Chipsmall

Chipsmall Limited consists of a professional team with an average of over 10 year of expertise in the distribution of electronic components. Based in Hongkong, we have already established firm and mutual-benefit business relationships with customers from,Europe,America and south Asia,supplying obsolete and hard-to-find components to meet their specific needs.

With the principle of "Quality Parts,Customers Priority,Honest Operation,and Considerate Service",our business mainly focus on the distribution of electronic components. Line cards we deal with include Microchip,ALPS,ROHM,Xilinx,Pulse,ON,Everlight and Freescale. Main products comprise IC,Modules,Potentiometer,IC Socket,Relay,Connector.Our parts cover such applications as commercial,industrial, and automotives areas.

We are looking forward to setting up business relationship with you and hope to provide you with the best service and solution. Let us make a better world for our industry!

Contact us

Tel: +86-755-8981 8866 Fax: +86-755-8427 6832
Email & Skype: info@chipsmall.com Web: www.chipsmall.com
Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China

3-WIRE REAL-TIME CLOCK

Rev.3.2_02

The S-35192A is a CMOS 3-wire real-time clock IC which operates with the very low current consumption in the wide range of operation voltage. The operation voltage is 1.3 V to 5.5 V so that the S-35192A can be used for various power supplies from main supply to backup battery. Due to the 0.45 μA current consumption and wide range of power supply voltage at time keeping, the S-35192A makes the battery life longer. In the system which operates with a backup battery, the included free registers can be used as the function for user's backup memory. Users always can take back the information in the registers which is stored before power-off the main power supply, after the voltage is restored.

The S-35192A has the function to correct advance / delay of the clock data speed, in the wide range, which is caused by the crystal oscillation circuit's frequency deviation. Correcting according to the temperature change by combining this function and a temperature sensor, it is possible to make a high precise clock function which is not affected by the ambient temperature.

■ Features

- Low current consumption: 0.45 μA typ. (V_{DD} = 3.0 V, Ta = +25°C)
- Constant output of 32.768 kHz clock pulse (Nch open-drain output)
- Wide range of operating voltage: 1.3 V to 5.5 V
- Built-in clock correction function
- Built-in free user register
- 3-wire (MICROWIRE) CPU interface
- Built-in alarm function
- Built-in flag generator during detection of low power voltage or at power-on
- Auto calendar up to the year 2099, automatic leap year calculation function
- Built-in constant voltage circuit
- Built-in 32.768 kHz crystal oscillator (built-in C_d, external C_g)
- Lead-free (Sn 100%), halogen-free

■ Applications

- Mobile game device
- Mobile AV device
- Digital still camera
- Digital video camera
- Electronic power meter
- DVD recorder
- TV, VCR
- Mobile phone, PHS
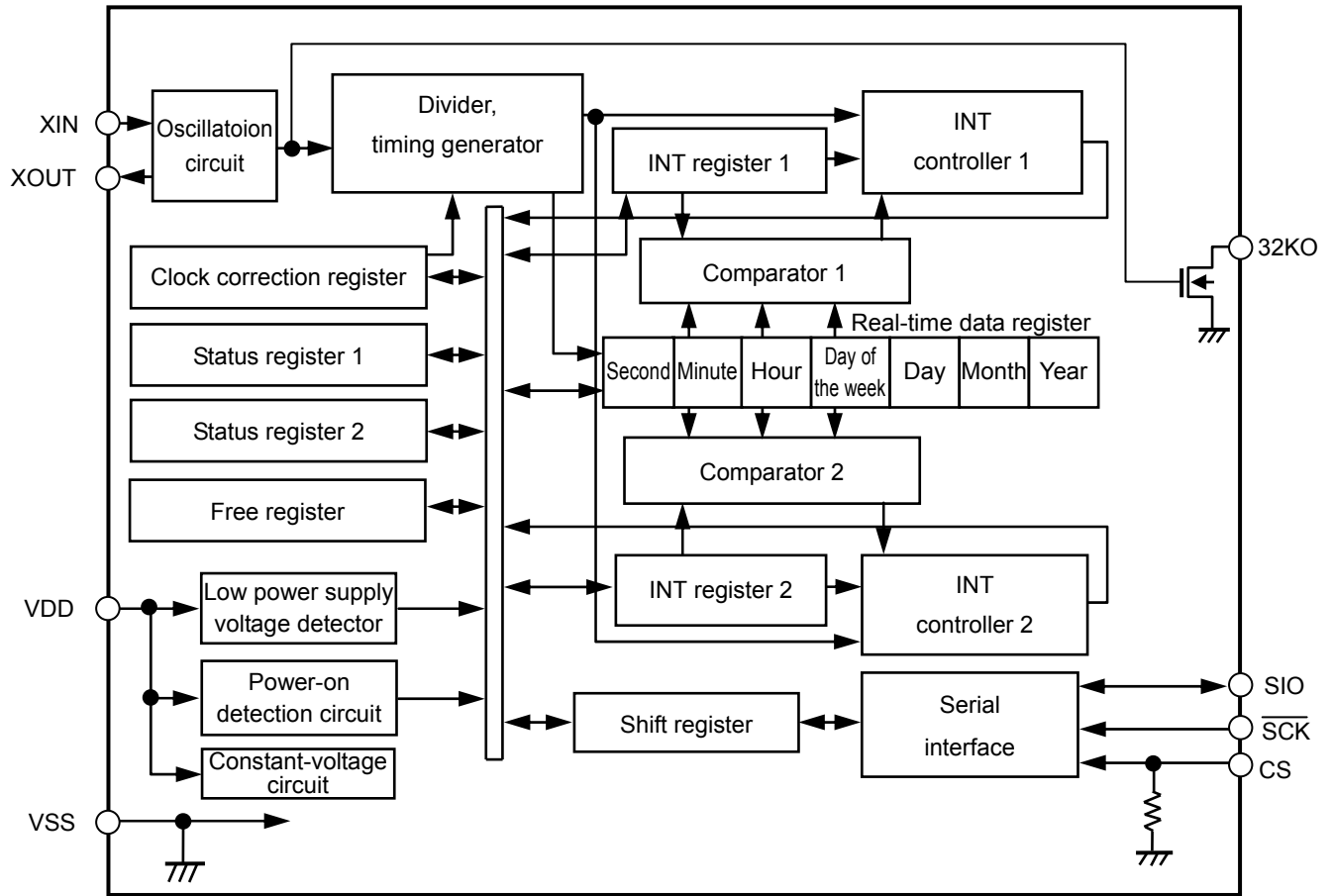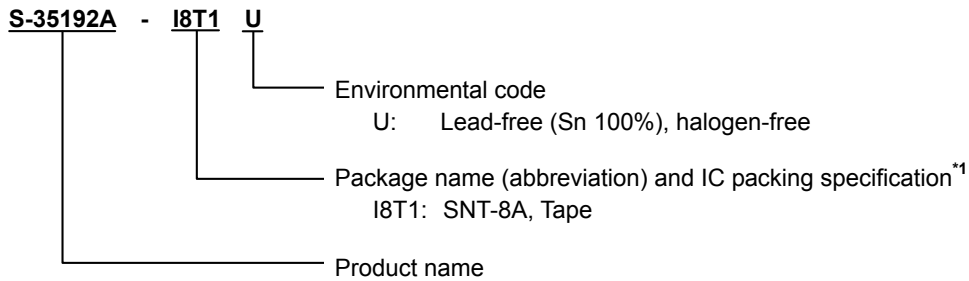
■ Package

- SNT-8A

■ Block Diagram

Figure 1

■ Product Name Structure

1. Product name

S-35192A - **I8T1** **U**

Environmental code
  U: Lead-free (Sn 100%), halogen-free

Package name (abbreviation) and IC packing specification[1]
  I8T1: SNT-8A, Tape

Product name

*1.   Refer to the tape drawing.

2. Package

Table 1   Package Drawing Codes

Package Name	Dimension	Tape	Reel	Land
SNT-8A	PH008-A-P-SD	PH008-A-C-SD	PH008-A-R-SD	PH008-A-L-SD

■ Pin Configuration

1. SNT-8A

Top view

```
1 ┌─●──┐ 8
2 │     │ 7
3 │     │ 6
4 └─────┘ 5
```
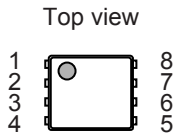
Figure 2   S-35192A-I8T1U

Table 2   List of Pins

Pin No.	Symbol	Description	I/O	Configuration
1	32KO	Pin for constant output of 32.768 kHz	Output	Nch open-drain output (no protective diode at VDD)
2	XOUT	Connection pins for crystal oscillator	–	–
3	XIN			
4	VSS	GND pin	–	–
5	CS	Input pin for chip select	Input	CMOS input (built-in pull-down resistor. no protective diode at VDD)
6	$\overline{\text{SCK}}$	Input pin for serial clock	Input	CMOS input (no protective diode at VDD)
7	SIO	I/O pin for serial data	Bi-directional	Nch open-drain output (no protective diode at VDD) CMOS input
8	VDD	Pin for positive power supply	–	–

■ Pin Functions

1. CS (input for chip select) pin

This pin is to input chip select, has a pull-down resistor. Communication is available when this pin is in "H". If not using communication, set this pin "L" or open.

2. $\overline{\text{SCK}}$ (input for serial clock) pin

This pin is to input a clock pulse for serial interface. When the CS pin is in "H", the SIO pin inputs / outputs data by synchronizing with the clock pulse. When the CS pin is in "L" or open, the $\overline{\text{SCK}}$ pin does not accept inputting a clock pulse.

3. SIO (I/O for serial data) pin

This pin is a data input / output pin of serial interface. When the CS pin is in "H", the SIO pin inputs / outputs data by synchronizing with a clock pulse from the $\overline{\text{SCK}}$ pin. The status is in "High-Z" when the CS pin is in "L" or open, so that the S-35192A does not transmit data. Setting the CS pin to "H" from "L" or open, this SIO pin goes in the input status so that it receives the command data. This pin has CMOS input and Nch open drain output.

4. XIN, XOUT (crystal oscillator connect) pins

Connect a crystal oscillator between XIN and XOUT.

5. 32KO (constant output of 32.768 kHz) pin

This is an output pin for 32.768 kHz. This pin constantly outputs a clock pulse after power-on.

6. VDD (positive power supply) pin

Connect this VDD pin with a positive power supply. Regarding the values of voltage to be applied, refer to "■ **Recommended Operation Conditions**".

7. VSS pin

Connect this VSS pin to GND.
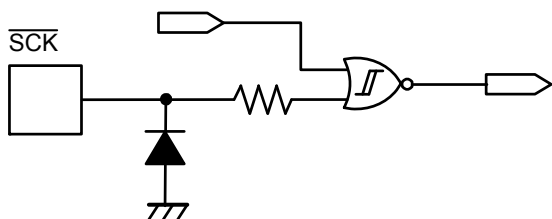
■ Equivalent Circuits of Pins
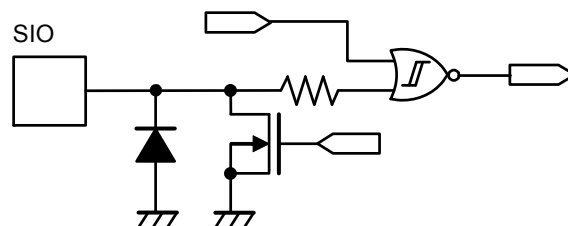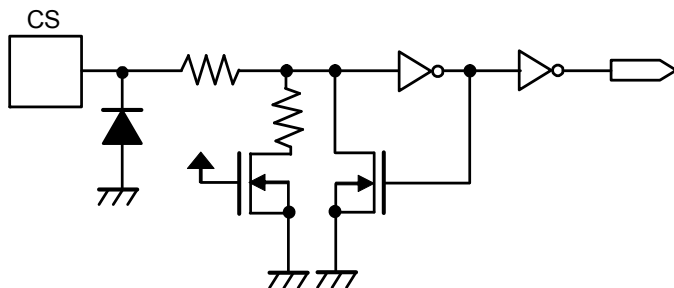
Figure 3 $\overline{\text{SCK}}$ pin

Figure 4 SIO pin

Figure 5 CS pin
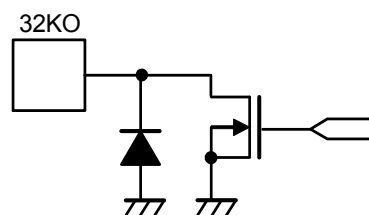
Figure 6 32KO pin

■ Absolute Maximum Ratings

Table 3

Item	Symbol	Applied Pin	Absolute Maximum Rating	Unit
Power supply voltage	V_{DD}	–	V_{SS} – 0.3 to V_{SS} + 6.5	V
Input voltage	V_{IN}	CS, $\overline{SCK}$, SIO	V_{SS} – 0.3 to V_{SS} + 6.5	V
Output voltage	V_{OUT}	SIO, 32KO	V_{SS} – 0.3 to V_{SS} + 6.5	V
Operating ambient temperature[*1]	T_{opr}	–	−40 to +85	°C
Storage temperature	T_{stg}	–	−55 to +125	°C

*1. Conditions with no condensation or frost. Condensation or frost causes short-circuiting between pins, resulting in a malfunction.

Caution   The absolute maximum ratings are rated values exceeding which the product could suffer physical damage. These values must therefore not be exceeded under any conditions.

■ Recommended Operation Conditions

Table 4

(V_{SS} = 0 V)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Power supply voltage[*1]	V_{DD}	Ta = −40°C to +85°C	1.3	3.0	5.5	V
Time keeping power supply voltage[*2]	V_{DDT}	Ta = −40°C to +85°C	V_{DET} – 0.15	–	5.5	V
Crystal oscillator C_L value	C_L	–	–	6	7	pF

*1. The power supply voltage that allows communication under the conditions shown in **Table 9** of "■ AC Electrical Characteristics"

*2. The power supply voltage that allows time keeping. For the relationship with V_{DET} (low power supply voltage detection voltage), refer to "■ **Characteristics (Typical Data)**".

■ Oscillation Characteristics

Table 5

(Ta = +25°C, V_{DD} = 3.0 V, V_{SS} = 0 V, VT-200 crystal oscillator (C_L = 6 pF, 32.768 kHz) manufactured by Seiko Instruments Inc.)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Oscillation start voltage	V_{STA}	Within 10 seconds	1.1	–	5.5	V
Oscillation start time	t_{STA}	–	–	–	1	s
IC-to-IC frequency deviation[*1]	δIC	–	−10	–	+10	ppm
Frequency voltage deviation	δV	V_{DD} = 1.3 V to 5.5 V	−3	–	+3	ppm/V
External capacitance	C_g	Applied to XIN pin	–	–	9.1	pF
Internal oscillation capacitance	C_d	Applied to XOUT pin	–	8	–	pF

*1. Reference value

■ DC Electrical Characteristics

Table 6   DC Characteristics (V$_{DD}$ = 3.0 V)

(Ta = −40°C to +85°C, V$_{SS}$ = 0 V, VT-200 crystal oscillator (C$_L$ = 6 pF, 32.768 kHz, C$_g$ = 9.1 pF) manufactured by Seiko Instruments Inc.)

Item	Symbol	Applied Pin	Condition	Min.	Typ.	Max.	Unit
Current consumption 1	I$_{DD1}$	–	Out of communication	–	0.45	1.13	μA
Current consumption 2	I$_{DD2}$	–	During communication ($\overline{SCK}$ = 100 kHz)	–	3.3	8	μA
Input current leakage 1	I$_{IZH}$	$\overline{SCK}$, SIO	V$_{IN}$ = V$_{DD}$	−0.5	–	0.5	μA
Input current leakage 2	I$_{IZL}$	$\overline{SCK}$, SIO	V$_{IN}$ = V$_{SS}$	−0.5	–	0.5	μA
Input current 1	I$_{IH1}$	CS	V$_{IN}$ = V$_{DD}$	2	6	16	μA
Input current 2	I$_{IH2}$	CS	V$_{IN}$ = 0.4 V	40	100	300	μA
Input current 3	I$_{IH3}$	CS	V$_{IN}$ = 1.0 V	–	215	–	μA
Output current leakage 1	I$_{OZH}$	SIO, 32KO	V$_{OUT}$ = V$_{DD}$	−0.5	–	0.5	μA
Output current leakage 2	I$_{OZL}$	SIO, 32KO	V$_{OUT}$ = V$_{SS}$	−0.5	–	0.5	μA
Input voltage 1	V$_{IH}$	CS, $\overline{SCK}$, SIO	–	0.8 × V$_{DD}$	–	V$_{SS}$ + 5.5	V
Input voltage 2	V$_{IL}$	CS, $\overline{SCK}$, SIO	–	V$_{SS}$ − 0.3	–	0.2 × V$_{DD}$	V
Output current 1	I$_{OL1}$	32KO	V$_{OUT}$ = 0.4 V	3	5	–	mA
Output current 2	I$_{OL2}$	SIO	V$_{OUT}$ = 0.4 V	5	10	–	mA
Power supply voltage detection voltage	V$_{DET}$	–	–	0.65	1	1.35	V

Table 7   DC Characteristics (V$_{DD}$ = 5.0 V)

(Ta = −40°C to +85°C, V$_{SS}$ = 0 V, VT-200 crystal oscillator (C$_L$ = 6 pF, 32.768 kHz, C$_g$ = 9.1 pF) manufactured by Seiko Instruments Inc.)

Item	Symbol	Applied Pin	Condition	Min.	Typ.	Max.	Unit
Current consumption 1	I$_{DD1}$	–	Out of communication	–	0.6	1.4	μA
Current consumption 2	I$_{DD2}$	–	During communication ($\overline{SCK}$ = 100 kHz)	–	6	14	μA
Input current leakage 1	I$_{IZH}$	$\overline{SCK}$, SIO	V$_{IN}$ = V$_{DD}$	−0.5	–	0.5	μA
Input current leakage 2	I$_{IZL}$	$\overline{SCK}$, SIO	V$_{IN}$ = V$_{SS}$	−0.5	–	0.5	μA
Input current 1	I$_{IH1}$	CS	V$_{IN}$ = V$_{DD}$	8	16	50	μA
Input current 2	I$_{IH2}$	CS	V$_{IN}$ = 0.4 V	40	150	350	μA
Input current 3	I$_{IH3}$	CS	V$_{IN}$ = 2.0V	–	610	–	μA
Output current leakage 1	I$_{OZH}$	SIO, 32KO	V$_{OUT}$ = V$_{DD}$	−0.5	–	0.5	μA
Output current leakage 2	I$_{OZL}$	SIO, 32KO	V$_{OUT}$ = V$_{SS}$	−0.5	–	0.5	μA
Input voltage 1	V$_{IH}$	CS, $\overline{SCK}$, SIO	–	0.8 × V$_{DD}$	–	V$_{SS}$ + 5.5	V
Input voltage 2	V$_{IL}$	CS, $\overline{SCK}$, SIO	–	V$_{SS}$ − 0.3	–	0.2 × V$_{DD}$	V
Output current 1	I$_{OL1}$	32KO	V$_{OUT}$ = 0.4 V	5	8	–	mA
Output current 2	I$_{OL2}$	SIO	V$_{OUT}$ = 0.4 V	6	13	–	mA
Power supply voltage detection voltage	V$_{DET}$	–	–	0.65	1	1.35	V

■ AC Electrical Characteristics

Table 8   Measurement Conditions

Input pulse voltage	$V_{IH} = 0.8 \times V_{DD}$, $V_{IL} = 0.2 \times V_{DD}$
Input pulse rise / fall time	20 ns
Output determination voltage	$V_{OH} = 0.8 \times V_{DD}$, $V_{OL} = 0.2 \times V_{DD}$
Output load	80 pF + pull-up resistor 10 kΩ

V_{DD}

R = 10 kΩ

SIO

C = 80 pF
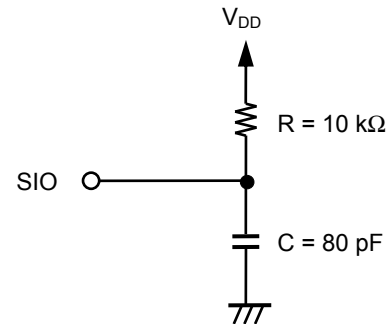
Remark The power supplies of the IC and load have the same electrical potential.

Figure 7   Output Load Circuit

Table 9   AC Electrical Characteristics

(Ta = −40°C to +85°C)

Item	Symbol	V_{DD}[2] ≥ 1.3 V			V_{DD}[2] ≥ 3.0 V			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
Clock pulse width	t_{SCK}	5	–	250000	1	–	250000	μs
Setup time before CS rise	t_{DS}	1	–	–	0.2	–	–	μs
Hold time after CS rise	t_{CSH}	1	–	–	0.2	–	–	μs
Input data setup time	t_{ISU}	1	–	–	0.2	–	–	μs
Input data hold time	t_{IHO}	1	–	–	0.2	–	–	μs
Output data definition time[1]	t_{ACC}	–	–	3.5	–	–	1	μs
Setup time before CS fall	t_{CSS}	1	–	–	0.2	–	–	μs
Hold time after CS fall	t_{DH}	1	–	–	0.2	–	–	μs
Input rise / fall time	t_R, t_F	–	–	0.1	–	–	0.05	μs

[1]. Since the output format of the SIO pin is Nch open-drain output, output data definition time is determined by the values of the load resistance (R_L) and load capacity (C_L) outside the IC. Therefore, use this value only as a reference value.

[2]. Regarding the power supply voltage, refer to "■ **Recommended Operation Conditions**".
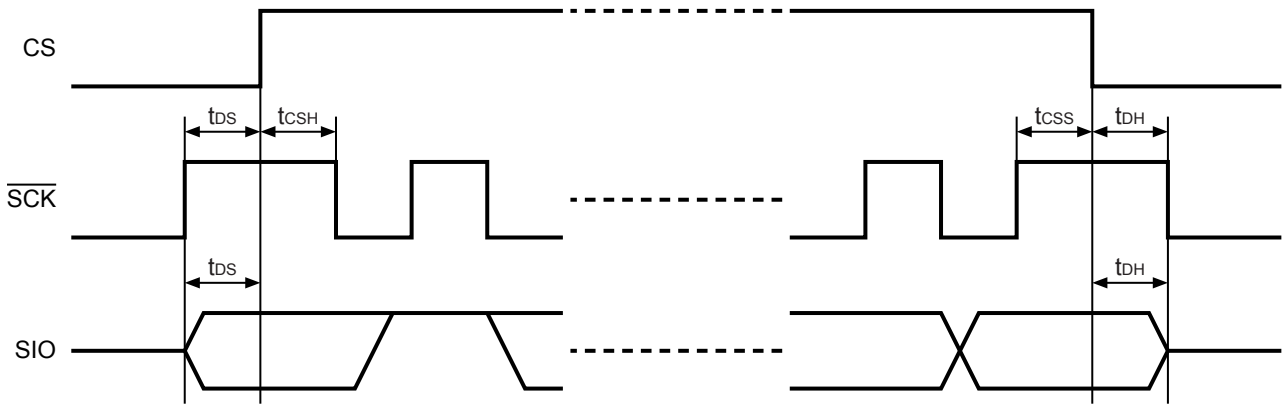
Figure 8　Timing Diagram 1 during 3-wire Communication
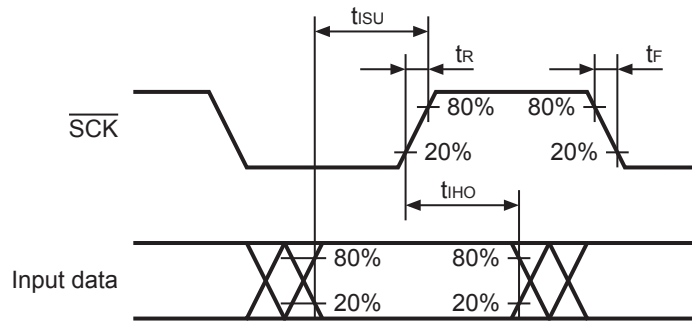
Figure 9　Timing Diagram 2 during 3-wire Communication
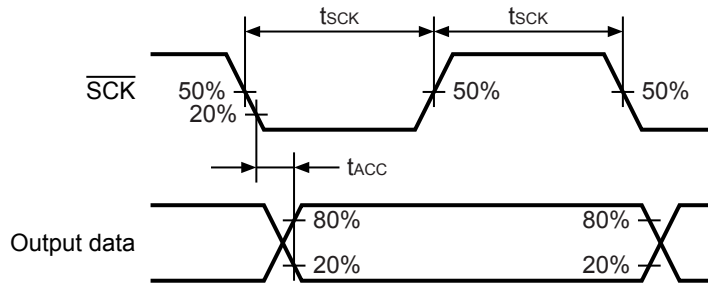
Figure 10　Timing Diagram 3 during 3-wire Communication

■ **Configuration of Data Communication**

   1.   Data communication

      After setting the CS pin "H", transmit the 4-bit fixed code "0110", after that, transmit a 3-bit command and 1-bit read / write command. Next, data is output or input from B7. Regarding details, refer to "■ **Serial Interface**".

Read / write bit

←	Fixed code	→	←	Command	→	←	→
0	1	1	0	C2	C1	C0	R / $\overline{W}$

←			1-byte data				→
B7	B6	B5	B4	B3	B2	B1	B0

Figure 11   Data Communication

2. Configuration of command

8 types of command are available for the S-35192A. The S-35192A reads / writes the various registers by inputting these fixed codes and commands. The S-35192A does not perform any operation with any codes and commands other than those below. However, in case that the fixed codes or the commands are failed to be recognized in the 1st byte but are successfully recognized in the 2nd and higher bytes, the commands are executed.

Table 10   List of Commands

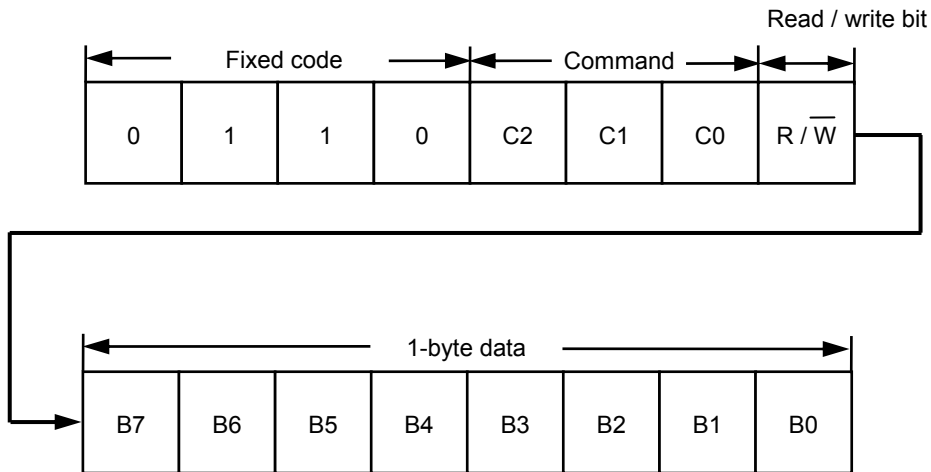| Fixed Code	Command				Data							
	C2	C1	C0	Description	B7	B6	B5	B4	B3	B2	B1	B0
0110	0	0	0	Status register 1 access	RESET[*1]	$\overline{12/24}$	SC0[*2]	SC1[*2]	INT1[*3]	INT2[*3]	BLD[*4]	POC[*4]
	0	0	1	Status register 2 access	INT1FE	INT1ME	INT1AE	SC2[*2]	SC3[*2]	SC4[*2]	INT2AE	TEST[*5]
	0	1	0	Real-time data 1 access (year data to)	Y1	Y2	Y4	Y8	Y10	Y20	Y40	Y80
					M1	M2	M4	M8	M10	_[*6]	_[*6]	_[*6]
					D1	D2	D4	D8	D10	D20	_[*6]	_[*6]
					W1	W2	W4	_[*6]	_[*6]	_[*6]	_[*6]	_[*6]
					H1	H2	H4	H8	H10	H20	$\overline{AM/PM}$	_[*6]
					m1	m2	m4	m8	m10	m20	m40	_[*6]
					s1	s2	s4	s8	s10	s20	s40	_[*6]
	0	1	1	Real-time data 2 access (hour data to)	H1	H2	H4	H8	H10	H20	$\overline{AM/PM}$	_[*6]
					m1	m2	m4	m8	m10	m20	m40	_[*6]
					s1	s2	s4	s8	s10	s20	s40	_[*6]
	1	0	0	INT register 1 access (alarm time 1: week / hour / minute) (INT1AE = 1, INT1ME = 0, INT1FE = 0)	W1	W2	W4	_[*6]	_[*6]	_[*6]	_[*6]	A1WE
					H1	H2	H4	H8	H10	H20	$\overline{AM/PM}$	A1HE
					m1	m2	m4	m8	m10	m20	m40	A1mE
				INT register 1 access (free register function) (settings other than alarm time 1)	SC5[*2]	SC6[*2]	SC7[*2]	SC8[*2]	SC9[*2]	SC10[*2]	SC11[*2]	SC12[*2]
	1	0	1	INT register 2 access (alarm time 2: week / hour / minute) (INT2AE = 1)	W1	W2	W4	_[*6]	_[*6]	_[*6]	_[*6]	A2WE
					H1	H2	H4	H8	H10	H20	$\overline{AM/PM}$	A2HE
					m1	m2	m4	m8	m10	m20	m40	A2mE
	1	1	0	Clock correction register access	V0	V1	V2	V3	V4	V5	V6	V7
	1	1	1	Free register access	F0	F1	F2	F3	F4	F5	F6	F7

*1. Write-only flag. The S-35192A initializes by writing "1" in this register.

*2. Scratch bit. This is a register which is available for read / write operations and can be used by users freely.

*3. Read-only flag. Valid only when using the alarm function. When the alarm time matches, this flag is set to "1", and it is cleared to "0" when reading.

*4. Read-only flag. "POC" is set to "1" when power is applied. It is cleared to "0" when reading. Regarding "BLD", refer to "■ **Low Power Supply Voltage Detection Circuit**".

*5. Test bit for SII Semiconductor Corporation. Be sure to set to "0" in use.

*6. No effect when writing. It is "0" when reading.

■ Configuration of Registers

1. Real-time data register

The real-time data register is a 7-byte register that stores the data of year, month, day, day of the week, hour, minute, and second in the BCD code. To write / read real-time data 1 access, transmit / receive the data of year in B7, month, day, day of the week, hour, minute, second in B0, in 7-byte. When you skip the procedure to access the data of year, month, day, day of the week, read / write real-time data 2 access. In this case, transmit / receive the data of hour in B7, minute, second in B0, in 3-byte.

The S-35192A transfers a set of data of time to the real-time data register when it recognizes a reading instruction. Therefore, the S-35192A keeps precise time even if time-carry occurs during the reading operation of the real-time data register.

Year data (00 to 99)

·····Start bit of real-time data 1 data access

Y1	Y2	Y4	Y8	Y10	Y20	Y40	Y80
B7							B0

Month data (01 to 12)

M1	M2	M4	M8	M10	0	0	0
B7							B0

Day data (01 to 31)

D1	D2	D4	D8	D10	D20	0	0
B7							B0

Day of the week data (00 to 06)

W1	W2	W4	0	0	0	0	0
B7							B0

Hour data (00 to 23 or 00 to 11)

·····Start bit of real-time data 2 data access

H1	H2	H4	H8	H10	H20	$\overline{AM}$ / PM	0
B7							B0

Minute data (00 to 59)

m1	m2	m4	m8	m10	m20	m40	0
B7							B0

Second data (00 to 59)

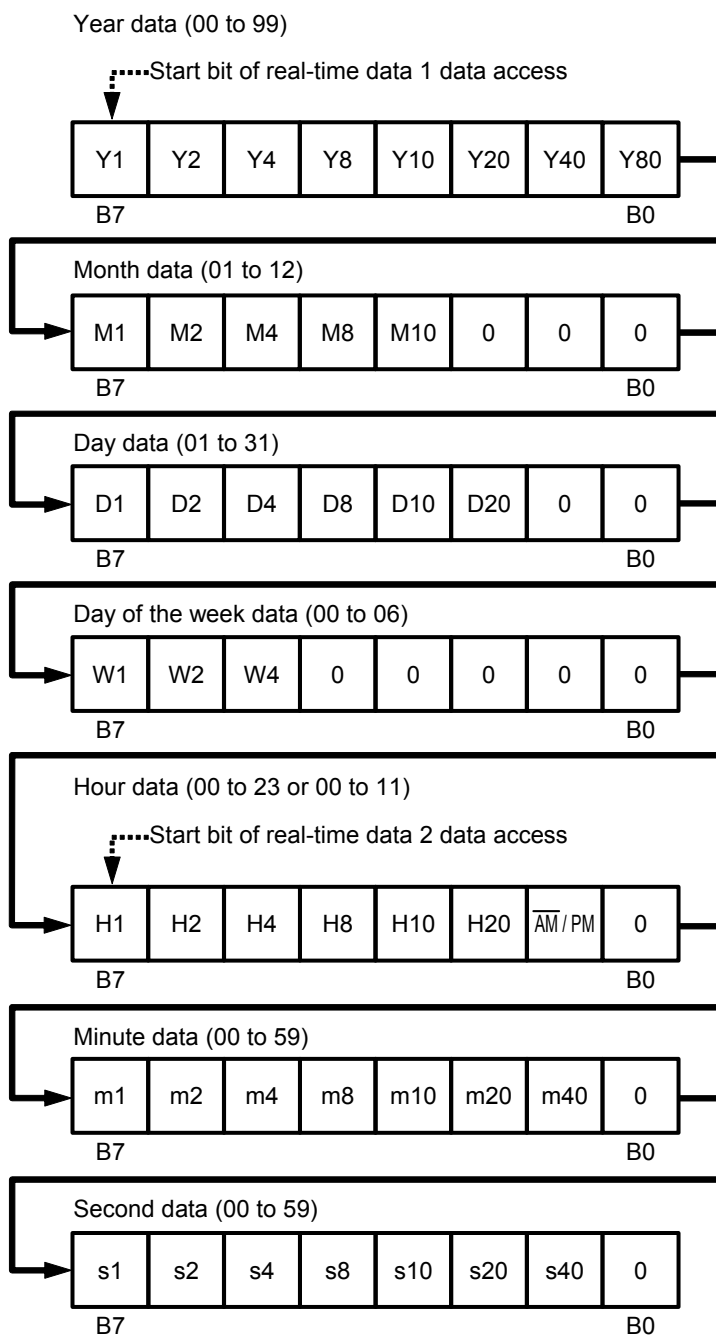| s1	s2	s4	s8	s10	s20	s40	0
B7							B0

Figure 12   Real-time Data Register

Year data (00 to 99): Y1, Y2, Y4, Y8, Y10, Y20, Y40, Y80

Sets the lower two digits of the Western calendar year (00 to 99) and links together with the auto calendar function until 2099.
Example: 2053 (Y1, Y2, Y4, Y8, Y10, Y20, Y40, Y80) = (1, 1, 0, 0, 1, 0, 1, 0)

Month data (01 to 12): M1, M2, M4, M8, M10

Example: December (M1, M2, M4, M8, M10, 0, 0, 0) = (0, 1, 0, 0, 1, 0 ,0 ,0)

Day data (01 to 31): D1, D2, D4, D8, D10, D20

The count value is automatically changed by the auto calendar function.
1 to 31: Jan., Mar., May, July, Aug., Oct., Dec., 1 to 30: April, June, Sep., Nov.
1 to 29: Feb. (leap year), 1 to 28: Feb. (non-leap year)
Example: 29 (D1, D2, D4, D8, D10, D20, 0, 0) = (1, 0, 0, 1, 0, 1, 0, 0)

Day of the week data (00 to 06): W1, W2, W4

A septenary up counter. Day of the week is counted in the order of 00, 01, 02, …, 06, and 00. Set up day of the week and the count value.

Hour data (00 to 23 or 00 to 11): H1, H2, H4, H8, H10, H20, $\overline{\text{AM}}$ / PM

In 12-hour mode, write 0; AM, 1; PM in the $\overline{\text{AM}}$ / PM bit. In 24-hour mode, users can write either 0 or 1. 0 is read when the hour data is from 00 to 11, and 1 is read when from 12 to 23.

Example (12-hour mode): 11 p.m.   (H1, H2, H4, H8, H10, H20, $\overline{\text{AM}}$ / PM , 0) = (1, 0, 0, 0, 1, 0, 1, 0)

Example (24-hour mode): 22   (H1, H2, H4, H8, H10, H20, $\overline{\text{AM}}$ / PM , 0) = (0, 1, 0, 0, 0, 1, 1, 0)

Minute data (00 to 59): m1, m2, m4, m8, m10, m20, m40

Example: 32 minutes (m1, m2, m4, m8, m10, m20, m40, 0) = (0, 1, 0, 0, 1, 1, 0, 0)
Example: 55 minutes (m1, m2, m4, m8, m10, m20, m40, 0) = (1, 0, 1, 0, 1, 0, 1, 0)

Second data (00 to 59): s1, s2, s4, s8, s10, s20, s40

Example: 19 seconds (s1, s2, s4, s8, s10, s20, s40, 0) = (1, 0, 0, 1, 1, 0, 0, 0)

2. Status register 1

Status register 1 is a 1-byte register that is used to display and set various modes. The bit configuration is shown below.
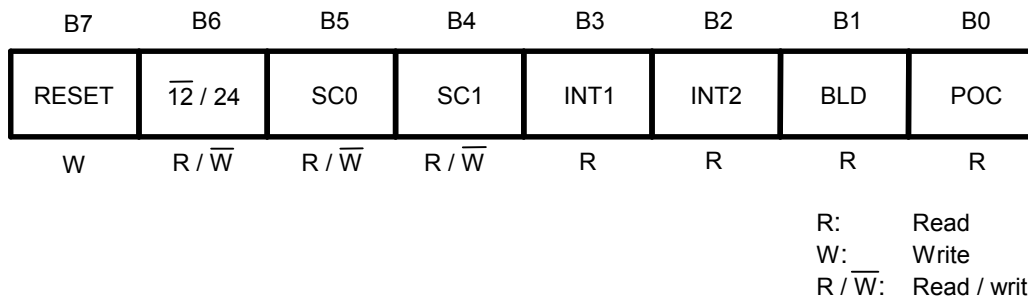
B7	B6	B5	B4	B3	B2	B1	B0
RESET	$\overline{12}$ / 24	SC0	SC1	INT1	INT2	BLD	POC
W	R / $\overline{W}$	R / $\overline{W}$	R / $\overline{W}$	R	R	R	R

R: Read
W: Write
R / $\overline{W}$:   Read / write

Figure 13   Status Register 1

B0: POC

This flag is used to confirm whether the power is on. The power-on detection circuit operates at power-on and B0 is set to "1". This flag is Read-only. Once it is read, it is automatically set to "0". When this flag is "1", be sure to initialize. Regarding the operation after power-on, refer to "■ **Power-on Detection Circuit and Register Status**".

B1: BLD

This flag is set to "1" when the power supply voltage decreases to the level of detection voltage (V_{DET}) or less. Users can detect a drop in the power supply voltage. Once this flag is set to "1", it is not set to "0" again even if the power supply increases to the level of detection voltage (V_{DET}) or more. This flag is read-only. When this flag is "1", be sure to initialize. Regarding the operation of the power supply voltage detection circuit, refer to "■ **Low Power Supply Voltage Detection Circuit**".

B2: INT2, B3: INT1

This flag indicates the time set by alarm and when the time has reached it. This flag is set to "1" when the time that users set by using the alarm function has come. The INT1 flag in the alarm 1 function and the INT2 flag in the alarm 2 function are set to "1". Set "0" in INT1AE (B5 in the status register 2) or in INT2AE (B1 in the status register 2) after reading "1" in the INT1 flag or in the INT2 flag. This flag is read-only. Once this flag is read, it is set to "0" automatically.

B4: SC1, B5: SC0

These are SRAM type registers, they are 2 bits as a whole, can be freely set by users.

B6: $\overline{12}$ / 24

This flag is used to set 12-hour or 24-hour mode. Set the flag ahead of write operation of the real-time data register in case of 24-hour mode.
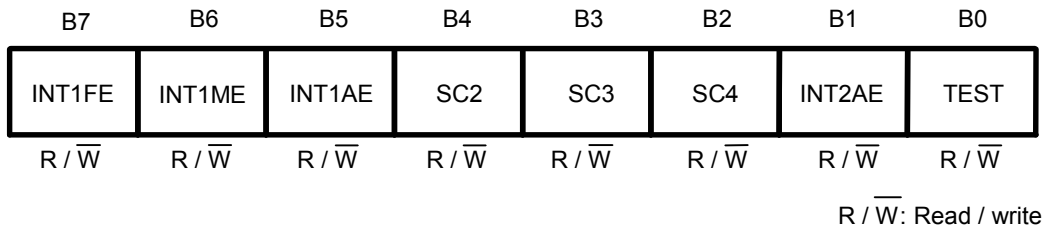
    0: 12-hour mode
    1: 24-hour mode

B7: RESET

The internal IC is initialized by setting this bit to "1". This bit is write-only. It is always "0" when reading. When applying the power supply voltage to the IC, be sure to write "1" to this bit to initialize the circuit. Regarding each status of registers after initialization, refer to "■ **Register Status After Initialization**".

3. Status register 2

Status register 2 is a 1-byte register that is used to display and set various modes. The bit configuration is shown below.

B7	B6	B5	B4	B3	B2	B1	B0
INT1FE	INT1ME	INT1AE	SC2	SC3	SC4	INT2AE	TEST
R / $\overline{W}$	R / $\overline{W}$	R / $\overline{W}$	R / $\overline{W}$	R / $\overline{W}$	R / $\overline{W}$	R / $\overline{W}$	R / $\overline{W}$

R / $\overline{W}$: Read / write

Figure 14   Status Register 2

B0: TEST

This is a test flag for SII Semiconductor Corporation. Be sure to set this flag to "0" in use. If this flag is set to "1", be sure to initialize to set "0".

B1: INT2AE

To use the alarm 2 function, access the INT register 2 after setting this flag enable. Disable when this flag is in "0", enable when this flag is in "1".

B2: SC4, B3: SC3, B4: SC2

These flags are SRAM type registers, they are 3 bits as a whole, can be freely set by users.

B5: INT1AE, B6: INT1ME, B7: INT1FE

To use the alarm 1 function, access the INT register 1 after setting INTA1AE = "1", INT1ME = "0", and INT1FE = "0". In other settings than this, these flags are disable for setting the alarm time (free registers).

4. INT register 1 and INT register 2

The INT register 1 and the INT register 2 are to set up the alarm time. The alarm output mode gets enable by using the status register 2, these registers work as data registers for alarm time. When disable, the INT register 1 works as a 1-byte free register. Users are able to make sure the alarm output by reading the INT1 / INT2 flag (B3 or B2 in the status register 1).

4. 1 Alarm function

Users can set the alarm time (the data of day of the week, hour, minute) by using the INT register 1 and 2 which are 3-byte data registers. The configuration of register is as well as the data register of day of the week, hour, minute, in the real-time data register; is expressed by the BCD code. Do not set a nonexistent day. Users are necessary to set up the alarm-time data according to the 12 / 24 hour mode that they set by using the status register 1.
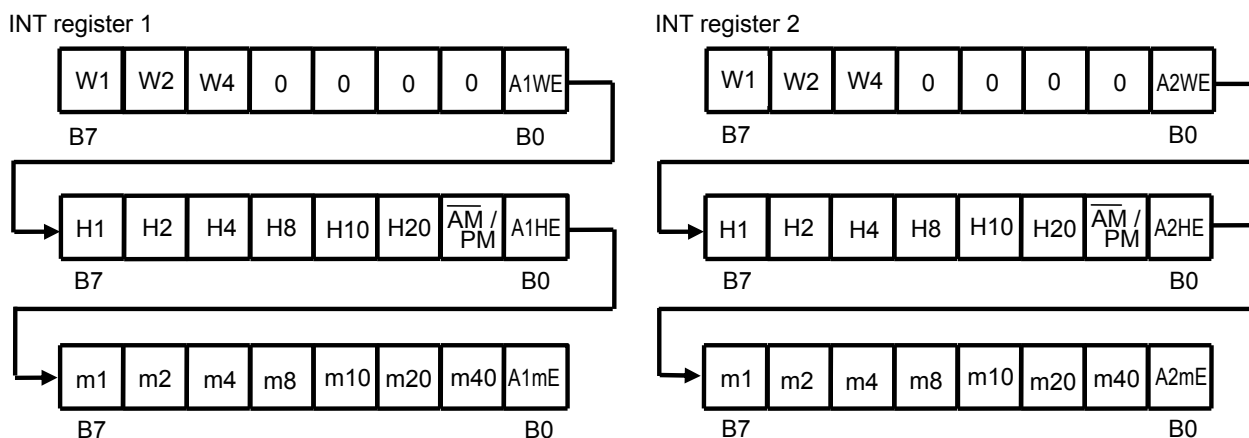
INT register 1

W1	W2	W4	0	0	0	0	A1WE
B7							B0

H1	H2	H4	H8	H10	H20	$\overline{AM}$/PM	A1HE
B7							B0

m1	m2	m4	m8	m10	m20	m40	A1mE
B7							B0

INT register 2

W1	W2	W4	0	0	0	0	A2WE
B7							B0

H1	H2	H4	H8	H10	H20	$\overline{AM}$/PM	A2HE
B7							B0

m1	m2	m4	m8	m10	m20	m40	A2mE
B7							B0

Figure 15 INT Register 1 and INT Register 2 (Alarm-Time Data)

The INT register 1 has A1WE, A1HE, A1mE at B0 in each byte. It is possible to make data valid; the data of day of the week, hour, minute which are in the corresponding byte; by setting these bits to "1". This is as well in A2WE, A2HE, A2mE in the INT register 2.

Setting example: alarm time "7:00 pm" in the INT register 1

(1) 12-hour mode (status register 1 B6 = 0)

set up 7:00 PM
Data written to INT register 1

Day of the week	−[*1]	−[*1]	−[*1]	−[*1]	−[*1]	−[*1]	−[*1]	0
Hour	1	1	1	0	0	0	1	1
Minute	0	0	0	0	0	0	0	1

B7 ————————————————————— B0

*1. Don't care (both of 0 and 1 are acceptable).

(2) 24-hour mode (status register 1 B6 = 1)

set up 19:00 PM
Data written to INT register 1

Day of the week	−[*1]	−[*1]	−[*1]	−[*1]	−[*1]	−[*1]	−[*1]	0
Hour	1	0	0	1	1	0	1[*2]	1
Minute	0	0	0	0	0	0	0	1

B7 ————————————————————— B0

*1. Don't care (both of 0 and 1 are acceptable).

*2. Set up $\overline{AM}$/ PM flag along with the time setting.

4. 2 Free register

The INT register 1 is a 1-byte SRAM type register that can be set freely by users.

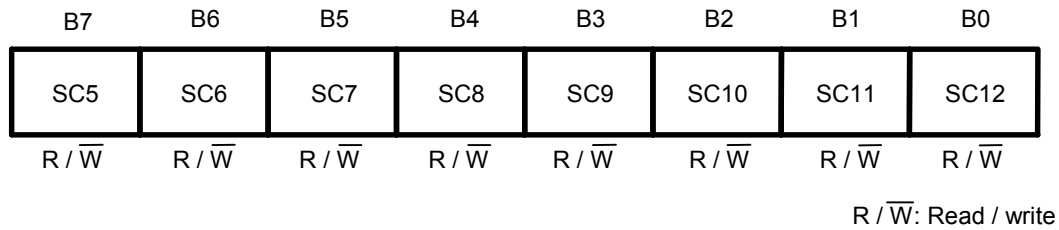| B7	B6	B5	B4	B3	B2	B1	B0
SC5	SC6	SC7	SC8	SC9	SC10	SC11	SC12
R / $\overline{W}$	R / $\overline{W}$	R / $\overline{W}$	R / $\overline{W}$	R / $\overline{W}$	R / $\overline{W}$	R / $\overline{W}$	R / $\overline{W}$

R / $\overline{W}$: Read / write

Figure 16   INT Register 1 (Free register)

5. Clock correction register

The clock correction register is a 1-byte register that is used to correct advance / delay of the clock. When not using this function, set this register to "00h". Regarding the register values, refer to **"■ Function of Clock Correction"**.
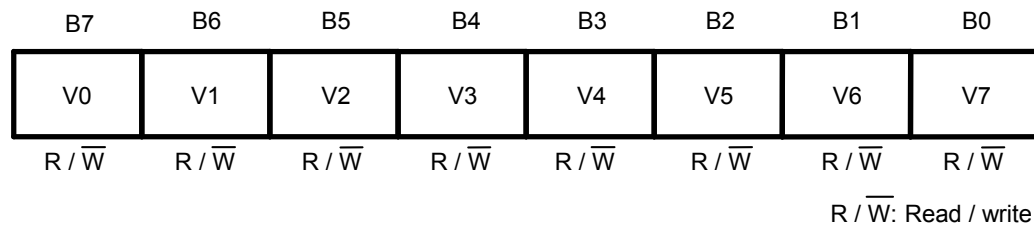
B7	B6	B5	B4	B3	B2	B1	B0
V0	V1	V2	V3	V4	V5	V6	V7
R / $\overline{W}$	R / $\overline{W}$	R / $\overline{W}$	R / $\overline{W}$	R / $\overline{W}$	R / $\overline{W}$	R / $\overline{W}$	R / $\overline{W}$

R / $\overline{W}$: Read / write

Figure 17   Clock Correction Register

6. Free register

The free register is a 1-byte SRAM type register that can be set freely by users.

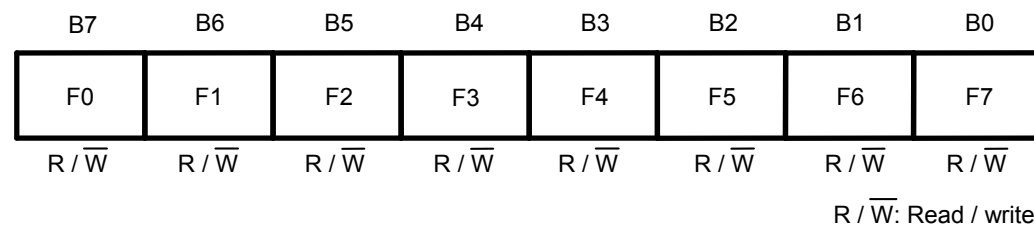| B7	B6	B5	B4	B3	B2	B1	B0
F0	F1	F2	F3	F4	F5	F6	F7
R / $\overline{W}$	R / $\overline{W}$	R / $\overline{W}$	R / $\overline{W}$	R / $\overline{W}$	R / $\overline{W}$	R / $\overline{W}$	R / $\overline{W}$

R / $\overline{W}$: Read / write

Figure 18   Free Register

■ Power-on Detection Circuit and Register Status

The power-on detection circuit operates by power-on the S-35192A, as a result each register is cleared; each register is set as follows.

Real-time data register:	00 (Y), 01 (M), 01 (D), 0 (day of the week), 00 (H), 00 (M), 00 (S)
Status register 1:	"01h"
Status register 2:	"80h"
INT register 1:	"80h"
INT register 2:	"00h"
Clock correction register:	"00h"
Free register:	"00h"

"1" is set in the POC flag (B0 in the status register 1) to indicate that power has been applied. In this case, be sure to initialize. The POC flag is set to "0" due to initialization. (Refer to "■ **Register Status After Initialization**".)

For the regular operation of power-on detection circuit, as seen in **Figure 19**, the period to power-up the S-35192A is that the voltage reaches 1.3 V within 10 ms after setting the IC's power supply voltage at 0 V. When the power-on detection circuit is not working normally is; the POC flag (B0 in the status register 1) is not in "1", or 1 Hz is not output from the INT pin. In this case, power-on the S-35192A once again because the internal data may be in the indefinite status.

Moreover, regarding the processing right after power-on, refer to "■ **Flowchart of Initialization and Example of Real-time Data Set-up**".
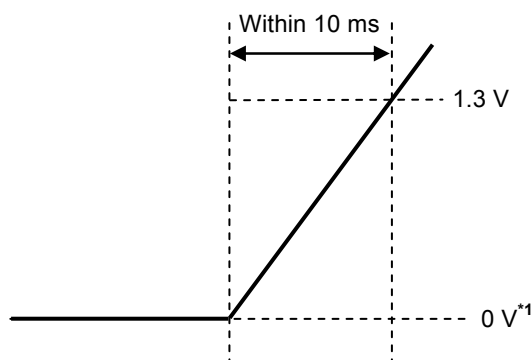
*1. 0 V indicates that there are no potential differences between the VDD pin and VSS pin of the S-35192A.

Figure 19   How to Raise the Power Supply Voltage

■ Register Status After Initialization

The status of each register after initialization is as follows.

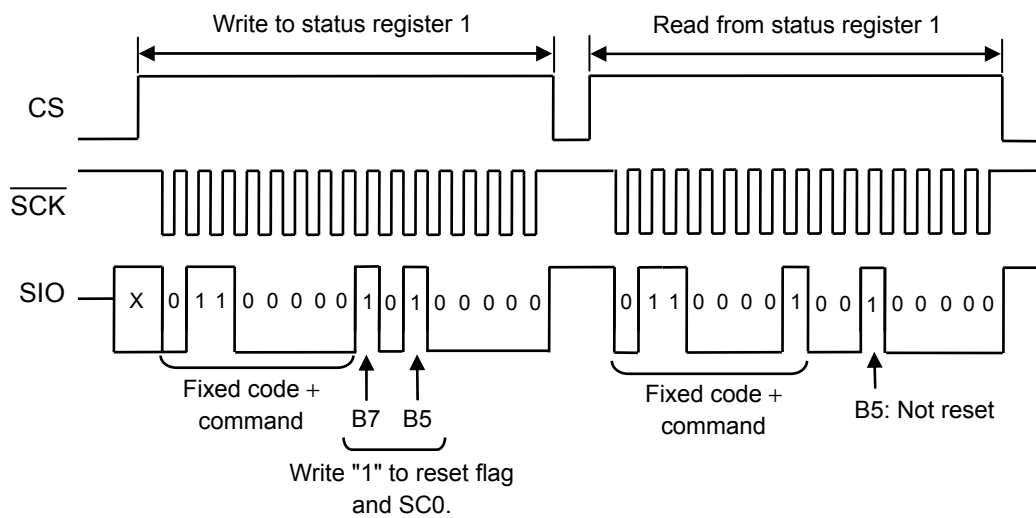|	
Real-time data register:	00 (Y), 01 (M), 01 (D), 0 (day of the week), 00 (H), 00 (M), 00 (S)
Status register 1:	"0 B6 B5 B4 0 0 0 0 b"
	(In B6, B5, B4, the data of B6, B5, B6 in the status register 1 at initialization is set. Refer to **Figure 20**.)
Status register 2:	"00h"
INT register 1:	"00h"
INT register 2:	"00h"
Clock correction register:	"00h"
Free register:	"00h"

Figure 20   Status Register 1 Data At Initialization

■ Low Power Supply Voltage Detection Circuit

The S-35192A has a low power supply voltage detection circuit, so that users can monitor drops in the power supply voltage by reading the BLD flag (B1 in the status register 1). There is a hysteresis width of approx. 0.15 V (typ.) between detection voltage and release voltage (refer to "■ **Characteristics (Typical Data)**"). The low power supply voltage detection circuit does the sampling operation only once in one sec for 15.6 ms.

If the power supply voltage decreases to the level of detection voltage (V_{DET}) or less, "1" is set to the BLD flag so that sampling operation stops. Once "1" is detected in the BLD flag, no sampling operation is performed even if the power supply voltage increases to the level of release voltage or more, and "1" is held in the BLD flag.

Furthermore, the S-35192A does not initialize the internal circuit even if "1" is set to the BLD flag. If the BLD flag is "1" even after the power supply voltage is recovered, the internal circuit may be in the indefinite status. In this case, be sure to initialize the circuit. Without initializing, if the next BLD flag reading is done after sampling, the BLD flag gets reset to "0". In this case, be sure to initialize although the BLD flag is in "0" because the internal circuit may be in the indefinite status.
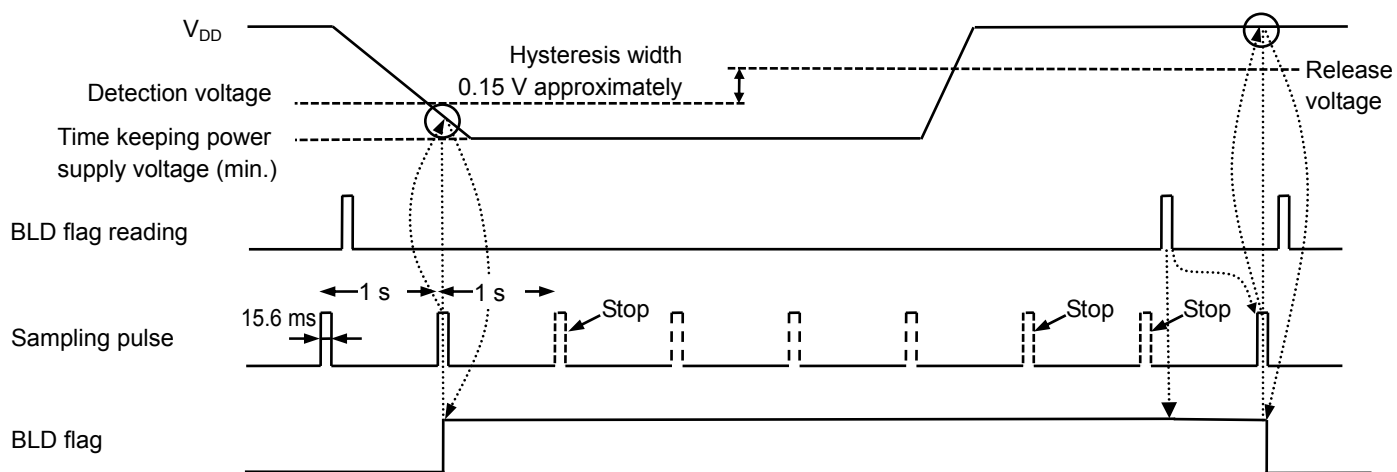
Figure 21   Timing of Low Power Supply Voltage Detection Circuit

■ Circuits Power-on and Low Power Supply Voltage Detection

Figure 22 shows the changes of the POC flag and BLD flag due to V_{DD} fluctuation.
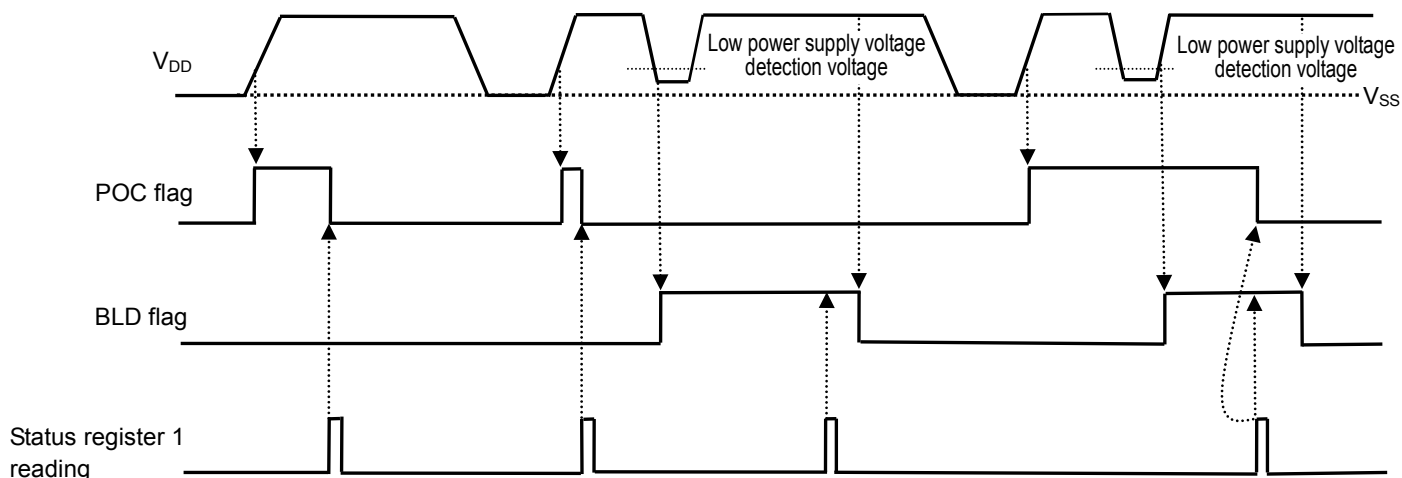
Figure 22   POC Flag and BLD Flag

■ Correction of Nonexistent Data and End-of-Month

When users write the real-time data, the S-35192A checks it. In case that the data is invalid, the S-35192A does the following procedures.

1. Processing of nonexistent data

Table 11   Processing of Nonexistent Data

Register		Normal Data	Nonexistent Data	Result
Year data		00 to 99	XA to XF, AX to FX	00
Month data		01 to 12	00, 13 to 19, XA to XF	01
Day data		01 to 31	00, 32 to 39, XA to XF	01
Day of the week data		0 to 6	7	0
Hour data*1	24-hour	0 to 23	24 to 29, 3X, XA to XF	00
	12-hour	0 to 11	12 to 20, XA to XF	00
Minute data		00 to 59	60 to 79, XA to XF	00
Second data 2		00 to 59	60 to 79, XA to XF	00

*1. In 12-hour mode, write the AM / PM flag (B1 in hour data in the real-time data register).
In 24-hour mode, the AM / PM flag in the real-time data register is omitted. However in the flag of reading, users are able to read 0; 0 to 11, 1; 12 to 23.

*2. Processing of nonexistent data, regarding second data, is done by a carry pulse which is generated in 1 second, after writing. At this point the carry pulse is sent to the minute-counter.

2. Correction of end-of-month

A nonexistent day, such as February 30 and April 31, is set to the first day of the next month.

■ Alarm Function

By this alarm function, the INT1 flag or the INT2 flag (B2 or B3 in the status register1) is set to "H" when the time that users set has come.

Set up the data of day of the week, hour and minute as alarm time in the INT register 1 / 2. Refer to "**4.   INT register 1 and INT register 2**" in "**■ Configuration of Registers**".

1.   Alarm setting of "W (day of the week), H (hour), m (minute)"

Status register 2 setting
- Alarm 1 function
  INT1ME = INT1FE = 0
- Alarm 2 function
  None

INT register x alarm enable flag
- AxHE = AxmE = AxWE = "1"

INT register 1
INT register 2

| mx | Hx | Wx |

Comparator → Alarm output to INT1 flag / INT2 flag (B3 or B2 in status register 1)

| Second | Minute | Hour | Day of the week | Day | Month | Year |

Real-time data

W (day of the week)

| Real-time data | H h (m − 1) m 59 s | H h m m 00 s | 01 s | 59 s | H h (m + 1) m 00 s |

Change by program   Change by program   Change by program

INT1AE / INT2AE

Alarm time matches   Read status register 1

INT1 flag / INT2 flag
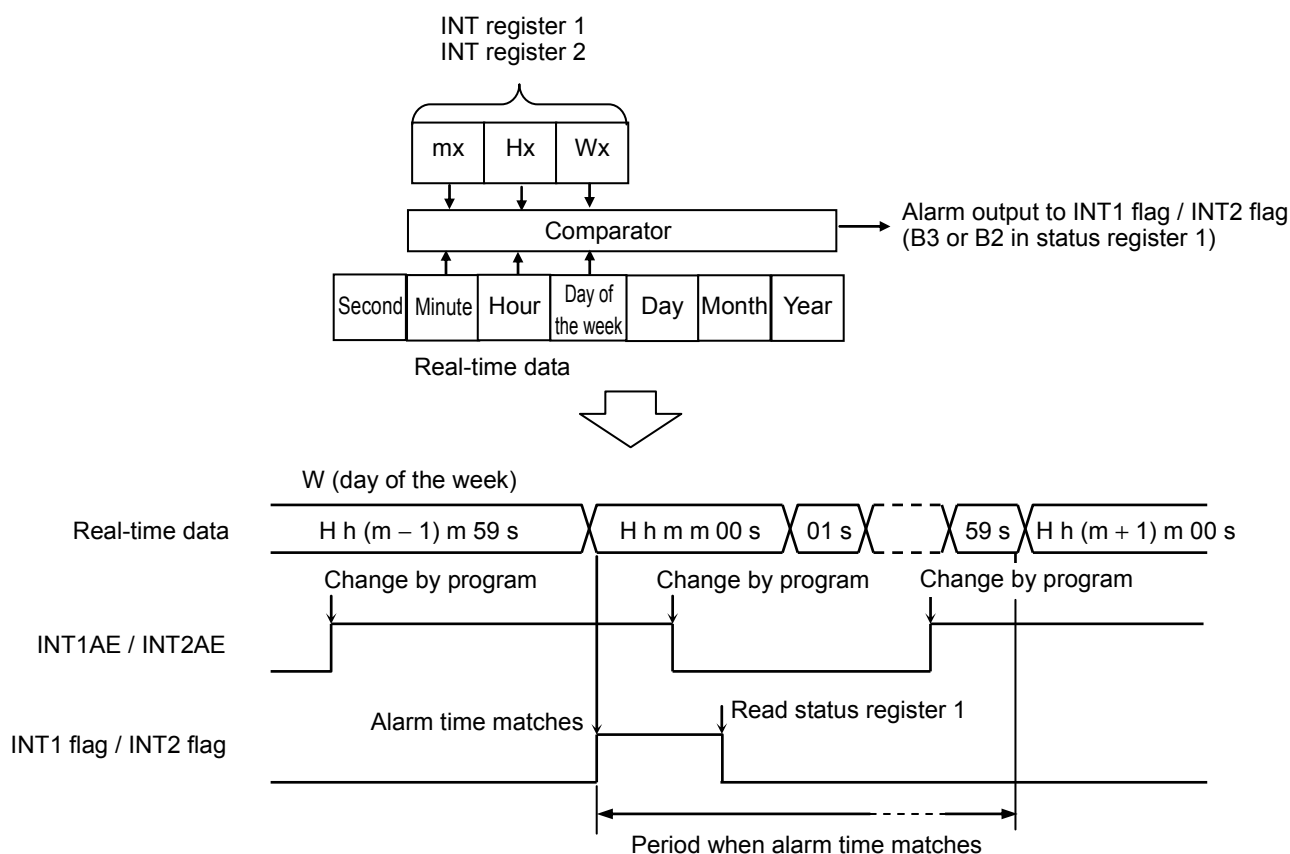
Period when alarm time matches

Figure 23   Output Timing of INT1 Flag and INT2 Flag

2. Alarm setting of "H (hour)"

Status register 2 setting
- Alarm 1 function
  INT1ME = INT1FE = 0
- Alarm 2 function
  None

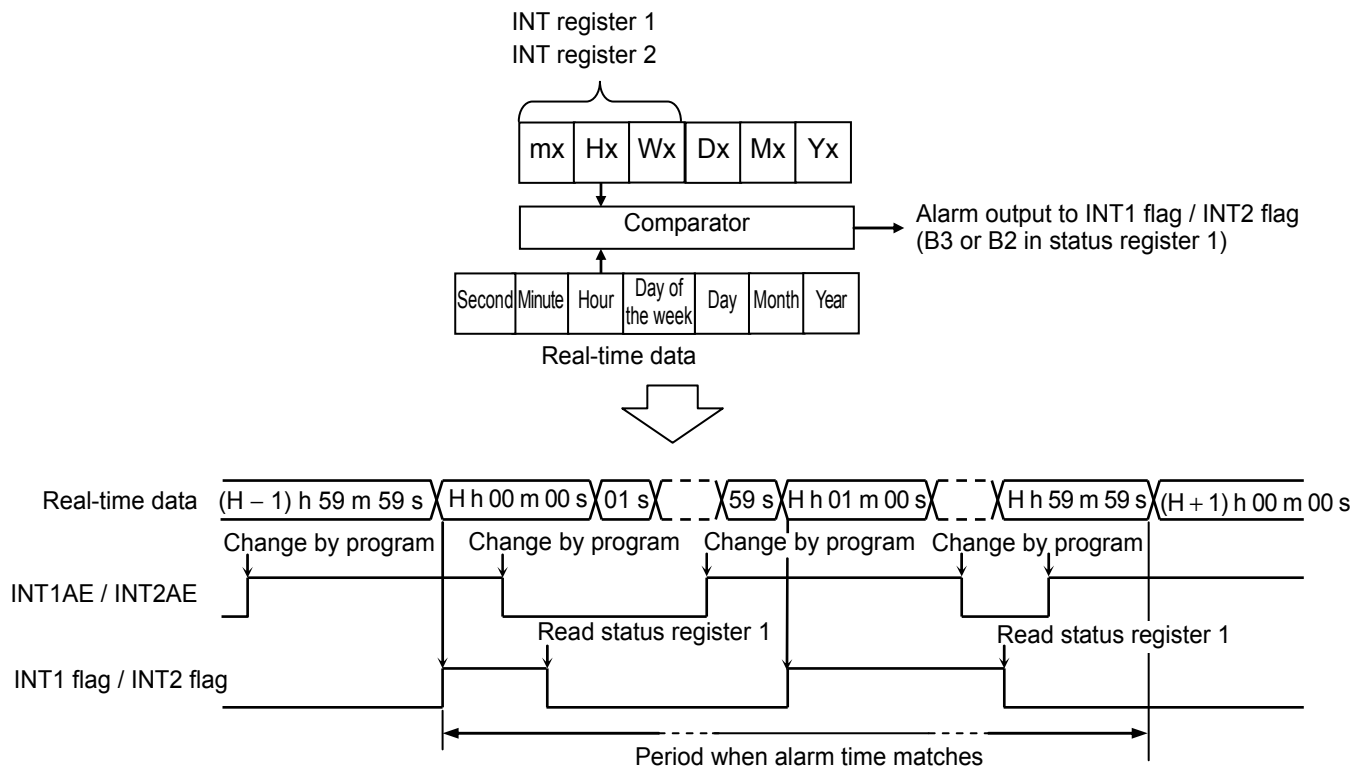INT register x alarm enable flag
- AxWE = AxmE = "0", AxHE = "1"

Figure 24   Output Timing of INT1 Flag and INT2 Flag

■ Function of Clock Correction

The function of clock correction is to correct advance / delay of the clock due to the deviation of oscillation frequency, in order to make a high precise clock. For correction, the S-35192A adjusts the clock pulse by using a certain part of the dividing circuit, not adjusting the frequency of the crystal oscillator. Correction is performed once every 20 seconds (or 60 seconds). The minimum resolution is approx. 3 ppm (or approx. 1 ppm) and the S-35192A corrects in the range of −195.3 ppm to +192.2 ppm (or of −65.1 ppm to +64.1 ppm). (Refer to **Table 12**.) Users can set up this function by using the clock correction register. Regarding how to calculate the setting data, refer to "**1.   How to calculate**". When not using this function, be sure to set "00h".

Table 12   Function of Clock Correction

Item	B0 = 0	B0 = 1
Correction	Every 20 seconds	Every 60 seconds
Minimum resolution	3.052 ppm	1.017 ppm
Correction range	−195.3 ppm to +192.2 ppm	−65.1 ppm to +64.1 ppm

1. How to calculate

1. 1 If current oscillation frequency > target frequency (in case the clock is fast)

$$\text{Correction value}^{*1} = 128 - \text{Integral value}\left(\frac{(\text{Current oscillation frequency actual measurement value}^{*2}) - (\text{Target oscillation frequency}^{*3})}{(\text{Current oscillation frequency actual measurement value}^{*2}) \times (\text{Minimum resolution}^{*4})}\right)$$

Caution   The figure range which can be corrected is that the calculated value is from 0 to 64.

*1. Convert this value to be set in the clock correction register. For how to convert, refer to "**(1)   Calculation example 1**".
*2. Measurement value of a clock pulse output from the 32KO pin.
*3. Target value of average frequency when the clock correction function is used.
*4. Refer to "**Table 12   Function of Clock Correction**".

(1)   Calculation example 1

In case of current oscillation frequency actual measurement value = 32.771 [kHz], target oscillation frequency = 32.768 [kHz], B0 = 0 (Minimum resolution = 3.052 ppm)

$$\text{Correction value} = 128 - \text{Integral value}\left(\frac{(32771) - (32768)}{(32771) \times (3.052 \times 10^{-6})}\right)$$
$$= 128 - \text{Integral value} (29.99) = 128 - 29 = 99$$

Convert the correction value "99" to 7-bit binary and obtain "01100011 b".
Reverse the correction value "01100011 b" and set it to B7 to B1 of the clock correction register.
Thus, set the clock correction register:
(B7, B6, B5, B4, B3, B2, B1, B0) = (1, 1, 0, 0, 0, 1, 1, 0)

1. 2 If current oscillation frequency < target frequency (in case the clock is slow)

$$\text{Correction value} = \text{Integral value}\left(\frac{(\text{Target oscillation frequency}) - (\text{Current oscillation frequency actual measurement value})}{(\text{Current oscillation frequency actual measurement value}) \times (\text{Minimum resolution})}\right) + 1$$

Caution   The figure range which can be corrected is that the calculated value is from 0 to 62.

(1)   Calculation example 2

In case of current oscillation frequency actual measurement value = 32.765 [kHz], target oscillation frequency = 32.768 [kHz]. B0 = 0 (Minimum resolution = 3.052 ppm)

$$\text{Correction value} = \text{Integral value}\left(\frac{(32768) - (32765)}{(32765) \times (3.052 \times 10^{-6})}\right) + 1$$
$$= \text{Integral value} (30.00) + 1 = 30 + 1 = 31$$

Thus, set the clock correction register:
(B7, B6, B5, B4, B3, B2, B1, B0) = (1, 1, 1, 1, 1, 0, 0, 0)

(2)   Calculation example 3

In case of current oscillation frequency actual measurement value = 32.765 [kHz], target oscillation frequency = 32.768 [kHz], B0 = 1 (Minimum resolution = 1.017 ppm)

$$\text{Correction value} = \text{Integral value}\left(\frac{(32768) - (32765)}{(32765) \times (1.017 \times 10^{-6})}\right) + 1$$
$$= \text{Integral value} (90.03) + 1$$

This calculated value exceeds the correctable range 0 to 62.
B0 = "1" (minimum resolution = 1.017 ppm) indicates the correction is impossible.

2. Setting values for registers and correction values

Table 13 Setting Values for Registers and Correction Values (Minimum Resolution: 3.052 ppm (B0 = 0))

B7	B6	B5	B4	B3	B2	B1	B0	Correction Value [ppm]	Rate [s / day]
1	1	1	1	1	1	0	0	192.3	16.61
0	1	1	1	1	1	0	0	189.2	16.35
1	0	1	1	1	1	0	0	186.2	16.09
			•	•	•			•	•
			•	•	•			•	•
			•	•	•			•	•
0	1	0	0	0	0	0	0	6.1	0.53
1	0	0	0	0	0	0	0	3.1	0.26
0	0	0	0	0	0	0	0	0	0
1	1	1	1	1	1	1	0	−3.1	−0.26
0	1	1	1	1	1	1	0	−6.1	−0.53
1	0	1	1	1	1	1	0	−9.2	−0.79
			•	•	•			•	•
			•	•	•			•	•
			•	•	•			•	•
0	1	0	0	0	0	1	0	−189.2	−16.35
1	0	0	0	0	0	1	0	−192.3	−16.61
0	0	0	0	0	0	1	0	−195.3	−16.88

Table 14 Setting Values for Registers and Correction Values (Minimum Resolution: 1.017 ppm (B0 = 1))

B7	B6	B5	B4	B3	B2	B1	B0	Correction Value [ppm]	Rate [s / day]
1	1	1	1	1	1	0	1	64.1	5.54
0	1	1	1	1	1	0	1	63.1	5.45
1	0	1	1	1	1	0	1	62.0	5.36
			•	•	•			•	•
			•	•	•			•	•
			•	•	•			•	•
0	1	0	0	0	0	0	1	2.0	0.18
1	0	0	0	0	0	0	1	1.0	0.09
0	0	0	0	0	0	0	1	0	0
1	1	1	1	1	1	1	1	−1.0	−0.09
0	1	1	1	1	1	1	1	−2.0	−0.18
1	0	1	1	1	1	1	1	−3.0	−0.26
			•	•	•			•	•
			•	•	•			•	•
			•	•	•			•	•
0	1	0	0	0	0	1	1	−63.1	−5.45
1	0	0	0	0	0	1	1	−64.1	−5.54
0	0	0	0	0	0	1	1	−65.1	−5.62