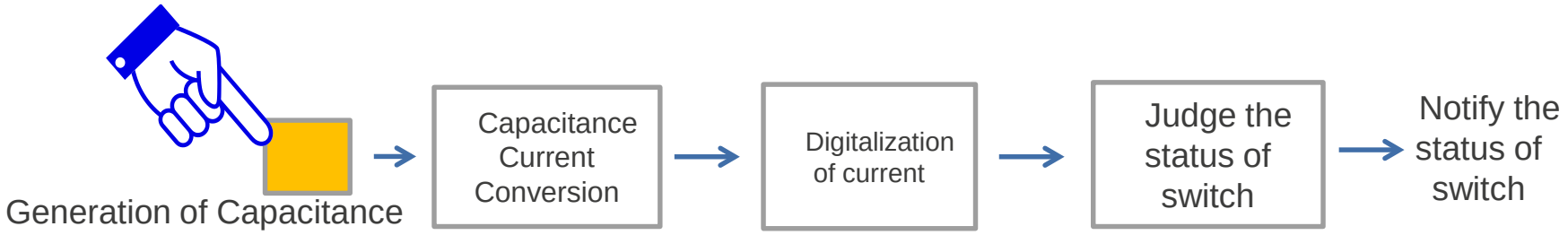
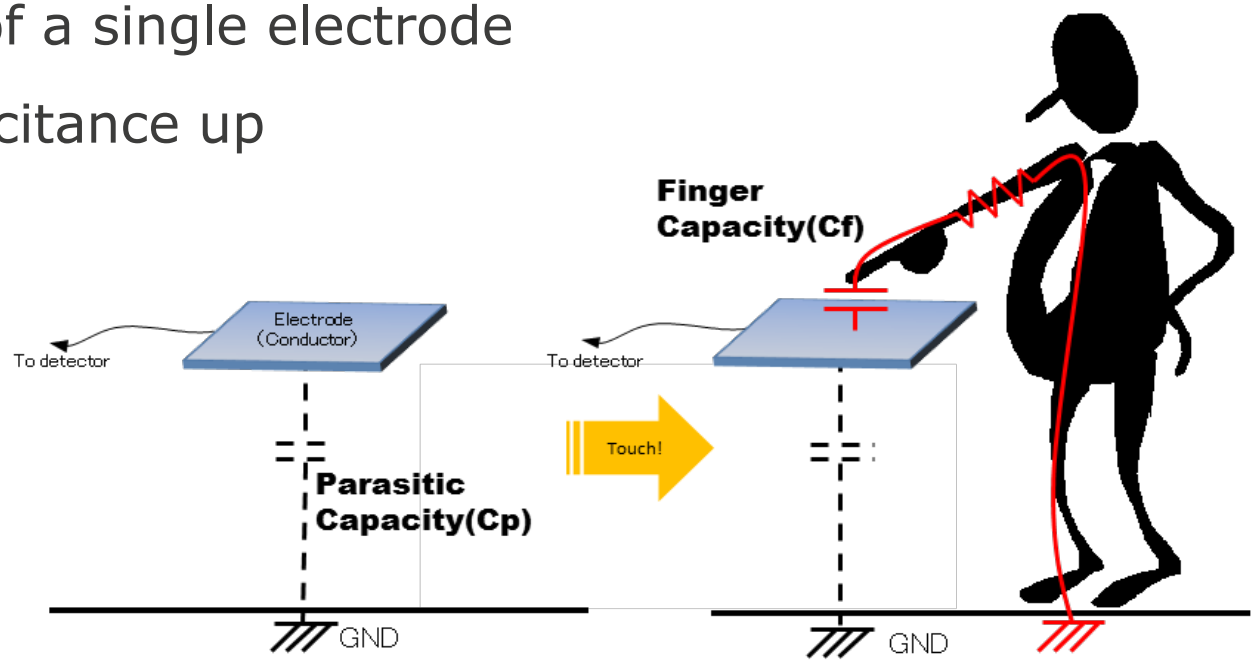
The basis of capacitive touch switch

- Detect a small capacitive (1pF or less) change
  - High sensitivity and high noise immunity dedicated hardware is necessary.
  - Many noise troubles may occur on the system using a general purpose MCU or easy built with logic IC.
- Capacitive touch detection principle of Renesas



Generation of Electrostatic Capacity

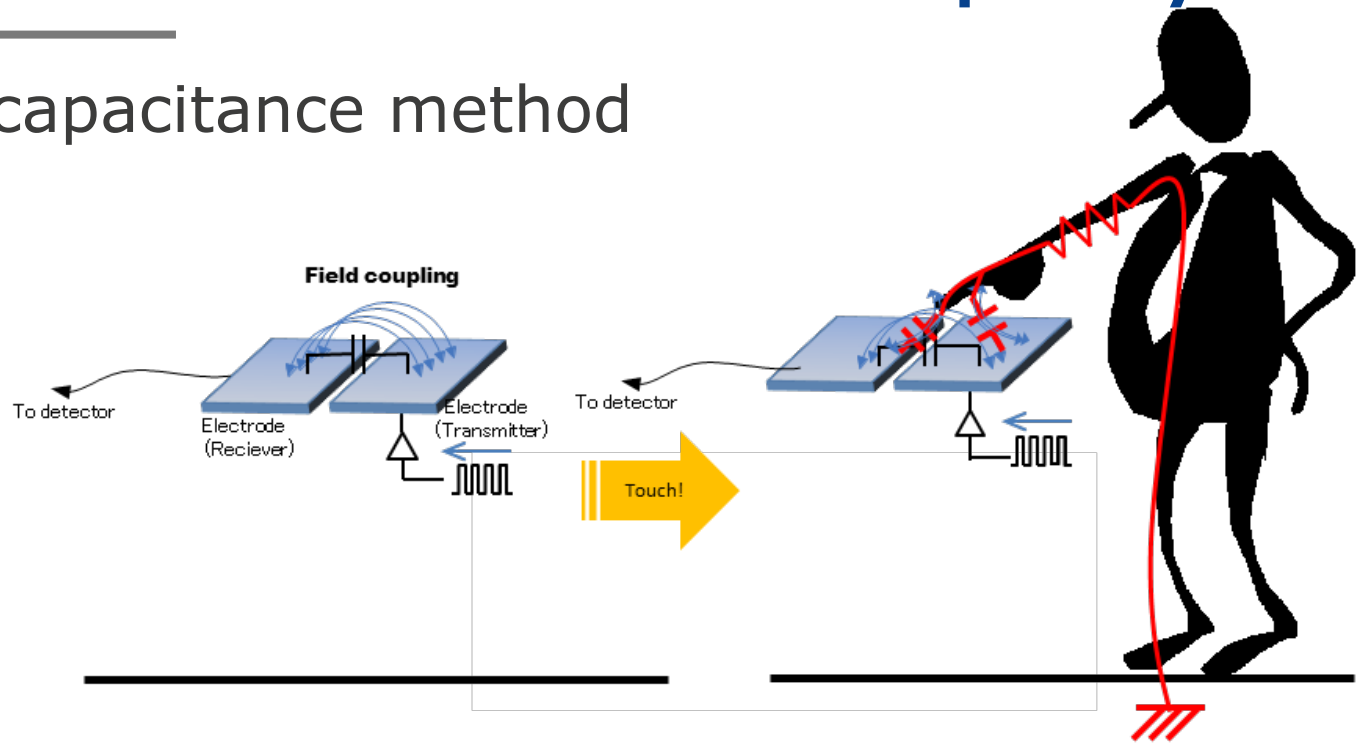
- Self-capacitance method
  - Composed of a single electrode
  - Detect capacitance up



$$\text{Total Capacity} = \text{Cp} + \text{Cf}$$

Generation of Electrostatic Capacity

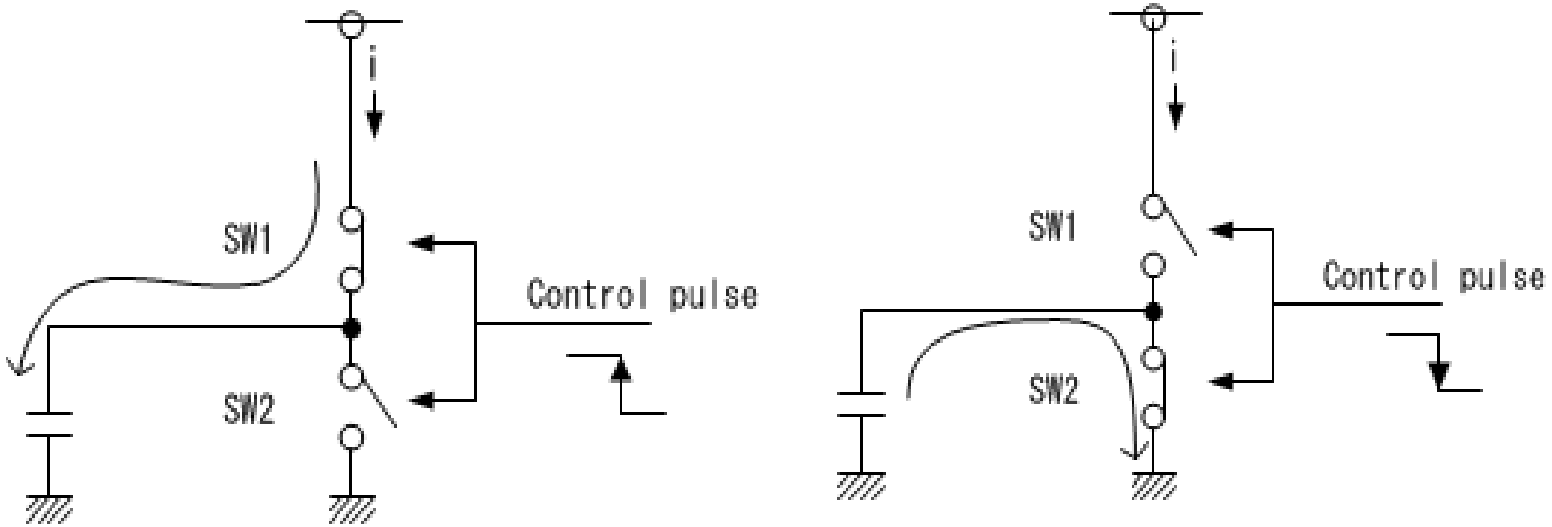
- Mutual-capacitance method



- Composed a pair of transmission electrode and reception electrode
- Detect inter electrode capacitance down
- Supported Matrix structured key for multiple keys

Capacitance - Current conversion

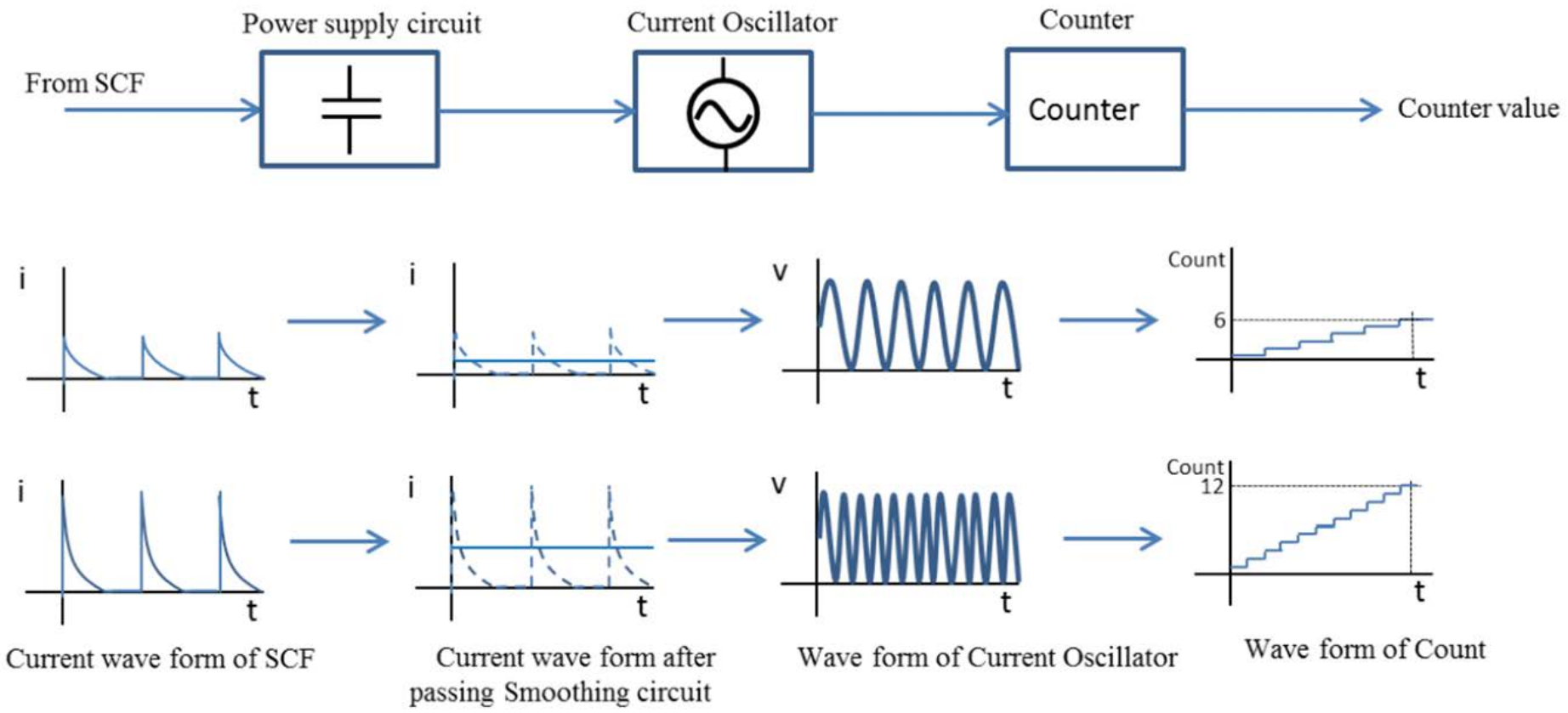
- Switched capacitor filter (SCF)



SW1	ON	OFF	ON	OFF	OFF
SW2	OFF	ON	OFF	ON	ON

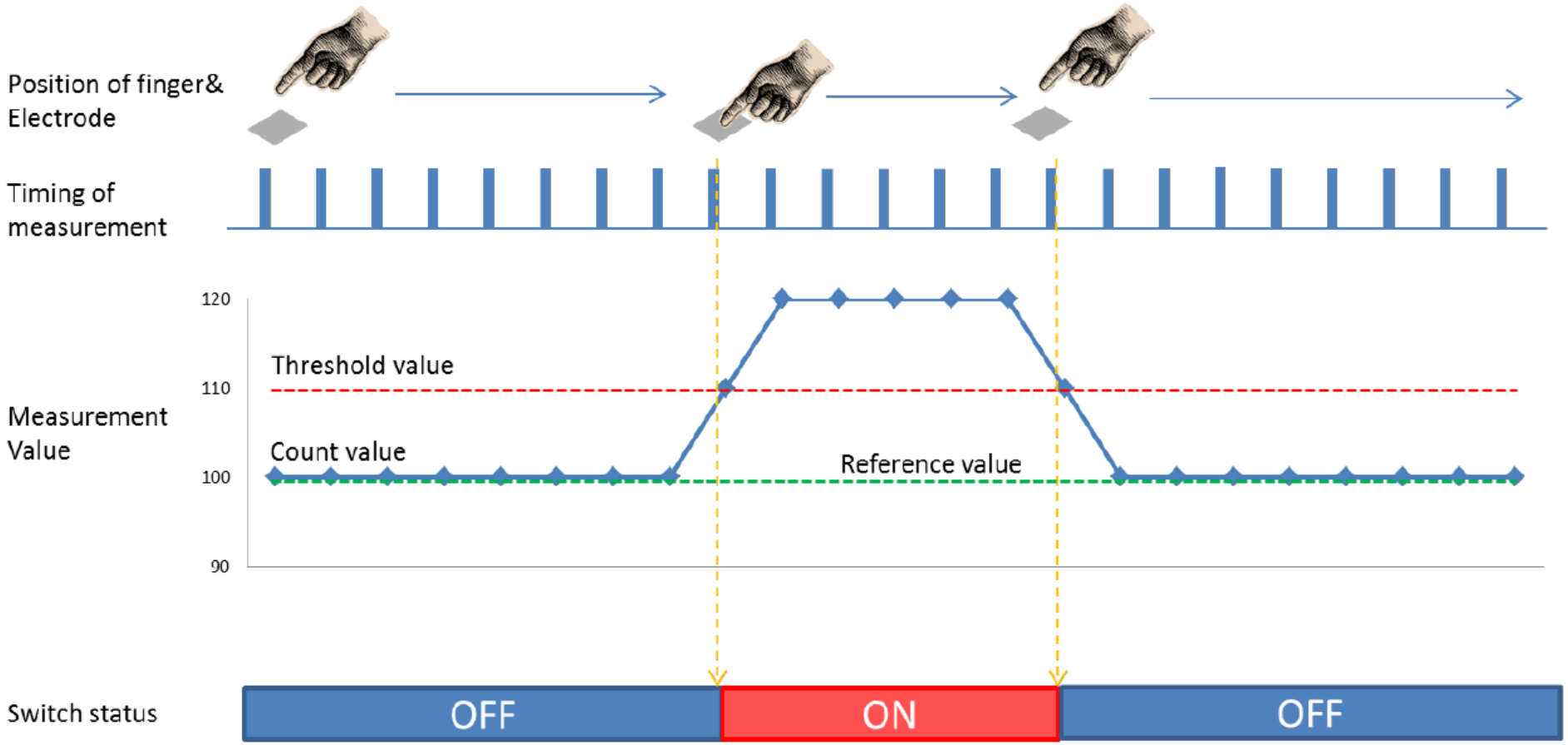
Digitalizing of Current

- Flow of current digitalization



Touch Switch ON/OFF judgement

- Measurement values and Touch ON/OFF judgement



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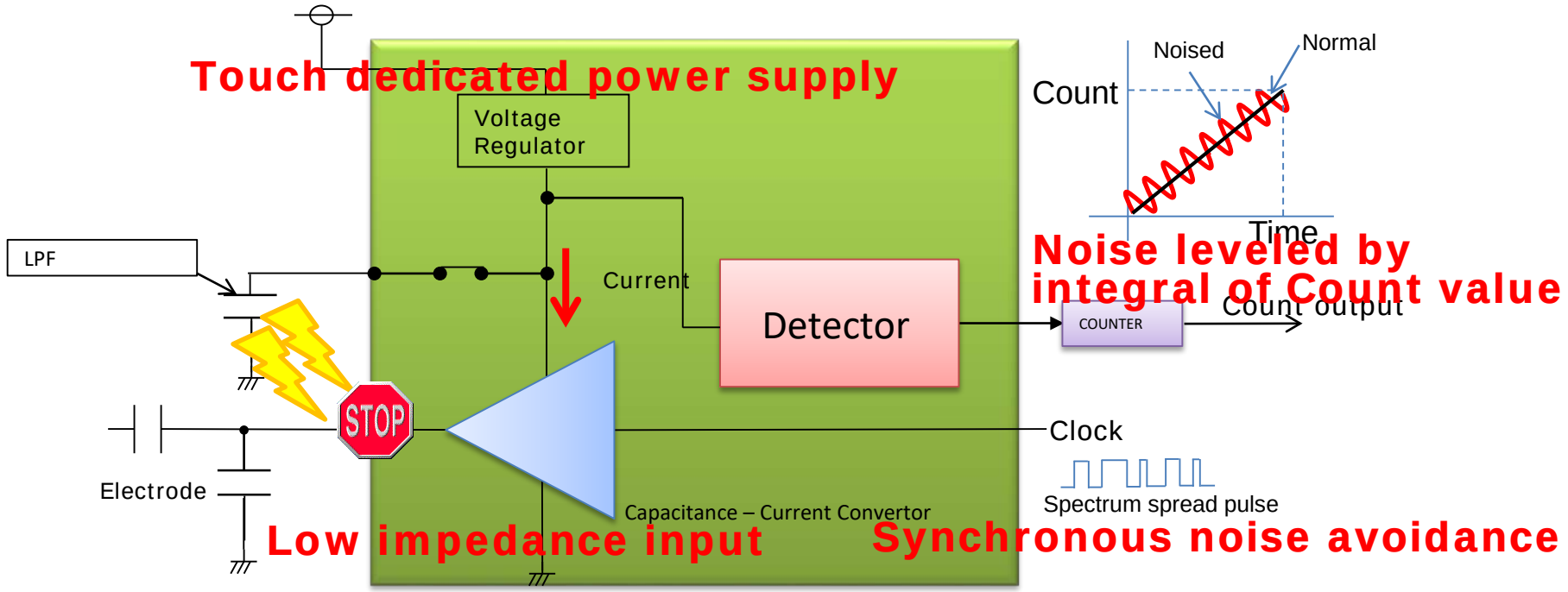
1. Capacitive touch detection system of Renesas
2. The basis of capacitive touch
3. **Noise Immunity**
4. 3D Gesture solution

Countermeasure for Noise by CTSU

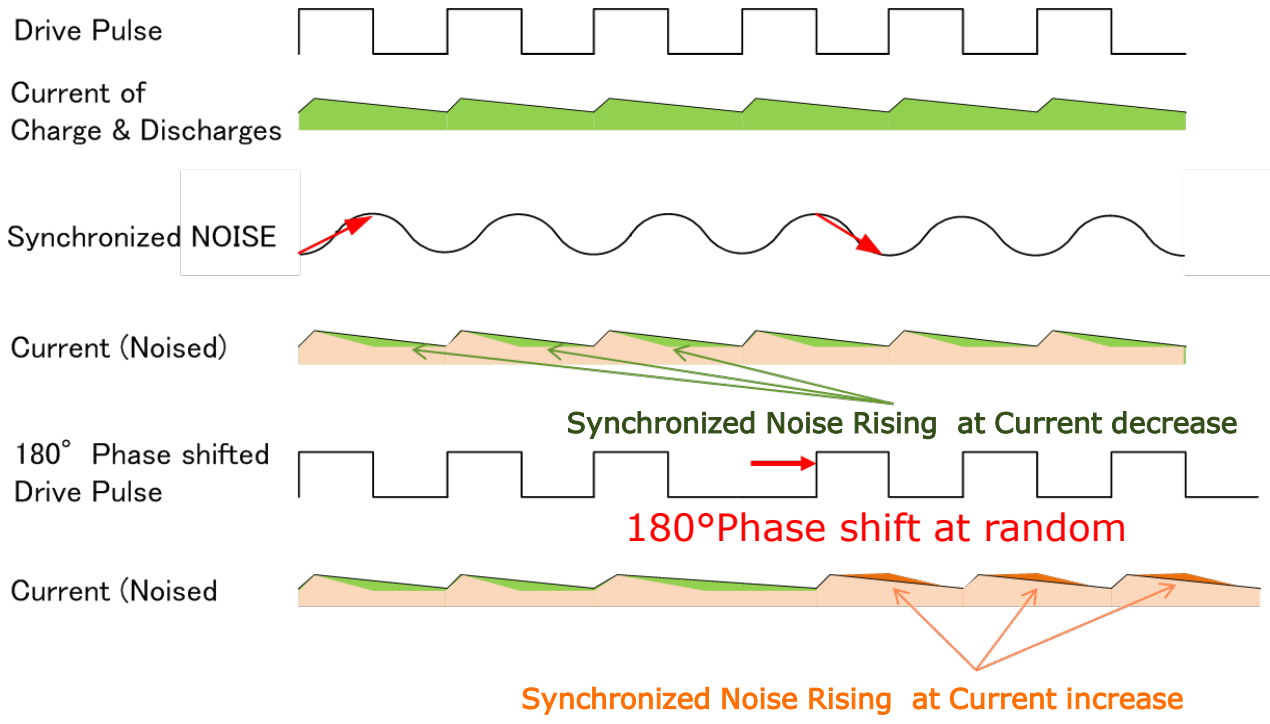
Overview



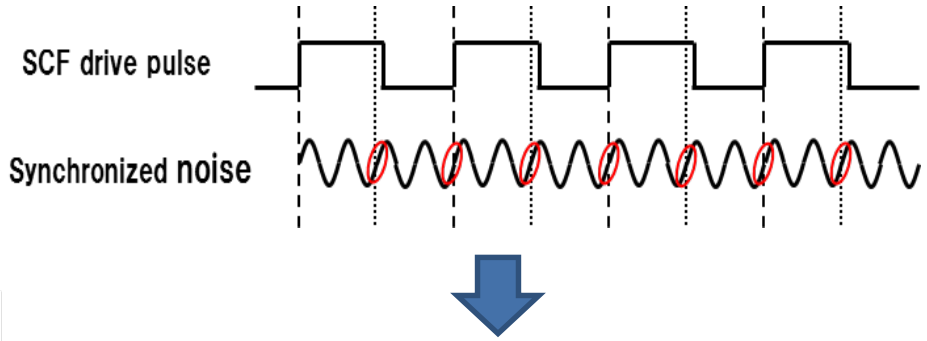
Countermeasure for synchronous noise

■ SCF Clock phase shift

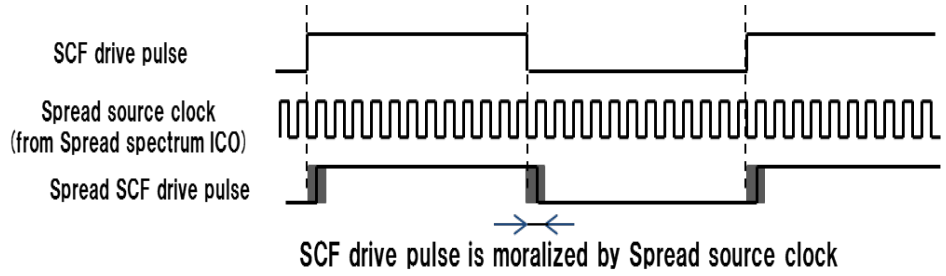
Built-in SCF Drive Pulse Phase Shift Circuit
Avoiding Drive Pulse synchronize with noise mountain / valley by Phase shifting



■ SCF Drive Pulse Spread Edge

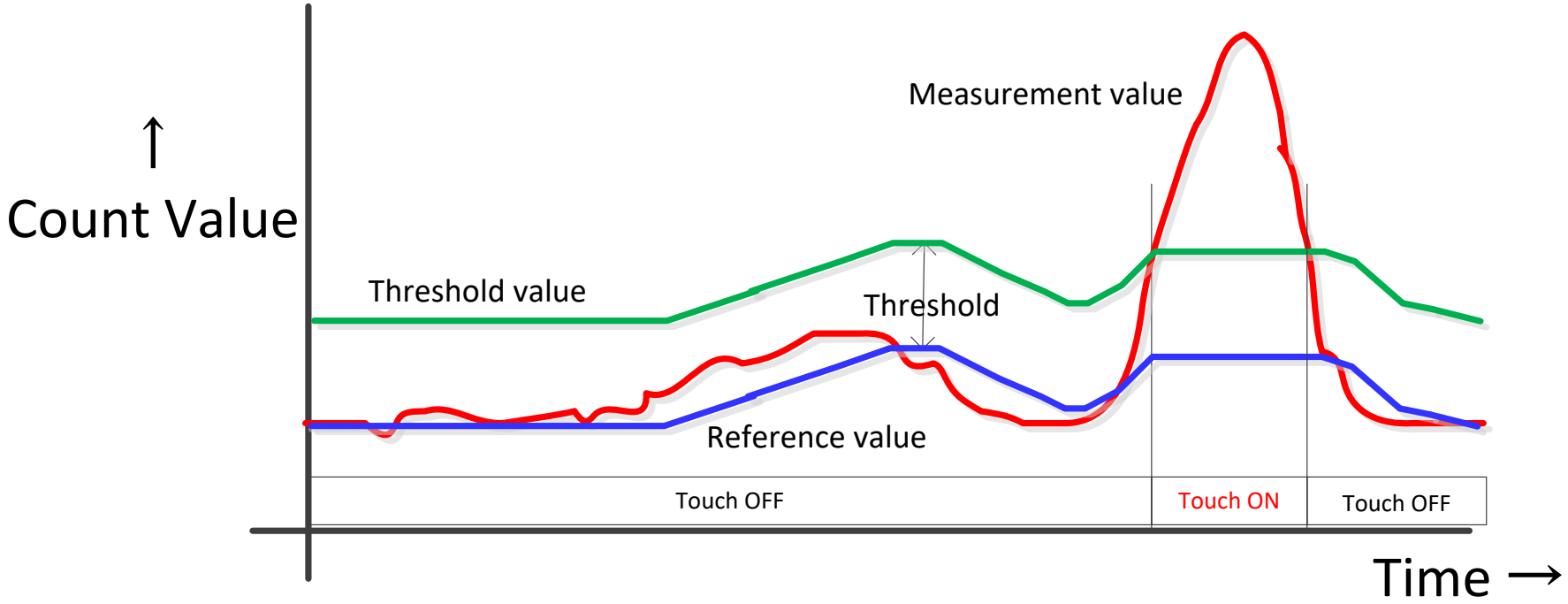


Reducing noise effect using a spread edge frequency that edges of SCF Drive Pulse is determined by Spread clock source which is un-synchronized with Drive pulse as a high frequency noise countermeasure.



Countermeasure for noise by software

Threshold and Drift Correction Process



- Taking a noise margin by threshold setting
- Tracking of Reference and threshold by Drift Correction Process

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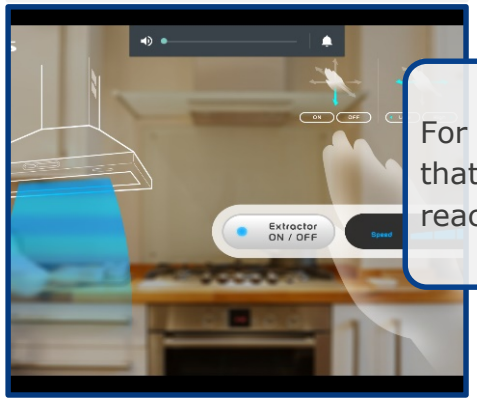
INTRODUCING TOUCH-FREE CONTROLS FOR HOME APPLIANCES

Bidet toilet seat

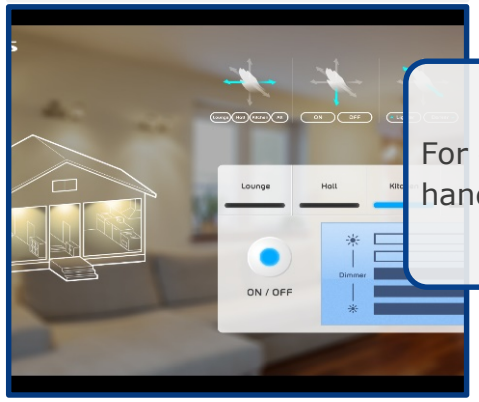
For avoiding hand contact

Range top



For hands that can't reach

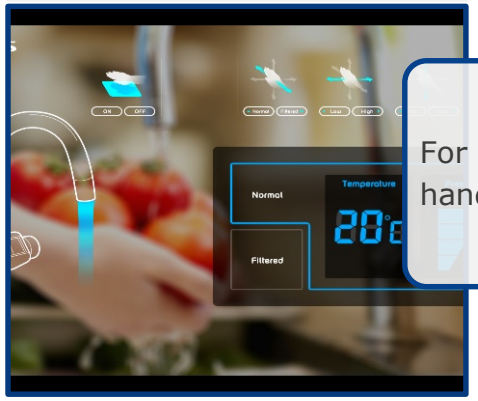
Light dimmer switch



For occupied hands

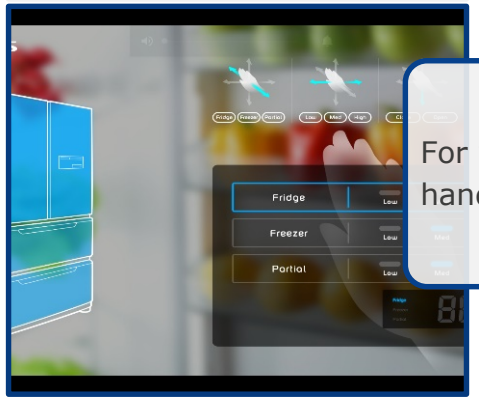
A solution for various home appliance needs using electrostatic capacitance to sense 3D gestures

Automatic faucet



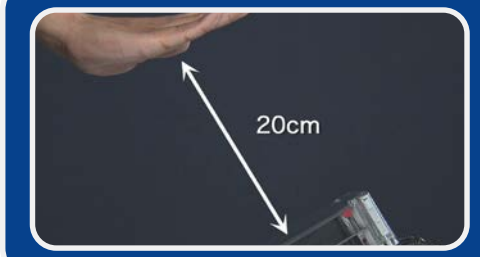
For dirty hands

Refrigerator



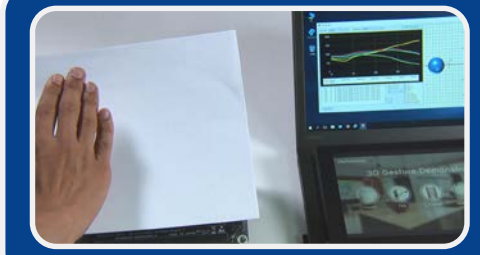
For wet hands

Renesas 3D Gesture Technology Features



Renesas highly sensitive and highly noise-resistant capacitive Touch Sensor Solution

- Recognizes hand gestures up to 20cm away from sensor
- Max. accuracy: 1mm



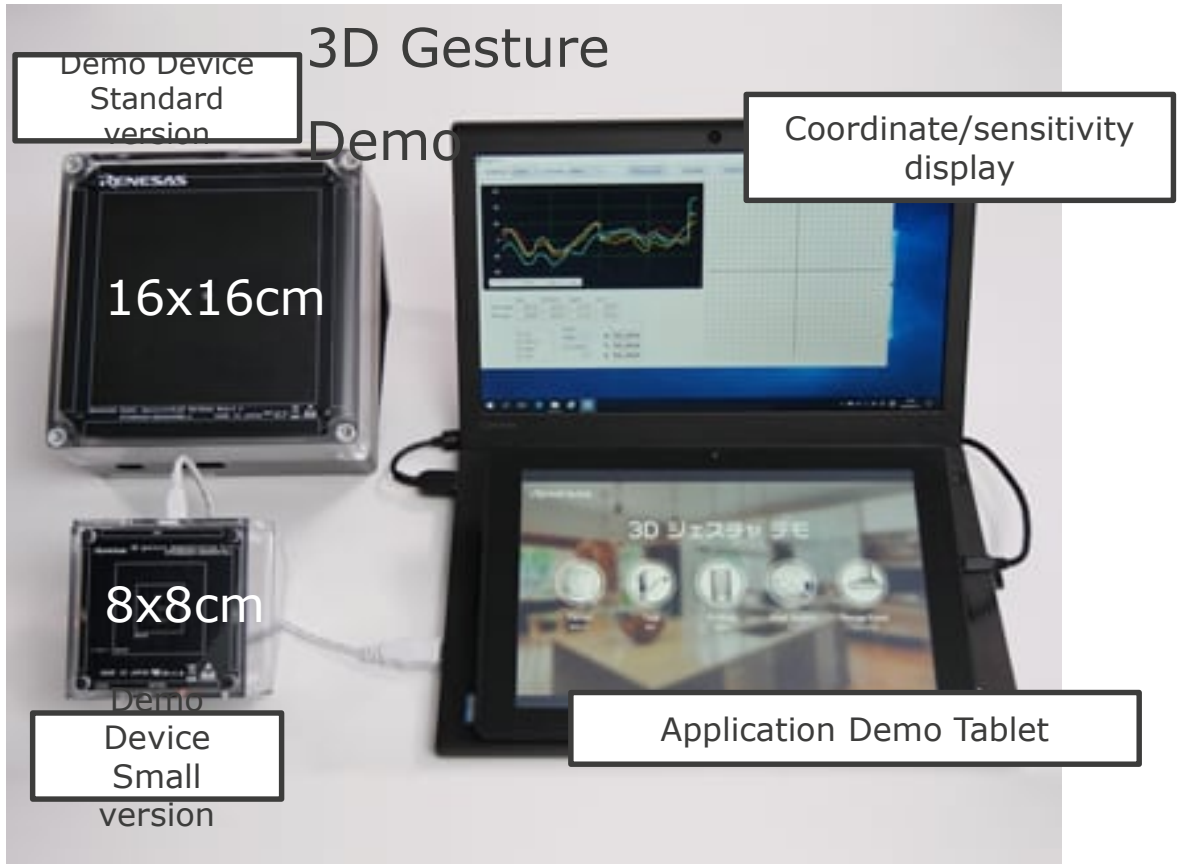
Effective even with noise or shields

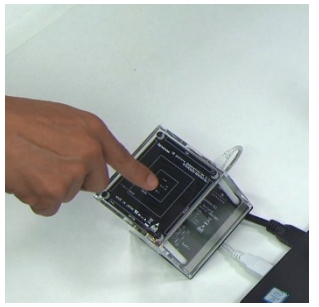
- Sensing though any non-conducting material, easy to embed in walls
- IEC61000 4-3, 4-6 LEVEL3 compatible (No miss detection under the noise-test)

Applicable in wide range of products

- Product system and gesture controls enable through high-performance, low-power 16-bit MCU + touch IP
- 3D Gesture + Touch button: use in combination with touch keys

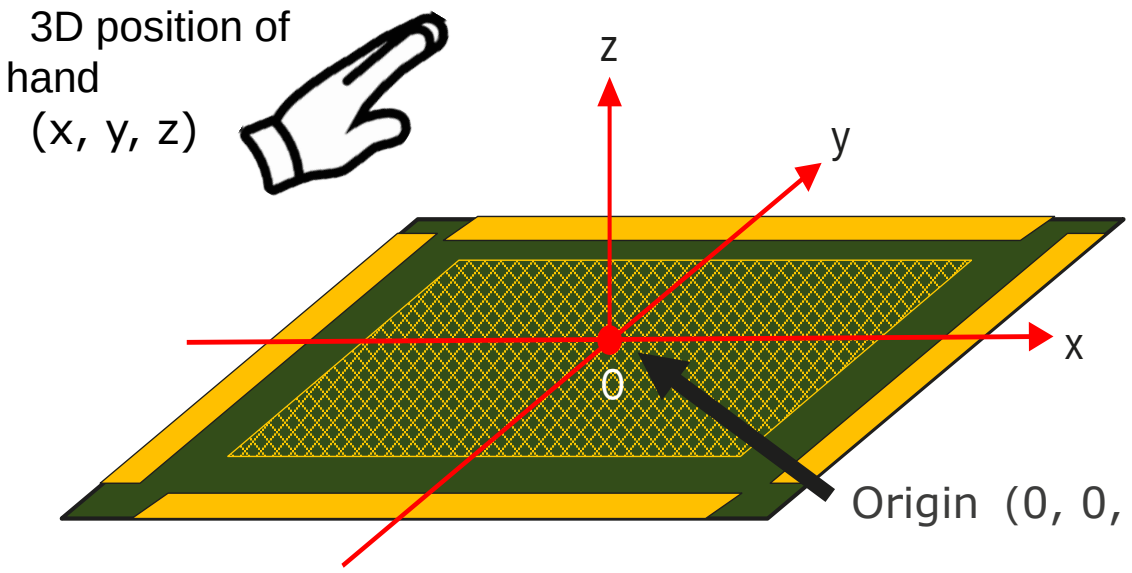
3D Gesture Demo Outline





- Spatial recognition based on electrostatic capacitance detection technology
- Converts hand position to 3D coordinates
- Detects hand movement within approx. 20cm cubic space with 16*16 cm electrode
- Detects hand movement within approx. 10cm cubic space with 8*8 cm electrode
- Approx. 1mm accuracy (minimum resolution)
- Converts hand movement in 6 directions (front/back, left/right, up/down) with high speed coordinate detection (approx. 8ms)

3D Position definition



- Origin of coordinates is the center of the substrate surface
- X axis: Left-right horizontal direction
- Y axis: Top-bottom horizontal direction
- Z axis: vertical direction

Capacitance measurement results of the four electrodes (top, bottom, right and left) is called the "count value,"
which is calculated by the 3D Position Calculation Middleware from the 3D position (x, y, z).

BIG IDEAS FOR EVERY SPACE

www.renesas.com