APPLICATION NOTE

R8C/33T Group

Details of touch slider detection principle

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Summary

Touch panel microcomputer R8C/33T group builds hardware (SCU: sensor control unit) that perceives the contact of the human body by measuring the stray capacity generated between the touch electrode and the human body into.

In this application note, we provide the optimization of slider electrodes shape and the detection method regarding the slider function that detects finger speed and direction in one-dimensional space.

Object device

R8C/33T group

Contents

1. Slider electrode

1.1 What is the slider electrode

The slider electrodes detect a finger speed and direction that the single electrode can not do. And it is possible to enhance the resolution using the same electrodes and the centroid computation.. By these features, the slider is used for the customer product to control the sound volume of audio, fire power of oven, brightness of lighting and etc.

1.2 Slider electrode shape

The slider electrodes should be over-lapped to continuously detect the capacitance because it uses to changing capacitance as a finger movement. Figure 1-1,Figure 1-2 and Figure 1-3 show the shape of the slider electrodes.

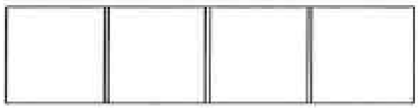


Figure 1-1 Normal electrodes

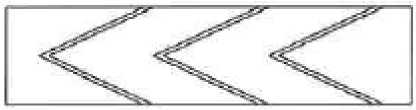


Figure 1-2 Electrodes with single ‘V’ shape

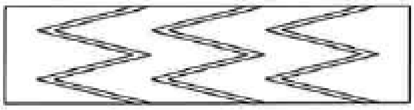


Figure 1-3 Electrodes with double ’V’ shape

1.3 Slider electrodes shape and it’s characteristic

In this chapter, we show the verification result of the relation between numbers of ‘V’ shape and slider characteristic.

(‘V’ shape is shown Figure 1-1,1-2,1-3)

1.3.1 Verification of slider characteristic

The slider characteristic is vivificated as follows;

i) The capacitances of each electro lodes are measured with moving touch position on these electrodes.

ii) Change value of capacitance is calculated by the following expressions.

Z (Change value of capacitance) = $n_i * (-2) + n_{i+1} * (-1) + n_{i+2} * 1 + n_{i+3} * 2$

(n i: value of each electrode) (i: Electrode number)

Figure 1-4 shows the image chart that a left electrode is defined as electrode 1.

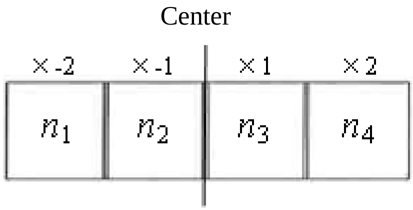


Figure 1-4 Operational expression image

iii) The change value linearity for touch point is compared with each slider shapes by plotting the chart of touch position and Z(Change value of the capacitance).

1.3.2 Basic characteristic

Figure 1-6, figure 1-7 and Figure 1-8 show the basic characteristic of each slider shape. And Figure 1-5 shows the tracks of touch and the slider size that use to measure these results.

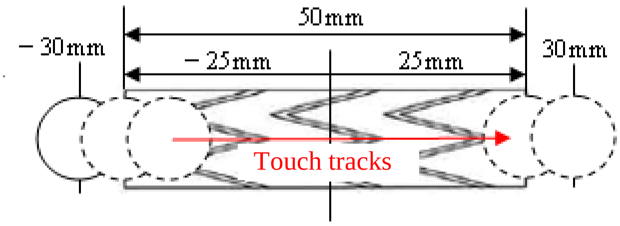


Figure 1-5 Touch tracks

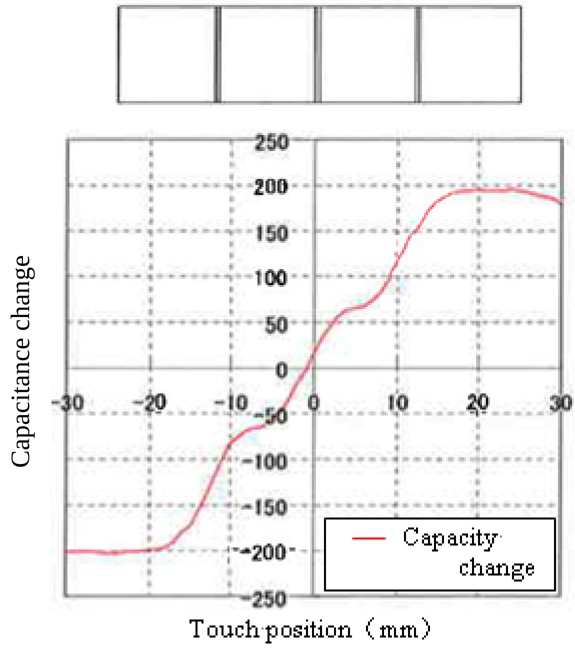


Figure 1-6 Normal electrodes

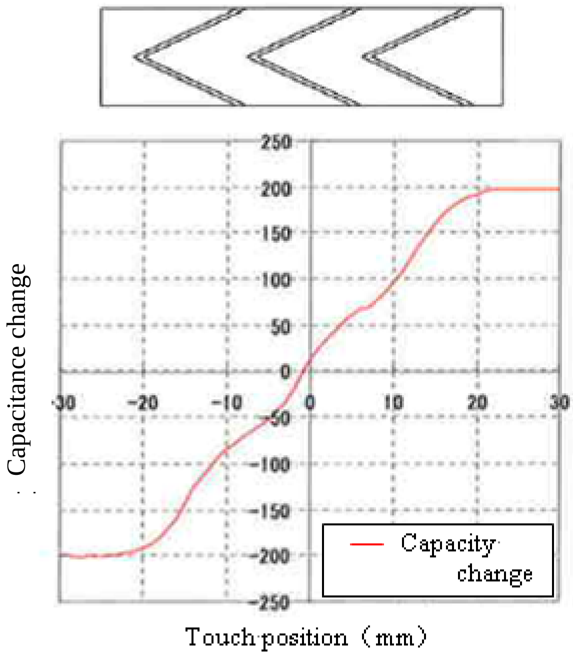


Figure 1-7 Electrodes with single 'V' shape

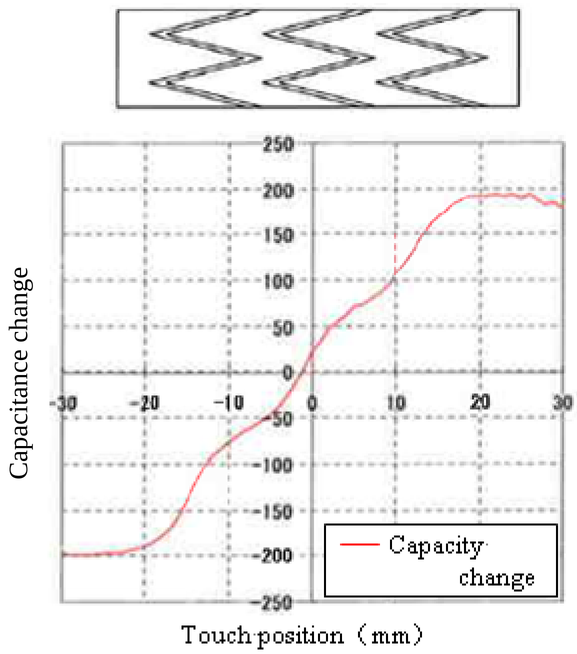


Figure 1-8 Electrodes with double 'V' shape

As shown Figure 1-6, 1-7 and 1-8, the best slider shape is the electrodes with single 'V' shape.
As a result, because all electrodes of the capacitance change are used for this verification, it is better for basic characteristic that the electrodes overlap each other.

1.3.3 Touch position characteristic

Figure 1-10 to 1-12 show the touch position characteristic of each slider electrodes single, double, triple ‘V’ shape. As shown Figure 1-9, the capacitance changes measured with changing the starting position of touch. The starting position was changed vertically (direction of Y) between +/- 8mm per 2mm.

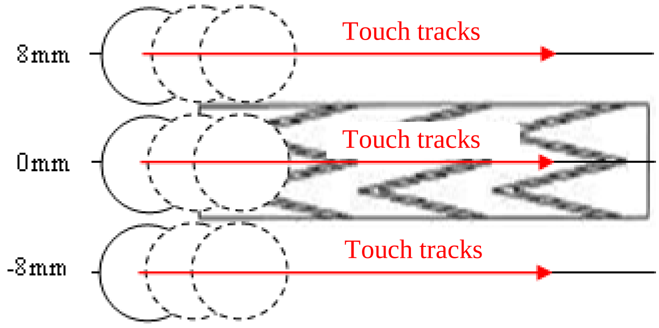


Figure 1-9 Touch tracks and starting position

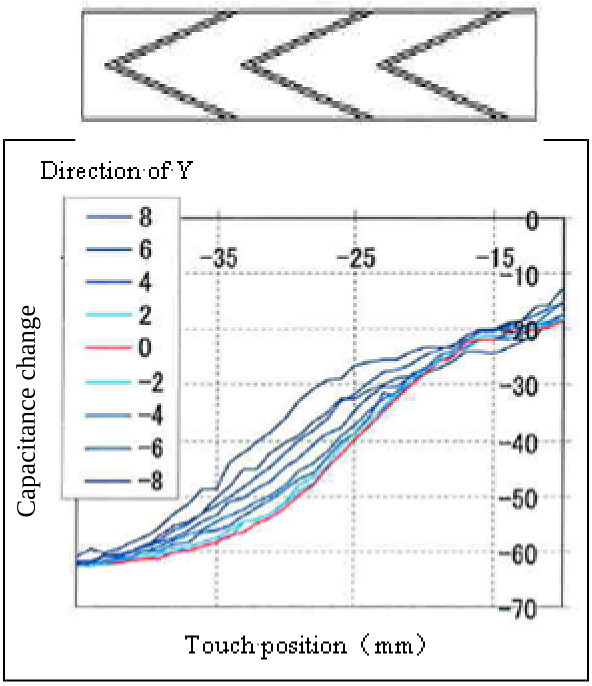


Figure 1-10 Electrodes with single ‘V’ shape

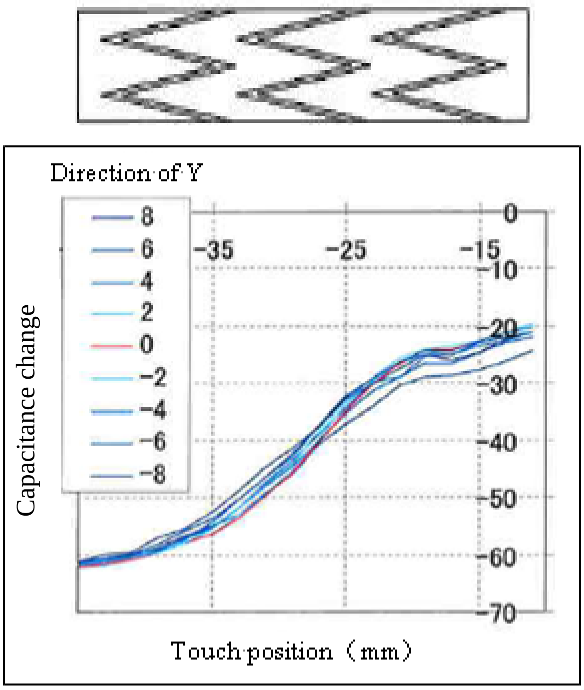


Figure 1-11 Electrodes with double ‘V’ shape

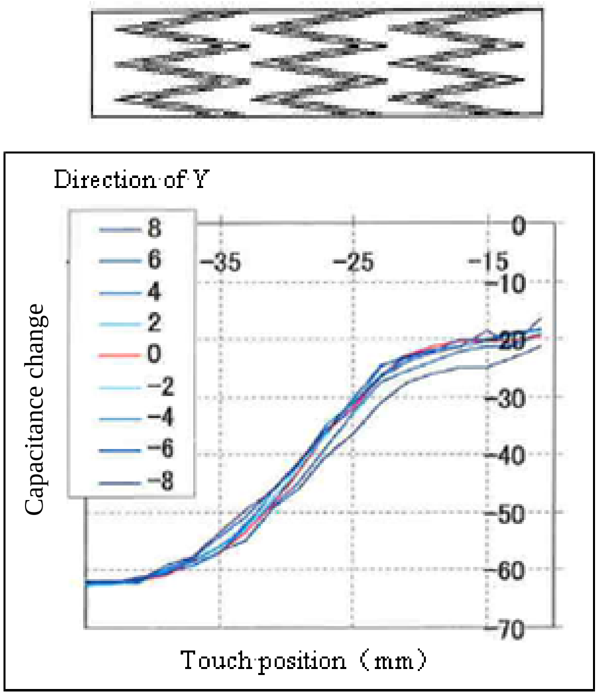


Figure 1-12 3 mountain electrode shape

As shown Figure1-10 to 12, the double or triple ‘V’ shape are better than single ‘V’ shape for stability and lineally of touch.

1.3.4 Electrode interference characteristic

By the results above, the optimum requirements of the slider are as follows;

- 'V' shape electrode geometry;
  The linearity of the capacitance change be kept by effecting each 'V' shape electrodes.
- Double or Triple 'V' shapes.
  →The capacitance change difference by the touch position can be reduced.

As the other requirement, we should consider the touch sensitivity. Increasing number of 'V' shape makes the area of each electrodes contact large. Then the parasitic capacitance increase and the touch sensitivity become bad. The double 'V' is the best shape for the touch sensitivity.
As all requirements above, the best shape of the slider is the double 'V' shape.

Then, we verified the electrodes interference characteristic for the basic characteristic improvement of double 'V' shape. For improvement of the linearity, we verified the capacity change characteristic by making the slider electrode as shown Figure 1-13,Figure 1-14. As shown Figure 1-14, 'V' shape is modified sharp and long to increase the electrode interference each other.

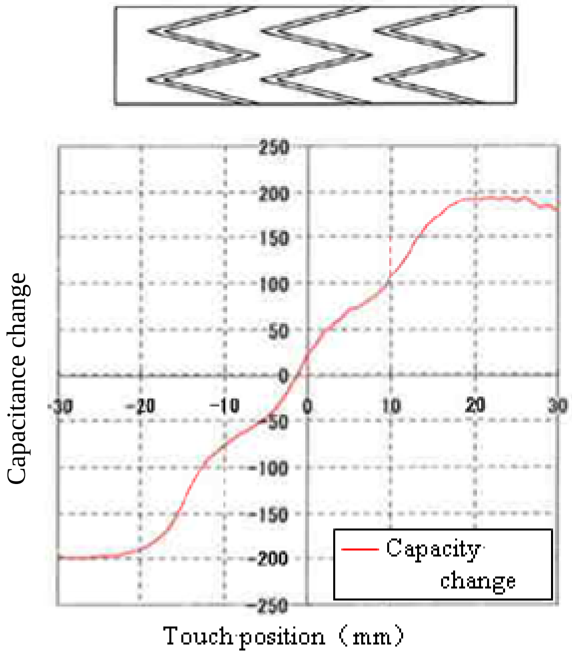


Figure 1-13 Before changing shape

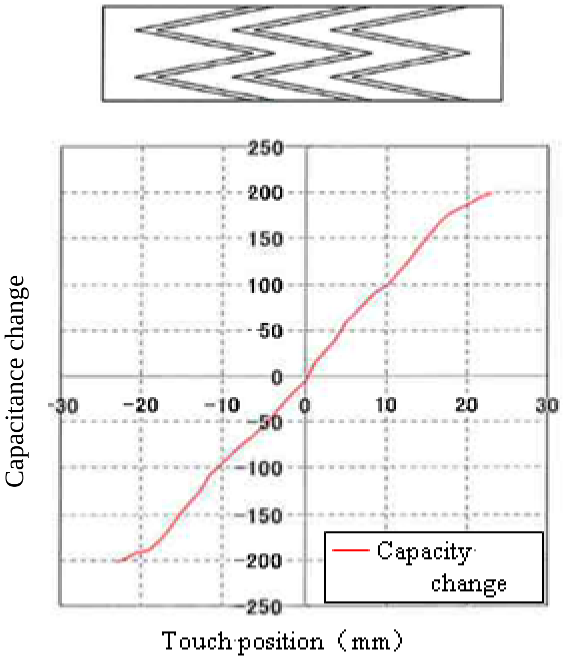


Figure 1-14 After changing shape

The verification results show the improvement of linearity by increasing the electrode interference.

1.3.5 Electrode interval characteristic and amount of change

As the result above, Increasing the electrode interference is good for the improvement of linearity. But increasing the electrode interference makes the detecting of touch or not goes bad because of increasing the parasitic capacitance. Then, we verified the change value of touch or not to modify the electrodes gap. We made two kinds (0.5mm & 0.8mm) of sliders and measured it. Figure 1-15 & Figure 1-16 show the result.

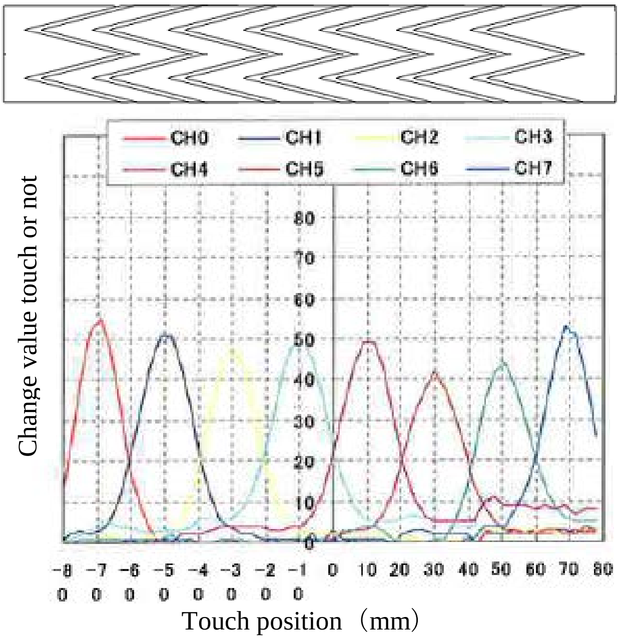


Figure 1-15 electrodes gap 0.5mm

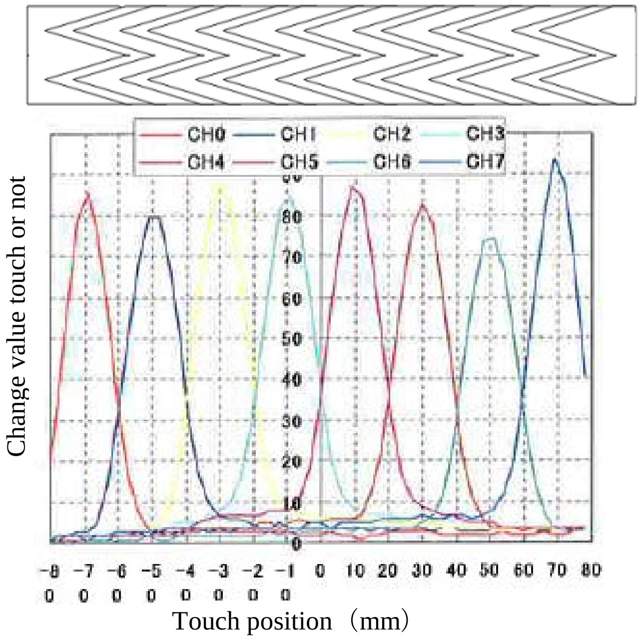


Figure 1-16 electrodes gap 0.8mm

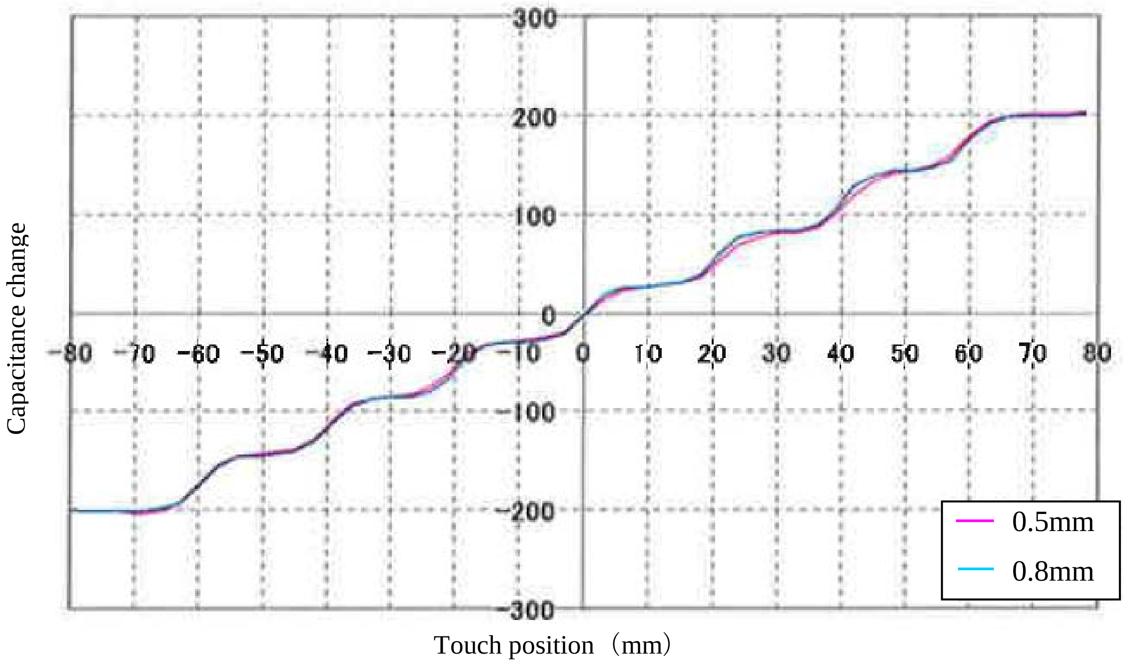


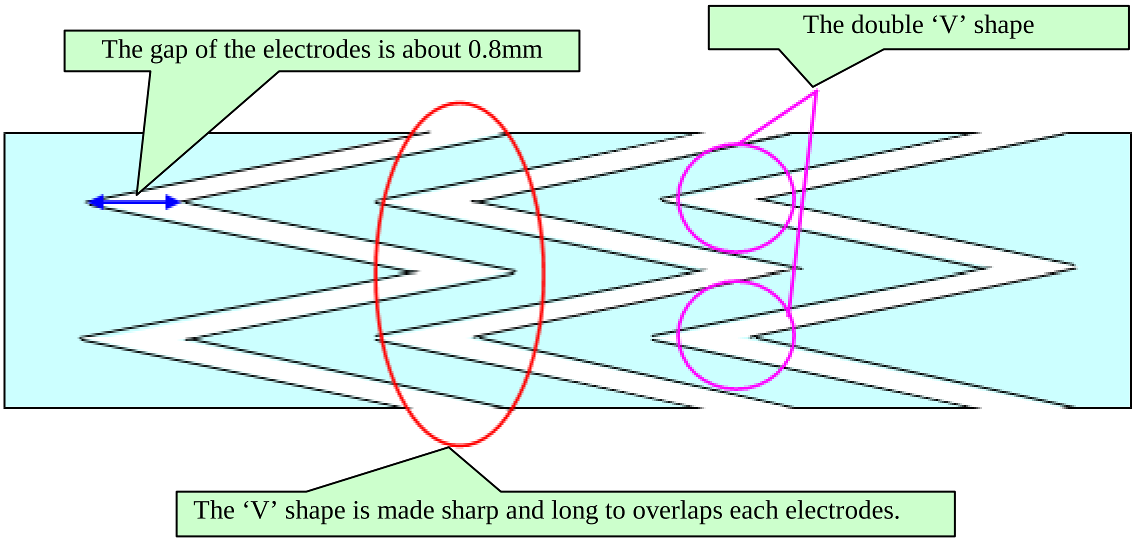
Figure 1-17 0.5mm,0.8mm gap characteristic

As the result, the electrodes gap 0.8mm makes the change value of touch increase. And Figure 1-17 shows the basic characteristic of 0.5mm & 0.8mm gap. Even the electrodes gap is modified , it is no inference to the capacitance change.

1.3.6 Summary of the best electrodes shape

Ground on the result above, the best electrodes shape of slider is as follows;

- The double ‘V’ shape
- The ‘V’ shape is made sharp and long to overlaps each electrodes.
- The gap of the electrodes is about 0.8mm.



Notice; It is only an example shape of slider. Please modify it for your system, environment, and etc. Because the touch sensitivity is depend on the target of touch detecting (such as light touch or strong touch), the board condition (such as length of line, circuit constants and etc.), external or internal environments and so on.

2. Application example of Slider process

2.1 Example flowchart for slider process

Figure 2-1 shows the flowchart of slider process.

First, the measurement value by R8C/33T SCU is judged which CH touches. If the slider electrodes CH are touched, slider calculation process is started. The drift process is stopped because slider calculation should calculate some electrodes. After calculation, the slider CH id decoded. Please refer the application note regarding the drift process.

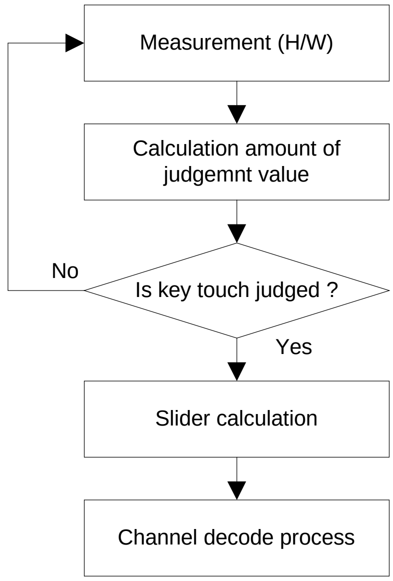


Figure 2-1 The flowchart of slider process

2.2 Slider calculation

Figure 2-2 shows the slider image. We describe it as follows;

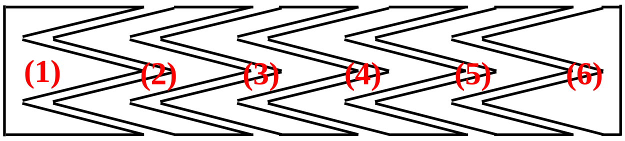


Figure 2-2 slider image

Control parameters:

Ncount[x] : Measurement value of channels 1 - channel 6

Nref[x] : Reference values of channels 1 - channel 6

Nthr[x] : Amount of threshold change of channels 1 - channel 6

⊿CNTx : Amount of judgement value of channels 1 - channel 6

Sldsum = ⊿CNT1+⊿CNT2+⊿CNT3+⊿CNT4+⊿CNT5+⊿CNT6

: Amount of judgement values of channels 1 - channel 6

Sldthr : Threshold change values for Sldum

Nsld_dif : Result of the slider calculation

Control process

Multi touch canceling is judged according to the judgement value of all channels composing the slider.

Condition of key touch judgement

⊿x = Nref[x]- Ncount[x]

Sldsum = ⊿(1)+⊿(2)+⊿(3)+⊿(4)+⊿(5)+⊿(6)

Sldsum > Sldthr

Sldthr is amount threshold change for Sldum. Because the values are effect by the shape of slider electrode(s) and wiring, Sldthr must to be calculated according to each case.

Slider calculation

In case of a slider consisting 6 channels, a formula is as follows. The minimum value is 100 and the maximum value is 600

$$\text{Nsld\_dif} = \frac{1*\angle\text{CNT1} + 2*\angle\text{CNT2} + 3*\angle\text{CNT3} + \cdots + 6*\angle\text{CNT6}}{\angle\text{CNT1} + \angle\text{CNT2} + \angle\text{CNT3} + \cdots + \angle\text{CNT6}}$$

2.3 Channel decode process

For example, the image below divides a slider electrode of 6 channels into 12 positions.

R8C/33T starts the channel decode process from Spos12. The order of channel decode process is

Spos12 -> Spos11 -> Spos10 -> ... Sch1

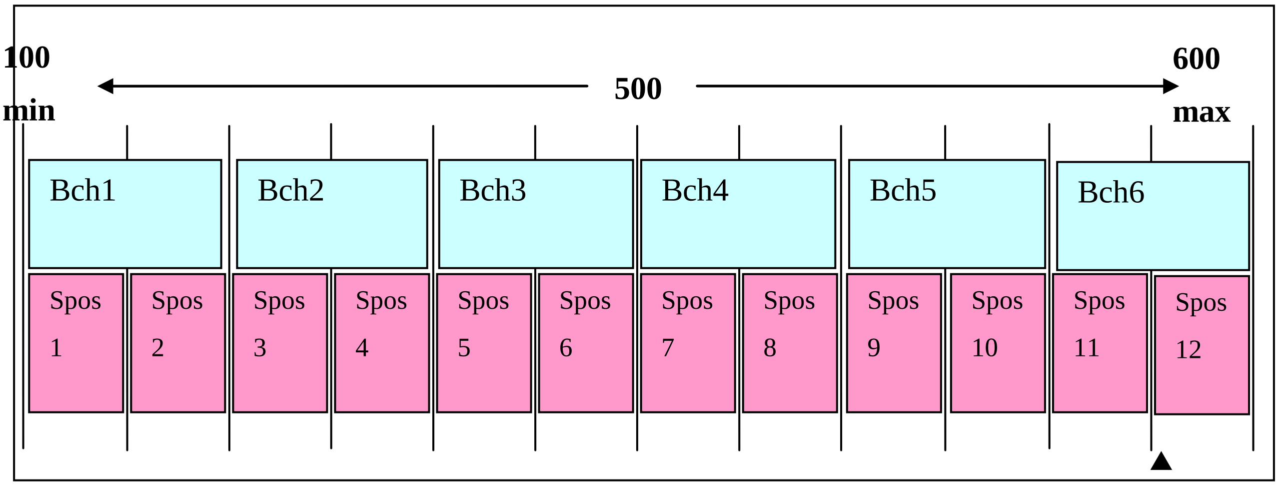


Figure2-3 The image of the channel decode process

Bchx : An electrode channel of the slider

Sposx : A decoded position of the slider

An example of the channel decode process to Spos12

Nsld_dif >= (dif_val/Sld_ch_max*11)+Nsld_dif_min

Nsld_dif	: A calculated value of the slider
dif_val	: difference value of the calculation (600-100=500)
Sld_pos_max	: The number of slider positions (12)
Nsld_dif_min	: The minimum value of the calculation (100)

The value denoted by (▲) in Figure2-3 is as follows.

▲ = (500/12*11)+100

= 558.33

Therefore, Spos12 is touched when the * is in a range from 558 to 600.

The slider sample codes show as follows.

Website and Support

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Revision Record

Rev.	Date	Description	
		Page	Summary
1.00	May 22. 2013	—	Numbering change (Contents is as same as R01AN0041EJ0100)

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.

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