R8C/33T Group

Development case of LED dimmer by PWM with touch detecting

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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 explain the touch board artwork technique to reduce the influence from LED drive and the other noise as much as possible.

Target device

R8C/33T group

Contents

1. Artwork and measurement operation

1.1 Outline

The SCU build in R8C/3xT detects the touch or not measuring the parasitic capacitance of the electrode and its wire. The parasitic capacitance of the electrode and its wire is changed to get the influence from all wired conductors around them.
The nearby GND pattern makes touch sensitivity down because of increasing the parasitic capacitance, and the signal lines along the electrode wires make the lines of electrodes noisy because of appearing capacitance coupling between them. It is important to arrange the lines of the electrodes correctly when the lines of the LED or the actuator plus drive are nearby them.

1.2 Occurrence of influence by LED drive

Figure 1-1 and Figure 1-3 show the influence of the plus drive line along the electrode's line as one example of LED drive.
When the circuit of Figure 1-1 is composed as the artwork of Figure 1-2, the parasitic capacitance that the electrode signal lines receive increases the amount of the parasitic capacitance between the electrodes signal lines and LED drive lines. The added parasitic capacitance depends on the interval and side by side length of them.

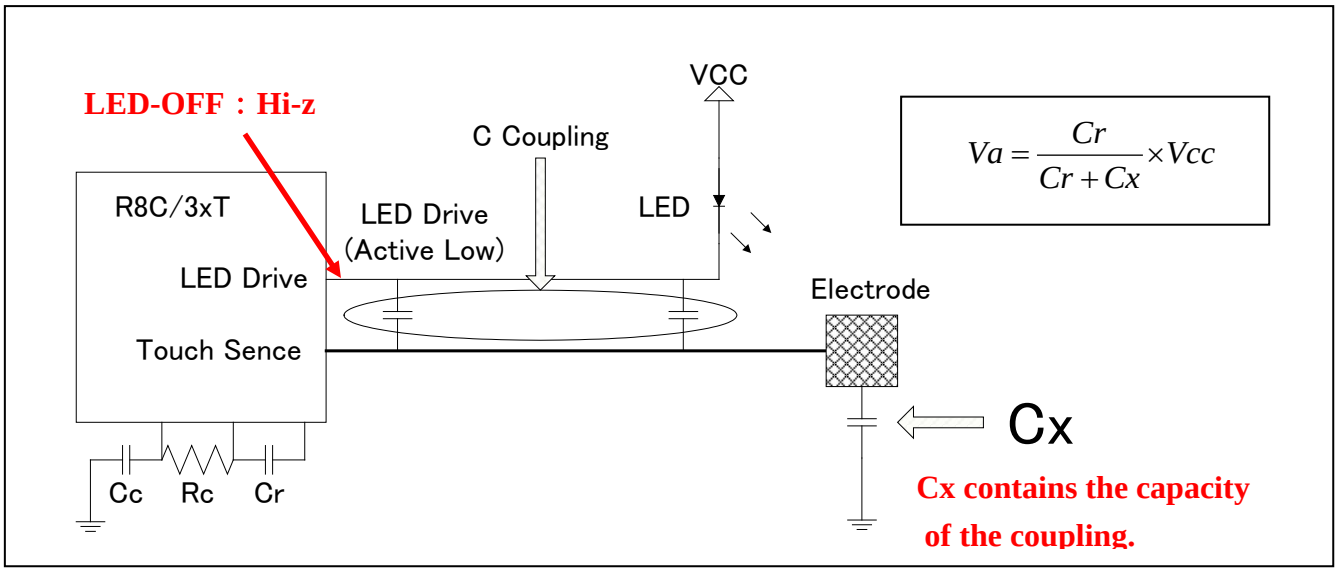


Figure 1-1 Influence when electrode signal line runs side by side with other signal wires

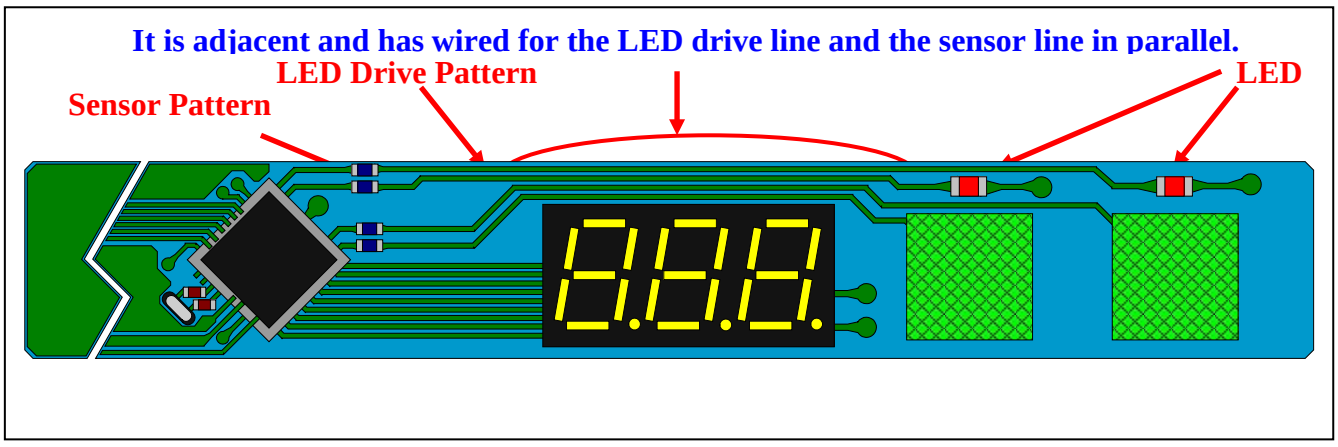


Figure 1-2 When the electrode signal line runs side by side with other signal wires (example of the artwork)

When LED is ON
When LED is ON (active Low), the LED signal line is GND level.
This is as same as GND pattern around the electrodes measurement line, as the result the parasitic capacitance of the electrode measurement lines increase.

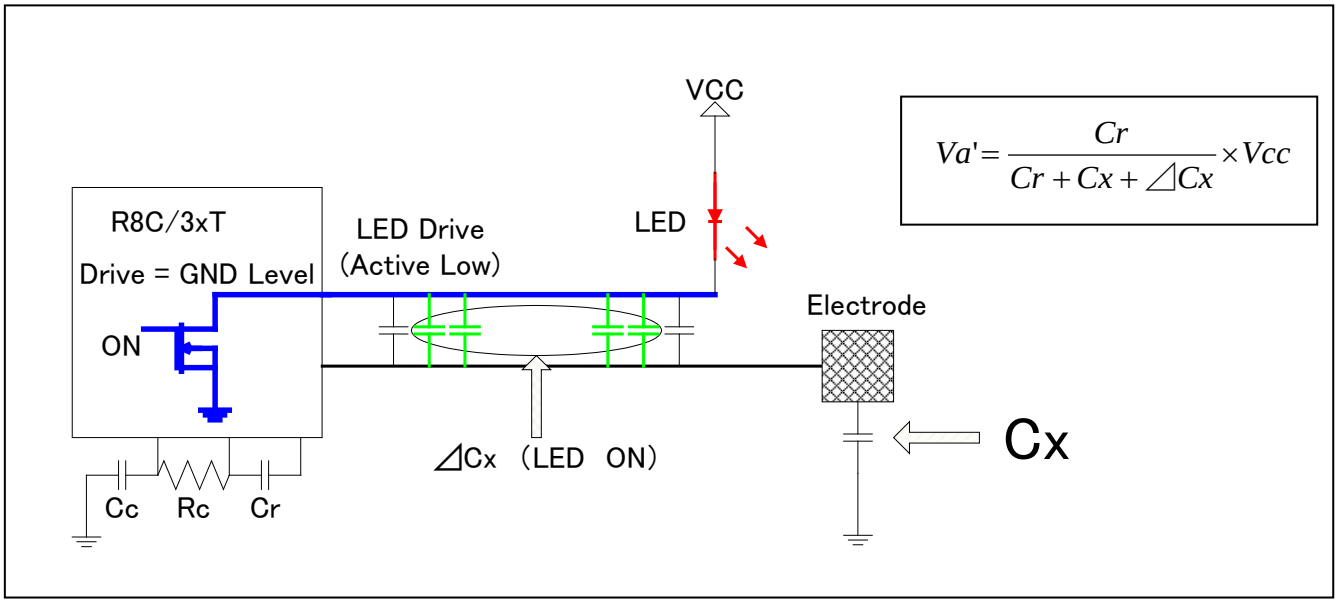


Figure 1-3 Influence when electrode signal line runs side by side with other signal wires (LED is ON)

A parasitic capacitance increase in the measurement line by the LED lighting influences the touch measurement result. In the situation in which “Hi-z" ／ "Low "is repeated alternately repeated by the PWM control, The movement of the touch measurement will synchronize it. (Change of measurement result -> Noise)
It may be influenced to the sensitivity of the touch if the count value difference is small (ex. Noise margin is small and multiplying the count value) and the parasitic capacitance value change (by the LED lighting) is large.

To avoid such a situation, the artwork becomes important.

2. Reducing the parasitic capacitance

2.1 Artwork

In the touch sensor, the sensitivity and the S/N characteristic of the sensor change by the arrangement of the pattern around the electrode signal line situation.
The surrounding of the electrode signal lines are preferable as much as possible other patterns and separated things, and when the signal that changes like the LED drive lines are adjoined, exemplifies it as follows.

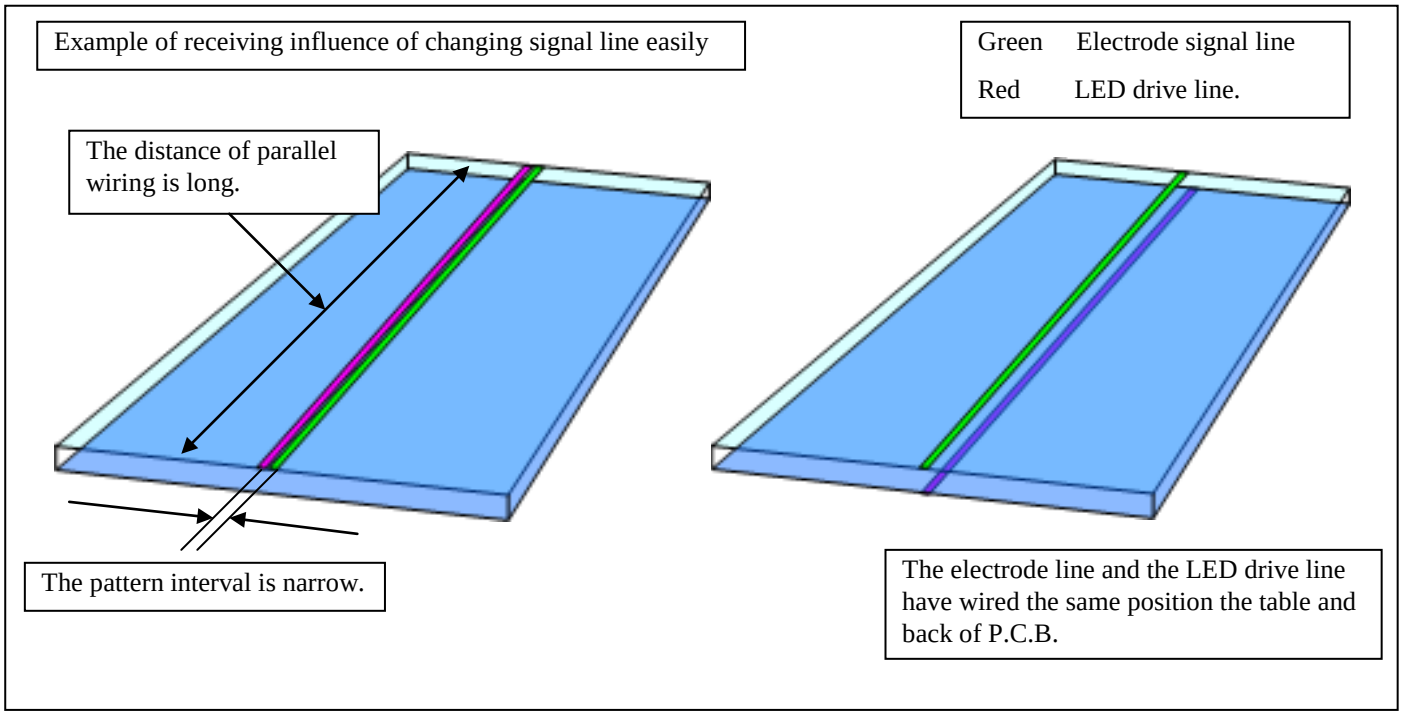


Figure 2-1 Example of LED drive line's influencing electrode signal line easily

When the LED line becomes “Low" level (GND potential), Figure 2-1 shows the example of increasing the parasitic capacitance value of the electrode signal line easily.
The increasing parasitic capacitance value is proportional to the length wired for in parallel with the interval between the electrode line and the LED drive line.
The parasitic capacitance change in the electrode signal line increases when similarly wiring by both sides of P.C.B.

It is necessary to avoid the above-mentioned artwork as much as possible for the S/N improvement of the touch sensor.

Next, a preferable example is shown for the electrode signal line.

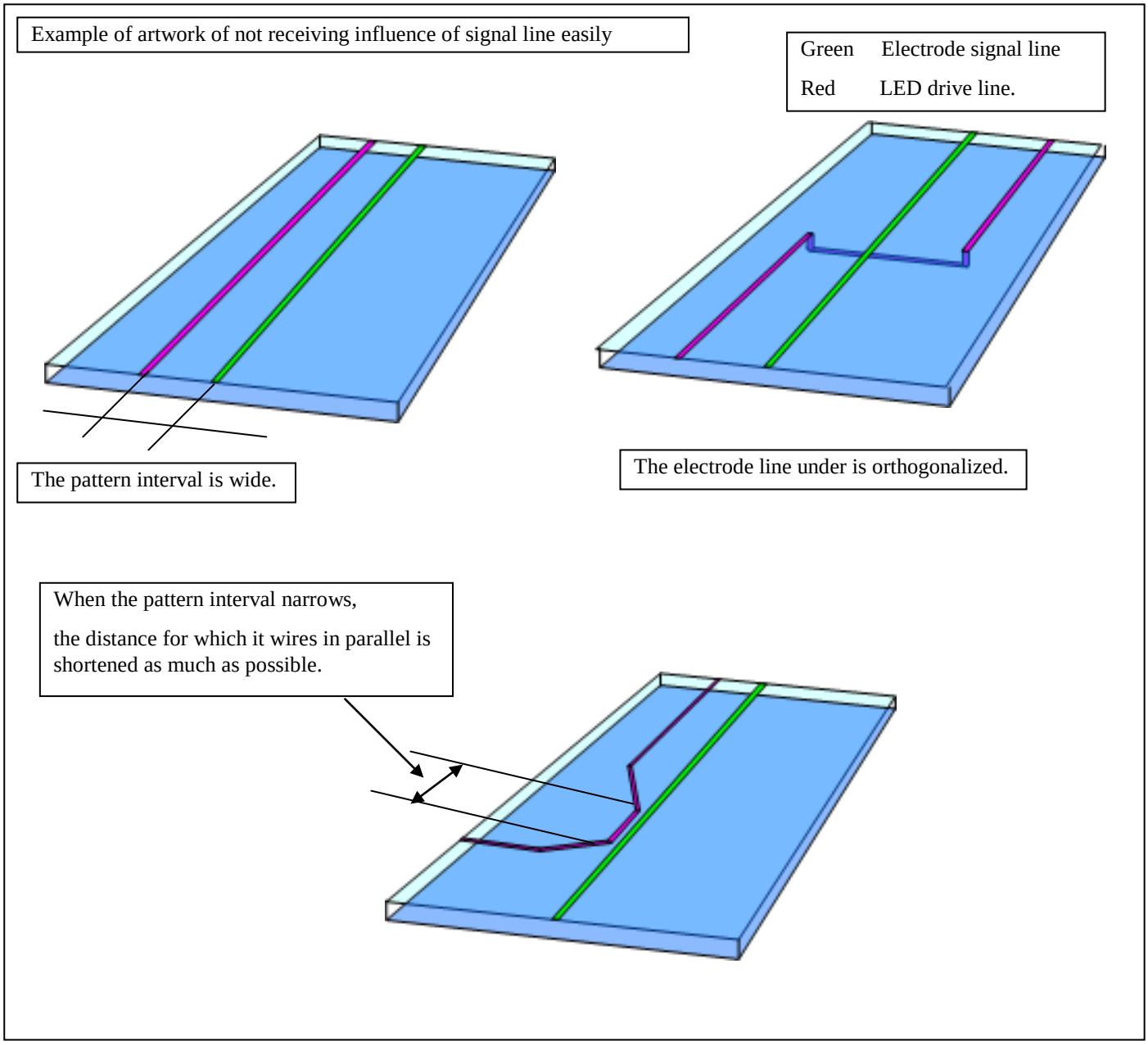


Figure 2-2 Example of LED drive line's not influencing electrode signal line easily

When the surrounding of the electrode signal line is overcrowded by the restriction of the artwork (P.C.B. size and circuit size, etc.)
The LED drive line etc. should not arrange the electrode signal line in the next soon.

Please consider the following two points when adjoining and wiring.
①The distance for which it concurrently wires is shortened as much as possible.
②The pattern interval is taken as widely as possible.

3. Parasitic capacitance change in electrode signal line

3.1 Parasitic capacitance change that touch sensor receives

3.1.1 Simulation condition

When there is an electrical change in the signal line near the electrode signal line
The parasitic capacitance change that the touch sensor detects is shown. (simulation result)

In the simulation, the electrode, the electrode line, and the LED drive line are arranged in P.C.B of 150mm*80mm.
The change in the parasitic capacitance that the electrode line receives is analyzed as follows.
①For "Hi-z" the state of the LED drive line
②For "Low" the state of the LED drive line

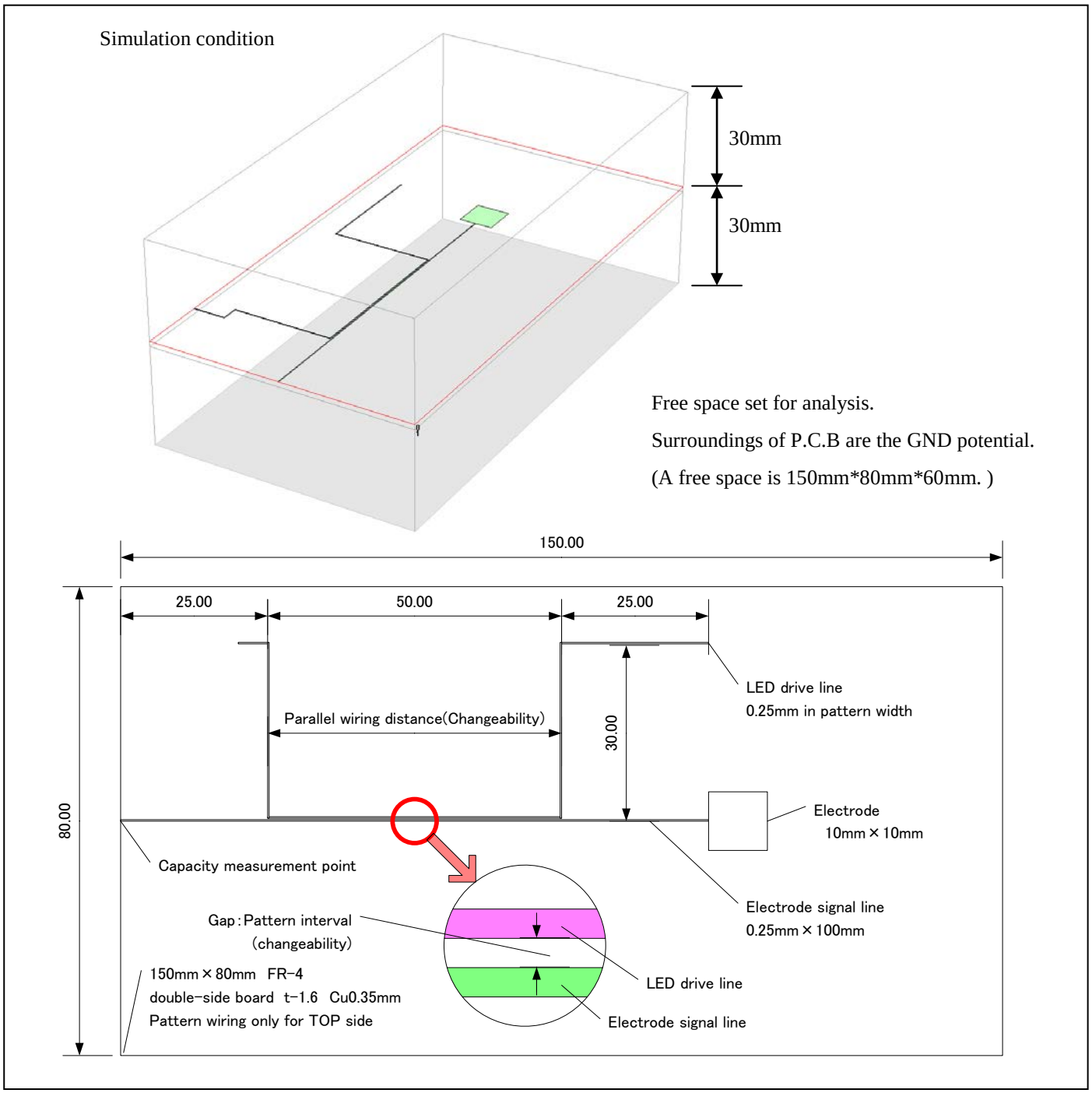


Figure 3-1 A parasitic capacitance increase by nearby wiring pattern (simulation condition)

3.1.2 Influence of nearby signal line

Figure 3-2 shows the change of the parasitic capacitance caused by the state of the signal line in the vicinity of the electrode signal line.

"Hi-z" and "Low" are in the state of the signal line. (“Low" : LED-ON. "Hi-z" : LED-OFF.)
The graph indicates the parasitic capacitance value of the electrode line.

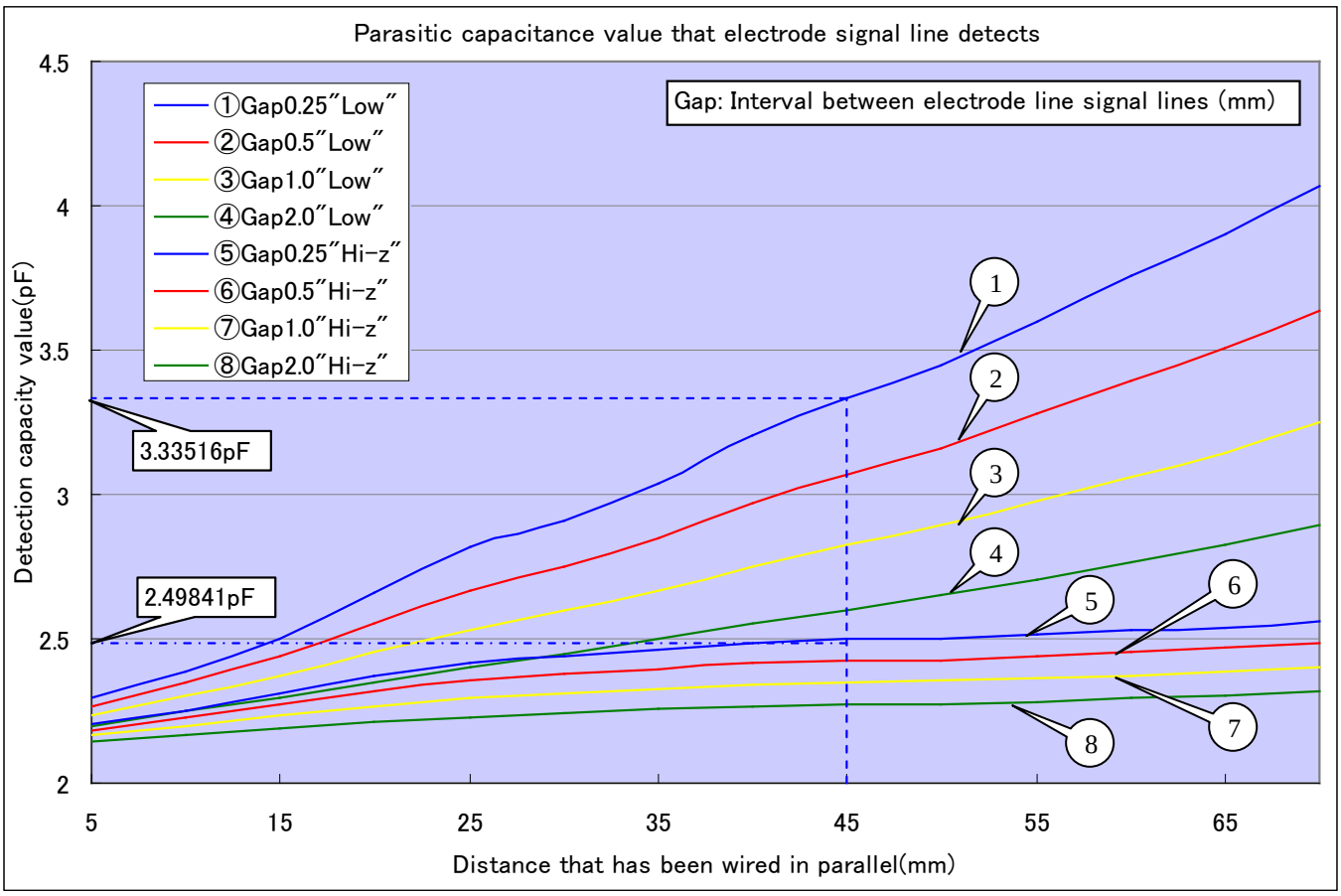


Figure 3-2 Difference of detection capacity value by state of signal line

Show in Figure 3-2.
The parasitic capacitance of the electrode line is in inverse proportion to the distance between patterns.
And, it grows in proportion to the length wired for in parallel.

Moreover, the parasitic capacitance value increases when the signal line is GND level.

Example

The nearby signal line : when Gap0.25mm and the distance wired for in parallel are 45mm.
The parasitic capacitance value that the electrode line measures

When the signal line is Hi-z 2.49841pF ----------Graph data 5
When the signal line is Low 3.33516pF ----------Graph data 1

3.1.3 Detection capacity value change ratio by level change in near signal line

The level change in a signal line near the touch electrode line influences the parasitic capacitance value that the touch electrode detects.
As an index that shows the influence
The change ratio of the parasitic capacitance value that the touch electrode detects is shown. (Figure 3-3)

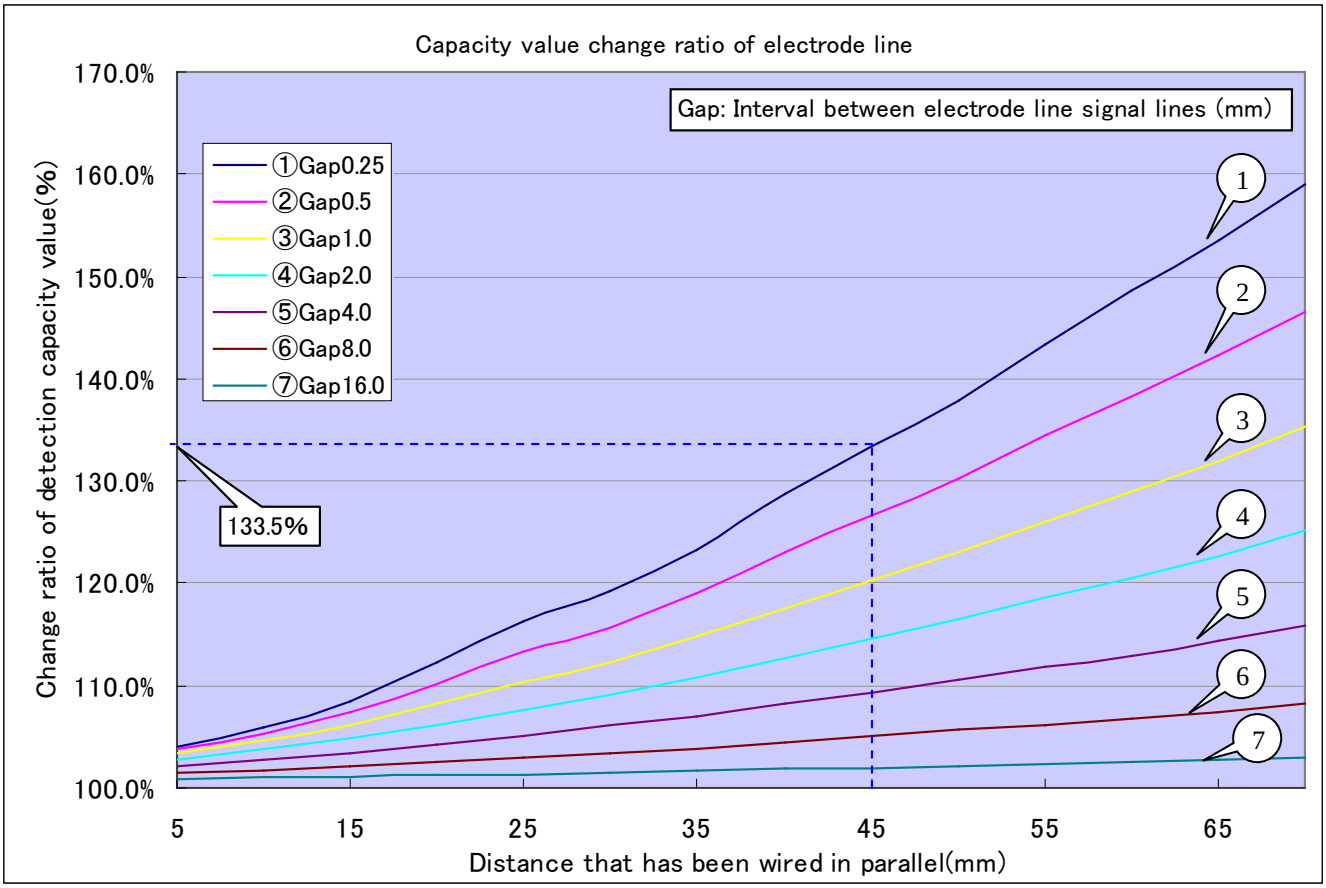


Figure 3-3 Detection capacity value change ratio by level change in near signal line

The parasitic capacitance that the touch electrode detects changes greatly by state (Hi-z/Low) of the nearby signal line as shown in Figure 3-3.
The change ratio of the detection capacity value when there is ON/OFF of LED while measuring the capacity of the touch electrode is calculated as follows.

Change ratio of parasitic capacitance value that touch electrode detects
= Detection capacity value at LED-ON(Low) / Detection capacity value at LED-OFF(Hi-z) * 100 (%)

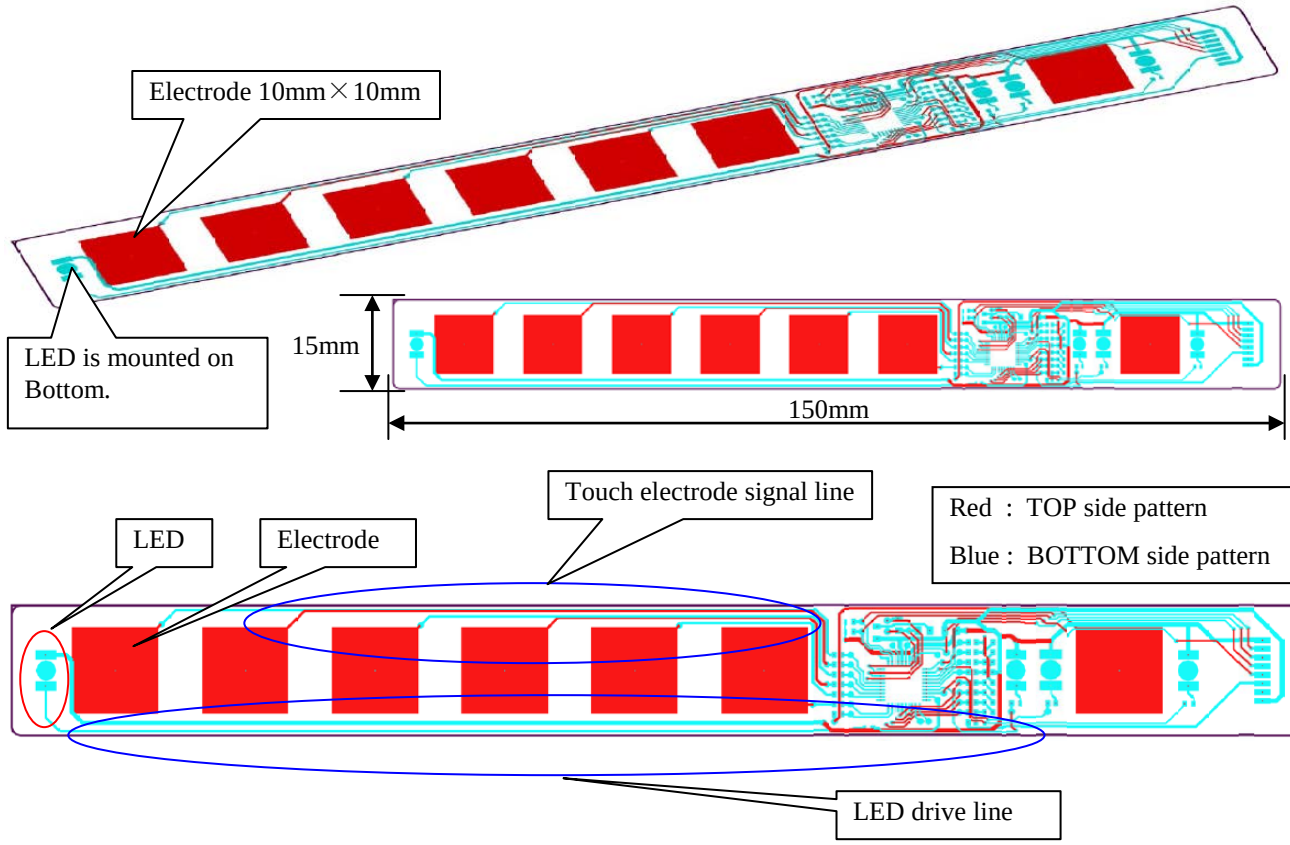
Example
The nearby signal line : when Gap0.25mm and the distance wired for in parallel are 45mm.
The change ratio of the detection volume by LED-ON
= 3.33516pF / 2.49841pF * 100(%)
= 133.5%
The detected capacity value will increase by driving LED by about 33.5%
(increasing rate about 33.5% of detection volume by LED-ON)

An increase in the detection volume becomes the variation factor of the measurement value (noise).
There is a possibility of becoming the factor of the malfunction according to the state of the system.
(State of system : Amount of change at time usually.
Change ratio of detection capacity value by electrical change of nearby line.
Condition of ON/OFF threshold etc.)

4. Development case

4.1 Development case in demonstration P.C.B

Figure 4-1 shows the development case in demonstration P.C.B.
In this demonstration P.C.B, the influence by LED of the PWM control arranged in the vicinity of the electrode is decreased by devising the arrangement of the LED drive line.



The LED line wires the underside and bottom side of P.C.B

Driving line of LED wired for the lower side of P.C.B.

The wiring for the COM line was arranged on a side near the electrode between driving line and the electrode.

The electrode signal line suppresses the interference with each other by using both sides of P.C.B.

The electrode signal line is consolidated in the upper side of P.C.B.

(Touch to the signal line by the user operation is avoided as much as possible.)

Figure 4-1 Example of wiring for touch board equipped with PWM drive LED

4.2 Example of arranging LED around touch electrode

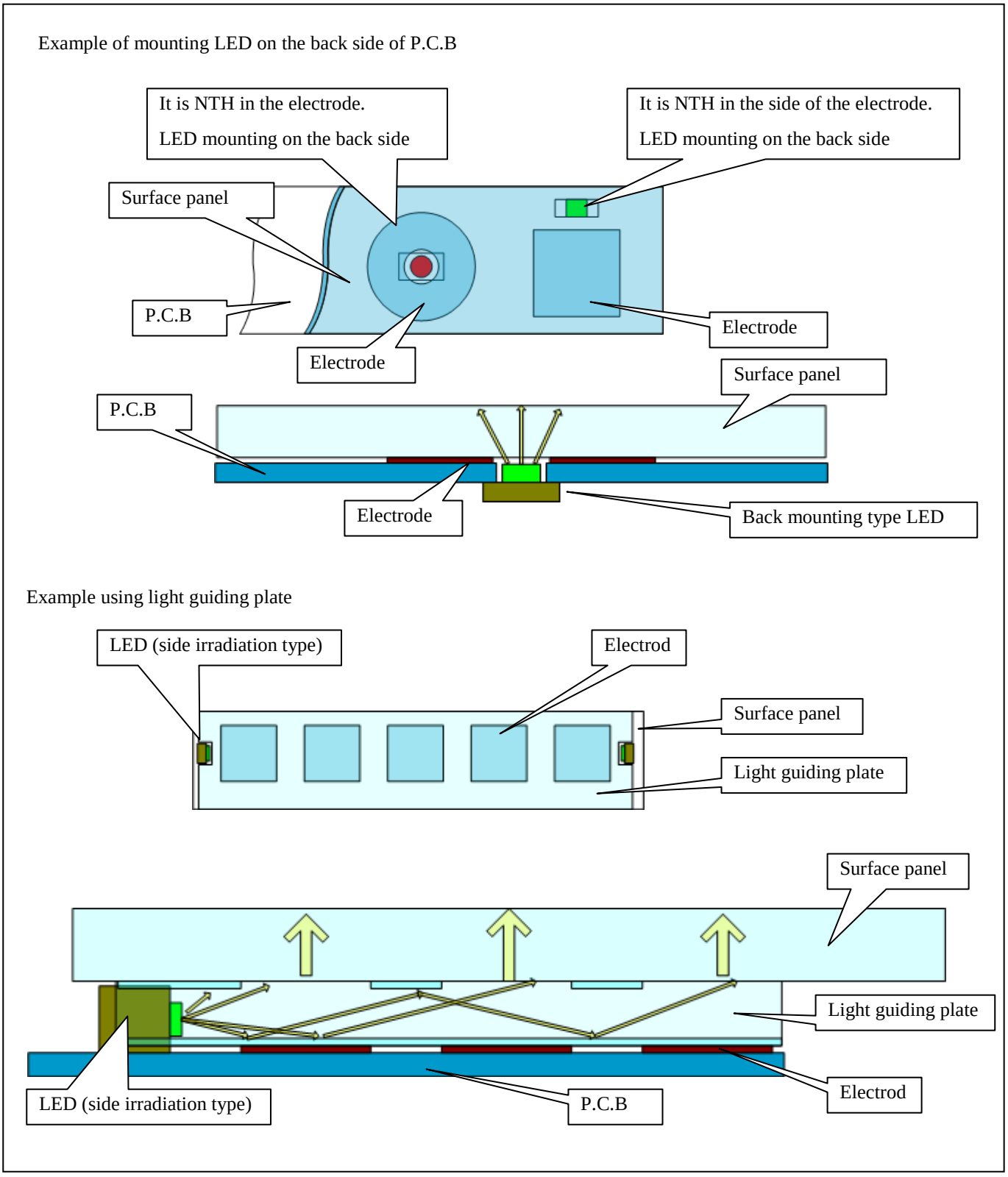


Figure 4-2 Example of arranging LED around touch electrode

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Revision Record

Rev.	Date	Description	
		Page	Summary
1.00	May 22. 2013	—	Numbering change (Contents is as same as R01AN0508EJ0100)

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.
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