R8C/38T-A group

Touch sensor IC principle of detection and adjustment of the external circuit

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Summary

Touch panel microcomputer R8C/38T-A group builds hardware (TSCU: touch 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 introduce the method of detecting touch by various electrostatic capacity methods and explain details about the method of comparison of partial pressure by series capacitance in SCU.

Target device

R8C/33T, R8C/3JT, R8C/3NT, R8C/36T-A, R8C/38T-A group

Contents

1. Principle of detection

1.1 Outline

The touch sensor IC of the R8C/33T group measures the floating capacitance of the touch electrode connected to the measurement terminal. As shown in Figure 1-1, there exist electrostatic capacitances between the electrode and the surrounding electric conductors.
Because the human body is an electrical conductor, when a finger is placed close to the electrode, the value of the floating capacitance increases. The R8C/33T detects the increase in floating capacitance to determine whether the electrode is being touched or not.

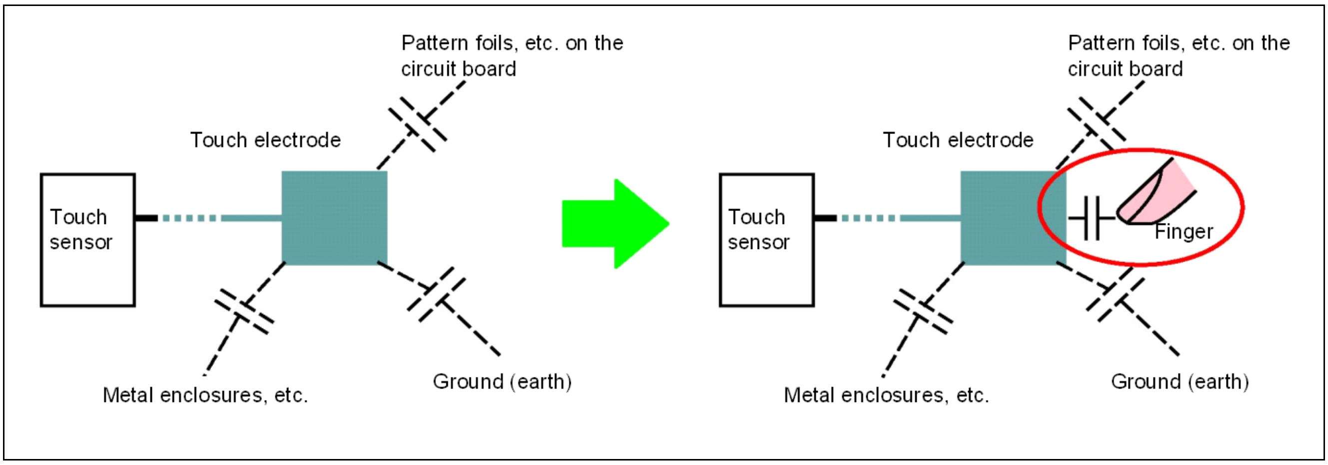

Figure 1-1 Increased floating capacitance due to the presence of a finger

1.2 Detection circuit

Connect resistors and capacitors to the R8C/33T as shown in Figure 1-2.

Here,

Cr: Capacitor for comparison (a few pF to a few tens of pF)

Rc: Resistor to control charge and discharge (a few kΩ to ten plus a few kΩ)

Cc: Capacitor for charge and discharge (about 0.1 µF)

The accuracy of the resistors and capacitors is not specified. However, large deviations among the parts may require adjustment of each individual product. Therefore, it is recommended to employ components of the highest accuracy possible (for resistors, tolerance of 5% or less, and for capacitors, tolerance of 10% or less).

Cx represents the floating capacitance of the touch electrode.

The value of Cx is generally a few pF to a few tens of pF (in the case of a double-sided circuit board without all-overlaying ground).

Changes in Cx caused by touch are of a few pF or less.

It is also recommended to insert a protective resistor (Rr of about 10 kΩ) between the R8C/33T and the touch electrode to protect the circuit.

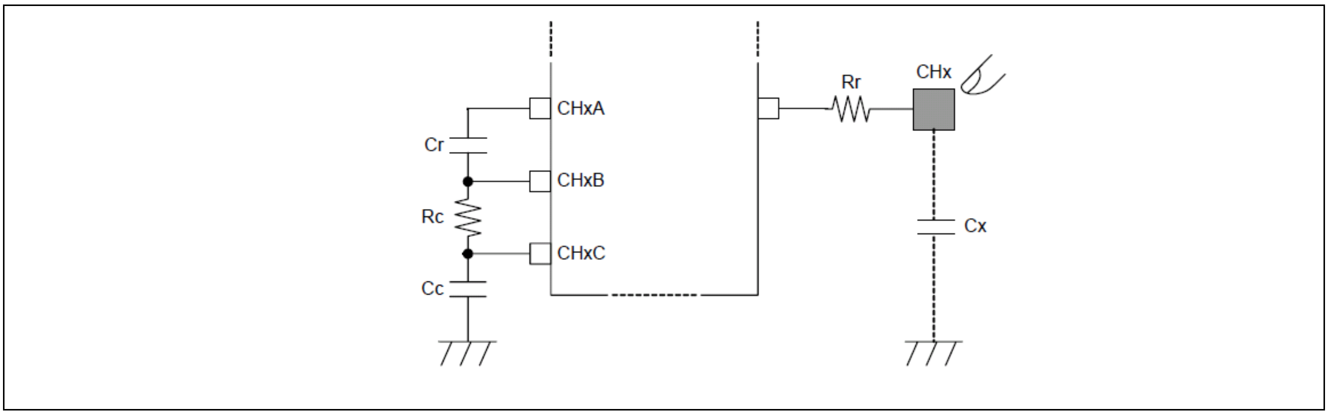

Figure 1-2 Measurement circuit section

1.3 Measurement of the touch electrode’s capacitance

The capacitance of the touch electrode is measured by measuring the voltage at CHxA while gradually discharging the electric charge stored in Cc. Specifically, execute the following steps:

(1) Charge Cc by connecting the CHxB (or COMxx) pin to the voltage supply (Vdd).
(2) After charging Cc fully, discharge Cc by connecting CHxB (or COMxx) to ground (0V). [Discharge]
(3) After discharging Cc for a short period of time, keep CHxB (or COMxx) at a high-impedance, and measure the voltage at the CHxA pin. [Voltage measurement]
(4) Repeat steps (2) and (3) (discharge and voltage measurement).

At this point, as shown in Figure 1-3, when the voltage measured at the CHxA pin, is Va and the voltage of Cc is Vc, Va at the time of voltage measurement is expressed by the formula below.

The time-dependent variation of Va and Vc is shown in Figure 1-4.

$$Va = \frac{Cr}{Cr + Cx} Vc \quad ... \quad (1\text{-}1)$$

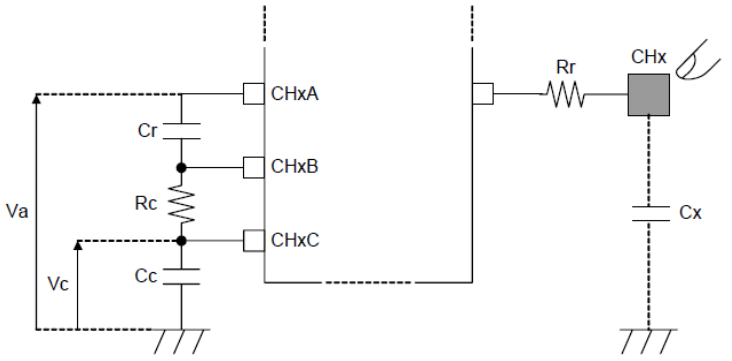

Figure 1-3 Measured voltage

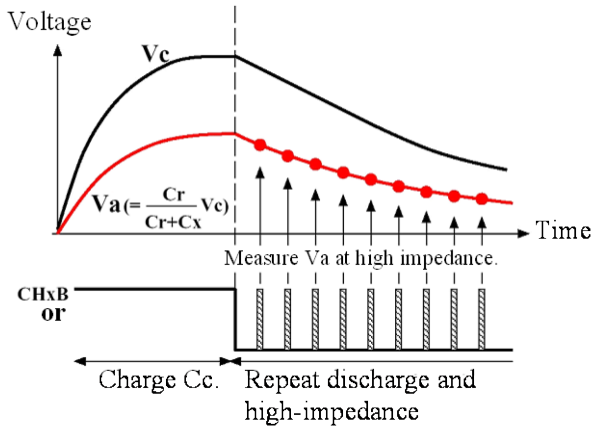

Figure 1-4 Time-dependent variation of Vc and Va

(5) A threshold voltage (Vth) is set for CHxA. Count the number of discharges before Va falls below Vth. [discharge count]

(6) Repeat steps (1) to (5) four times for each channel, and derive the measured value (output value) by averaging the voltages at the four discharges.

As the finger comes closer to the touch electrode, the value of **Cx** increases. At this time, the value of **Va** decreases as shown in **(1-1)**.

As a result, the number of discharge counts before **Va** falls below **Vth** gets smaller, as shown in Figure 1-5. Accordingly, the measured value (output value) will be smaller when the finger touches the touch electrode, as shown in Figure 1-6.

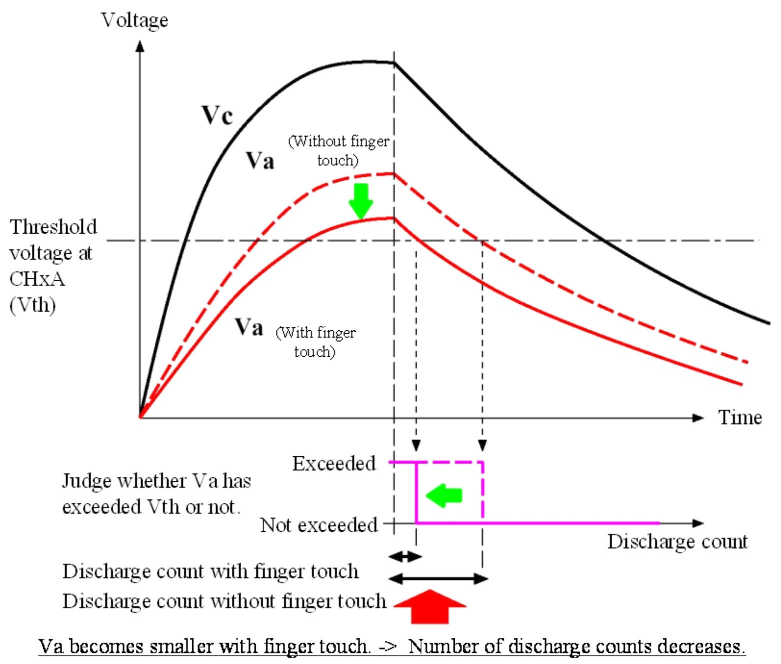

Figure 1-5 Variation of measured values with and without finger touch

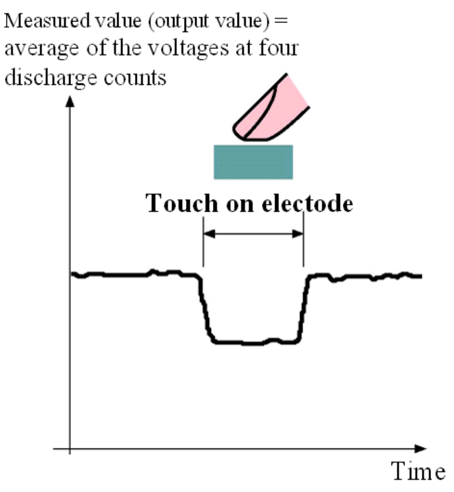

Figure 1-6 An example of measured value output

2. Adjustment of the external circuit

2.1 Adjusting Rc and Cc

When the values of Rc (resistor to control charge/discharge) and Cc (capacitor for charge/discharge) are changed, the time constant for charge and discharge varies.

For example, increasing the value of Rc or Cc makes the charge or discharge time longer. In this case, even if Cx changes by the same amount, the measured value will increase greatly, and the measurement time will be longer. (See Figure 2-1)

In actual adjustment, select values for Rc and Cc so that the difference between touch and no-touch may be clearly discriminated and the measurement time is as short as possible.

Cc: about 0.1μF is recommended.

Rc: in the range from a few k to twenty kΩ (2kΩ to 20kΩ), and as small as possible to discriminate between touch and no-touch.

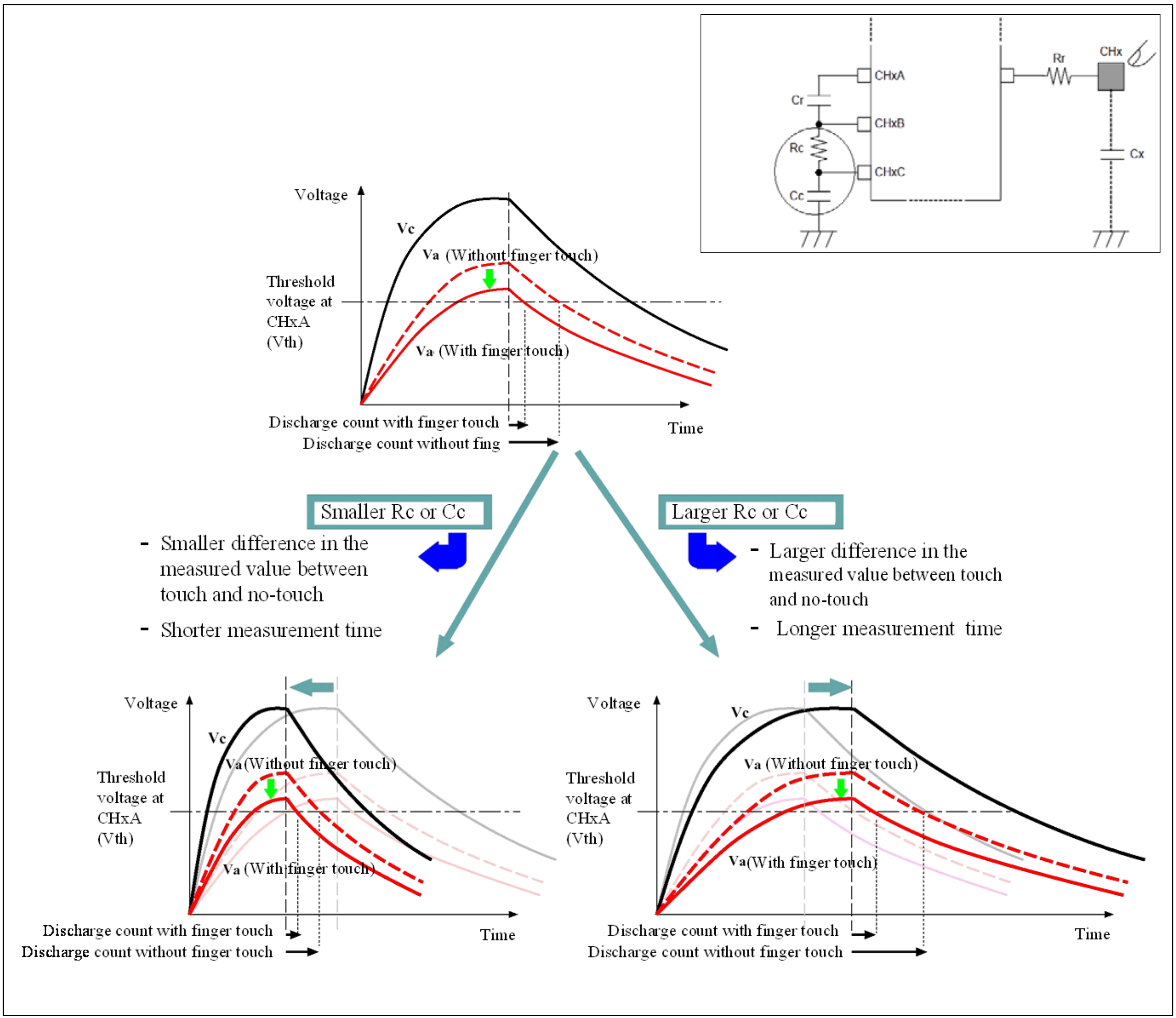

Figure 2-1 Variation of measured values due to changed Rc or Cc

2.2 Adjusting Cr

If the value of Cr (capacitor for comparison) is changed, the value of Va changes as shown in formula 1-1.

It is known from formula 1-1 that when Cx changes due to a finger touch, the smaller the value of Cr, the more the value of Va changes. However, if the value of Cr is too small, Va will always be lower than Vth (threshold voltage), and it will not be possible to measure the value of Va. (See Figure 2-2)

Further, if the floating capacitance of the touch electrode is large (if the value of Cx is large), the value of Cr must also be large to make it commensurate with Cx. Otherwise, Va will be constantly lower than Vth and it will not be possible to take the measurement.

In actual adjustment, select a value for Cr so that the measured value when touched is above 20.

Cr: in the range from a few pF to a few tens of pF (1pF to 50pF) and as small as possible, so as to make the measured value about 20 or more when touched

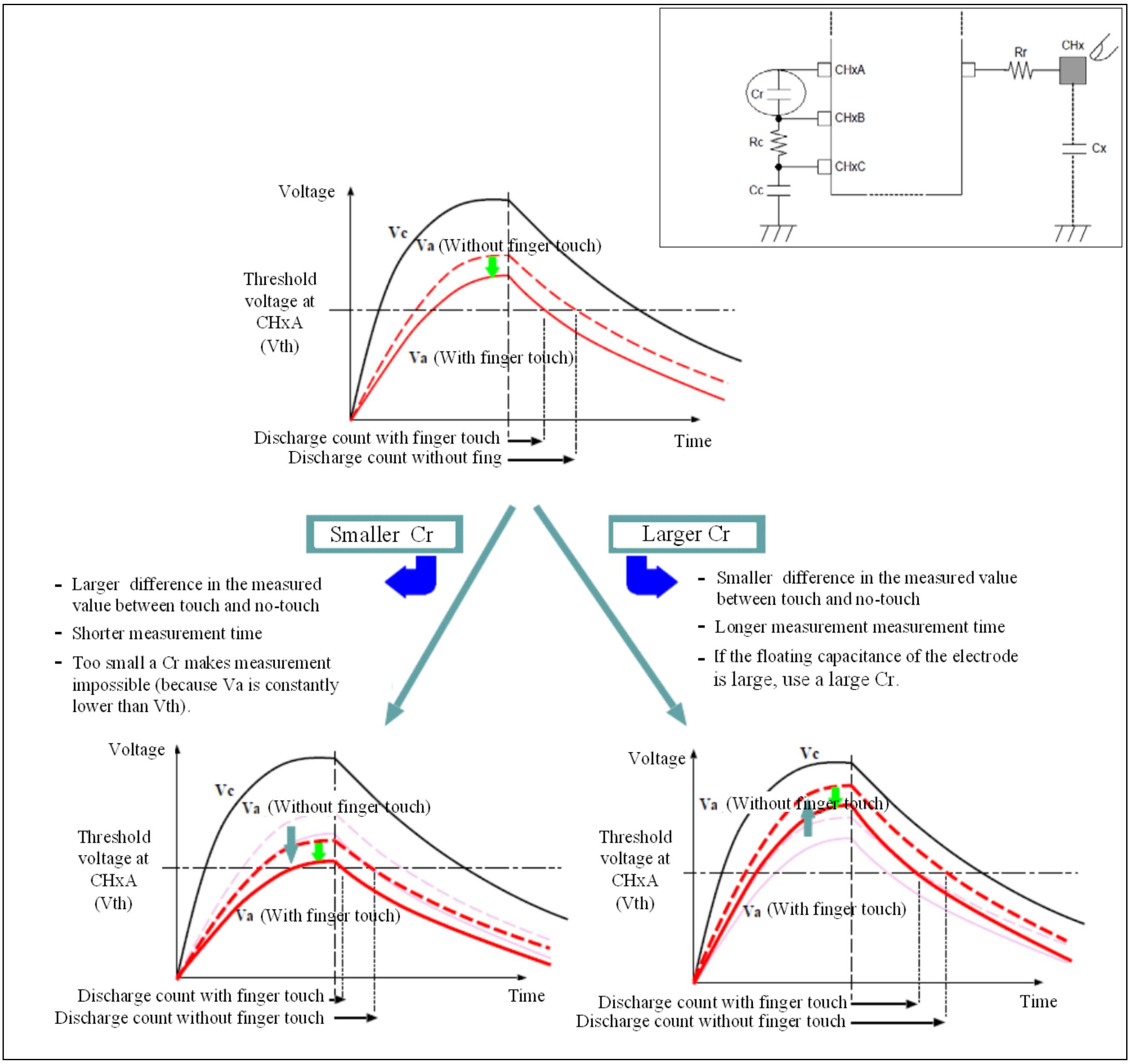

Figure 2-2 Variation of measured values due to changes in Cr

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Revision Record

Rev.	Date	Description	
		Page	Summary
1.00	May. 21, 2013	—	Numbering change (Contents is as same as REJ05B1344 102)
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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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