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2-WIRE REAL-TIME CLOCK

www.sii-ic.com

Rev.3.2_02

The S-35392A is a CMOS 2-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-35392A 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-35392A 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-35392A 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
- 2-wire (I^2C-bus) CPU interface
- Built-in alarm interrupter
- 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

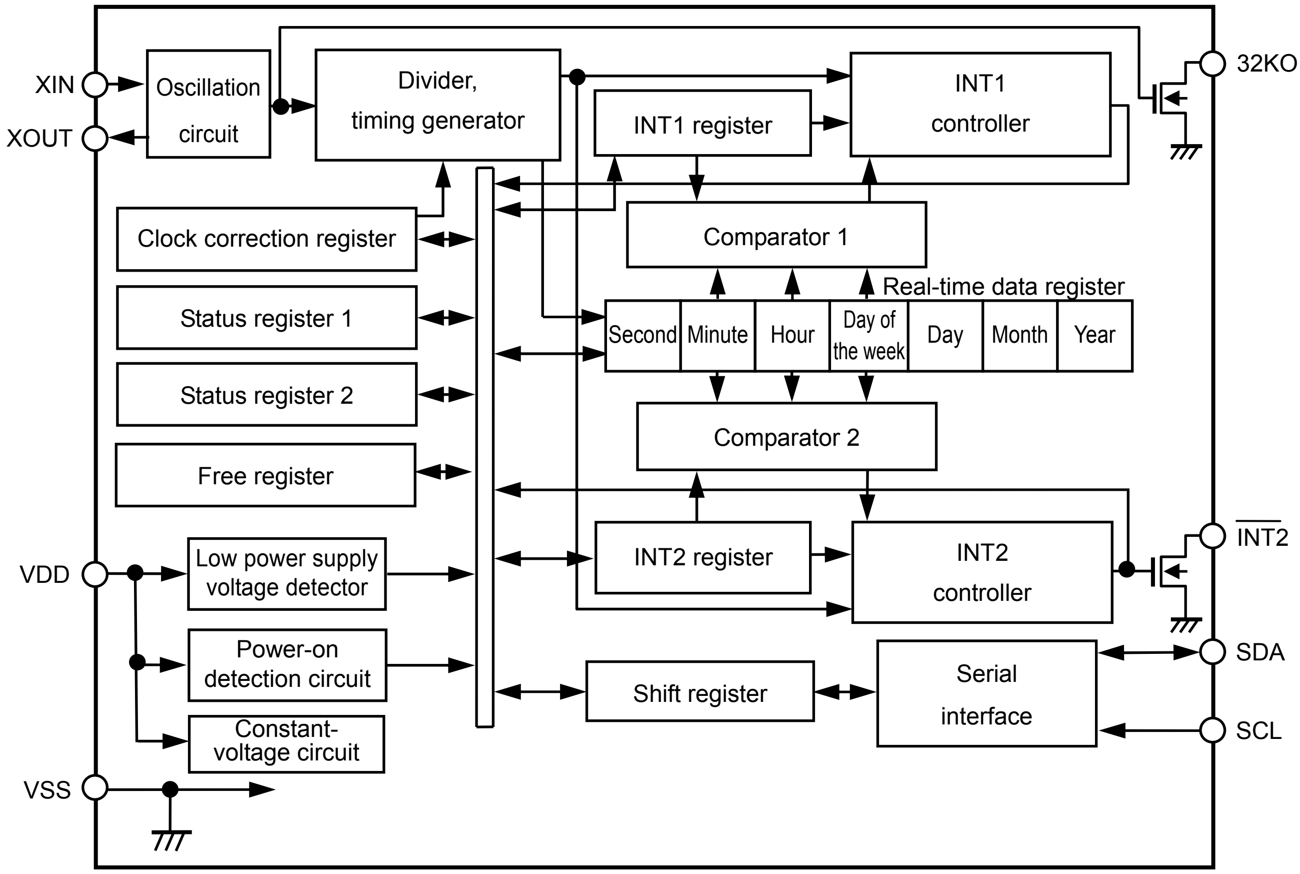


Figure 1

■ Product Name Structure

1. Product name

S-35392A - I8T1 U

- **U**: Environmental code
  - U: Lead-free (Sn 100%), halogen-free
- **I8T1**: Package name (abbreviation) and IC packing specification*1
  - I8T1: SNT-8A, Tape
- **S-35392A**: 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

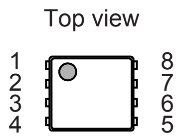


Figure 2 S-35392A-I8T1U

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	$\overline{\text{INT2}}$	Output pin for interrupt signal 2	Output	Nch open-drain output (no protective diode at VDD)
6	SCL	Input pin for serial clock	Input	CMOS input (no protective diode at VDD)
7	SDA	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. SDA (I/O for serial data) pin

This pin is a data input / output pin of I^2C-bus interface. This pin inputs / outputs data by synchronizing with a clock pulse from the SCL pin. This pin has CMOS input and Nch open drain output. Generally in use, pull up this pin to the VDD potential via a resistor, and connect it to any other device having open drain or open collector output with wired-OR connection.

2. SCL (input for serial clock) pin

This pin is to input a clock pulse for I^2C-bus interface. The SDA pin inputs / outputs data by synchronizing with the clock pulse.

3. XIN, XOUT (crystal oscillator connect) pins

Connect a crystal oscillator between XIN and XOUT.

4. 32KO (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.

5. $\overline{\text{INT2}}$ (output for interrupt signal 2) pin

This pin outputs a signal of interrupt, or a clock pulse. By using the status register 2, users can select either of; alarm interrupt, output of user-set frequency, or minute-periodical interrupt 1. This pin has Nch open drain output.

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

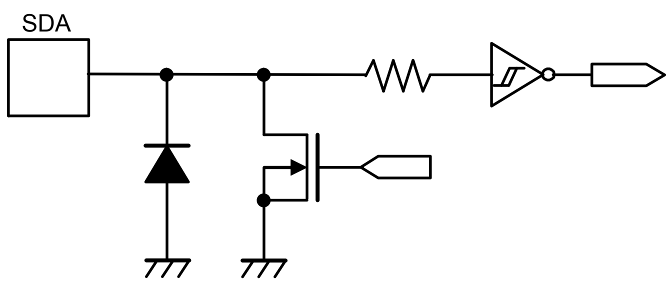


Figure 3 SDA Pin

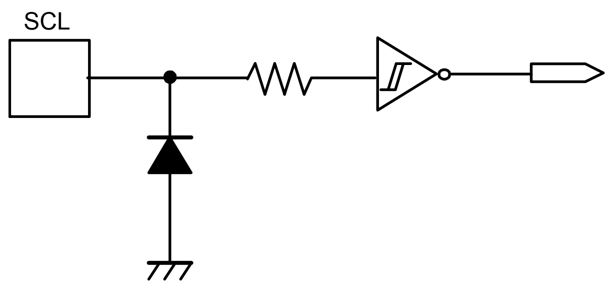


Figure 4 SCL Pin

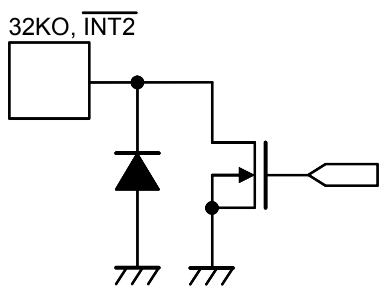


Figure 5 32KO Pin, $\overline{\text{INT2}}$ Pin

■ 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}	SCL, SDA	V_{SS} – 0.3 to V_{SS} + 6.5	V
Output voltage	V_{OUT}	SDA, 32KO, $\overline{INT2}$	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 (SCL = 100 kHz)	–	6	14	μA
Input current leakage 1	I_{IZH}	SCL, SDA	$V_{IN} = V_{DD}$	–0.5	–	0.5	μA
Input current leakage 2	I_{IZL}	SCL, SDA	$V_{IN} = V_{SS}$	–0.5	–	0.5	μA
Output current leakage 1	I_{OZH}	SDA, 32KO, $\overline{INT2}$	$V_{OUT} = V_{DD}$	–0.5	–	0.5	μA
Output current leakage 2	I_{OZL}	SDA, 32KO, $\overline{INT2}$	$V_{OUT} = V_{SS}$	–0.5	–	0.5	μA
Input voltage 1	V_{IH}	SCL, SDA	–	$0.8 \times V_{DD}$	–	$V_{SS} + 5.5$	V
Input voltage 2	V_{IL}	SCL, SDA	–	$V_{SS} - 0.3$	–	$0.2 \times V_{DD}$	V
Output current 1	I_{OL1}	32KO, $\overline{INT2}$	V_{OUT} = 0.4 V	3	5	–	mA
Output current 2	I_{OL2}	SDA	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)

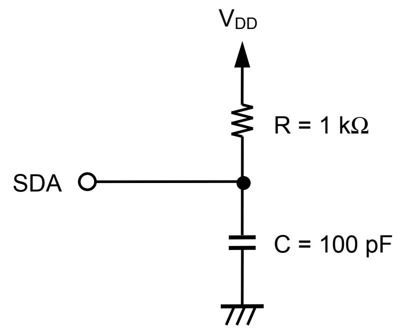
(Ta = –40°C to +85°C, V_{SS} = 0 V, VT-200 crystal oscillator (C_L = 6 pF, 32.768 kHz, C_g = 9.1 pF) manufactured by Seiko Instruments Inc.)

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 (SCL = 100 kHz)	–	14	30	μA
Input current leakage 1	I_{IZH}	SCL, SDA	$V_{IN} = V_{DD}$	–0.5	–	0.5	μA
Input current leakage 2	I_{IZL}	SCL, SDA	$V_{IN} = V_{SS}$	–0.5	–	0.5	μA
Output current leakage 1	I_{OZH}	SDA, 32KO, $\overline{INT2}$	$V_{OUT} = V_{DD}$	–0.5	–	0.5	μA
Output current leakage 2	I_{OZL}	SDA, 32KO, $\overline{INT2}$	$V_{OUT} = V_{SS}$	–0.5	–	0.5	μA
Input voltage 1	V_{IH}	SCL, SDA	–	$0.8 \times V_{DD}$	–	$V_{SS} + 5.5$	V
Input voltage 2	V_{IL}	SCL, SDA	–	$V_{SS} - 0.3$	–	$0.2 \times V_{DD}$	V
Output current 1	I_{OL1}	32KO, $\overline{INT2}$	V_{OUT} = 0.4 V	5	8	–	mA
Output current 2	I_{OL2}	SDA	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	$V_{IH} = 0.9 \times V_{DD}$, $V_{IL} = 0.1 \times V_{DD}$
Input pulse rise / fall time	20 ns
Output determination voltage	$V_{OH} = 0.5 \times V_{DD}$, $V_{OL} = 0.5 \times V_{DD}$
Output load	100 pF + pull-up resistor 1 kΩ



Remark The power supplies of the IC and load have the same electrical potential.

Figure 6 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.	
SCL clock frequency	f_{SCL}	0	–	100	0	–	400	kHz
SCL clock low time	t_{LOW}	4.7	–	–	1.3	–	–	μs
SCL clock high time	t_{HIGH}	4	–	–	0.6	–	–	μs
SDA output delay time*1	t_{PD}	–	–	3.5	–	–	0.9	μs
Start condition setup time	$t_{SU.STA}$	4.7	–	–	0.6	–	–	μs
Start condition hold time	$t_{HD.STA}$	4	–	–	0.6	–	–	μs
Data input setup time	$t_{SU.DAT}$	250	–	–	100	–	–	ns
Data input hold time	$t_{HD.DAT}$	0	–	–	0	–	–	μs
Stop condition setup time	$t_{SU.STO}$	4.7	–	–	0.6	–	–	μs
SCL, SDA rise time	t_R	–	–	1	–	–	0.3	μs
SCL, SDA fall time	t_F	–	–	0.3	–	–	0.3	μs
Bus release time	t_{BUF}	4.7	–	–	1.3	–	–	μs
Noise suppression time	t_I	–	–	100	–	–	50	ns

***1**. Since the output format of the SDA pin is Nch open-drain output, SDA output delay 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**".

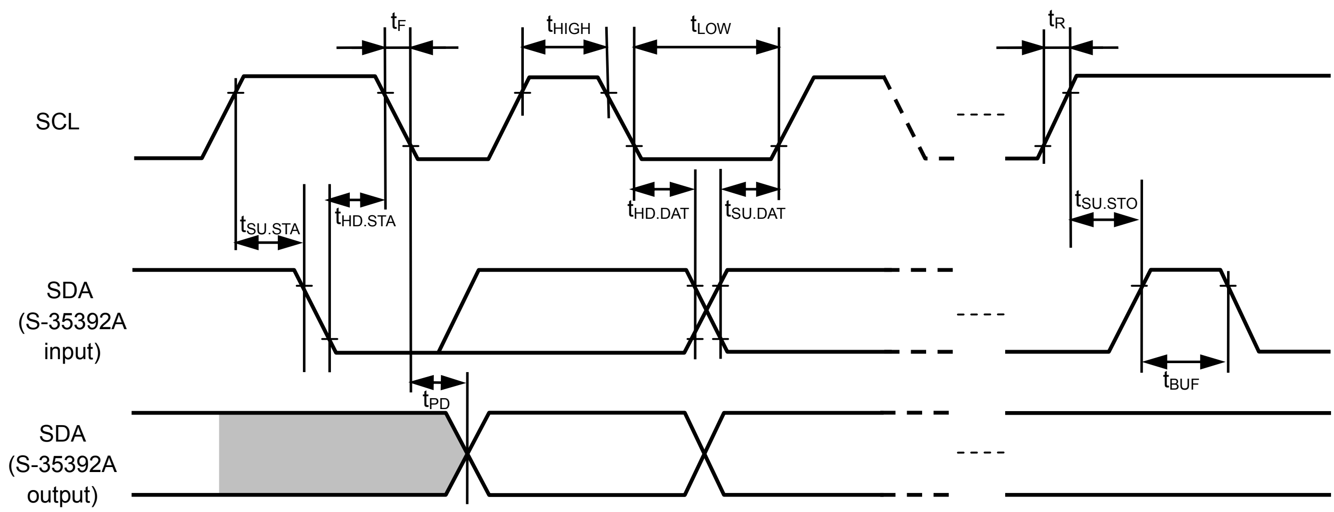


Figure 7 Bus Timing

■ Configuration of Data Communication

1. Data communication

For data communication, the master device in the system generates a start condition for the S-35392A. Next, the master device transmits 4-bit device code "0110", 3-bit command and 1-bit read / write command to the SDA line. After that, output or input is performed from B7 of data. If data I/O has been completed, finish communication by inputting a stop condition to the S-35392A. The master device generates an acknowledgment signal for every 1-byte. Regarding details, refer to "■ **Serial Interface**".

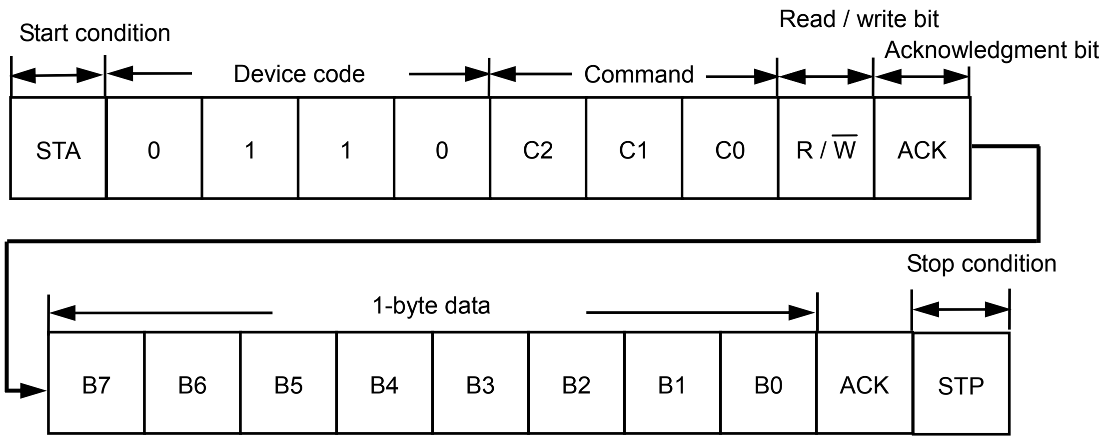


Figure 8 Data Communication

2. Configuration of command

8 types of command are available for the S-35392A. The S-35392A reads / writes the various registers by inputting these fixed codes and commands. The S-35392A does not perform any operation with any codes and commands other than those below.

Table 10 List of Commands

Device Code	Command C2	C1	C0	Description	Data 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	INT2FE	INT2ME	INT2AE	TEST*5
	0	1	0	Real-time data 1 access (year data to)	Y1 M1 D1 W1 H1 m1 s1	Y2 M2 D2 W2 H2 m2 s2	Y4 M4 D4 W4 H4 m4 s4	Y8 M8 D8 –*6 H8 m8 s8	Y10 M10 D10 –*6 H10 m10 s10	Y20 –*6 D20 –*6 H20 m20 s20	Y40 –*6 –*6 –*6 $\overline{AM}$ / PM m40 s40	Y80 –*6 –*6 –*6 –*6 –*6 –*6
	0	1	1	Real-time data 2 access (hour data to)	H1 m1 s1	H2 m2 s2	H4 m4 s4	H8 m8 s8	H10 m10 s10	H20 m20 s20	$\overline{AM}$ / PM m40 s40	–*6 –*6 –*6
	1	0	0	INT1 register access (alarm time 1: week / hour / minute) (INT1AE = 1, INT1ME = 0, INT1FE = 0)	W1 H1 m1	W2 H2 m2	W4 H4 m4	–*6 H8 m8	–*6 H10 m10	–*6 H20 m20	–*6 $\overline{AM}$ / PM m40	A1WE A1HE A1mE
				INT1 register access (free register) (settings other than alarm time 1)	SC3*2	SC4*2	SC5*2	SC6*2	SC7*2	SC8*2	SC9*2	SC10*2
	1	0	1	INT2 register access (alarm time 2: week / hour / minute) (INT2AE = 1, INT2ME = 0, INT2FE = 0)	W1 H1 m1	W2 H2 m2	W4 H4 m4	–*6 H8 m8	–*6 H10 m10	–*6 H20 m20	–*6 $\overline{AM}$ / PM m40	A2WE A2HE A2mE
				INT2 register access (output of user-set frequency) (INT2ME = 0, INT2FE = 1)	1 Hz	2 Hz	4 Hz	8 Hz	16 Hz	SC11*2	SC12*2	SC13*2
	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-35392A 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 accesses. In this case, transmit / receive the data of hour in B7, minute, second in B0, in 3-byte.
The S-35392A transfers a set of data of time to the real-time data register when it recognizes a reading instruction. Therefore, the S-35392A keeps precise time even if time-carry occurs during the reading operation of the real-time data register.

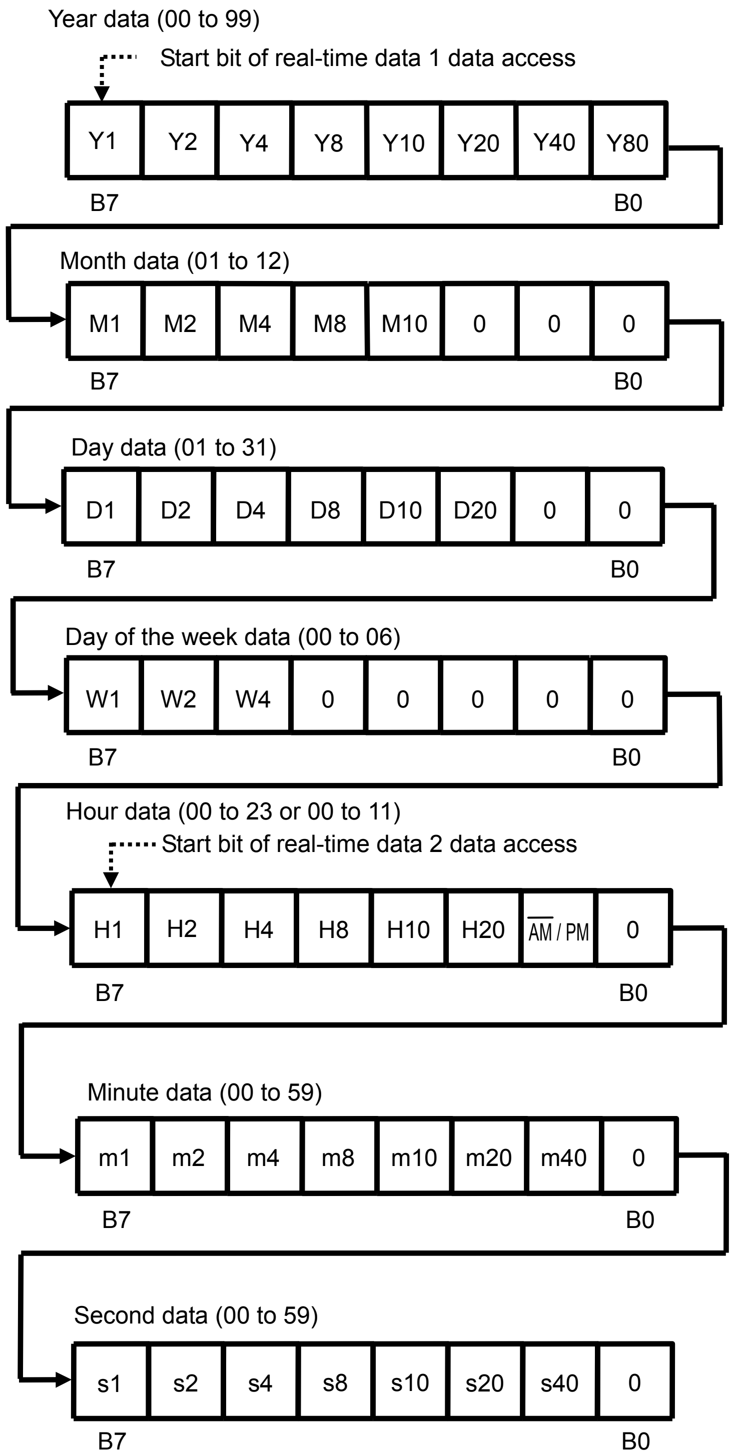


Figure 9 Real-Time Data Register

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, $\overline{AM}$ / PM

In 12-hour mode, write 0; AM, 1; PM in the $\overline{AM}$ / 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, $\overline{AM}$ / PM, 0) = (1, 0, 0, 0, 1, 0, 1, 0)
Example (24-hour mode): 22 (H1, H2, H4, H8, H10, H20, $\overline{AM}$ / 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 10 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. This flag is set to "1" once, 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 at alarm 2 interrupt mode are set to "0". 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. This flag is read once, it is set to "0" automatically.

B4: SC1, B5: SC0

These flags 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	INT2FE	INT2ME	INT2AE	TEST
R / $\overline{\text{W}}$	R / $\overline{\text{W}}$	R / $\overline{\text{W}}$	R / $\overline{\text{W}}$	R / $\overline{\text{W}}$	R / $\overline{\text{W}}$	R / $\overline{\text{W}}$	R / $\overline{\text{W}}$

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

Figure 11 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 to "0".

B1: INT2AE, B2: INT2ME, B3: INT2FE

These bits are used to select the output mode for the $\overline{\text{INT2}}$ pin. **Table 11** shows how to select the mode. To use alarm 2 interrupt, access the INT2 register after setting the alarm interrupt mode.

Table 11 Output Modes for $\overline{\text{INT2}}$ Pin

INT2AE	INT2ME	INT2FE	$\overline{\text{INT2}}$ Pin Output Mode
0	0	0	No interrupt
–*1	0	1	Output of user-set frequency
–*1	1	0	Per-minute edge interrupt
–*1	1	1	Minute-periodical interrupt 1 (50% duty)
1	0	0	Alarm 2 interrupt

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

B4: SC2

This is an SRAM type register that 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 INT1AE = "1", INT1ME = "0", and INT1FE = "0". In other settings than this, these flags are disable for setting the alarm time (free registers).

4. INT1 register and INT2 register

The INT1 register is to set up the alarm time. The INT2 register is to set up the output of user-set frequency or alarm interrupt. To switch the output mode, use the status register 2.
The INT1 register works as an alarm-time data register in the alarm 1 interrupt mode selected by users. The INT1 flag (B3 in the status register 1) displays the alarm time when it matches.
The INT2 register works as an alarm-time data register in the alarm interrupt mode selected by using the status register 2. In the mode output of user-set frequency, the INT2 register works as a data register to set up the frequency for output clock. Clock pulse and output of alarm interrupt are output from the $\overline{\text{INT2}}$ pin. And the INT2 flag (B2 in the status register 1) displays the alarm time when it matches.

4. 1 Alarm interrupt

Users can set the alarm time (the data of day of the week, hour, minute) by using the INT1 and INT2 registers 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.

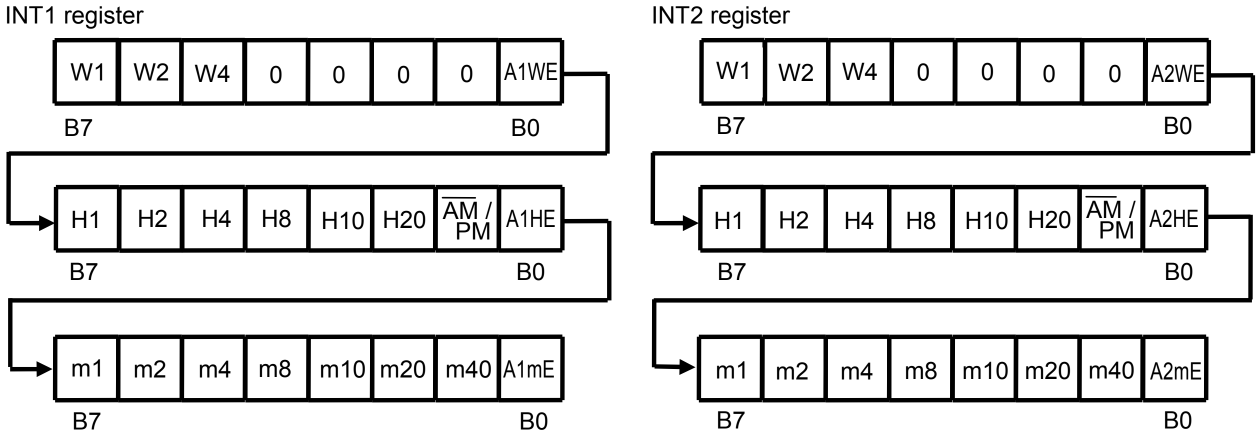


Figure 12 INT1 Register and INT2 Register (Alarm-Time Data)

The INT1 register 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 INT2 register.

Setting example: alarm time "7:00 pm" in the INT1 register

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

set up 7:00 PM
Data written to INT1 register

	B7							B0
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

***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 INT1 register

	B7							B0
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

***1.** Don't care (both of 0 and 1 are acceptable).
***2.** Set up the $\overline{\text{AM}}$ / PM flag along with the time setting.

4. 2 Free register (INT1 register)

The INT1 register is a 1-byte SRAM type register that can be set freely by users.

B7	B6	B5	B4	B3	B2	B1	B0
SC3	SC4	SC5	SC6	SC7	SC8	SC9	SC10
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 13 INT1 Register (Free Register)

4. 3 Output of user-set frequency (INT2 register)

The INT2 register is a 1-byte data register to set up the output frequency. Setting each bit B7 to B3 in the register to "1", the frequency which corresponds to the bit is output in the AND-form. SC11 to SC13 in the INT2 register are 3-bit SRAM type registers that can be freely set by users.

B7	B6	B5	B4	B3	B2	B1	B0
1 Hz	2 Hz	4 Hz	8 Hz	16 Hz	SC11	SC12	SC13
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 INT2 Register (Data Register for Output Frequency)

Example: B7 to B3 = 50h

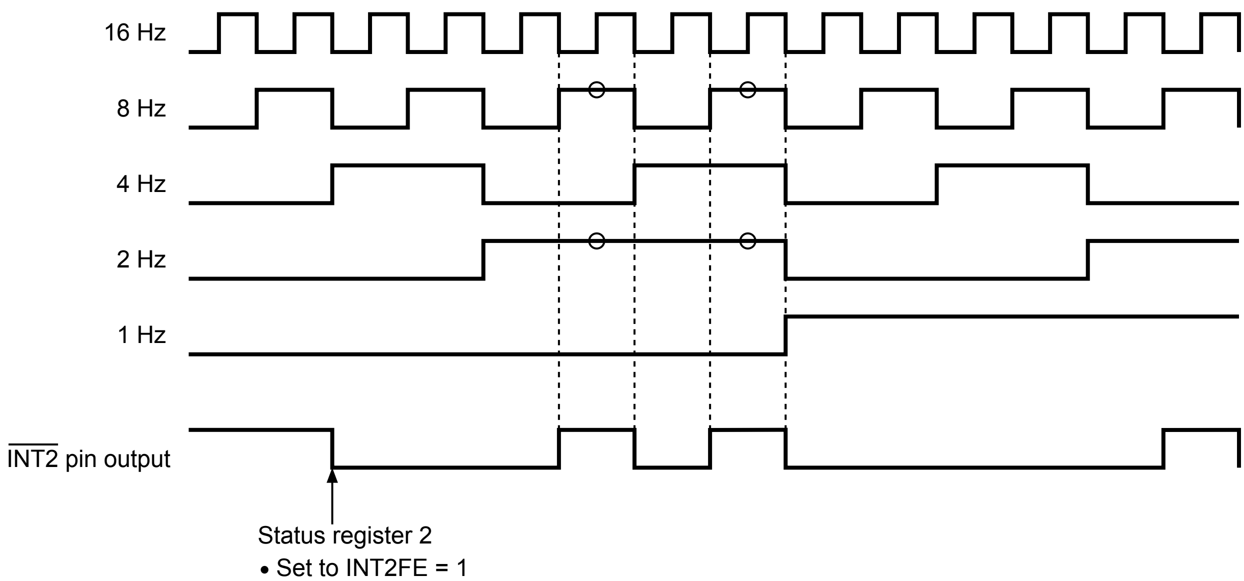


Figure 15 Example of Output from INT2 Register (Data Register for Output Frequency)

1 Hz clock output is synchronized with second-counter of the S-35392A.

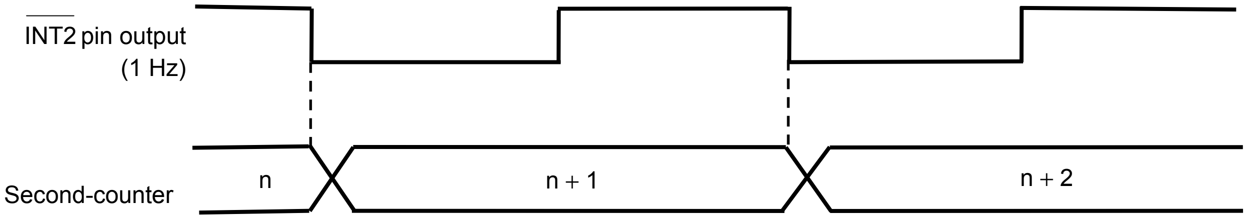


Figure 16 1 Hz Clock Output and Second-counter

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

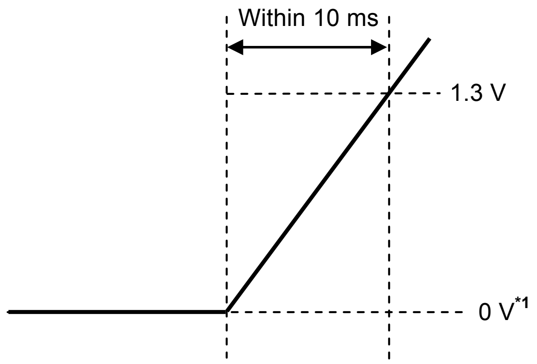
Figure 18 Free Register

■ Power-on Detection Circuit and Register Status

The power-on detection circuit operates by power-on the S-35392A, 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"
INT1 register:	"80h"
INT2 register:	"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-35392A is that the voltage reaches 1.3 V within 10 ms after setting the IC's power supply voltage at 0 V. When the POC flag (B0 in the status register 1) is not in "1", in this case, power-on the S-35392A once again.
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-35392A.

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, B4 in the status register 1 at initialization is set. Refer to **Figure 20**.)
Status register 2:	"00h"
INT1 register:	"00h"
INT2 register:	"00h"
Clock correction register:	"00h"
Free register:	"00h"

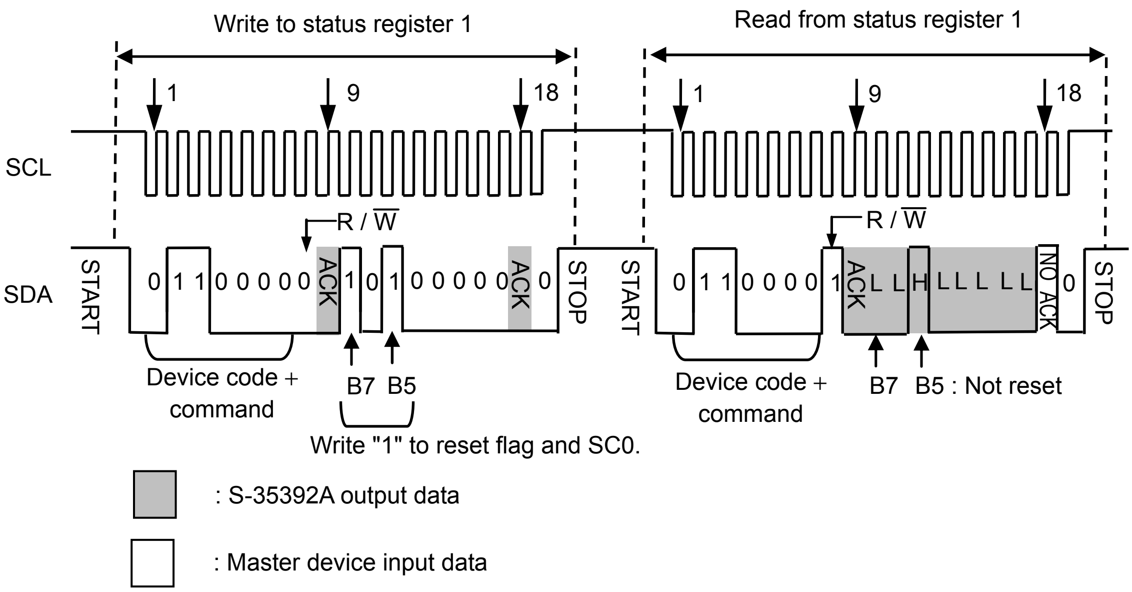


Figure 20 Data of Status Register 1 at Initialization

■ Low Power Supply Voltage Detection Circuit

The S-35392A 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-35392A 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.

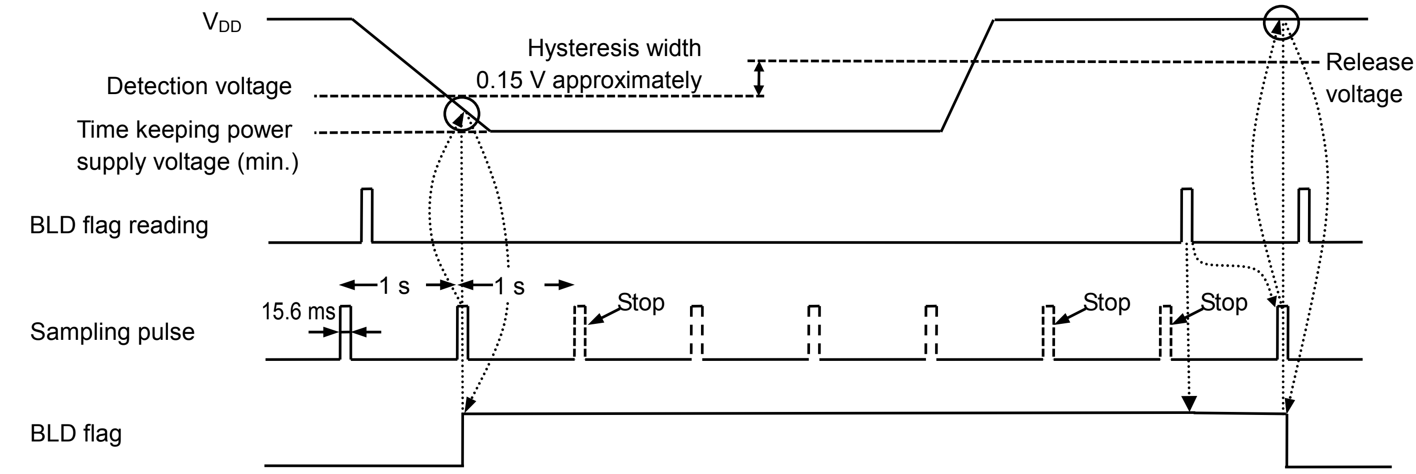


Figure 21 Timing of Low Power Supply Voltage Detection Circuit

■ 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.

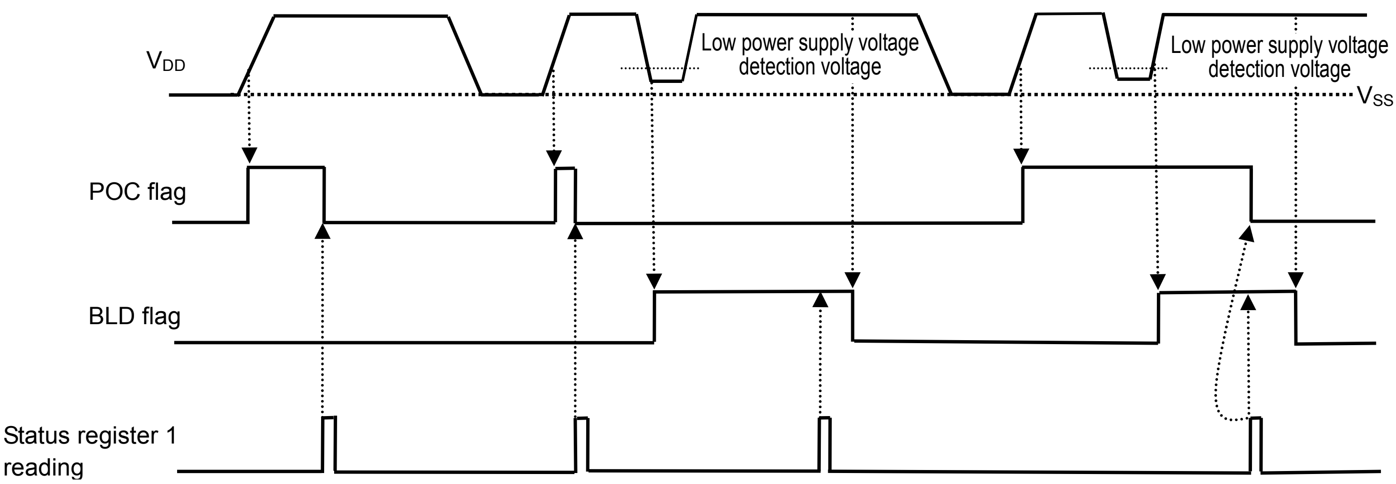


Figure 22 POC Flag and BLD Flag

■ Correction of Nonexistent Data and End-of-Month

When users write the real-time data, the S-35392A checks it. In case that the data is invalid, the S-35392A does the following procedures.

1. Processing of nonexistent data

Table 12 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 $\overline{AM}$ / PM flag (B1 in hour data in the real-time data register).
In 24-hour mode, the $\overline{AM}$ / 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 1 Function and $\overline{\text{INT2}}$ Pin Output Mode

In the output mode for $\overline{\text{INT2}}$ pin, users are able to select the output;
alarm 2 interrupt, user-set frequency, per-minute edge interrupt, minute-periodical interrupt. To switch the output mode for $\overline{\text{INT2}}$ pin and the alarm 1 function, use the status register 2. Refer to "**3. Status register 2**" in "**■ Configuration of Registers**".
When switching the output mode for $\overline{\text{INT2}}$ pin, be careful of the output status of the pin. Especially, when using alarm 2 interrupt output, or the output of user-set frequency, switch the output mode after setting "00h" in the INT2 register. In per-minute edge interrupt output / minute-periodical interrupt output, it is unnecessary to set data in the INT2 register for users.
Refer to the followings regarding each operation of output modes.

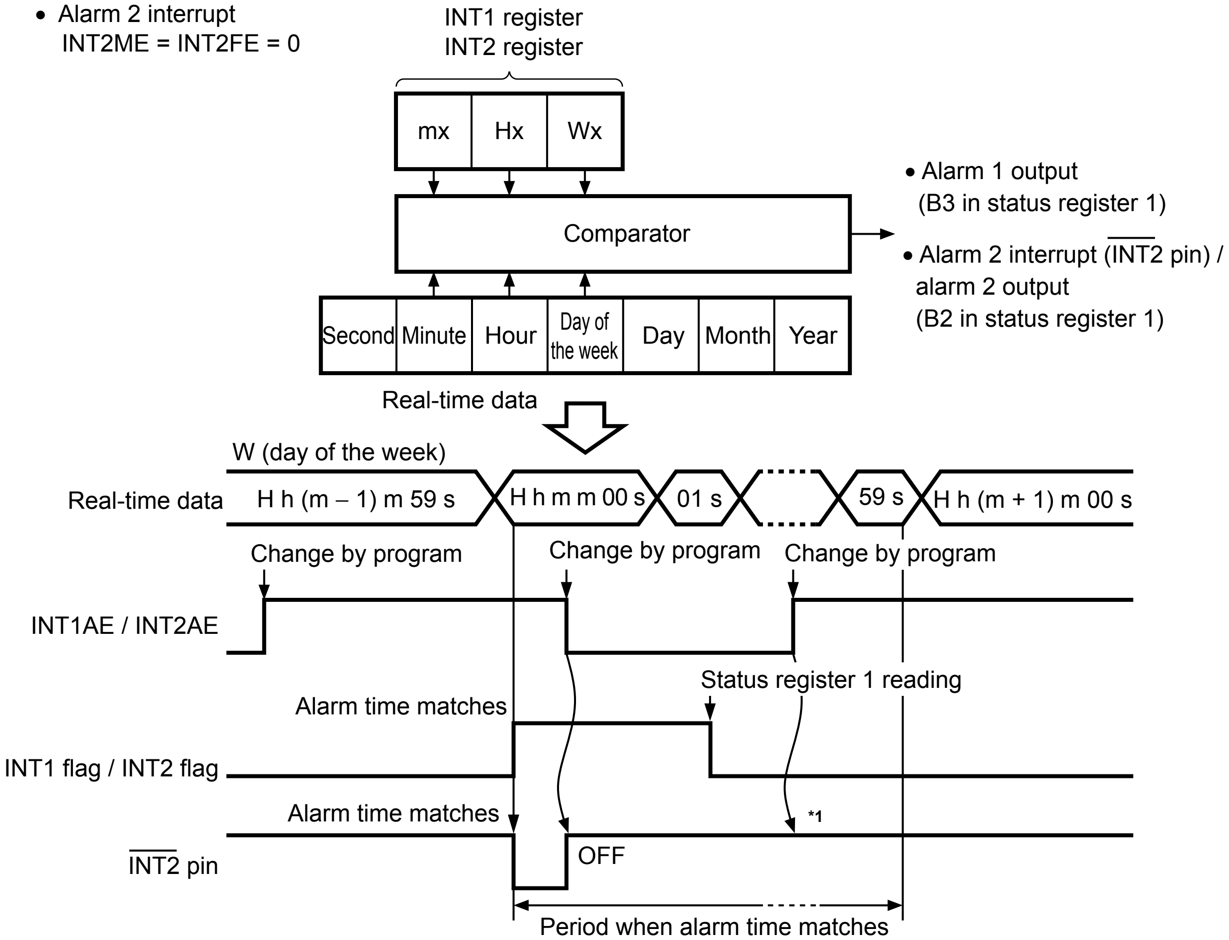
1. Alarm 1 function and alarm 2 interrupt

Alarm 2 interrupt output is the function to set the INT2 flag "H" by the output "L" from the $\overline{\text{INT2}}$ pin, at the alarm time which is set by user has come. If setting the pin output to "H", turn off the alarm function by setting "0" in INT2AE in the status register 2.
By reading, the INT2 flag is once cleared automatically. In the alarm 1 function, the INT1 flag (B3 in the status register 1) is set to "H" when the set time has come. The INT1 flag is also cleared once by reading.
In the alarm 1 function, set the data of day of the week, hour, minute of the alarm time in the INT1 register. In alarm 2 interrupt, set in the INT2 register. Refer to "**4. INT1 register and INT2 register**" in "**■ Configuration of Registers**".

1. 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 interrupt
  INT2ME = INT2FE = 0

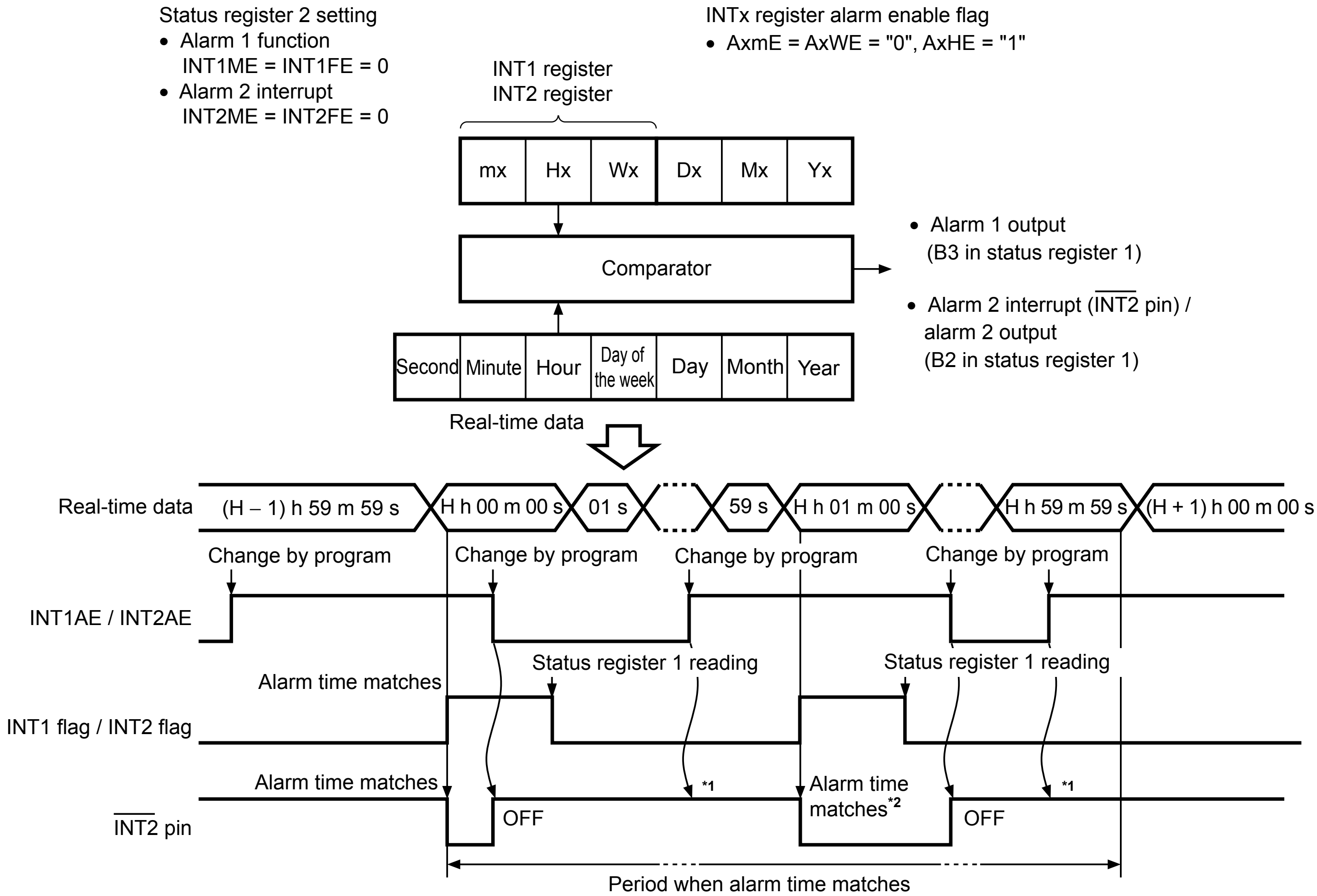
INTx register alarm enable flag
- AxHE = AxmE = AxWE = "1"



***1.** If users clear INT2AE once; "L" is not output from the $\overline{\text{INT2}}$ pin by setting INT2AE enable again, within a period when the alarm time matches real-time data.

Figure 23 Alarm Interrupt Output Timing

1. 2 Alarm setting of "H (hour)"



***1.** If users clear INT2AE once; "L" is not output from the $\overline{\text{INT2}}$ pin by setting INT2AE enable again, within a period when the alarm time matches real-time data.

***2.** If turning the alarm output on by changing the program, within the period when the alarm time matches real-time data, "L" is output again from the $\overline{\text{INT2}}$ pin when the minute is counted up.

Figure 24 Alarm Interrupt Output Timing

2. Output of user-set frequency

The output of user-set frequency is the function to output the frequency which is selected by using data, from the $\overline{\text{INT2}}$ pin, in the AND-form. Set up the data of frequency in the INT2 register.
Refer to "**4. INT1 register and INT2 register**" in "**■ Configuration of Registers**".

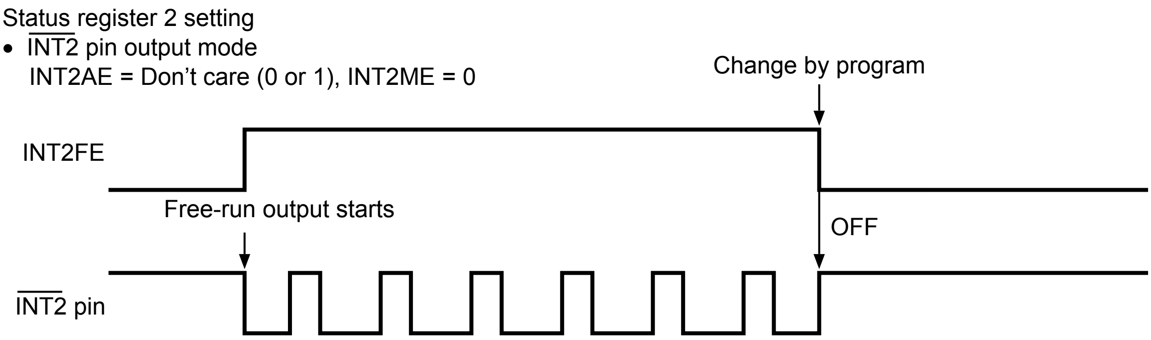
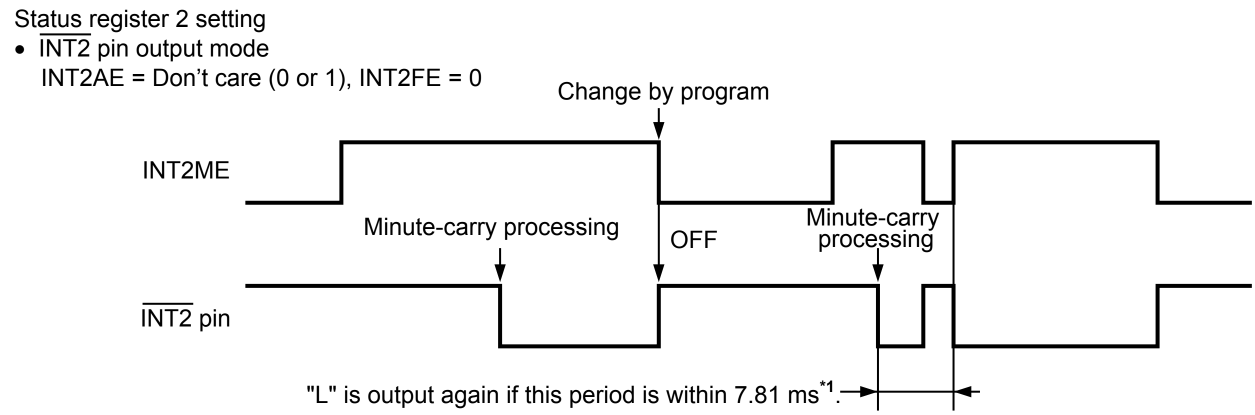


Figure 25 Output Timing of User-set Frequency

3. Per-minute edge interrupt output

Per-minute edge interrupt output is the function to output "L" from the $\overline{\text{INT2}}$ pin, when the first minute-carry processing is done, after selecting the output mode.
To set the pin output to "H", in the $\overline{\text{INT2}}$ pin output mode, input "0" in INT2ME in the status register 2 in order to turn off this mode.

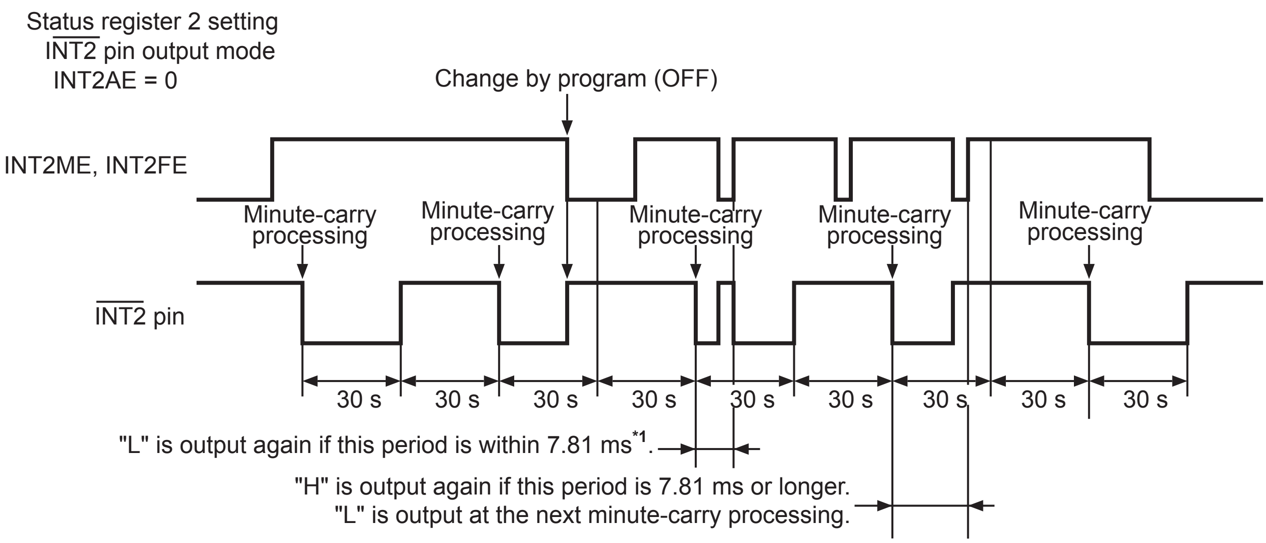


***1.** Pin output is set to "H" by disabling the output mode within 7.81 ms, because the signal of this procedure is maintained for 7.81 ms. Note that pin output is set to "L" by setting enable the output mode again.

Figure 26 Timing of Per-minute Edge Interrupt Output

4. Minute-periodical interrupt output 1

The minute-periodical interrupt 1 is the function to output the one-minute clock pulse (Duty 50%) from the $\overline{\text{INT2}}$ pin, when the first minute-carry processing is done, after selecting the output mode.



***1.** Setting the output mode disable makes the pin output "H", while the output from the $\overline{\text{INT2}}$ pin is in "L".
Note that pin output is set to "L" by setting enable the output mode again.

Figure 27 Timing of Minute-periodical Interrupt Output 1

■ 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-35392A 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-35392A corrects in the range of −195.3 ppm to +192.2 ppm (or of −65.1 ppm to +64.1 ppm) (Refer to **Table 13**). 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 13 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