R8C/38T-A group

Random measurement: Touch detection using random timing

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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.

This application note explains a method to measure by a Random timing in the measurement with a capacitance-type touch sensor adopted by the R8C/33T group.

Target device

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

Contents

1. Random timing of Touch detection

1.1 Summary

The touch sensor of the R8C/33T series judges electric potential ("H" or “L”) of the touch electrode periodically.

The floating capacity of touch electrode is measured according to a period that a electric potential is become "L" from "H". Random measurement timing improves the weakness for the outside factor (periodical noise such as a broadcasting waves) by losing the periodicity of the electric potential judgment.

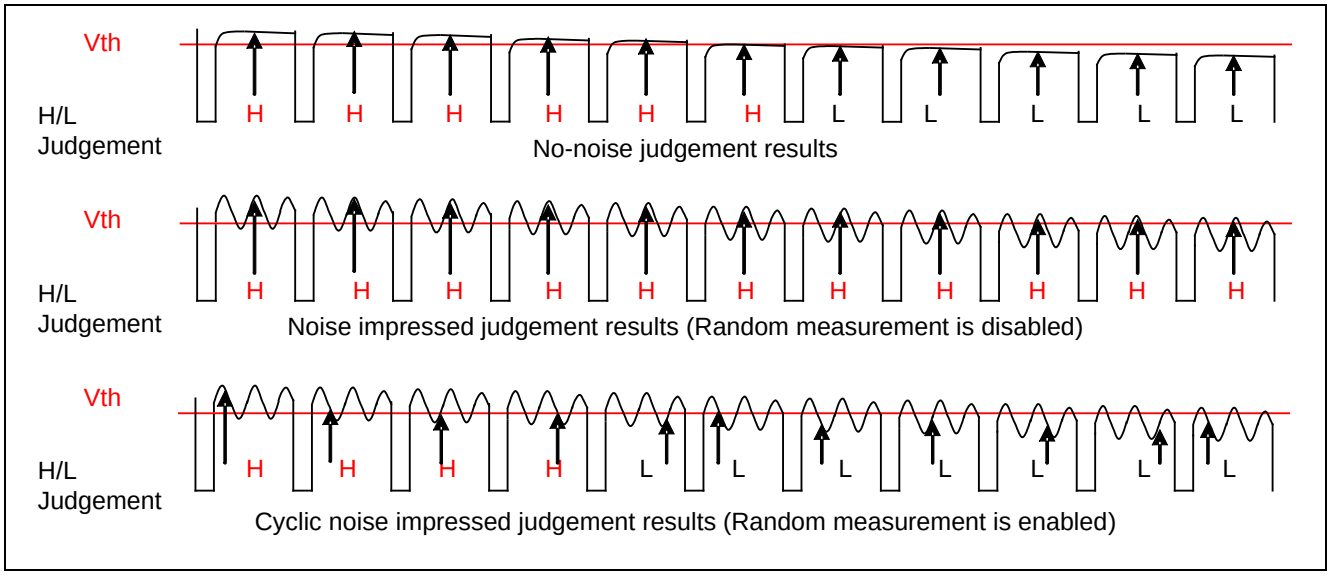

Figure 1-1 Judgement timings

1.2 What is Random measurement

"Figure 1-2" shows SCU Status Periods. Refer "R8C/33T Group Hardware Manual" for detail.

The random measurement can change a timing of "Main Measurement" shown in "Figure 1-3".

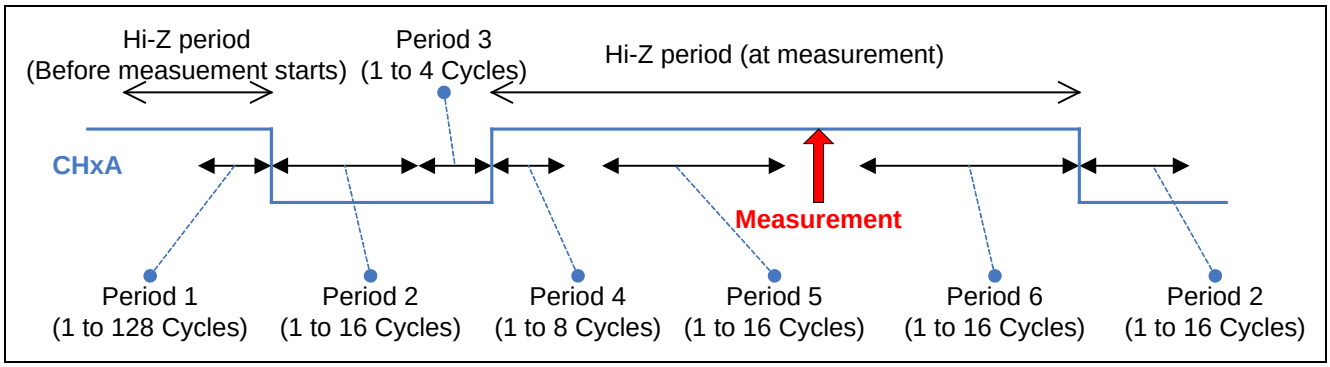

Figure 1-2 SCU Status Periods

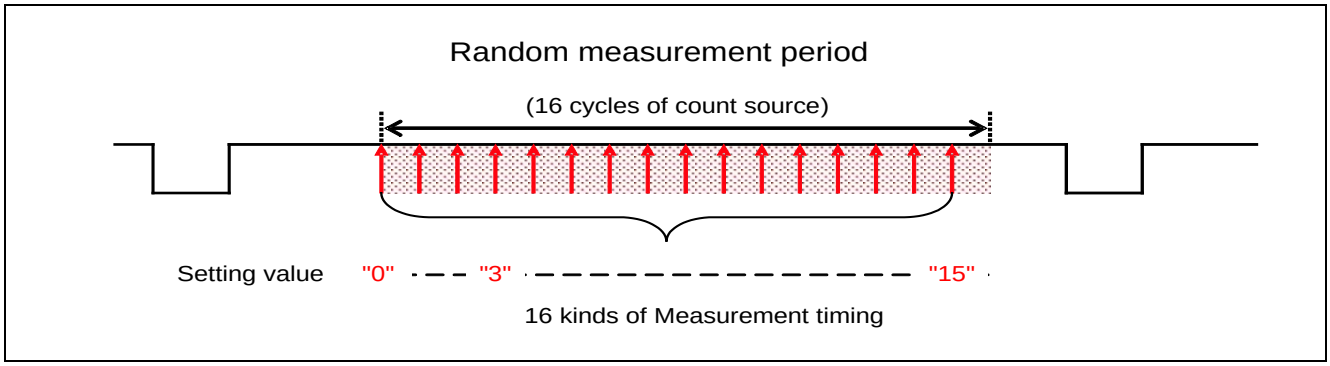

Figure 1-3 Random measurement period

<Specification>

1. Random measurement uses Random value storage register (SCRVR0 - SCRVR7). (4bit × 16 = 64bit = 8byte)
2. Measurement timing is 16 kinds. The value of SCRVR0 - SCRVR7 decides the measurement timing and the measurement order.

The timing of Random measurement is decided according to the value in Random value storage register (SCRVR0 - SCRVR7) after Status Period 5 showing “Figure 1-2”.

The range of the timing: “the setting values in SCRVR0 - 7” × “the cycle of count source”

SCRVR0 - 7 is referred in order from 0 to 15 at a measurement.

When the channel to measure is changed, SCRVR0 - 7 is referred to from (0).

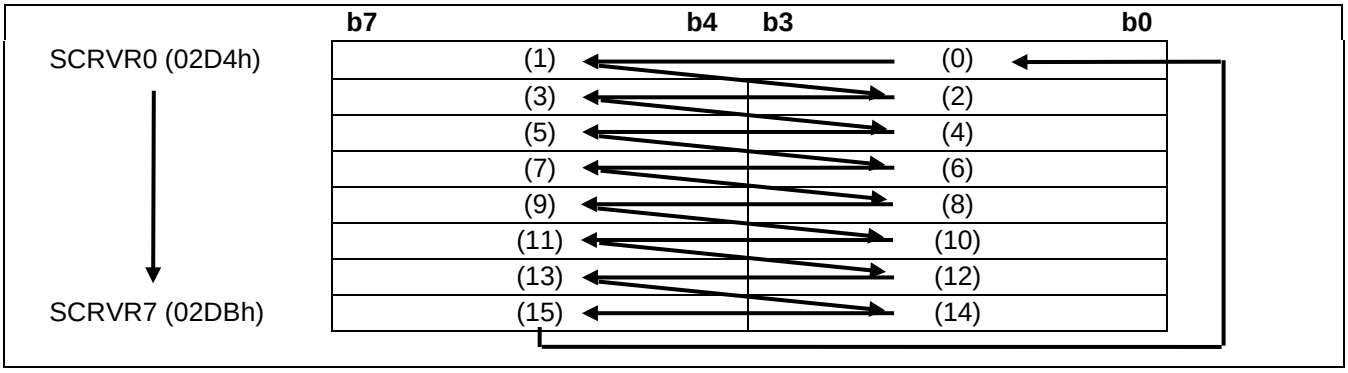

Figure 1-4 The order of reference to Random value storage register

2. Register settings for Random measurement

2.1 SCU Mode register setting

Address 02C1h

bit	b7	b6	b5	b4	b3	b2	b1	b0
Symbol	SCCAP1	SCCAP0	CONST	-	-	-	RANDOM	-
Initial value	0	0	0	0	0	0	0	0

Figure 2-1 Summary of SCU Mode register

Table 2-1 SCU Mode register

Bit	Symbol	Bit name	Function	R/W
b0	-	Reserved bits	Set to 0.	R/W
b1	RANDOM	Random measurement enable bit	0: Random measurement disabled 1: Random measurement enabled	R/W
b2	-	Reserved bits	Set to 0.	R/W
b3	-			
b4	-			
b5	CONST	Measurement period constants select bit	0: No constant 1: Constant	R/W
b6	SCCAP0	Touch sensor measurement start trigger select bit	00: Software trigger (the SCSTRT bit in the SCUCR0 register) 01: Do not set. 10: Measurement start trigger from timer RC 11: External trigger (SCUTRG)	R/W
b7	SCCAP1			R/W

- Set “1” to RANDOM bit in case of using Random measurement.
- Set “1” to CONST bit, when the measurement period is made constant regardless of the measurement timing at the Random measurement. (The setting of CONST bit is valid when Random measurement or Majority measurement is enabled)

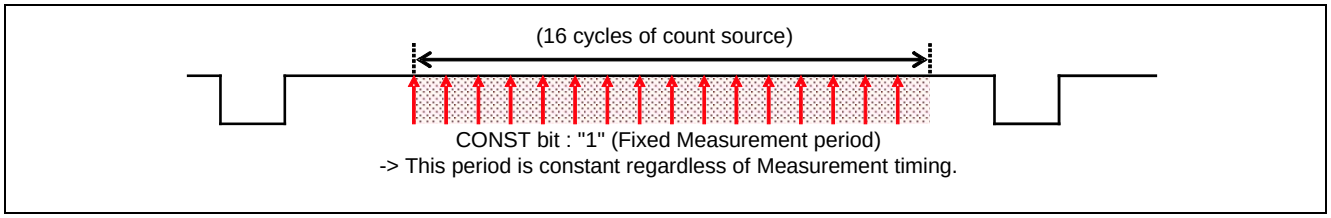

Figure 2-2 Fixed Measurement period

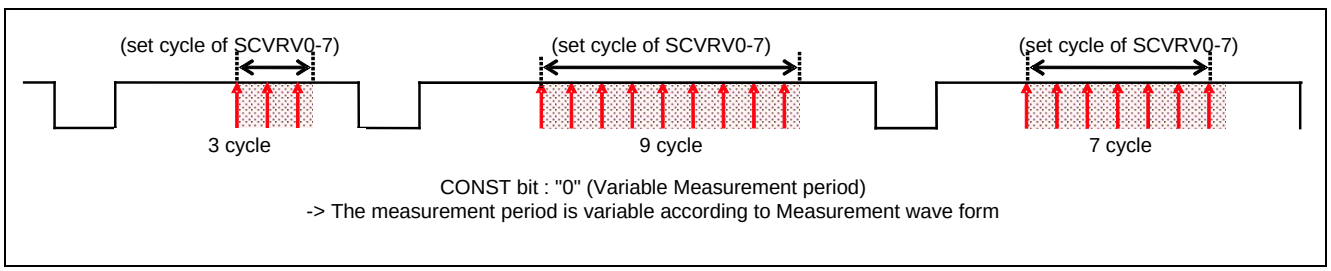

Figure 2-3 Variable Measurement period

2.2 Random value storage register settings

Table 2-2 Random value storage register

Address	Symbol	b7	b6	b5	b4	b3	b2	b1	b0	Value after reset
02D4h	SCRVR0	Reference (1)				Reference (0)				00h
02D5h	SCRVR1	Reference (3)				Reference (2)				00h
02D6h	SCRVR2	Reference (5)				Reference (4)				00h
02D7h	SCRVR3	Reference (7)				Reference (6)				00h
02D8h	SCRVR4	Reference (9)				Reference (8)				00h
02D9h	SCRVR5	Reference (11)				Reference (10)				00h
02DAh	SCRVR6	Reference (13)				Reference (12)				00h
02DBh	SCRVR7	Reference (15)				Reference (14)				00h

- Set the measurement timing to reference (0) - (15) in the range of "0x00" - "0x0F". It is not necessary to be unique value, if the value is within the above range.

A example of setting of Random value storage register settings and measurement timing related to the setting are as follows.

Table 2-3 Example of SCRVR0 - 7 settings

02D4h	SCRVR0	A	3
02D5h	SCRVR1	5	C
02D6h	SCRVR2	1	8
02D7h	SCRVR3	4	9
02D8h	SCRVR4	E	2
02D9h	SCRVR5	6	B
02DAh	SCRVR6	F	0
02DBh	SCRVR7	7	D

Table 2-4 Measurement timing changing

Reference order	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	0	1	2	3	4	--	--	--
Measurement timing	3	A	C	5	8	1	9	4	2	E	B	6	0	F	D	7	3	A	C	5	8	--	--	--

Note:

The settings of Random value storage register(SCRVR0 - 7) is held until the setting is changed. Therefore, Measurement will be carried out repeatedly according to the 16 kinds of measurement timings.

16 kinds of measurement timings may not be effective in the specific noise frequency band. In that case, consider countermeasures, for example, to decide the value of the Random value storage register settings using a random number.

3. Sample Source code

3.1 Header file for SCU setting

The sample code of SCU definitions is as follows.

```
/***********************************************************************/
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 * And Renesas Solutions Corporation
 * All Rights Reserved.
***********************************************************************/

/***********************************************************************/
/* File name: 3JT.h                                                    */
/* Purpose  : Touch Sensor IC Renesas3JT (Macro definition)            */
/*                                                                     */
/* Revision :                                                          */
/*+-rv-+-date---+-by---------+-reason--------------------------------*/
/***********************************************************************/

/*********************************************************/
/* defines                                               */
/*********************************************************/
/* ===================================================== */
/* SCU Default                                           */
/* ===================================================== */
#define DF_SCUCR0    0xA6     /* SCU Control Register 0                    */
                              /* F=1/4(5MHz),Non Short Mode ,SCU_INT ENABLE */

#define DF_SCUMR     0x02     /* SCU Mode Register USE RANDOM MODE(FIX)    */

//#define DF_SCUMR   0x22     /* SCU Mode Register USE RANDOM MODE(VAL)    */

#define DF_SCTCR0    0x20     /* SCU Timing Control Register 0 Charge 49cyc */
#define DF_SCTCR1    0x01     /* SCU Timing Control Register 1 "L" 2cyc    */
#define DF_SCTCR2    0x00     /* SCU Timing Control Register 2             */
#define DF_SCTCR3    0x00     /* SCU Timing Control Register 3             */
#define DF_SCHCR     0x95     /* SCU Channel Control Register 22ch UP SCAN */
#define DF_SCSCSR    0x07     /* SCU Secondary Counter Set Register 7Count */
#define DF_SCUCR1    0x01     /* SCU Control Register 1  TGVSEL VCC        */

#define DF_SCRVR0    0x20     /* SCU Random Parameter 0 */
#define DF_SCRVR1    0x64     /* SCU Random Parameter 1 */
#define DF_SCRVR2    0x31     /* SCU Random Parameter 2 */
#define DF_SCRVR3    0x75     /* SCU Random Parameter 3 */
#define DF_SCRVR4    0xCF     /* SCU Random Parameter 4 */
#define DF_SCRVR5    0x9E     /* SCU Random Parameter 5 */
#define DF_SCRVR6    0xDB     /* SCU Random Parameter 6 */
#define DF_SCRVR7    0x8A     /* SCU Random Parameter 7 */
```

注) DF_SCUCR0 0x02 Random measurement is enabled and fixed Random measurement periods
DF_SCUCR0 0x22 Random measurement is enabled and variable Random measurement periods

DF_SCRVR0 - 7 Random value at the fixed Random measurement

3.2 SCU Initialization

The sample code of SCU Initialization is as follows.

```
/************************************************************/
/* Function name: scu_init                                  */
/*    Function: SCU register initialization                 */
/*    Input : non                                           */
/*    Output: non                                           */
/*    Subfunc  : non                                        */
/*    Return: non                                           */
/*                                                          */
/* Revision :                                               */
/*+-rv-+-date---+-by---------+-reason----------------------=*/
/*|    |        |            |                            */
/************************************************************/
/* Process :                                                */
/* SUC register is initialized                              */
/*                                                          */
/************************************************************/
/* Attention : #                                            */
/*                                                          */
/************************************************************/
void scu_init( void )
{
  /* =====  SCU initialization  ===== */
  scucr0 = DF_SCUCR0;    /* SCU control register 0                 */
  scumr = DF_SCUMR;      /* SCU mode register                      */
  sctcr0 = DF_SCTCR0;    /* SCU timing control register 0          */
  sctcr1 = DF_SCTCR1;    /* SCU timing control register 1          */
  sctcr2 = DF_SCTCR2;    /* SCU timing control register 2          */
  sctcr3 = DF_SCTCR3;    /* SCU timing control register 3          */
  schcr = DF_SCHCR;      /* SCU channel control register           */
  scscsr = DF_SCSCSR;    /* SCU secondary counter setting register */
  scucr1 = DF_SCUCR1;    /* SCU control register 1                 */

  scrvr0 = DF_SCRVR0;    /* SCU Random Parameter */
  scrvr1 = DF_SCRVR1;    /* SCU Random Parameter */
  scrvr2 = DF_SCRVR2;    /* SCU Random Parameter */
  scrvr3 = DF_SCRVR3;    /* SCU Random Parameter */
  scrvr4 = DF_SCRVR4;    /* SCU Random Parameter */
  scrvr5 = DF_SCRVR5;    /* SCU Random Parameter */
  scrvr6 = DF_SCRVR6;    /* SCU Random Parameter */
  scrvr7 = DF_SCRVR7;    /* SCU Random Parameter */
}
```

3.3 Random measurement execution

The sample code of creating random value every measurements and measurements is as follows.

```
/************************************************************************/
/* Function name: Measure(Random Mode)                                  */
/*    Function: main process                                            */
/*    Input : non                                                       */
/*    Output: non                                                       */
/*+-rv-+-date---+-by---------+-reason-----------------------------------*/
/************************************************************************/
/* Process :                                                            */
/************************************************************************/
/* Attention : #                                                        */
/*                                                                      */
/************************************************************************/
void Measure( void )
{
 /***************  random number generation for measurement ************/
  RND_create();          /* Make Randum data for the measurement      */

  scstrt = ON;           /* SCU Measurement starting                  */
}
```

3.4 Random value creation

Timer RB Initialization for creating Random value is as follows.

```
/************************************************************/
/* Function name: trb_015                                   */
/*    Function: trb register initialization                 */
/* Revision :                                               */
/*+-rv-+-date---+-by---------+-reason----------------------=-*/
/*|    |        |            |                              */
/************************************************************/
/* Process :                                                */
/* TRB register is initialized                              */
/*                                                          */
/************************************************************/
/* Attention : #  generate a random number from 0 to 15     */
/*                                                          */
/************************************************************/
void trb_015(void)
{
  /* ===== Timer RB initial setting ===== */
  trbmr   = 0x30;     // 010BH    /* Timer RB mode register     */
                      // Count source/f2
  trbpre  = 0;        // 010CH    /* Timer RB prescaler register*/
  trbsc   = 0;        // 010DH    /* Timer RB secondary register*/
  trbpr   = 15;       // 010EH    /* Timer RB primary register  */
  tstart_trbcr = 1;               /* Timer RB count start       */
}
```

3.5 Random value settings

The sample code of SCRVR0 - 7 settings using Random value created from Timer RB is as follows.

```
/*********************************************************/
/* Function : RND_create                                 */
/* Input    : unsigned char *                            */
/* Output   : void                                       */
/* Subfuc   : NONE                                       */
/* Return   : void                                       */
/*--rev-+--date--+-by-------+-------------------------------*/
/*********************************************************/
/* Process     : create random N.o for SCRVR0-7           */
/*********************************************************/
#define RNDmask 0b00001111

void RND_create(void)
{
  unsigned char Rd,Rdx;
  Rd = trbpr;                        /* Read TRB For Rundom Measurement  */

  Rdx = (Rd + 4) << 4;                  /* scrvr0 upper data             */
  scrvr0 = Rdx & (Rd & RNDmask);        /* scrvr0 upper and lower data   */
  Rdx = (Rd + 5) << 4;                  /* scrvr1 upper data             */
  scrvr1 = Rdx & ((Rd + 1) & RNDmask);  /* scrvr1 upper and lower data   */
  Rdx = (Rd + 6) << 4;                  /* scrvr2 upper data             */
  scrvr2 = Rdx & ((Rd + 2) & RNDmask);  /* scrvr2 upper and lower data   */
  Rdx = (Rd + 7) << 4;                  /* scrvr3 upper data             */
  scrvr3 = Rdx & ((Rd + 3) & RNDmask);  /* scrvr3 upper and lower data   */
  Rdx = (Rd + 11) << 4;                 /* scrvr4 upper data             */
  scrvr4 = Rdx & ((Rd + 15) & RNDmask); /* scrvr4 upper and lower data   */
  Rdx = (Rd + 12) << 4;                 /* scrvr5 upper data             */
  scrvr5 = Rdx & ((Rd + 14) & RNDmask); /* scrvr5 upper and lower data   */
  Rdx = (Rd + 13) << 4;                 /* scrvr6 upper data             */
  scrvr6 = Rdx & ((Rd + 9) & RNDmask);  /* scrvr6 upper and lower data   */
  Rdx = (Rd + 8) << 4;                  /* scrvr7 upper data             */
  scrvr7 = Rdx & ((Rd + 10) & RNDmask); /* scrvr7 upper and lower data   */
}
```

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Revision Record

Rev.	Date	Description	
		Page	Summary
1.00	May 22. 2013	—	Numbering change (Contents is as same as REJ05B1408-0100)

General Precautions in the Handling of MPU/MCU Products

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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.
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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.
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   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.
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   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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