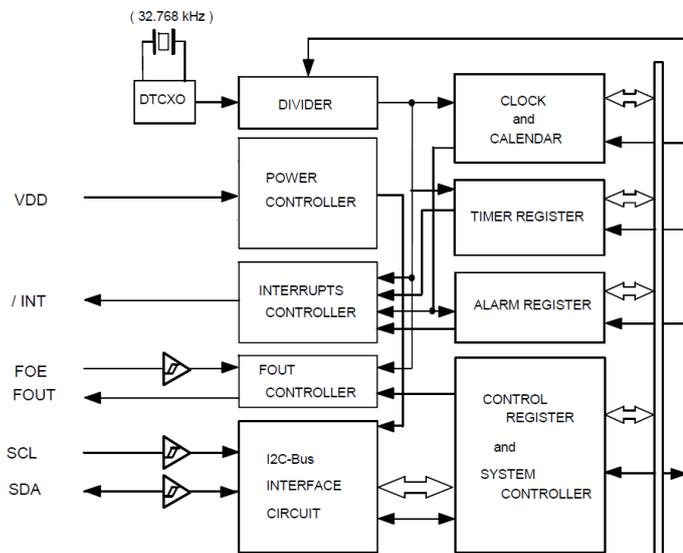




Features

- Built-in 32.768 kHz DTCXO
- High Stability: $< \pm 5\text{ppm}@-40^{\circ}\text{C} \sim 105^{\circ}\text{C}$
- Supports I2C-Bus's high-speed mode (Up to 400 kHz)
- Alarm interrupt function for day, date, hour, and minute settings
- Wakeup timer interruption
- Time update interrupt function for Seconds, minutes
- Temperature compensated 32.768 kHz output with OE function (FOE and FOUT pins)
- Auto correction of leap years (from 2000 to 2099)
- Wide interface voltage range: 1.6V ~ 5.5 V
- Low current consumption: 0.54 uA / 3 V (Typ.)
- Industry Temperature ($-40^{\circ}\text{C} \sim 105^{\circ}\text{C}$).

Block Diagram



Description

This module is an I2C bus interface-compliant real-time clock which includes a 32.768 kHz DTCXO. In addition to providing a calendar (year, month, date, day, hour, minute, second) function and a clock counter function, this module provides an abundance of other functions including an alarm function, Wakeup timer function, time update interrupt function, and 32.768 kHz output function.

Ordering Information

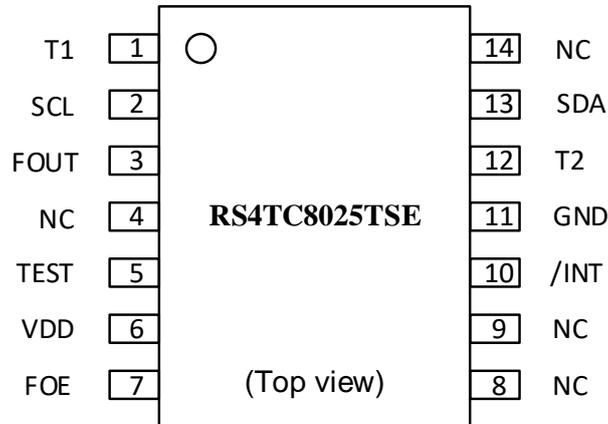
Part Number	Package	Description
RS4TC8025TSE	SOP14	10.1mm x7.4mm

Notes:

[1] E = Pb-free and Green



Pin Configuration



Pin Name	Pin No.	Type	Description
FOE	7	Input	This is an input pin used to control the output mode of the FOUT pin. When this pin's level is high, the FOUT pin is in output mode. When it is low, output via the FOUT pin is stopped.
VDD	6	Power	This pin is connected to a positive power supply.
Test	5	-	Used by the manufacturer for testing. (Do not connect externally.)
FOUT	3	Output	This is the C-MOS output pin with output control provided via the FOE pin. When FOE = "H" (high level), this pin outputs a 32.768 kHz signal. (depend on FSEL bit) When output is stopped, the FOUT pin = "Hi-Z" (high impedance).
SCL	2	Input	This is the serial clock input pin for I2C Bus communications.
T1	1	Input	Used by the manufacturer for testing. (Do not connect externally.)
SDA	13	I/O	This pin's signal is used for input and output of address, data, and ACK bits, synchronized with the serial clock used for I2C communications. Since the SDA pin is an open drain pin during output, be sure to connect a suitable pull-up resistance relative to the signal line capacity.
T2	12	Input	Used by the manufacturer for testing. (Do not connect externally.)
GND	11	Power	This pin is connected to a ground.
/INT	10	Output	This pin is used to output alarm signals, timer signals, time update signals, and other signals. This pin is an open drain pin.
N.C.	4,8,9,14	-	This pin is not connected to the internal IC. Leave N.C. pins open or connect them to GND.



Absolute Maximum Ratings

Symbol	Parameter	MIN	TYP	MAX	Unit
T _{store}	Storage Temperature	-55	-	+125	°C
V _{DD}	DC Supply Voltage VDD	-0.3	-	6.5	V
V _{BAT}	Battery Supply voltage	-0.3	-	6.5	V
V _I	Input Voltage on FOE, SCL, SDA	GND-0.3	-	6.5	V
V _{O1}	Output Voltage on FOUT pins	GND-0.3		VDD+0.3	V
V _{O2}	Output Voltage on SDA and /INT pins	GND-0.3		6.5	V
LU	Latch-Up			±200	mA
CDM	Charged Device Model			1000	V
HBM	Human Body Model			5000	V

Notes:

- Stresses greater than those listed under MAXIMUM RATINGS may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect reliability.

Recommended operation conditions

Symbol	Parameter	MIN	TYP	MAX	Unit
V _{DD}	Operating supply voltage (V _{DD})	1.6	3.0	5.5	V
V _{CLK}	Clock supply voltage ^{*1}	1.15	3.0	5.5	V
V _{TEM}	Temp. compensation voltage	2.0	3.0	5.5	V
T _{OPR}	Operating temperature	-40	+25	+105	°C

Notes:

- The temperature compensation stops working below Min. value of V_{TEM}. The Min. value of V_{CLK} is the Min. voltage required to retain the time counting function; it is however necessary to maintain V_{TEM} till the oscillation of the oscillator has stabilized (oscillation start time t_{STA}).



DC Electrical Characteristics

Unless otherwise specified, $-40^{\circ}\text{C} \leq T_A \leq 105^{\circ}\text{C}$,

Symbol	Item	Condition	MIN	TYP	MAX	Unit
I _{DD1}	Average Current Consumption (1)	f _{SCL} = 0 Hz, / INT = V _{DD} FOE = GND, V _{DD} = V _{BAT}	V _{DD} = 5 V	0.59	3.8	μA
I _{DD2}	Average Current Consumption (2)	FOUT: output OFF (High Z) Compensation interval 2.0 s VDET3 voltage detection time 2ms	V _{DD} = 3 V	0.54	3.6	
I _{DD3}	Current Consumption (3)	f _{SCL} = 0 Hz, / INT = V _{DD} FOE = V _{DD} , V _{DD} = V _{BAT}	V _{DD} = 5 V	1.66	5.3	μA
I _{DD4}	Current Consumption (4)	FOUT :32.768 kHz, CL =0pF Compensation interval 2.0 s VDET3 voltage detection time 2ms	V _{DD} = 3 V	1.18	4.5	
V _{IH}	High-level Input voltage	SCL, SDA, FOE pins	0.8 × V _{DD}		5.5	V
V _{IL}	Low-level Input voltage	SCL, SDA, FOE pins	GND – 0.3		0.2 × V _{DD}	V
VOH1	High-level output voltage	FOUT pin	V _{DD} =5 V, I _{OH} =–1 mA	4.5	5.0	V
VOH2			V _{DD} =3 V, I _{OH} =–1 mA	2.2	3.0	
VOH3			V _{DD} =3 V, I _{OH} =–100 μA	2.9	3.0	
VOL1	Low-level output voltage	FOUT pin	V _{DD} =5 V, I _{OL} =1 mA	GND	GND+0.5	V
VOL2			V _{DD} =3 V, I _{OL} =1 mA	GND	GND+0.8	
VOL3			V _{DD} =3 V, I _{OL} =100 μA	GND	GND+0.1	
VOL4		/ INT pin	V _{DD} =5 V, I _{OL} =1 mA	GND	GND+0.25	V
VOL5			V _{DD} =3 V, I _{OL} =1 mA	GND	GND+0.4	
VOL6			SDA pin	V _{DD} ≥ 2 V, I _{OL} =3 mA	GND	
I _{LK}	Input leakage current	FOE, SCL, SDA pins, V _{IN} = V _{DD} or GND	–0.5		0.5	μA
I _{OZ}	Output leakage current	/ INT, SDA, FOUT pins, V _{OUT} = V _{DD} or GND	–0.5		0.5	μA

AC Characteristics - Frequency

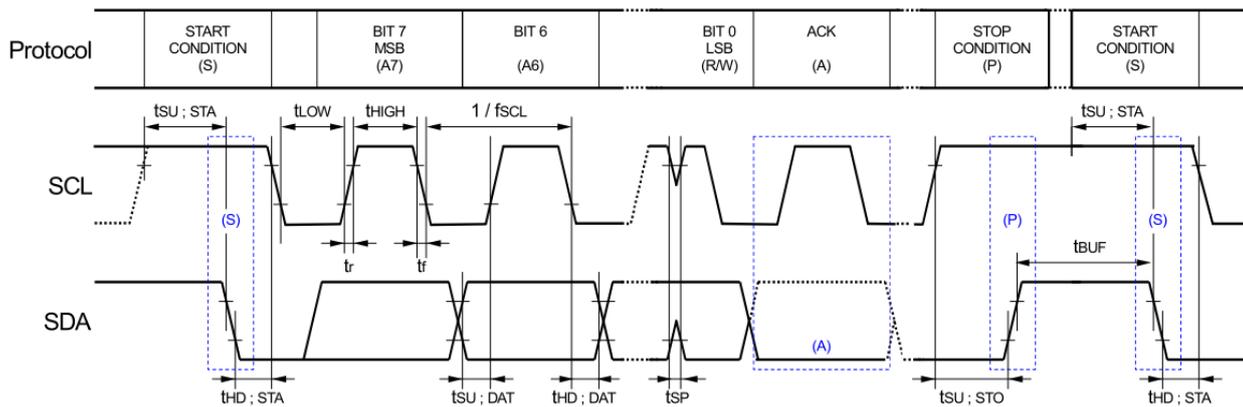
Symbol	Parameter	Suffix	Condition	MIN	TYP	MAX	Unit
Δf / f	Frequency stability		T _a = 0 to +50°C, V _{DD} =3.0 V T _a = -40 to +105°C, V _{DD} =3.0 V	-3 -5		3 5	ppm
f / V	Frequency/voltage characteristics		T _a = +25°C, V _{DD} =2.0 V to 5.5 V	-1		1	ppm
t _{STA}	Oscillation start time		T _a = +25°C, V _{DD} =1.6 V to 5.5 V			0.5	s
			T _a = -40 to +105°C, V _{DD} =1.6 V to 5.5 V			1	
f _a	Aging		T _a = +25°C, V _{DD} =3.0 V, first year	-3		3	ppm
T _{sensor}	Temperature Sensor Accuracy		V _{DD} =3.0 V	-4		4	°C
Duty	FOUT duty		50% of V _{DD} level	40	50	60	%



AC Characteristics – I2C Bus

($T_A = -40^{\circ}\text{C}$ to $+105^{\circ}\text{C}$)

Item	Symbol	Condition	MIN	TYP	MAX	Unit
SCL clock frequency	fSCL				400	kHz
Start condition setup time	tSU;STA		0.6			μs
Start condition hold time	tHD;STA		0.6			μs
Data setup time	tSU;DAT	Fast mode	100			ns
Data hold time	tHD;DAT		0			ns
Stop condition setup time	tSU;STO		0.6			μs
Bus idle time between start condition and stop condition	tBUF		1.3			μs
Time when SCL = "L"	tLOW		1.3			μs
Time when SCL = "H"	tHIGH		0.6			μs
Rise time for SCL and SDA	tr				0.3	μs
Fall time for SCL and SDA	tf				0.3	μs
Allowable spike time on bus	tSP				50	ns





Register Table

Basic Time and Calendar Registers

Address	Function	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	R/W
00 or 10	SEC	○	40	20	10	8	4	2	1	R/W
01 or 11	MIN	○	40	20	10	8	4	2	1	R/W
02 or 12	HOUR	○	○	20	10	8	4	2	1	R/W
03 or 13	WEEK	○	6	5	4	3	2	1	0	R/W
04 or 14	DAY	○	○	20	10	8	4	2	1	R/W
05 or 15	MONTH	○	○	○	10	8	4	2	1	R/W
06 or 16	YEAR	80	40	20	10	8	4	2	1	R/W
07	RAM	●	●	●	●	●	●	●	●	R/W
08	MIN Alarm	AE	40	20	10	8	4	2	1	R/W
09	HOUR Alarm	AE	●	20	10	8	4	2	1	R/W
0A	WEEK Alarm	AE	6	5	4	3	2	1	0	R/W
	DAY Alarm		●	20	10	8	4	2	1	R/W
0B or 1B	Timer Counter 0	128	64	32	16	8	4	2	1	R/W
0C or 1C	Timer Counter 1	●	●	●	●	2048	1024	512	256	R/W
0D or 1D	Extension Register	TEST	WADA	USEL	TE	FSEL1	FSEL0	TSEL1	TSEL0	R/W
0E or 1E	Flag Register	○	○	UF	TF	AF	○	VLF	VDET	R/W
0F or 1F	Control Register	CSEL1	CSEL0	UIE	TIE	AIE	○	○	RESET	R/W

Note:

1. After the initial power-up (from 0 V) or in case the VLF bit returns "1", make sure to initialize all registers, before using the RTC.

Be sure to avoid entering incorrect date and time data, as clock operations are not guaranteed when the data or time data is incorrect.

2. During the initial power-up, the following are the default settings for the register values

Initial value_0 :

TEST,WADA,USEL,TE,FSEL1,FSEL0,TSEL0,UF,TF,AF,CSEL1,UIE,TIE,AIE,RESETVDETOFF,SWOFF,BKSMP1,BKSMP0

Initial value_1 :

TSEL1,VLF,VDET,CSEL0

At this point, all other register values are undefined, so be sure to perform a reset before using the module.

3. Only a "0" can be written to the UF, TF, AF, VLF, or VDET bit.

4. Any bit marked with "○" should be used with a value of "0" after initialization.

5. Any bit marked with "●" is a RAM bit that can be used to read or write any data.

6. The TEST bit is used by the manufacturer for testing. Be sure to set "0" for this bit when writing.

7. If an alarm function is not used, registers 08h-0Ah can be used as RAM. (AIE : "0")

8. Reading register value of address 0Bh-0Ch is pre-set data.

9. If a timer function is not used, register of 0Bh-0Ch can be used as RAM. (TE,TIE : "0")

Temperature Data register

Address	Function	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	R/W
17	TEMP	128	64	32	16	8	4	2	1	READ

The temperature data are updated during operation of the temperature compensation circuit.



Details of Registers

Clock counter (SEC - HOUR)

Address	Function	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	R/W
00 or 10	SEC	○	40	20	10	8	4	2	1	R/W
01 or 11	MIN	○	40	20	10	8	4	2	1	R/W
02 or 12	HOUR	○	○	20	10	8	4	2	1	R/W

Note

1. "○" indicates write-protected bits. A zero is always read from these bits.
2. The clock counter counts seconds, minutes, and hours.
3. The data format is BCD format. For example, when the "seconds" register value is "0101 1001" it indicates 59 seconds.
4. Note with caution that writing non-existent time data may interfere with normal operation of the clock counter.

Second counter

The second counter counts from "00" to "01," "02," and up to 59 seconds, after which it starts again from 00 seconds.

Minute counter

The minute counter counts from "00" to "01," "02," and up to 59 minutes, after which it starts again from 00 minutes.

Hour counter

The hour counter counts from "00" hours to "01," "02," and up to 23 hours, after which it starts again from 00 hours.

Calendar counter (WEEK - YEAR)

Address	Function	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	R/W
03 or 13	WEEK	○	6	5	4	3	2	1	0	R/W

Day of the WEEK counter

The day (of the week) is indicated by 7 bits, bit 0 to bit 6.

The day data values are counted as follows: Day 01h , Day 02h ,Day 04h ,Day 08h ,Day 10h ,Day 20h Day 40h ,Day 01h, Day 02h, etc.

Week	Data	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
Sunday	01h	0	0	0	0	0	0	0	1
Monday	02h	0	0	0	0	0	0	1	0
Tuesday	04h	0	0	0	0	0	1	0	0
Wednesday	08h	0	0	0	0	1	0	0	0
Thursday	10h	0	0	0	1	0	0	0	0
Friday	20h	0	0	1	0	0	0	0	0
Saturday	40h	0	1	0	0	0	0	0	0



Date counter

Address	Function	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	R/W
04 or 14	DAY	○	○	20	10	8	4	2	1	R/W

The updating of dates by the date counter varies according to the month setting. A leap year is set whenever the year value is a multiple of four (such as 04, 08, 12, 88, 92, or 96). In February of a leap year, the counter counts dates from "01," "02," "03," to "28," "29," "01," etc.

Month	Date update pattern
1, 3, 5, 7, 8, 10, or 12	1~31
4, 6, 9, or 11	1~30
February in normal year	1~28
February in leap year	1~29

Month counter

Address	Function	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	R/W
05 or 15	MONTH	○	○	○	10	8	4	2	1	R/W
06 or 16	YEAR	80	40	20	10	8	4	2	1	R/W

The month counter counts from 01 (January), 02 (February), and up to 12 (December), then starts again at 01 (January).

Year counter

Address	Function	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	R/W
06 or 16	YEAR	80	40	20	10	8	4	2	1	R/W

The year counter counts from 00, 01, 02 and up to 99, then starts again at 00. Any year that is a multiple of four (04, 08, 12, 88, 92, 96, etc.) is handled as a leap year.

Alarm registers

Address	Function	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	R/W
08	MIN Alarm	AE	40	20	10	8	4	2	1	R/W
09	HOUR Alarm	AE	●	20	10	8	4	2	1	R/W
0A	WEEK Alarm	AE	6	5	4	3	2	1	0	R/W
	DAY Alarm		●	20	10	8	4	2	1	R/W

The alarm interrupt function is used, along with the AEI, AF, and WADA bits, to set alarms for specified date, day, hour, and minute values. When the settings in the above alarm registers and the WADA bit match the current time, the /INT pin goes to low level and "1" is set to the AF bit to report that an alarm interrupt event has occurred.

Note: AE-bit is low active, so in order to enable 1 interrupt every hour once the actual minutes match the alarm setting, it is necessary to set the AE of register 08h to 0 and the AE of 09h and 0Ah to 1.

In order to generate an alarm interrupt only once a week, all 3 AE-bits have to be set "0"

*1) The alarm function is not a HW feature but software function inside the RTC!

*2) In case "AE" bit of register 0Ah is set to "1", the day will be ignored and an interrupt occurs ones the actual time matches the minutes and/or hour setting of the alarm register.



Fixed-cycle timer control registers

Address	Function	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	R/W
0B or 1B	Timer Counter 0	128	64	32	16	8	4	2	1	R/W
0C or 1C	Timer Counter 1	●	●	●	●	2048	1024	512	256	R/W

Note:

These registers are used to set the preset countdown value for the fixed-cycle timer interrupt function. The TE, TF, TIE, and TSEL0/1 bits are also used to set the fixed-cycle timer interrupt function.

When a fixed-cycle timer interrupt event has occurred, the /INT pin goes to low level and "1" is set to the TF bit .

Extension registers

Address	Function	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	R/W
0B or 1B	Timer Counter 0	128	64	32	16	8	4	2	1	R/W
0C or 1C	Timer Counter 1	●	●	●	●	2048	1024	512	256	R/W
0D or 1D	Extension Register	TEST	WADA	USEL	TE	FSEL1	FSEL0	TSEL1	TSEL0	R/W

Note:

1. The default value is the value that is read (or is set internally) after powering up from 0 V
2. "0" mandatory "0" Make sure to always write 0 into this bit.
3. "-" indicates a default value is undefined.

This register is used to specify the target for the alarm function or time update interrupt function and to select or set operations such as fixed-cycle timer operations.

TEST bit

This is the manufacturer's test bit. Its value should always be "0". Be careful to avoid writing a "1" to this bit when writing to other bits.

TEST	Data	Description
Write/Read	0	Normal operation mode (Default)
	1	Setting prohibited (manufacturer's test bit)



WADA (Week Alarm/Day Alarm) bit

This bit is used to specify either WEEK or DAY as the target of the alarm interrupt function. Writing a "1" to this bit specifies a DAY alarm, meaning the alarm interrupt is initiated independent of the actual day when the set time is reached. Writing a "0" to this bit specifies a WEEK alarm, so an alarm interrupt is only generated when the set time is reached on a dedicated day of a week.

USEL (Update Interrupt Select) bit

This bit is used to define if the RTC should output a "second update" or "minute update" interrupt, allowing to synchronize external clocks with the time registers of the RTC.

USEL	Data	update interrupts	Auto reset time tRTN
Write/Read	0	second update (Default)	500 ms
	1	minute update	Min. 7.813 ms

TE (Timer Enable) bit

This bit controls the start/stop setting for the fixed-cycle timer interrupt function. Writing a "1" to this bit specifies starting of the fixed-cycle timer interrupt function (a countdown starts from a preset value). Writing a "0" to this bit specifies stopping of the fixed-cycle timer interrupt function.

FSEL0,1 (FOUT frequency Select 0, 1) bits

The combination of these two bits is used to set the FOUT frequency. Note: All frequencies are temperature compensated

FSEL1	FSEL0	FOUT
0	0	32768Hz
0	1	1024Hz
1	0	1Hz
1	1	32768Hz

TSEL0,1 (Timer Select 0, 1) bits

The combination of these two bits is used to set the countdown period (source clock) for the fixed-cycle timer interrupt function (four settings can be made).

TSEL1	TSEL0	Timer		Auto reset time tRT(Min.)	Effect of RESET bit
0	0	4096 Hz	Once per 244.14 μ s	122 us	---
0	1	64 Hz	Once per 15.625 ms	7.813 ms	Does not operate when the RESET bit value is "1".
1	0	"Second" update	Once per second	7.813 ms	
1	1	"Minute" update	Once per minute	7.813 ms	



Flag register

Address	Function	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	R/W
0E or 1E	Flag Register	○	○	UF	TF	AF	○	VLF	VDET	R/W

Default is values loaded automatically after power ON from 0V.

"o" indicates write-protected bits. A zero is always read from these bits.

"-" indicates a default value is undefined.

UF (Update Flag) bit

If set to "0" beforehand, this flag bit's value changes from "0" to "1" when a time update interrupt event has occurred. Once this flag bit's value is "1", its value is retained until a "0" is written to it.

TF (Timer Flag) bit

If set to "0" beforehand, this flag bit's value changes from "0" to "1" when a fixed-cycle timer interrupt event has occurred. Once this flag bit's value is "1", its value is retained until a "0" is written to it.

AF (Alarm Flag) bit

If set to "0" beforehand, this flag bit's value changes from "0" to "1" when an alarm interrupt event has occurred. Once this flag bit's value is "1", its value is retained until a "0" is written to it.

VLF (Voltage Low Flag) bit

VLF indicates the retained reliability of clock functions and internal data.

When VLF was set to "1", it indicates possibility that was lost of both memorized data and clock calendar data. The factor of VLF are 2kinds.

1 Supply voltage drop less than 1.6V(VCLK) was detected.

VLF-voltage-detector is active in anytime. Detection velocity is about 1ms to 10ms. 2 The internal crystal oscillation was stopped. This detector is active in anytime.

Detection velocity is about 100ms.

Once VLF value was set to "1", its "1" is retained until a "0" is written to it. After initial power ON from 0 V, make sure VLF was set to "1".

VLF	Data	Description
Write	0	The VLF bit is cleared to zero to prepare for the next status detection.
	1	Invalid (writing a 1 will be ignored)!
Read	0	No supply voltage drop occurred, so data are not compromised.
	1	Low voltage has been detected, so data loss might have occurred, and time information might be compromised. All registers must be initialized. (This setting is retained until a "zero" is written to this bit.)



VDET (Voltage Detection Flag) bit

VDET indicates the retained reliability of temperature compensation. When VDET was set to "1", it indicates possibility that was lost of clock stability history. The factor of VDET. Supply voltage drop less than 1.95V(VDET) was detected. VDET is detected in every temperature compensation timing. Detection velocity is about 1ms to 10ms. Once VDET value is "1", VDET is retained until a "0" is written to it. After powering up from 0 V, make sure to set this bit's value to "1".

VDET	Data	Description
Write	0	The VDET bit is cleared to zero to prepare for the next low voltage detection.
	1	Invalid (writing a 1 will be ignored)!
Read	0	Temperature compensation is normal.
	1	Temperature compensation has been stopped.

Control register

Address	Function	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	R/W
0F or 1F	Control Register	CSEL1	CSEL0	UIE	TIE	AIE	○	○	RESET	R/W

Notes

The default value is the value that is read (or is set internally) after powering up from 0 V. "o" indicates write-protected bits. A zero is always read from these bits. "-" indicates no default value has been defined.

This register is used to control interrupt event output from the /INT pin and the stop/start status of clock and calendar operations.

CSEL0,1 (Compensation interval Select 0, 1) bits

The combination of these two bits is used to set the temperature compensation interval.

CSEL0,1	CSEL1 (bit 7)	CSEL0 (bit 6)	Compensation Interval
Write/Read	0	0	0.5 s
	0	1	2.0 s (default)
	1	0	10 s
	1	1	30 s



UIE (Update Interrupt Enable) bit

When a time update interrupt event is generated (when the UF bit value changes from "0" to "1"), this bit's value specifies if an interrupt signal is generated (/INT status changes from Hi-Z to low) or is not generated (/INT status remains Hi-Z).

When a "1" is written to this bit, an interrupt signal is generated (/INT status changes from Hi-Z to low) when an interrupt event is generated.

When a "0" is written to this bit, no interrupt signal is generated when an interrupt event occurs

UIE	Data	Function
Write/Read	0	When a time update interrupt event occurs, an interrupt signal is not generated or is canceled (/INT status changes from low to Hi-Z).
	1	When a time update interrupt event occurs, an interrupt signal is generated (/INT status changes from Hi-Z to low). * When a time update interrupt event occurs, low-level output from the /INT pin occurs only when the value of the control register's UIE bit is "1". This /INT status is automatically cleared (/INT status changes from low to Hi-Z) earliest 7.813 ms after the interrupt occurs.

TIE (Timer Interrupt Enable) bit

When a fixed-cycle timer interrupt event occurs (when the TF bit value changes from "0" to "1"), this bit's value specifies if an interrupt signal is generated (/INT status changes from Hi-Z to low) or is not generated (/INT status remains Hi-Z). When a "1" is written to this bit, an interrupt signal is generated (/INT status changes from Hi-Z to low) when an interrupt event is generated.

When a "0" is written to this bit, no interrupt signal is generated when an interrupt event occurs.

TIE	Data	Function
Write/Read	0	When a fixed-cycle timer interrupt event occurs, an interrupt signal is not generated or is canceled (/INT status changes from low to Hi-Z).
	1	When a fixed-cycle timer interrupt event occurs, an interrupt signal is generated (/INT status changes from Hi-Z to low). * When a fixed-cycle timer interrupt event has been generated low-level output from the /INT pin occurs only when the value of the control register's TIE bit is "1". Earliest 7.813 ms after the interrupt occurs, the /INT status is automatically cleared (/INT status changes from low to Hi-Z).

AIE (Alarm Interrupt Enable) bit

When an alarm timer interrupt event occurs (when the AF bit value changes from "0" to "1"), this bit's value specifies if an interrupt signal is generated (/INT status changes from Hi-Z to low) or is not generated (/INT status remains Hi-Z).

When a "1" is written to this bit, an interrupt signal is generated (/INT status changes from Hi-Z to low) when an interrupt event is generated.

When a "0" is written to this bit, no interrupt signal is generated when an interrupt event occurs.

AIE	Data	Function
Write/Read	0	When an alarm interrupt event occurs, an interrupt signal is not generated or is canceled (/INT status changes from low to Hi-Z).
	1	When an alarm interrupt event occurs, an interrupt signal is generated (/INT status changes from Hi-Z to low). * When an alarm interrupt event has been generated low-level output from the /INT pin occurs only when the value of the control register's AIE bit is "1". This setting is retained until the AF bit value is cleared to zero. (No automatic cancellation)



RESET bit

RESET bit was prepared for the synchronized starting of time or timer. The detailed function of reset.

For example.

S is start condition. P is stop condition. RS is re-start condition.

S---Slave address(w)---ACK1---0Fh---ACK2---01h---ACK3---RS---R/W access---P.

RESET-bit is set at ACK3, but RESET doesn't execute.

after set of RESET, RESET-function executes momentarily at next P, and RESET-bit clears automatically.

RESET area of circuit is the count-down-chain of 2Hz from 16kHz, are cleared.

Therefore, RESET do not affect 32kHz output.

Next update timing of a Seconds counter from RESET. That range is 1000ms-30.5 μ s from just 1000ms.

RESET affects to time update interruption, alarm, and timer.

Note:

RESET is not released by the reception of a RE-START condition before receiving a STOP condition. Unnecessary use of RESET will be the cause of delay error of Calendar and Clock.

Temperature Data register

Address	Function	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	R/W
17	TEMP	128	64	32	16	8	4	2	1	READ

Notes

This register can be used to read digital temperature data.

The temperature data are updated during operation of the temperature compensation circuit.

You can make a conversion to a centigrade by temperature data by calculating in the following expression.



I²C Bus Interface

The RS4TC8025 supports the I²C protocol. The device that controls the message is called a master. The devices that are controlled by the master are referred to as slaves. The bus must be controlled by a master device, which generates the serial clock (SCL), controls the bus access, and generates the START and STOP conditions. The RS4TC8025 operates as a slave on the I²C bus. Within the bus specifications, a standard mode (100kHz cycle rate) and a fast mode (400kHz cycle rate) are defined. The RS4TC8025 works in both modes. Connections to the bus are made through the open-drain I/O lines SDA and SCL.

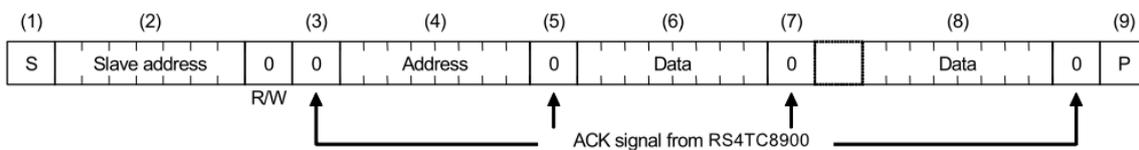
Slave addresses have a fixed length of 7 bits. This RTC's slave address is [0110010]. An R/W bit ("*" above) is added to each 7-bit slave address during 8-bit transfers.

	Transfer Data	Slave Address							R/W bit
		Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Read	65 h	0	1	1	0	0	1	0	1 = Read
Write	64 h								0 = Write

I²C write sequence

Since the RS4TC8025 includes an address auto increment function, once the initial address has been specified, the RS4TC8025 increments (by one byte) the receive address each time data is transferred.

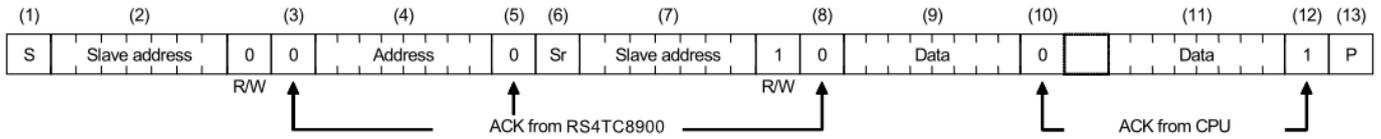
- (1) CPU transfers start condition [S].
- (2) CPU transmits the RS4TC8025's slave address with the R/W bit set to write mode.
- (3) Check for ACK signal from RS4TC8025.
- (4) CPU transmits write address to RS4TC8025.
- (5) Check for ACK signal from RS4TC8025.
- (6) CPU transfers write data to the address specified at (4) above.
- (7) Check for ACK signal from RS4TC8025.
- (8) Repeat (6) and (7) if necessary. Addresses are automatically incremented.
- (9) CPU transfers stop condition [P].



Address specification read sequence

After using write mode to write the address to be read, set read mode to read the actual data.

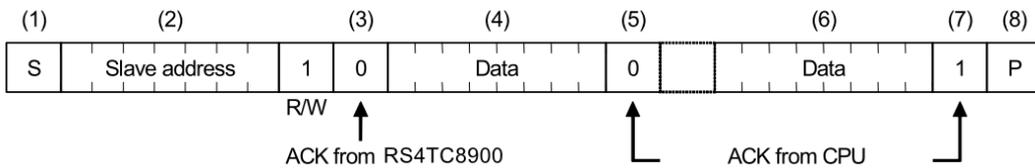
- (1) CPU transfers start condition [S].
- (2) CPU transmits the RS4TC8025's slave address with the R/W bit set to write mode.
- (3) Check for ACK signal from RS4TC8025.
- (4) CPU transfers address for reading from RS4TC8025.
- (5) Check for ACK signal from RS4TC8025.
- (6) CPU transfers RESTART condition [Sr] (in which case, CPU does not transfer a STOP condition [P]).
- (7) CPU transfers RS4TC8025's slave address with the R/W bit set to read mode.
- (8) Check for ACK signal from RS4TC8025
(from this point on, the CPU is the receiver and the RS4TC8025 is the transmitter).
- (9) Data from address specified at (4) above is output by the RS4TC8025.
- (10) CPU transfers ACK signal to RS4TC8025.
- (11) Repeat (9) and (10) if necessary. Read addresses are automatically incremented.
- (12) CPU transfers ACK signal for "1".
- (13) CPU transfers stop condition [P].



Read sequence when address is not specified

Once read mode has been initially set, data can be read immediately. In such cases, the address for each read operation is the previously accessed address + 1.

- (1) CPU transfers start condition [S].
- (2) CPU transmits the RS4TC8025's slave address with the R/W bit set to read mode.
- (3) Check for ACK signal from RS4TC8025
(from this point on, the CPU is the receiver and the RS4TC8025 is the transmitter).
- (4) Data is output from the RS4TC8025 to the address following the end of the previously accessed address.
- (5) CPU transfers ACK signal to RS4TC8025.
- (6) Repeat (4) and (5) if necessary. Read addresses are automatically incremented in the RS4TC8025.
- (7) CPU transfers ACK signal for "1".
- (8) CPU transfers stop condition [P].



The address auto increment in Read/Write.

In Basic time and calendar register.

Address: 08 - 09 - 0A - 0B - 0C - 0D - 0E - 0F - 00 - 01 - 02 -

In Extension register

Address : 18 - 19 - 1A - 1B - 1C - 1D - 1E - 1F - 10 - 11 - 12 -



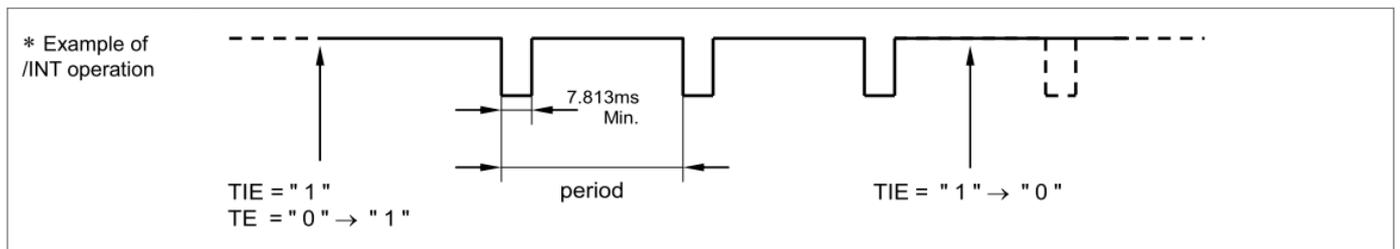
Function Description

Fixed Cycle Timer Interrupt Function

This interruption is released automatically, that is most suitable for a wakeup timer or an interval operation system.

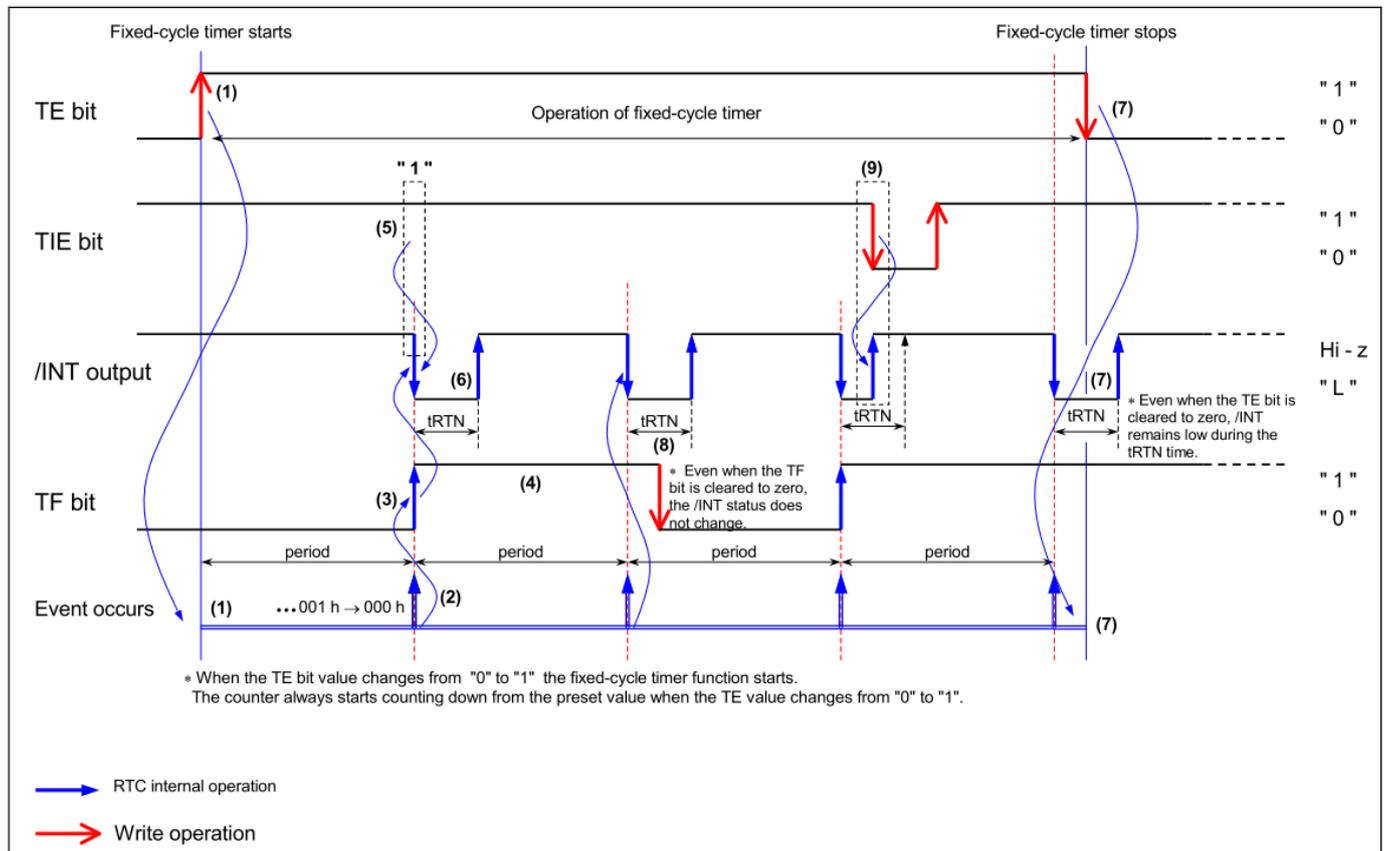
The fixed-cycle timer interrupt generation function generates an interrupt event periodically at any fixed cycle set between 244.14us and 4095 minutes.

When an interrupt event is generated, the /INT pin goes to low level and "1" is set to the TF bit to report that an event has occurred. However, when a fixed-cycle timer interrupt event has been generated low-level output from the /INT pin occurs only when the value of the control register's TIE bit is "1". Earliest 7.813 ms after the interrupt occurs, the /INT status is automatically cleared (/INT status changes from low-level to Hi-Z).





Fixed-cycle Timer Interrupt Timing Chart



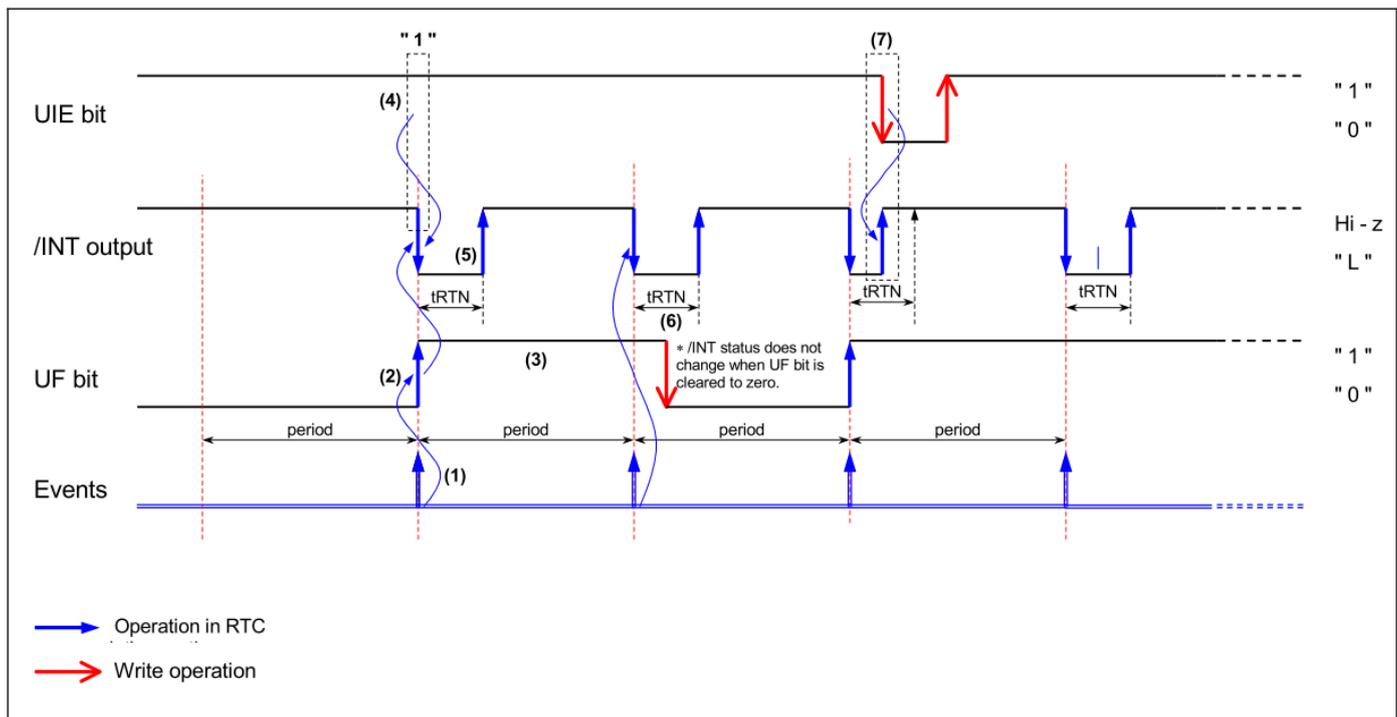
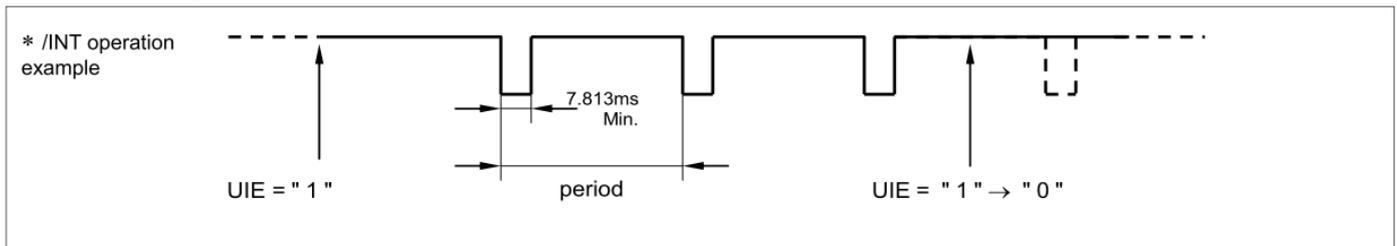
- (1) When a "1" is written to the TE bit, the fixed-cycle timer countdown starts from the preset value.
- (2) A fixed-cycle timer interrupt event starts a countdown based on the countdown period (source clock). After the interrupt event occurs, the counter automatically reloads the preset value and again starts to count down. (Repeated operation)
- (3) When a fixed-cycle timer interrupt event occurs, "1" is written to the TF bit.
- (4) When the TF bit = "1" its value is retained until it is cleared to zero.
- (5) If the TIE bit = "1" when a fixed-cycle timer interrupt occurs, /INT pin output goes low. If the TIE bit = "0" when a fixed-cycle timer interrupt occurs, /INT pin output remains Hi-Z.
- (6) Output from the /INT pin remains low during the t_{RTN} period following each event, after which it is automatically cleared to Hi-Z status. /INT is again set low when the next interrupt event occurs.
- (7) When a "0" is written to the TE bit, the fixed-cycle timer function is stopped, and the /INT pin is set to Hi-Z status. When /INT=low, the fixed-cycle timer function is stopped. The t_{RTN} period is the maximum amount of time before the /INT pin status changes from low to Hi-Z.
- (8) As long as /INT=low, the /INT pin status does not change when the TF bit value changes from "1" to "0".
- (9) When /INT=low, the /INT pin status changes from low to Hi-Z as soon as the TIE bit value changes from "1" to "0".



Time Update Interrupt Function

The time update interrupt function generates interrupt events at one-second or one-minute intervals, according to the timing of the internal clock.

When an interrupt event occurs, the UF bit value becomes "1" and the /INT pin goes to low level to indicate that an event has occurred. (However, when a fixed-cycle timer interrupt event has been generated, low-level output from the /INT pin occurs only when the value of the control register's UIE bit is "1". This /INT status is automatically cleared (/INT status changes from low level to Hi-Z) earliest 7.813ms (fixed value) after the interrupt occurs.

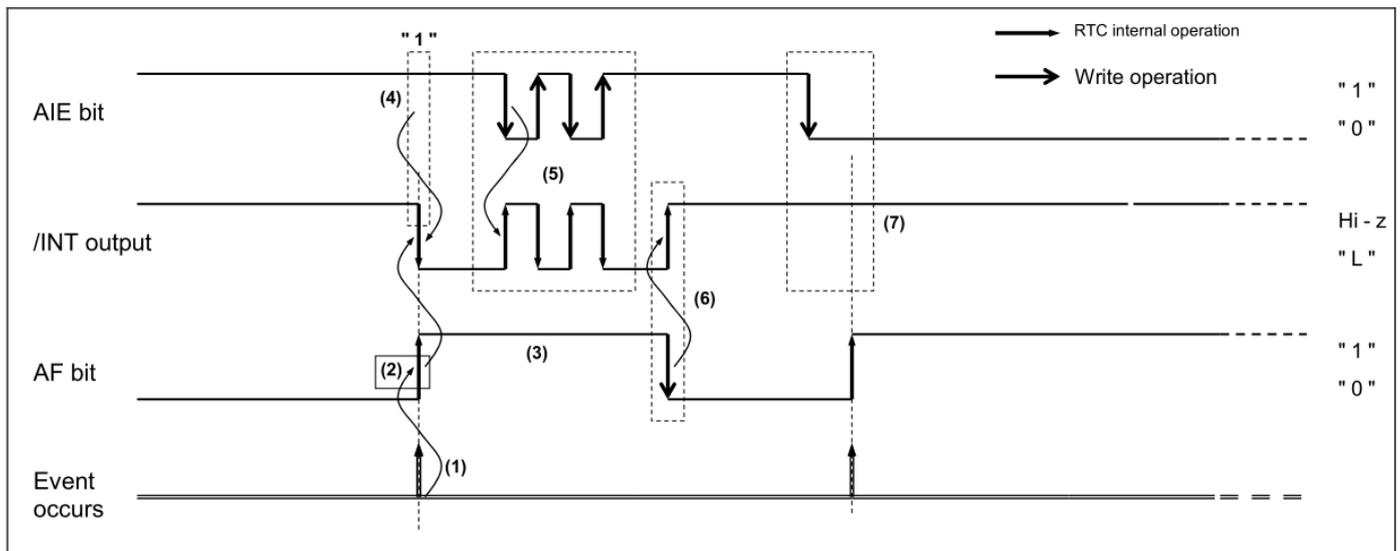
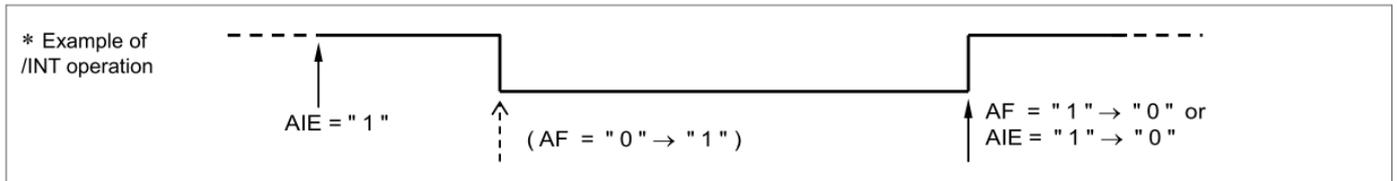


- (1) A time update interrupt event occurs when the internal clock's value matches either the second update time or the minute update time. The USEL bit's specification determines whether it is the second update time or the minute update time that must be matched.
- (2) When a time update interrupt event occurs, the UF bit value becomes "1".
- (3) When the UF bit value is "1" its value is retained until it is cleared to zero.
- (4) When a time update interrupt occurs, /INT pin output is low if UIE = "1".
If UIE = "0" when a timer update interrupt occurs, the /INT pin status remains Hi-Z.
- (5) Each time an event occurs, /INT pin output is low only up to the tRTN time (which is fixed as 7.813 ms for time update interrupts) after which it is automatically cleared to Hi-Z.
/INT pin output goes low again when the next interrupt event occurs.
- (6) As long as /INT=low, the /INT pin status does not change, even if the UF bit value changes from "1" to "0".
- (7) When /INT=low, the /INT pin status changes from low to Hi-Z as soon as the UIE bit value changes from "1" to "0".



Alarm Interrupt Function

The alarm interrupt generation function generates interrupt events for alarm settings such as date, day, hour, and minute settings. When an interrupt event occurs, the AF bit value is set to "1" and the /INT pin goes to low level to indicate that an event has occurred.



- (1) The minute, hour, day and date, when an alarm interrupt event is supposed to occur has to be set in advance, along with the WADA bit (Note) Even if the current date/time is used as the setting, the alarm will not occur until the counter counts up to the current date/time (i.e., an alarm will occur next time, not immediately).
- (2) When a time update interrupt event occurs, the AF bit values becomes "1".
- (3) When the AF bit = "1", its value is retained until it is cleared to zero.
- (4) If AIE = "1" when an alarm interrupt occurs, the /INT pin output goes low. When an alarm interrupt event occurs, /INT pin output goes low, and this status is then held until it is cleared via the AF bit or AIE bit.
- (5) If the AIE value is changed from "1" to "0" while /INT is low, the /INT status immediately changes from low to Hi-Z. After the alarm interrupt occurs and before the AF bit value is cleared to zero, the /INT status can be controlled via the AIE bit.
- (6) If the AF bit value is changed from "1" to "0" while /INT is low, the /INT status immediately changes from low to Hi-Z.
- (7) If the AIE bit value is "0" when an alarm interrupt occurs, the /INT pin status remains Hi-Z.



The interrupt functions via /INT or polling.

- How to identify events, when the interruption was occurred.

/INT output pin is common output terminal of interrupt events of three types (Fixed-cycle timer interrupt , Alarm interrupt, Time update interrupt).

When INT asserted to Low, the system can determine in which interruption was occurred, by confirming status of (TF, AF, UF).

- The method of detection of interruption with not using an INT output.
 1. be left open INT.
 2. be clears to 0 in TIE, AIE, and UIE bits.
 3. monitor the TF, AF, UF. (Polling).

Temperature compensation function

During the production process of the RTC, we are programming the individual characteristics of the built-in crystal into the non-volatile memory of the RTC. The build-in temperature sensor measures the actual temperature of the module and compensates the oscillation frequency of the crystal oscillator using the stored compensation data. This way not only the time information is temperature compensated, but as well the FOUT signal, even when outputting 32.768kHz. This function works in the supply voltage range VTEM.

Even if the power supply voltage falls below VTEM and a VDET bit is set to "1", the temperature compensation operation is performed again if the supply voltage raises above VTEM.

Address [h]	Function	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
0F,1F	Control Register	CSEL1	CSEL0	UIE	TIE	AIE	○	○	RESET

CSEL1, CSEL0 bit (Compensation Interval Select 1,0)

This bit sets an interval of a temperature compensation operation.

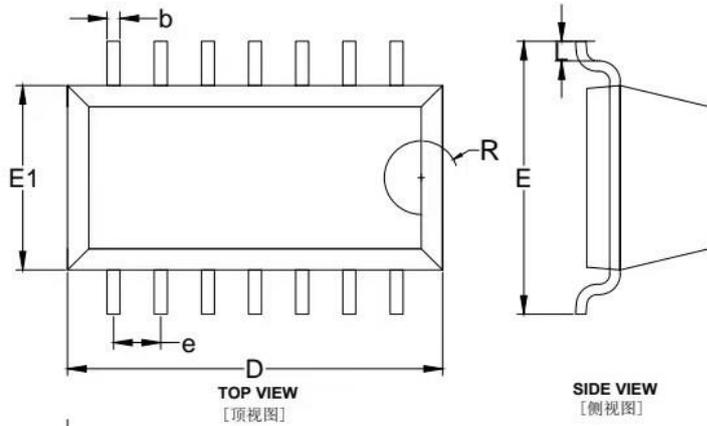
Current consumption decreases when increasing the Compensation Interval by means CSEL1,0. CSEL1,0 is set at the time of initial power-up to ("0","1") .

CSEL1	CSEL0	Compensation Interval
0	0	0.5s
0	1	2.0s
1	0	10s
1	1	30s

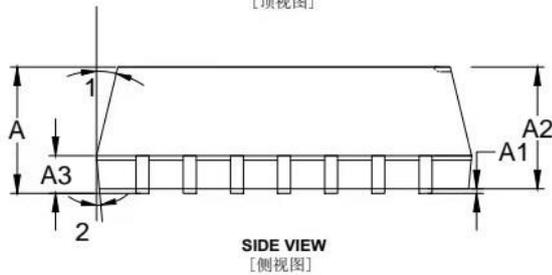


Package Information

SOP-14



Symbol	Dimensions (mm)		
	Min	TYP	Max
A	3.100	3.300	3.500
A1	0.050	0.125	0.200
A2	3.050	3.200	3.350
A3	0.800	0.900	1.000
b	0.200	0.350	0.500
D	9.800	10.100	10.400
E	7.100	7.400	7.700
E1	4.700	5.000	5.300
e	1.270BSC		
L	0.400	0.600	0.800
R	0.800	1.000	1.200
$\theta 1$	12°	13.5°	15°
$\theta 2$	3°	5°	7°



Note:

1. All dimensions are in mm. Angles in degrees.
2. Dimensions exclude burrs, mold flash or protrusions.
3. Refer Jeduc MS-012
4. Recommended land pattern is for reference only.





Revision History

Revision	Description	Date
V1.0	Initial release	2025/01/14
V1.1	Update Frequency stability	2025/01/20